

Supporting Information

RuPHOX-Ru Catalyzed Asymmetric Hydrogenation of α -Substituted Tetralones via a Dynamic Kinetic Resolution

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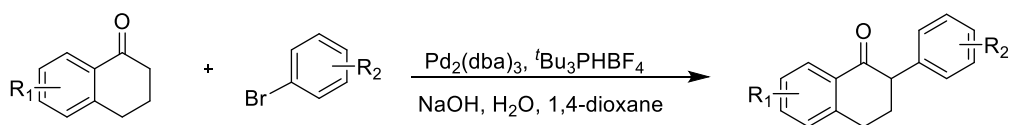
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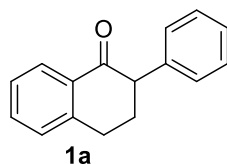
1. General Detail

Hydrogenation reactions were performed in an autoclave under an atmosphere of hydrogen. All air- and moisture-sensitive reactions were performed in dried glassware under an atmosphere of nitrogen. Solvents used in the glove box were dried and degassed by standard procedures. Melting points were measured with SGW X-4 micro melting point apparatus and the thermometer was uncorrected. All commercially available reagents were used without further purification. Column chromatography was performed using silica gel (100-200 mesh). ^1H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on a Bruker Ascend TM 400 (400 MHz, 100 MHz and 376 MHz, respectively). High resolution mass spectra (HRMS) were performed on a Fourier-transform mass spectrometry at the Instrumental Analysis Center of Shanghai Jiao Tong University. Enantioselectivity was measured by a high performance liquid chromatography (HPLC) using Daicel Chiral column IA, IB-3, IE, OJ-H, OD-H, AD-H or OX columns with *n*-hexane/*i*-PrOH as eluent. X-ray single crystal diffraction data were collected on a Bruker D8 VENTURE CMOS photon 100 diffractometer with helios mx multilayer monochromator Cu K α radiation ($\lambda = 1.54178 \text{ \AA}$) at the Instrumental Analysis Center of Shanghai Jiao Tong University.

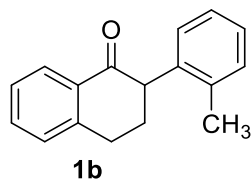
2. Preparation of Substrates



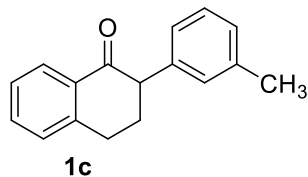
The substrates 1 were prepared by following literature procedures:^[1] Under a N_2 atmosphere, to a 100 mL of three-necked flask equipped with a magnetic stir bar were added $\text{Pd}_2(\text{dba})_3$ (1.5 mol%), $t\text{Bu}_3\text{PHBF}_4$ (6 mol%) and NaOH (2.0 equiv). Then α -tetralone (1.0 equiv), ArBr (1.2 equiv), 1,4-dioxane (6 mL) and H_2O (1.5 mL) were added respectively. The mixture was stirred for 1~2 h at 100 $^\circ\text{C}$ (oil bath) before the reaction was cooled to room temperature, diluted with EtOAc, washed with saturated aqueous NH_4Cl and dried over anhydrous Na_2SO_4 . The filtrate was concentrated in vacuo and the residue was purified by a silica gel column chromatography (PE/EtOAc = 20/1) to afford the tertiary aryl ketones **1**.



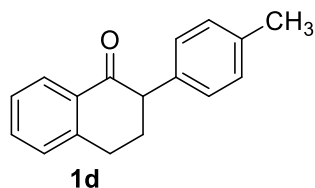
2-Phenyl-3,4-dihydronaphthalen-1(2H)-one (1a):^[2] White solid (14.0 g, 80%). ^1H NMR (400 MHz, CDCl_3) δ 8.10 (dd, $J = 7.6, 0.8 \text{ Hz}$, 1H), 7.51 (dt, $J = 13.6, 1.2 \text{ Hz}$, 1H), 7.36–7.33 (m, 3H), 7.29–7.25 (m, 2H), 7.20–7.18 (m, 2H), 3.83–3.79 (m, 1H), 3.17–3.01 (m, 2H), 2.47–2.41 (m, 2H).



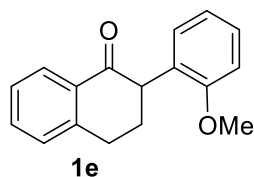
2-(2-Tolyl)-3,4-dihydronaphthalen-1(2H)-one (1b):^[2] White solid (3.3 g, 70%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, J = 8.0 Hz, 1H), 7.49 (t, J = 7.2 Hz, 1H), 7.33 (t, J = 8.0 Hz, 1H), 7.28–7.20 (m, 2H), 7.08 (d, J = 8.0 Hz, 1H), 7.00–6.97 (m, 2H), 3.77–3.73 (m, 1H), 3.15–3.00 (m, 2H), 2.49–2.37 (m, 2H), 2.33 (s, 3H).



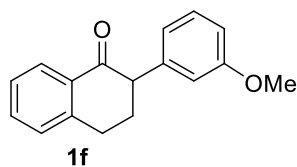
2-(3-Tolyl)-3,4-dihydronaphthalen-1(2H)-one (1c):^[3] White solid (3.6 g, 77%). ¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, J = 8.0 Hz, 1H), 7.51 (t, J = 8.0 Hz, 1H), 7.37–7.30 (m, 2H), 7.23–7.14 (t, J = 8.0 Hz, 3H), 7.07–7.05 (m, 1H), 4.01–3.97 (m, 1H), 3.21–3.04 (m, 2H), 2.50–2.34 (m, 2H), 2.32 (s, 3H).



2-(4-Tolyl)-3,4-dihydronaphthalen-1(2H)-one (1d):^[2] White solid (3.2 g, 68%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, J = 8.0 Hz, 1H), 7.49 (t, J = 7.2 Hz, 1H), 7.33 (t, J = 8.0 Hz, 1H), 7.26 (t, J = 8.0 Hz, 1H), 7.11 (dd, J = 28.8, 8.0 Hz, 4H), 3.78–3.74 (m, 1H), 3.00–3.15 (m, 2H), 2.39–2.45 (m, 2H), 2.34 (s, 3H).

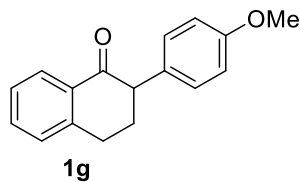


2-(2-Methoxyphenyl)-3,4-dihydronaphthalen-1(2H)-one (1e):^[2] White solid (3.6 g, 77%). ¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, J = 8.0 Hz, 1H), 7.48 (t, J = 8.0 Hz, 1H), 7.33 (t, J = 8.0 Hz, 1H), 7.29–7.23 (m, 2H), 7.11 (d, J = 7.2 Hz, 1H), 6.95–6.90 (m, 2H), 4.05 (dd, J = 12.0, 4.4 Hz, 1H), 3.75 (s, 3H), 3.17–3.09 (m, 1H), 3.04–2.98 (m, 1H), 2.55–2.44 (m, 1H), 2.30–2.24 (m, 1H).

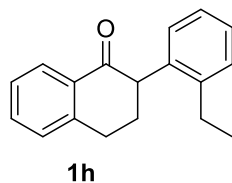


2-(3-Methoxyphenyl)-3,4-dihydronaphthalen-1(2H)-one (1f):^[2] White solid (3.5 g, 74%). ¹H

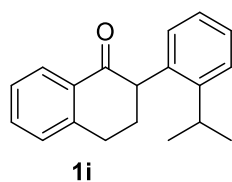
NMR (400 MHz, CDCl₃) δ 8.09 (d, J = 8.0 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.33 (t, J = 8.0 Hz, 1H), 7.28–7.24 (m, 2H), 6.83–6.74 (m, 3H), 3.78 (s, 3H), 3.15–3.01 (m, 2H), 2.46–2.40 (m, 2H).



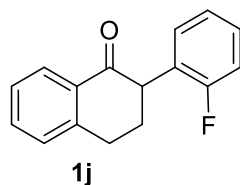
2-(4-Methoxyphenyl)-3,4-dihydronaphthalen-1(2H)-one (1g):^[2] White solid (4.0 g, 85%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, J = 8.0 Hz, 1H), 7.49 (t, J = 8.0 Hz, 1H), 7.33 (t, J = 8.0 Hz, 1H), 7.28–7.25 (m, 1H), 7.11 (dd, J = 8.0 Hz, 2H), 6.88 (d, J = 8.0 Hz, 2H), 3.80 (s, 3H), 3.77–3.73 (m, 1H), 3.15–3.01 (m, 2H), 2.43–2.38 (m, 2H).



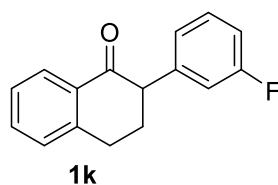
2-(2-Ethylphenyl)-3,4-dihydronaphthalen-1(2H)-one (1h): Yellow oil (3.0 g, 60%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (dd, J = 8.0, 1.6 Hz, 1H), 7.48 (td, J = 7.6, 1.6 Hz, 1H), 7.33–7.13 (m, 5H), 7.05–7.03 (m, 1H), 4.00 (dd, J = 12.4, 4.8 Hz, 1H), 3.18–3.10 (m, 1H), 3.04 (dt, J = 16.8, 4.0 Hz, 1H), 2.64 (qd, J = 7.6, 1.6 Hz, 2H), 2.46–2.29 (m, 2H), 1.22 (t, J = 7.6 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 198.5, 144.1, 142.4, 138.3, 133.5, 133.1, 128.9, 128.8, 128.1, 127.8, 127.1, 126.8, 126.2, 51.0, 31.4, 29.6, 26.3, 15.7. IR (KBr) (ν /cm⁻¹): 2963, 1684, 1599, 1454, 1371, 1221, 759. HRMS (ESI): m/z for C₁₈H₁₉O [M+H]⁺ calcd 251.1436, found 251.1436.



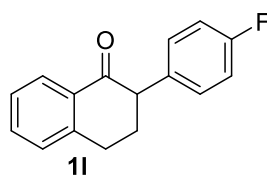
2-(2-Isopropylphenyl)-3,4-dihydronaphthalen-1(2H)-one (1i): Yellow oil (3.5 g, 67%). ¹H NMR (400 MHz, CDCl₃) δ 8.08 (dd, J = 7.6, 1.2 Hz, 1H), 7.42 (td, J = 7.2, 1.2 Hz, 1H), 7.32–7.18 (m, 4H), 7.10 (td, J = 7.2, 1.2 Hz, 1H), 7.02–7.00 (m, 1H), 4.01 (dd, J = 12.0, 4.8 Hz, 1H), 3.08 (ddd, J = 16.4, 11.5, 4.8 Hz, 1H), 3.03–2.92 (m, 2H), 2.43–2.23 (m, 2H), 1.30–1.14 (m, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 198.3, 147.0, 144.2, 137.8, 133.5, 133.2, 129.0, 128.6, 127.8, 127.4, 126.9, 126.0, 125.8, 51.6, 31.8, 29.74, 29.72, 24.4, 23.9. IR (KBr) (ν /cm⁻¹): 3061, 2962, 1685, 1598, 1454, 1220, 898, 758. HRMS (ESI): m/z for C₁₉H₂₁O [M+H]⁺ calcd 265.1592, found 265.1592.



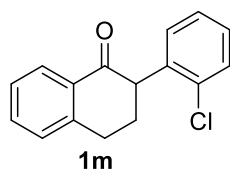
2-(2-Fluorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1j): White solid (3.3 g, 69%). Mp: 86–87 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, *J* = 8.0 Hz, 1H), 7.51 (t, *J* = 8.0 Hz, 1H), 7.36–7.24 (m, 3H), 7.18–7.06 (m, 3H), 4.02 (dd, *J* = 12.0, 4.0 Hz, 1H), 3.23–3.15 (m, 1H), 3.08–3.02 (m, 1H), 2.55–2.44 (m, 1H), 2.39–2.32 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 196.8, 161.0 (d, *J* = 244.3 Hz), 144.0, 133.6, 132.6, 129.9 (d, *J* = 4.7 Hz), 128.8, 128.7 (d, *J* = 8.3 Hz), 127.9, 127.4 (d, *J* = 14.9 Hz), 126.8, 124.2 (d, *J* = 3.4 Hz), 115.6 (d, *J* = 22.0 Hz), 49.4, 30.2 (d, *J* = 1.4 Hz), 29.5. ¹⁹F NMR (376 MHz, CDCl₃) δ –116.4 (d, *J* = 3.4 Hz). IR (KBr) (ν/cm⁻¹): 3740, 3570, 2938, 1694, 1496, 1457, 1226, 894, 758. HRMS (ESI): *m/z* for C₁₆H₁₄FO [M+H]⁺ calcd 241.1029, found 241.1022.



2-(3-Fluorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1k):^[4] White solid (3.4 g, 71%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, *J* = 8.0 Hz, 1H), 7.51 (t, *J* = 8.0 Hz, 1H), 7.37–7.26 (m, 3H), 6.99–6.90 (m, 3H), 3.84–3.77 (m, 1H), 3.18–3.02 (m, 2H), 2.45–2.40 (m, 2H).

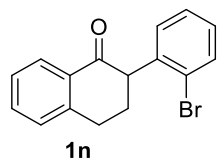


2-(4-Fluorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1l):^[2] White solid (3.2 g, 67%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, *J* = 4.0 Hz, 1H), 7.51 (t, *J* = 8.0 Hz, 1H), 7.34 (t, *J* = 8.0 Hz, 1H), 7.30–7.25 (m, 1H), 7.17–7.14 (m, 2H), 7.05–7.01 (m, 2H), 3.82–3.74 (m, 1H), 3.18–3.02 (m, 2H), 2.43–2.38 (m, 2H).

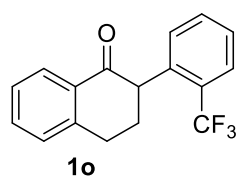


2-(2-Chlorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1m):^[5] White solid (2.4 g, 47%). ¹H NMR (400 MHz, CDCl₃) δ 8.11 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.51 (td, *J* = 7.6, 1.6 Hz, 1H), 7.45–7.38 (m, 1H), 7.38–7.26 (m, 2H), 7.26–7.12 (m, 3H), 4.28 (dd, *J* = 12.4, 4.6 Hz, 1H), 3.20 (ddd, *J* = 16.5, 11.8, 4.6 Hz, 1H), 3.05 (dt, *J* = 16.8, 4.0 Hz, 1H), 2.48 (qd, *J* = 12.5, 4.2 Hz, 1H), 2.39–2.32 (m,

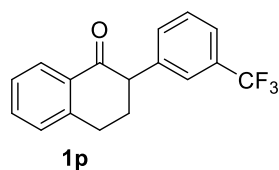
1H). ¹³C NMR (100 MHz, CDCl₃) δ 196.9, 143.9, 138.0, 134.4, 133.5, 132.8, 129.7, 129.6, 128.8, 128.3, 127.8, 127.0, 126.8, 52.1, 30.1, 29.4.



2-(2-Bromophenyl)-3,4-dihydronaphthalen-1(2H)-one (1n):^[6] Pale yellow oil (1.2 g, 34%). ¹H NMR (400 MHz, CDCl₃) δ 8.04 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.53 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.44 (td, *J* = 7.2, 1.2 Hz, 1H), 7.31–7.16 (m, 3H), 7.07 (ddd, *J* = 15.4, 7.8, 1.7 Hz, 2H), 4.24 (dd, *J* = 12.0, 4.8 Hz, 1H), 3.18–3.10 (m, 1H), 2.98 (dt, *J* = 16.8, 4.0 Hz, 1H), 2.47–2.25 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 197.0, 143.9, 139.7, 133.6, 133.0, 132.9, 129.6, 128.9, 128.6, 127.9, 127.7, 126.9, 125.3, 54.4, 30.5, 29.4.

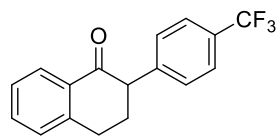


2-(2-(Trifluoromethyl)phenyl)-3,4-dihydronaphthalen-1(2H)-one (1o): Pale yellow oil (3.2 g, 55%). ¹H NMR (400 MHz, CDCl₃) δ 8.12 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.71 (d, *J* = 8.0 Hz, 1H), 7.55–7.48 (m, 2H), 7.42–7.25 (m, 4H), 4.26 (dd, *J* = 12.4, 4.8 Hz, 1H), 3.23 (ddd, *J* = 17.0, 10.8, 6.2 Hz, 1H), 3.06 (dt, *J* = 16.9, 3.6 Hz, 1H), 2.48–2.32 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 97.2, 144.0, 139.6 (d, *J* = 1.0 Hz), 133.6, 132.8, 132.0, 129.3, 128.9, 128.6 (d, *J* = 333.5 Hz), 127.7, 126.8, 126.0, 125.8 (q, *J* = 5.7 Hz), 123.3, 51.3 (d, *J* = 2.0 Hz), 32.3, 29.7. ¹⁹F NMR (376 MHz, CDCl₃) δ –58.6. IR (KBr) (ν/cm⁻¹): 3069, 2935, 1687, 1599, 1454, 1313, 1108, 766. IR (KBr) (ν/cm⁻¹): 3061, 2962, 1685, 1598, 1454, 1220, 898, 758, HRMS (ESI): *m/z* for C₁₇H₁₄OF₃ [M+H]⁺ calcd 291.0997, found 291.0994.



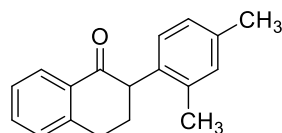
2-(3-(Trifluoromethyl)phenyl)-3,4-dihydronaphthalen-1(2H)-one (1p): White solid (2.4 g, 57%). Mp: 80–81 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.08 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.60–7.42 (m, 4H), 7.39–7.23 (m, 3H), 3.84 (dd, *J* = 10.6, 6.0 Hz, 1H), 3.21–3.13 (m, 1H), 3.06 (dt, *J* = 16.8, 4.3 Hz, 1H), 2.52–2.38 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 197.3, 142.3 (d, *J* = 320.1 Hz), 133.7, 132.6, 132.1, 130.8 (d, *J* = 32.0 Hz), 128.9 (d, *J* = 6.4 Hz), 126.9, 125.5, 125.4 (q, *J* = 3.9 Hz), 123.9 (q, *J* = 4.0 Hz), 122.8, 54.4, 31.1, 29.1. ¹⁹F NMR (376 MHz, CDCl₃) δ –62.5 IR (KBr) (ν/cm⁻¹): 3744, 3641, 3570, 2954, 1692, 1453, 1340, 11230, 1121. HRMS (ESI): *m/z* for C₁₇H₁₄F₃O [M+H]⁺ calcd

291.0997, found 291.1004.



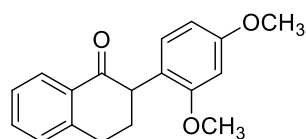
1q

2-(4-(Trifluoromethyl)phenyl)-3,4-dihydronaphthalen-1(2H)-one (1q): White solid (2.8 g, 62%). Mp: 151–152 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.10 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.61 (d, *J* = 8.0 Hz, 2H), 7.53 (td, *J* = 7.2, 1.2 Hz, 1H), 7.38–7.26 (m, 4H), 3.86 (dd, *J* = 10.4, 6.4 Hz, 1H), 3.22–3.14 (m, 1H), 3.07 (dt, *J* = 16.8, 4.4 Hz, 1H), 2.54–2.36 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 197.3, 143.88, 143.82, 133.7, 132.6, 129.4, 128.9, 128.8, 127.9, 127.0, 125.5 (q, *J* = 3.8 Hz), 122.9, 54.4, 31.1, 29.0. ¹⁹F NMR (376 MHz, CDCl₃) δ –62.2. IR (KBr) (ν/cm⁻¹): 3663, 3572, 2964, 1680, 1463, 1348, 1074. HRMS (ESI): *m/z* for C₁₇H₁₄F₃O [M+H]⁺ calcd 291.0997, found 291.1004.



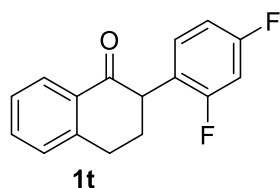
1r

2-(2,4-Dimethylphenyl)-3,4-dihydronaphthalen-1(2H)-one (1r): White solid (2.1 g, 46%). Mp: 106–107 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, *J* = 8.0 Hz, 1H), 7.50 (t, *J* = 8.0 Hz, 1H), 7.34 (t, *J* = 8.0 Hz, 1H), 7.28 (d, *J* = 8.0 Hz, 1H), 6.28 (s, 1H), 6.81 (s, 2H), 3.72 (dd, *J* = 8.0, 4.0 Hz, 1H), 3.15–3.01 (m, 2H), 2.49–2.37 (m, 2H), 2.31 (s, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 198.5, 144.2, 139.8, 138.0, 133.4, 133.0, 128.9, 128.7, 127.9, 126.8, 126.3, 54.5, 31.3, 29.0, 21.4. IR (KBr) (ν/cm⁻¹): 3943, 3730, 3643, 2916, 1710, 1506, 1469, 1218, 750. HRMS (ESI): *m/z* for C₁₈H₁₉O [M+H]⁺ calcd 251.1436, found 251.1440.

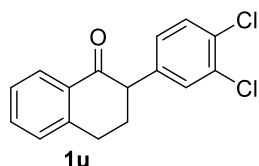


1s

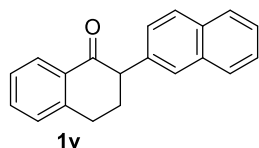
2-(2,4-Dimethoxyphenyl)-3,4-dihydronaphthalen-1(2H)-one (1s):^[7] White solid (2.2 g, 39 %). ¹H NMR (400 MHz, CDCl₃) δ 8.08 (d, *J* = 8.0 Hz, 1H), 7.47 (t, *J* = 8.0 Hz, 1H), 7.31 (t, *J* = 8.0 Hz, 1H), 7.25 (d, *J* = 8.0 Hz, 1H), 6.36 (dd, *J* = 10.8, 2.0 Hz, 3H), 3.74–3.68 (m, 7H), 3.11–2.99 (m, 2H), 2.42–2.37 (m, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 197.8, 160.9, 158.1, 144.1, 142.0, 133.4, 132.9, 128.7, 127.8, 126.8, 106.8, 98.9, 55.2, 54.6, 31.1, 28.8.



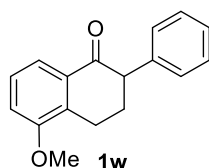
2-(2,4-Difluorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1t): White solid (2.3 g, 45%). Mp: 123–124 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.06 (d, *J* = 8.0 Hz, 1H), 7.50 (t, *J* = 8.0 Hz, 1H), 7.34–7.26 (m, 2H), 6.73–6.67 (m, 3H), 3.74–3.68 (m, 1H), 3.17–3.01 (m, 2H), 2.42–2.31 (m, 2H). ¹³C NMR (100 MHz, CDCl₃): δ 196.8, 163.0 (dd, *J* = 251.0, 12.8 Hz), 143.8, 143.5 (t, *J* = 10.0 Hz), 133.8, 132.5, 128.9, 127.9, 127.0, 111.6 (dd, *J* = 18.0, 6.0 Hz), 102.5 (t, *J* = 25.0 Hz), 54.1, 30.8, 28.9. ¹⁹F NMR (376 MHz, CDCl₃) δ –110.0. IR (KBr) (v/cm⁻¹): 3819, 3698, 3570, 2968, 1680, 1595, 1457, 1125, 981, 867. HRMS (ESI): *m/z* for C₁₆H₁₃F₂O [M+H]⁺ calcd 259.0934, found 259.0931.



2-(3,4-Dichlorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1u): White solid (2.6 g, 56%). Mp: 97–98 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.07 (d, *J* = 7.8 Hz, 1H), 7.55–7.48 (m, 1H), 7.41 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.35 (t, *J* = 7.6 Hz, 1H), 7.31–7.25 (m, 2H), 7.04 (dt, *J* = 8.3, 1.6 Hz, 1H), 3.75 (t, *J* = 8.4 Hz, 1H), 3.16 (dt, *J* = 16.0, 7.8 Hz, 1H), 3.06 (dt, *J* = 16.9, 4.4 Hz, 1H), 2.43–2.37 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 194.5, 141.3, 137.4, 131.2, 130.0, 129.9, 128.5, 128.0, 127.9, 126.3, 125.5, 125.4, 124.4, 51.2, 28.5, 26.4. IR (KBr) (v/cm⁻¹): 3939, 37332, 3574, 2936, 1678, 1605, 1475, 1224, 1032, 738. HRMS (ESI): *m/z* for C₁₆H₁₃Cl₂O [M+H]⁺ calcd 291.0343, found 291.0344.

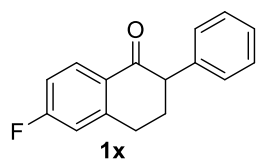


3,4-Dihydro-[2,2'-binaphthalen]-1(2H)-one (1v):^[8] White solid (1.1 g, 51%). ¹H NMR (400 MHz, CDCl₃) δ 8.13 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.85–7.73 (m, 3H), 7.63 (d, *J* = 1.6 Hz, 1H), 7.51 (td, *J* = 7.6, 1.6 Hz, 1H), 7.48–7.41 (m, 2H), 7.40–7.22 (m, 3H), 3.96 (dd, *J* = 11.2, 4.8 Hz, 1H), 3.22–3.02 (m, 2H), 2.63–2.42 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 198.4, 144.2, 137.4, 133.6, 133.0, 132.7, 129.0, 128.3, 128.0, 127.9, 127.8, 127.2, 126.8, 126.1, 125.8, 54.7, 31.4, 29.0.

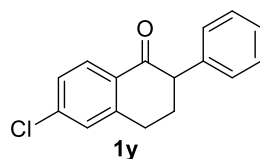


5-Methoxy-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1w):^[9] White solid. (3.6 g, 72%). ¹H NMR (400 MHz, CDCl₃) δ 7.69 (d, *J* = 8.0 Hz, 1H), 7.35–7.24 (m, 4H), 7.18 (d, *J* = 8.0 Hz, 2H),

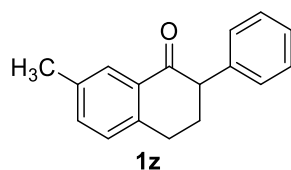
7.03 (d, $J = 8.0$ Hz, 1H), 3.87 (s, 3H), 3.78 (dd, $J = 13.0, 8.0$ Hz, 1H), 3.12 (dt, $J = 16.0, 8.0$ Hz, 1H), 2.90–2.82 (m, 1H), 2.43–2.37 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 198.4, 156.8, 139.7, 133.9, 133.1, 128.5, 128.4, 127.0, 126.9, 119.3, 114.3, 53.9, 30.3, 22.3.



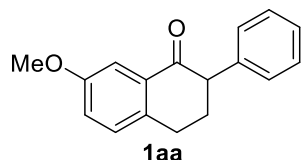
6-Fluoro-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1x): White solid (1.6 g, 75%). Mp: 101–102 °C. ^1H NMR (400 MHz, CDCl_3) δ 8.13 (dd, $J = 8.8, 6.0$ Hz, 1H), 7.34 (t, $J = 7.2$ Hz, 2H), 7.27 (t, $J = 7.2$ Hz, 1H), 7.18 (d, $J = 7.2$ Hz, 2H), 7.02 (td, $J = 8.4, 6.0$ Hz, 1H), 6.96 (dd, $J = 9.2, 2.0$ Hz, 1H), 3.81–3.77 (m, 1H), 3.14–2.99 (m, 2H), 2.49–2.41 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 196.8, 165.8 (d, $J = 254.0$ Hz), 147.2 (d, $J = 10.0$ Hz), 139.5, 131.0 (d, $J = 10.0$ Hz), 129.6 (d, $J = 2.0$ Hz), 128.6, 128.4, 127.1, 115.1 (d, $J = 100.0$ Hz), 114.5 (d, $J = 21.0$ Hz), 54.1, 31.0, 28.9 (d, $J = 1.0$ Hz). ^{19}F NMR (376 MHz, CDCl_3) δ –104.7 (d, $J = 5.4$ Hz). IR (KBr) (v/cm^{-1}): 3653, 3673, 3566, 2948, 1684, 1609, 1483, 1236, 1096, 872, 691. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{14}\text{FO}$ $[\text{M}+\text{H}]^+$ calcd 241.1029, found 241.1033.



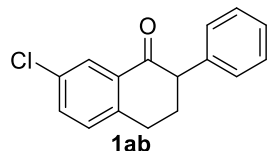
6-Chloro-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1y): White solid (1.0 g, 71%). Mp: 83–84 °C. ^1H NMR (400 MHz, CDCl_3) δ 8.03 (d, $J = 8.0$ Hz, 1H), 7.36–7.25 (m, 5H), 7.17 (d, $J = 8.0$ Hz, 2H), 3.82–3.75 (m, 1H), 3.12–2.97 (m, 2H), 2.45–2.40 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 197.2, 145.7, 139.6, 139.4, 131.3, 129.5, 128.7, 128.6, 128.4, 127.3, 127.1, 54.2, 30.9, 28.6. IR (KBr) (v/cm^{-1}): 3870, 3744, 3570, 3025, 2952, 1678, 1585, 1455, 1218, 1082, 872, 752. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{14}\text{ClO}$ $[\text{M}+\text{H}]^+$ calcd 257.0733, found 257.0739.



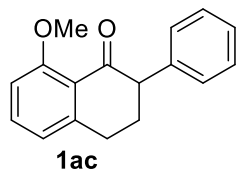
7-Methyl-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1z): White solid (1.6 g, 71%). Mp: 66–67 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.91 (d, $J = 4.0$ Hz, 1H), 7.36–7.29 (m, 3H), 7.28–7.23 (m, 1H), 7.21–7.15 (m, 3H), 3.82–3.73 (m, 1H), 3.11–2.95 (m, 2H), 2.44–2.39 (m, 2H), 2.38 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 198.5, 141.2, 140.0, 136.5, 134.5, 132.7, 128.8, 128.6, 128.5, 127.9, 126.9, 54.4, 31.4, 28.3, 21.0. IR (KBr) (v/cm^{-1}): 3746, 3645, 3556, 3033, 2938, 1680, 1498, 1240, 906, 819, 701. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{13}\text{Cl}_2\text{O}$ $[\text{M}+\text{H}]^+$ calcd 237.1279, found 237.1280.



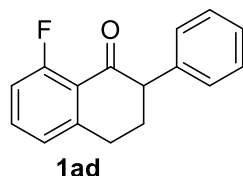
7-Methoxy-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1aa):^[9] White solid (4.1 g, 81%). ¹H NMR (400 MHz, CDCl₃) δ 7.57 (d, J = 4.0 Hz, 1H), 7.33 (t, J = 8.0 Hz, 2H), 7.27–7.24 (m, 1H), 7.19–7.16 (m, 3H), 7.08 (dd, J = 8.0, 4.0 Hz, 1H), 3.83 (s, 3H), 3.77 (t, J = 4.0 Hz, 1H), 3.07–2.93 (m, 2H), 2.42–2.37 (m, 2H).



7-Chloro-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1ab): White solid. (1.3 g, 63%). Mp: 85–86 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.05 (d, J = 2.4 Hz, 1H), 7.45 (dd, J = 8.2, 2.4 Hz, 1H), 7.37–7.33 (m, 2H), 7.31–7.28 (m, 1H), 7.26–7.22 (m, 1H), 7.18–7.16 (m, 2H), 3.85–3.73 (m, 1H), 3.15–2.97 (m, 2H), 2.45–2.40 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 197.1, 142.3, 139.2, 134.1, 133.3, 133.0, 130.4, 128.6, 128.4, 127.5, 127.1, 54.1, 31.0, 28.2. IR (KBr) (ν /cm⁻¹): 3375, 2922, 2851, 1701, 1664, 1529, 1438, 1355, 778, 704. HRMS (ESI): m/z for C₁₆H₁₄ClO [M+H]⁺ calcd 257.0733, found 257.0735.

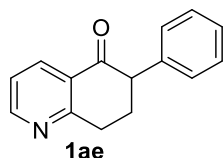


8-Methoxy-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1ac):^[2] White solid (0.72 g, 51%). ¹H NMR (400 MHz, CDCl₃) δ 7.40 (t, J = 8.0 Hz, 1H), 7.33–7.29 (m, 2H), 7.27–7.22 (m, 1H), 7.22–7.17 (m, 2H), 6.85 (dd, J = 8.4, 5.2 Hz, 2H), 3.88 (s, 3H), 3.79 (dd, J = 9.2, 6.4 Hz, 1H), 3.10–2.97 (m, 2H), 2.42–2.31 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 197.4, 160.6, 146.5, 140.2, 134.0, 128.5, 128.4, 126.7, 122.6, 120.7, 110.0, 55.9, 55.1, 30.6, 29.5.

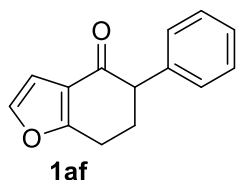


8-Fluoro-2-phenyl-3,4-dihydronaphthalen-1(2H)-one (1ad): Pale yellow solid (0.94 g, 64%). Mp: 55–57 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.44–7.39 (m, 1H), 7.34–7.30 (m, 2H), 7.29–7.22 (m, 1H), 7.21–7.16 (m, 2H), 7.05 (d, J = 7.6 Hz, 1H), 6.97 (dd, J = 11.2, 8.4 Hz, 1H), 3.86–3.72 (m, 1H), 3.11–3.01 (m, 2H), 2.43–2.37 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 196.1, 162.4 (d, J = 265.0 Hz), 146.3, 139.2, 134.4 (d, J = 10.2 Hz), 128.5, 128.4, 127.0, 124.4 (d, J = 4.1 Hz), 121.8 (d,

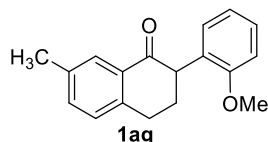
$J = 5.0$ Hz), 115.1 (d, $J = 21.0$ Hz), 55.2, 30.5, 28.9 (d, $J = 3.0$ Hz). ^{19}F NMR (376 MHz, CDCl_3) δ -111.3. IR (KBr) (v/cm^{-1}): 3749, 1699, 1608, 1465, 1213, 700. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{14}\text{OF}$ $[\text{M}+\text{H}]^+$ calcd 241.1029, found 241.1029.



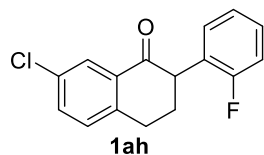
6-Phenyl-7,8-dihydroquinolin-5(6H)-one (1ae):^[2] Pale yellow solid (0.9 g, 48%). ^1H NMR (400 MHz, CDCl_3) δ 8.69 (dd, $J = 4.8, 1.6$ Hz, 1H), 8.32 (dd, $J = 8.0, 2.0$ Hz, 1H), 7.40–7.23 (m, 4H), 7.19–7.17 (m, 1H), 3.82 (dd, $J = 9.2, 7.2$ Hz, 1H), 3.29–3.26 (m, 2H), 2.52–2.41 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 197.7, 163.2, 153.6, 138.9, 135.7, 128.6, 128.4, 128.3, 127.2, 122.4, 53.9, 31.9, 29.7.



5-Phenyl-6,7-dihydrobenzofuran-4(5H)-one (1af):^[2] Yellow solid (0.82 g, 21%). ^1H NMR (400 MHz, CDCl_3) δ 7.38–7.29 (m, 3H), 7.29–7.23 (m, 1H), 7.20–7.12 (m, 2H), 6.73 (d, $J = 2.0$ Hz, 1H), 3.71 (dd, $J = 8.4, 6.0$ Hz, 1H), 3.01–2.87 (m, 2H), 2.48–2.36 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 194.1, 166.5, 143.0, 139.2, 128.6, 128.2, 127.0, 121.5, 107.0, 53.1, 31.0, 22.7.

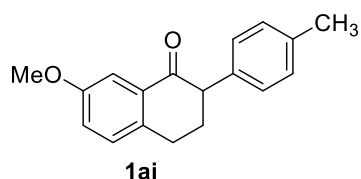


2-(2-Methoxyphenyl)-7-methyl-3,4-dihydronaphthalen-1(2H)-one (1ag): White solid (1.6 g, 63%). Mp: 112–113 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.90 (d, $J = 2.4$ Hz, 1H), 7.30–7.19 (m, 2H), 7.15–7.13 (m, 1H), 7.07 (dd, $J = 7.6, 2.0$ Hz, 1H), 6.93–6.85 (m, 2H), 4.01 (dd, $J = 12.0, 3.6$ Hz, 1H), 3.71 (s, 3H), 3.08–3.00 (m, 1H), 2.93 (dt, $J = 16.4, 4.0$ Hz, 1H), 2.50–2.40 (m, 1H), 2.35 (s, 3H), 2.25–2.20 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 198.3, 157.2, 141.3, 136.3, 134.1, 133.0, 129.8, 129.6, 128.7, 128.2, 127.8, 120.8, 111.2, 55.5, 50.1, 30.2, 29.1, 21.1. IR (KBr) (v/cm^{-1}): 3900, 3746, 3578, 2944, 1688, 1500, 1451, 1275, 1167, 1034, 898, 708. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{14}\text{ClO}$ $[\text{M}+\text{H}]^+$ calcd 267.1385, found 267.1390.

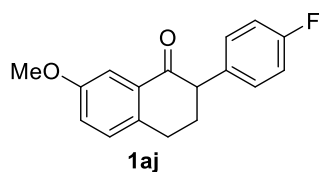


7-Chloro-2-(2-fluorophenyl)-3,4-dihydronaphthalen-1(2H)-one (1ah): White solid (1.3 g, 58%).

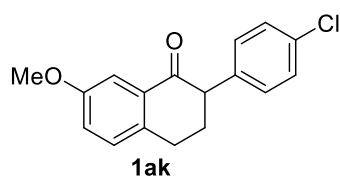
Mp: 122–123 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.05 (d, *J* = 2.3 Hz, 1H), 7.45 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.32–7.26 (m, 1H), 7.23 (s, 1H), 7.18–7.04 (m, 3H), 3.98 (dd, *J* = 12.4, 4.4 Hz, 1H), 3.17–3.09 (m, 1H), 3.02 (dt, *J* = 16.8, 4.0 Hz, 1H), 2.52–2.41 (m, 1H), 2.38–2.31 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 195.6, 160.9 (d, *J* = 244.5 Hz), 142.2, 133.8, 133.4, 133.3, 130.4, 129.9 (d, *J* = 4.6 Hz), 128.9 (d, *J* = 8.3 Hz), 127.5, 126.9 (d, *J* = 15.0 Hz), 124.3 (d, *J* = 8.0 Hz), 115.6 (d, *J* = 22.0 Hz), 49.2, 30.0 (d, *J* = 1.5 Hz), 28.9. ¹⁹F NMR (376 MHz, CDCl₃) δ –116.3. IR (KBr) (v/cm⁻¹): 3807, 3647, 3566, 2940, 1682, 1236, 902, 762. HRMS (ESI): *m/z* for C₁₆H₁₃ClFO [M+H]⁺ calcd 275.0639, found 275.0641.



7-Methoxy-2-(4-tolyl)-3,4-dihydronaphthalen-1(2H)-one (1ai):^[10] White solid (2.2 g, 91%). ¹H NMR (400 MHz, CDCl₃) δ 7.90 (d, *J* = 2.4 Hz, 1H), 7.29–7.18 (m, 2H), 7.16–7.04 (m, 2H), 6.93–6.85 (m, 2H), 4.01 (dd, *J* = 12.1, 4.6 Hz, 1H), 3.71 (s, 3H), 3.03 (ddd, *J* = 16.3, 11.7, 4.4 Hz, 1H), 2.93 (dt, *J* = 16.4, 4.2 Hz, 1H), 2.50–2.38 (m, 1H), 2.35 (s, 3H), 2.25–2.12 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 198.3, 158.5, 136.9, 136.8, 136.5, 133.8, 130.1, 129.3, 128.3, 121.7, 109.8, 55.5, 53.9, 31.7, 28.0, 21.1.

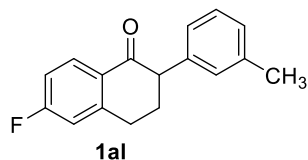


2-(4-Fluorophenyl)-7-methoxy-3,4-dihydronaphthalen-1(2H)-one (1aj): White solid (1.2 g, 54%). Mp: 88–89 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.54 (d, *J* = 3.2 Hz, 1H), 7.20–7.10 (m, 3H), 7.10–6.96 (m, 3H), 3.80 (s, 3H), 3.75–3.66 (m, 1H), 3.07–2.88 (m, 2H), 2.37–2.31 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 207.6, 161.8 (d, *J* = 243.4 Hz), 158.5, 136.6, 135.6 (d, *J* = 3.3 Hz), 133.5, 130.1 (d, *J* = 4.8 Hz), 123.0, 121.8, 115.3 (d, *J* = 21.1 Hz), 109.8, 55.5, 53.6, 31.6, 28.1. ¹⁹F NMR (376 MHz, CDCl₃) δ –116.0. IR (KBr) (v/cm⁻¹): 3765, 3653, 2950, 1694, 1613, 1504, 1433, 1177, 1032, 857, 746, 572. HRMS (ESI): *m/z* for C₁₇H₁₆FO₂ [M+H]⁺ calcd 271.1134, found 271.1136.

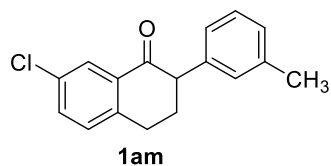


2-(4-Chlorophenyl)-7-methoxy-3,4-dihydronaphthalen-1(2H)-one (1ak): White solid (1.4 g, 63%). Mp: 95–96 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.54 (d, *J* = 2.8 Hz, 1H), 7.33–7.26 (m, 2H),

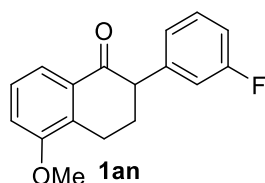
7.19–7.17 (m, 1H), 7.13–7.06 (m, 3H), 3.82 (s, 3H), 3.76–3.69 (m, 1H), 3.08–2.92 (m, 2H), 2.40–2.32 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 197.7, 158.5, 138.4, 136.6, 133.4, 132.8, 130.1, 129.9, 128.7, 121.9, 109.7, 55.5, 53.7, 31.4, 28.0. IR (KBr) (v/cm⁻¹): 3749, 3653, 2938, 1674, 1611, 1503, 1242, 1030, 874, 838, 734. HRMS (ESI): *m/z* for C₁₇H₁₆ClO₂ [M+H]⁺ calcd 287.0839, found 287.0844.



6-Fluoro-2-(3-tolyl)-3,4-dihydronaphthalen-1(2H)-one (1al): White solid (1.3 g, 62%). Mp: 111–112 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.12 (dd, *J* = 8.8, 6.0 Hz, 1H), 7.25–7.19 (m, 1H), 7.09–7.07 (m, 1H), 7.03–6.91 (m, 4H), 3.74 (dd, *J* = 10.0, 6.0 Hz, 1H), 3.12–2.98 (m, 2H), 2.47–2.36 (m, 2H), 2.33 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 196.9, 165.8 (d, *J* = 254.1 Hz), 147.2 (d, *J* = 31.7 Hz), 139.4, 138.2, 131.0 (d, *J* = 9.6 Hz), 129.6 (d, *J* = 2.8 Hz), 129.2, 128.5, 127.9, 125.4, 115.1 (d, *J* = 21.0 Hz), 114.5 (d, *J* = 22.0 Hz), 54.1, 31.1, 28.9 (d, *J* = 1.7 Hz), 21.5. ¹⁹F NMR (376 MHz, CDCl₃) δ –104.8. IR (KBr) (v/cm⁻¹): 3738, 3651, 3580, 2948, 1704, 1587, 1496, 1271, 1107, 801, 707. HRMS (ESI): *m/z* for C₁₇H₁₆FO [M+H]⁺ calcd 255.1185, found 255.1188.

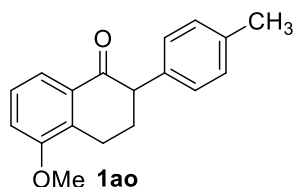


7-Chloro-2-(3-tolyl)-3,4-dihydronaphthalen-1(2H)-one (1am): White solid (1.2 g, 53%). Mp: 128–129 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.04 (d, *J* = 2.4 Hz, 1H), 7.44 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.25–7.19 (m, 2H), 7.11–7.06 (m, 1H), 6.99–6.93 (m, 2H), 3.79–3.69 (m, 1H), 3.10–2.96 (m, 2H), 2.43–2.36 (m, 2H), 2.33 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 197.2, 142.3, 139.2, 138.2, 134.1, 133.3, 133.0, 130.4, 129.2, 128.5, 127.9, 127.5, 125.4, 54.1, 31.0, 28.3, 21.5. IR (KBr) (v/cm⁻¹): 3744, 3566, 2932, 1692, 1437, 1206, 904, 705. HRMS (ESI): *m/z* for C₁₇H₁₆ClO [M+H]⁺ calcd 271.0890, found 271.0895.

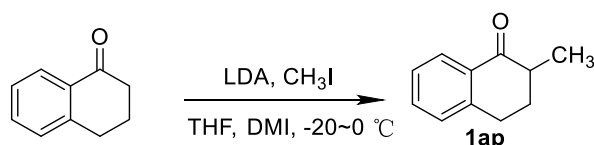


2-(3-Fluorophenyl)-5-methoxy-3,4-dihydronaphthalen-1(2H)-one (1an): White solid (1.2 g, 53%). Mp: 91–92 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.68 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.30–7.24 (m, 2H), 7.02 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.00–6.86 (m, 3H), 3.84 (s, 3H), 3.73 (dd, *J* = 11.2, 5.2 Hz, 1H),

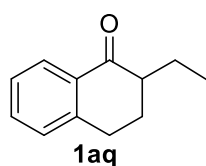
3.13 (dt, $J = 18.0, 4.4$ Hz, 1H), 2.83 (ddd, $J = 17.6, 10.0, 4.8$ Hz, 1H), 2.42–2.25 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 197.6, 162.8 (d, $J = 243.8$ Hz), 156.8, 142.1 (d, $J = 7.3$ Hz), 133.6, 132.9, 129.8 (d, $J = 8.3$ Hz), 127.0, 124.2 (d, $J = 2.9$ Hz), 119.2, 115.4 (d, $J = 21.4$ Hz), 114.4, 113.7 (d, $J = 20.8$ Hz), 55.6, 53.5 (d, $J = 1.8$ Hz), 30.0, 22.3. ^{19}F NMR (376 MHz, CDCl_3) δ -113.2. IR (KBr) (v/cm^{-1}): 3744, 3566, 2934, 1692, 1507, 1459, 1038, 759, 742. HRMS (ESI): m/z for $\text{C}_{17}\text{H}_{16}\text{FO}_2$ $[\text{M}+\text{H}]^+$ calcd 271.1134, found 271.1138.



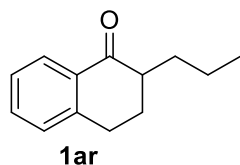
5-Methoxy-2-(4-tolyl)-3,4-dihydronaphthalen-1(2H)-one (1ao): White solid (2.3 g, 93%). Mp: 122–123 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.70 (d, $J = 8.0$ Hz, 1H), 7.31–7.24 (m, 1H), 7.14 (d, $J = 8.0$ Hz, 2H), 7.08–7.02 (m, 3H), 3.87 (s, 3H), 3.74 (dd, $J = 8.0, 4.0$ Hz, 1H), 3.12 (dt, $J = 20.0, 4.0$ Hz, 1H), 2.89–2.81 (m, 1H), 2.41–2.35 (m, 2H), 3.33 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 198.4, 156.9, 136.7, 136.4, 134.1, 133.2, 129.3, 128.2, 127.1, 119.4, 114.2, 55.7, 53.5, 30.3, 22.4, 21.2. IR (KBr) (v/cm^{-1}): 3874, 3728, 3657, 2938, 1696, 1597, 1496, 1250, 1042, 760, 732. HRMS (ESI): m/z for $\text{C}_{18}\text{H}_{19}\text{O}_2$ $[\text{M}+\text{H}]^+$ calcd 267.1385, found 267.1385.



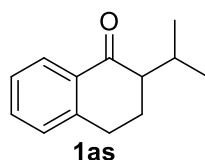
2-Methyl-3,4-dihydronaphthalen-1(2H)-one (1ap):^[11] A THF solution of LDA (10.4 mL, 20.8 mmol, 2 mol/L) was added slowly to THF (50 mL) at -20 °C under N_2 atmosphere and then 1-tetralone (2.8 g, 18.9 mmol) was added, and stirred for 1 h at 0 °C. Subsequently, CH_3I (2.5 g, 18.9 mmol) and 1,3-dimethyl-2-imidazolidinone (DMI, 2.1 g, 18.9 mmol) were added to the reaction mixture. After stirring for a further 12 h at 0 °C, water (20 mL) was added followed by extraction with EtOAc (3 \times 20 mL). The combined organic layer was washed with brine (50 mL), dried over anhydrous Na_2SO_4 , and concentrated under reduced pressure to afford the crude product. Purification by a silica gel column chromatography (PE/EtOAc = 20/1) gave the product (**1ap**) as colorless oil (0.4 g, 31% yield). ^1H NMR (400 MHz, CDCl_3) δ 8.02 (dd, $J = 8.0, 1.6$ Hz, 1H), 7.43 (td, $J = 7.6, 1.6$ Hz, 1H), 7.32–7.19 (m, 2H), 3.08–2.90 (m, 2H), 2.63–2.52 (m, 1H), 2.21–2.15 (m, 1H), 1.93–1.81 (m, 1H), 1.25 (d, $J = 6.8$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 201.0, 144.3, 133.2, 132.5, 128.8, 127.5, 126.7, 42.8, 31.5, 29.0, 15.6.



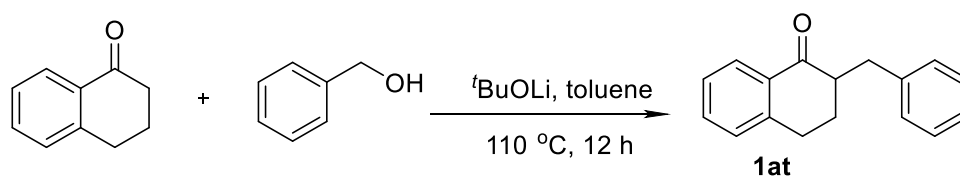
2-Ethyl-3,4-dihydronaphthalen-1(2H)-one (1aq):^[12] Colorless oily liquid (0.35 g, 32%). ¹H NMR (400 MHz, CDCl₃) δ 8.03 (dd, J = 8.0, 1.6 Hz, 1H), 7.45 (td, J = 7.2, 1.2 Hz, 1H), 7.29 (t, J = 7.6 Hz, 1H), 7.23 (d, J = 7.6 Hz, 1H), 3.04–2.94 (m, 2H), 2.47–2.36 (m, 1H), 2.27–2.20 (m, 1H), 2.03–1.84 (m, 2H), 1.60–1.53 (m, 1H), 1.00 (t, J = 7.6 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 200.4, 144.1, 133.2, 132.7, 128.8, 127.5, 126.6, 49.0, 28.5, 27.9, 22.5, 11.6.



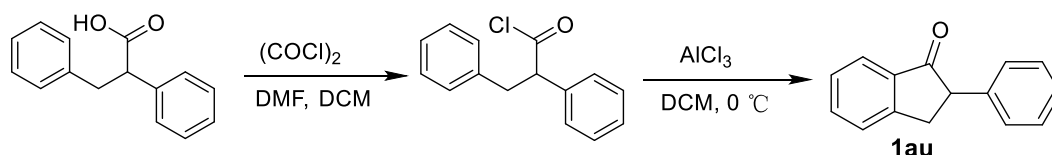
2-Propyl-3,4-dihydronaphthalen-1(2H)-one (1ar):^[13] Colorless oily liquid (0.3 g, 26%). ¹H NMR (400 MHz, CDCl₃) δ 8.02 (dd, J = 8.0, 1.6 Hz, 1H), 7.44 (td, J = 7.6, 1.6 Hz, 1H), 7.28 (td, J = 7.6, 1.2 Hz, 1H), 7.22 (d, J = 7.6 Hz, 1H), 3.04–2.91 (m, 2H), 2.51–2.41 (m, 1H), 2.26–2.19 (m, 1H), 2.00–1.83 (m, 2H), 1.55–1.33 (m, 3H), 0.95 (t, J = 7.2 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 200.6, 144.1, 133.2, 132.7, 128.8, 127.5, 126.6, 47.3, 31.7, 28.4, 28.3, 20.3, 14.3.



2-Isopropyl-3,4-dihydronaphthalen-1(2H)-one (1as):^[13] Colorless oily liquid (0.26 g, 31%). ¹H NMR (400 MHz, CDCl₃) δ 8.02 (dd, J = 8.0, 1.6 Hz, 1H), 7.43 (td, J = 7.2, 1.2 Hz, 1H), 7.27 (t, J = 7.6 Hz, 1H), 7.21 (d, J = 7.6 Hz, 1H), 3.09–2.88 (m, 2H), 2.56–2.48 (m, 1H), 2.33–2.28 (m, 1H), 2.17–2.10 (m, 1H), 1.98–1.84 (m, 1H), 1.00 (d, J = 7.2 Hz, 3H), 0.90 (d, J = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 199.9, 144.0, 133.07, 133.05, 128.7, 127.5, 126.6, 53.8, 28.6, 26.3, 23.6, 20.7, 18.6.



2-Benzyl-3,4-dihydronaphthalen-1(2H)-one (1at):^[11] Under a N₂ atmosphere, ^tBuOLi (40.0 mmol, 2.0 equiv), α -tetralone (20.0 mmol, 1.0 equiv), benzyl alcohol (30 mmol, 1.5 equiv) and toluene (60 mL) were added respectively to a 50 mL three-necked flask equipped with a magnetic stir bar. The reaction was stirred for 12 h at 110 °C (oil bath), then cooled to room temperature. The reaction mixture was diluted and extracted with EtOAc, washed with water, and dried over anhydrous Na₂SO₄. The filtrate was concentrated in vacuo and the residue was purified by a silica gel column chromatography (PE/EtOAc = 20/1) to afford **1at** as pale yellow solid (1.2g, 53%). ¹H NMR (400 MHz, CDCl₃) δ 8.09 (dd, J = 8.0, 1.6 Hz, 1H), 7.47 (td, J = 7.2, 1.2 Hz, 1H), 7.35–7.30 (m, 3H), 7.27–7.20 (m, 4H), 3.51 (dd, J = 13.6, 4.0 Hz, 1H), 2.96–2.92 (m, 2H), 2.80–2.74 (m, 1H), 2.66 (dd, J = 13.6, 9.6 Hz, 1H), 2.15–2.09 (m, 1H), 1.86–1.76 (m, 1H).

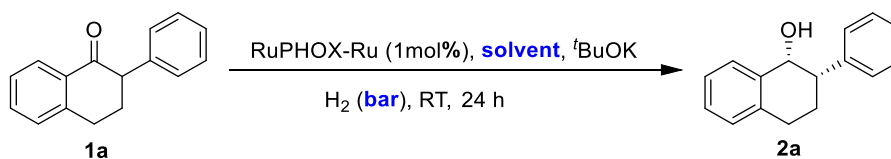


2-Phenyl-2,3-dihydro-1H-inden-1-one (1au):^[14] To a stirred solution of 2,3-diphenylpropanoic acid (1.8 g, 8.0 mmol) and oxalyl chloride (1.2 equiv, 4.8 mL) in DCM, a solution of DMF (10 mol%) in DCM was slowly added at 0 °C. The reaction mixture was stirred for 1 h at this temperature and was allowed to warm up to room temperature over 1 h. Solvent and excess oxalyl chloride were then removed under reduced pressure to afford 2,3-diphenylpropanoyl chloride, which was directly submitted to the next step. 2,3-Diphenylpropanoyl chloride was resolved in DCM (20 mL) and AlCl₃ (3.4 g, 3.2 equiv) were subsequently added to this solution at 0 °C. The reaction mixture was stirred for 1 h at this temperature. Upon completion, the reaction was quenched with saturated aqueous NH₄Cl, extracted with DCM, dried over Na₂SO₄, filtered, and concentrated. The residue was purified by a silica gel column chromatography (PE/EtOAc = 10/1) to afford **1au** as white solid (0.5 g, 33%). ¹H NMR (400 MHz, CDCl₃) δ 7.74 (d, *J* = 7.6 Hz, 1H), 7.57 (td, *J* = 7.6, 2.0 Hz, 1H), 7.49–7.39 (m, 1H), 7.35 (t, *J* = 7.6 Hz, 1H), 7.27–7.22 (m, 2H), 7.20–7.15 (m, 1H), 7.14–7.07 (m, 2H), 3.83 (dd, *J* = 8.4, 4.0 Hz, 1H), 3.62 (dd, *J* = 17.2, 8.0 Hz, 1H), 3.20 (dd, *J* = 17.6, 4.4 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 206.0, 153.7, 139.7, 136.3, 135.1, 128.9, 127.9, 127.8, 127.1, 126.5, 124.6, 53.4, 35.9.

3. Asymmetric Hydrogenation of α -Substituted Tetralones

3.1 Hydrogen pressure and solvents screening

Initially, the asymmetric hydrogenation of α -phenyl tetralones (**1a**) using RuPHOX-Ru (1 mol%) was carried out under 40 bar hydrogen pressure with ^tBuOK as a base in ^tAmOH at RT over 24 h (Table S1, entry 1). To our delight, the reaction provided complete conversion and excellent ee and dr values (99.1% ee and >20:1 dr). These promising results prompted us to further investigate the use of lower hydrogen pressures. It was found that reducing the hydrogen pressure from 40 bar to 2 bar showed nearly no change in either conversion or diastereoselectivity (entries 2~5). Further reducing hydrogen pressure by using a hydrogen balloon resulted in only a trace amount of product being detected (entry 6). The following asymmetric hydrogenation was therefore carried out under 2 bar hydrogen pressure to examine the effect of various solvents on the reaction. Full conversions with excellent enantio- and diastereoselectivities were obtained in alcoholic solvents such as ^tBuOH, ⁱPrOH and EtOH (entries 7~9). However, when MeOH was employed in the reaction, the conversion was sharply reduced with unsatisfactory enantio- and diastereoselectivities (entry 10), mostly likely due to strong hydrogen bonding interactions. Aprotic solvent such as DCM only gave the desired product in 21% conversion, 2:1 dr and 71% ee (entry 11). No reaction was detected in the polar aprotic solvent THF (entry 12). We chose EtOH as the reaction solvent owing to it being high performing and inexpensive.

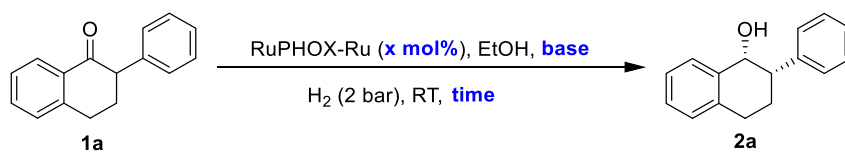
Table S1. Hydrogen pressure and solvents screening

entry	solvent	H ₂ (bar)	conv ^b (%)	ee ^c (%)	dr ^b
1	<i>t</i> -AmOH	40	>99	99.1	>20:1
2	<i>t</i> -AmOH	20	>99	99.1	>20:1
3	<i>t</i> -AmOH	10	>99	99.4	>20:1
4	<i>t</i> -AmOH	5	>99	99.4	>20:1
5	<i>t</i> -AmOH	2	>99	99.1	>20:1
6	<i>t</i> -AmOH	balloon	trace	-	-
7	<i>t</i> -BuOH	2	>99	98	>20:1
8	<i>i</i> -PrOH	2	>99	98	>20:1
9	EtOH	2	>99	99.1	>20:1
10	MeOH	2	57	46	10:1
11	DCM	2	21	71	2:1
12	THF	2	NP ^d	-	-

^a Reaction conditions: **1a** (0.15 mmol), (*S,S*)-RuPHOX-Ru (1.0 mol%) and ^tBuOK (1.0 equiv) in a suitable solvent (1.5 mL) under a certain hydrogen pressure at RT for 24 h. ^b Determined by ¹H NMR. ^c Determined by chiral HPLC analysis of **2a** using an IA column. ^d“NP” means no product detected.

3.2 Base screening

The effect of the base on this reaction was then examined (Table S2). Organic bases, such as ^tBuOK, ^tBuONa, and ^tBuOLi afforded full conversion and excellent enantio- and diastereoselectivities (entries 1~3). Slightly inferior results were obtained when DBU was used as a base (entry 4). Inorganic bases were also found to be suitable for the reaction. Both alkali hydroxides (KOH and NaOH) and alkali carbonates (K₂CO₃ and Na₂CO₃) gave full conversions and 94~98% ees and >20:1 drs (entries 5~8). Next, the amount of ^tBuONa was investigated in the reaction (entries 9~10). It was shown that the amount of base had little effect on the reaction and almost the same catalytic behavior was obtained when the catalyst loading was reduced from 1 to 0.2 equiv. The reaction activity of the asymmetric hydrogenation was also investigated and it was found the reaction could go to completion with a very low catalyst loading (0.2 mol%, entry 11~12). When the reaction time was shortened to 2 hours, no significant effect on the activity was observed (entries 13~15). However, the reaction cannot go to completion in an hour (entry 16). Therefore, the optimal reaction conditions were chosen as the following: using 0.2 mol% RuPHOX-Ru as the catalyst and 0.2 equiv ^tBuONa as the base in EtOH under 2 bar H₂ pressure at room temperature for 2 h.

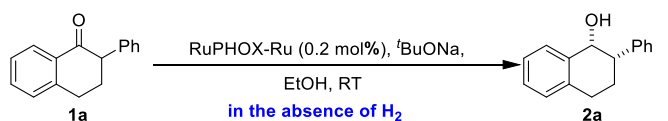
Table S2. Base screening

entry	base (equiv)	conv (%)	ee (%)	dr
1	^t BuOK	>99	99.1	>20:1
2	^t BuONa	>99	99.7	>20:1
3	^t BuOLi	>99	99	>20:1
4	DBU	71	77	6:1
5	KOH	>99	98	>20:1
6	NaOH	>99	98	>20:1
7	Na ₂ CO ₃	>99	95	>20:1
8	K ₂ CO ₃	>99	94	>20:1
9 ^b	^t BuONa	>99	99.3	>20:1
10 ^c	^t BuONa	>99	99.3	>20:1
11 ^{c,d}	^t BuONa	>99	99.1	>20:1
12 ^{c,e}	^t BuONa	>99	99.1	>20:1
13 ^{c,e,f}	^t BuONa	>99	99.1	>20:1
14 ^{c,e,g}	^t BuONa	>99	99.1	>20:1
15 ^{c,e,h}	^t BuONa	>99	99.1	>20:1
16 ^{c,e,i}	^t BuONa	90	99.1	>20:1

^a Reaction conditions: **1a** (0.15 mmol), (*S,S*)-RuPHOX-Ru (1.0 mol%) and base (1.0 equiv) in a EtOH (1.5 mL) under 2 bar H₂ at RT for 24 h. ^b Using 0.5 equiv of base. ^c Using 0.2 equiv of base. ^d Using 0.5 mol% of RuPHOX-Ru. ^e Using 0.2 mol% of RuPHOX-Ru. ^f The reactions were carried out over 12 h. ^g The reactions were carried out over 6 h. ^h The reactions were carried out over 2 h. ⁱ The reactions were carried out over 1 h.

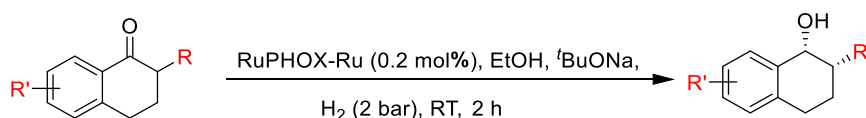
3.3 Control experiment

In order to further confirm whether or not transfer hydrogenation occurs in the reaction, we conducted the asymmetric hydrogenation of **1a** under the optimal reaction conditions in the absence of H₂ (Table S3). It was found that almost no transfer hydrogenation occurred within 8 h, and only 12% conversion has been obtained even after 48 h; the hydrogenated product **2a** was obtained with very poor stereoselectivity. The results indicated that asymmetric transfer hydrogenation is negligible during the reaction and H₂ is the hydrogen source for efficient asymmetric hydrogenation.

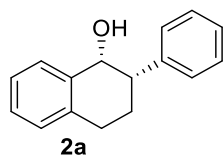
Table S3. Asymmetric hydrogenation of 1a in the absence of H₂

reaction time / h	~8	12	24	48
conv of 1a / %	ND	3	6	12 (40% ee, 1.25:1 dr)

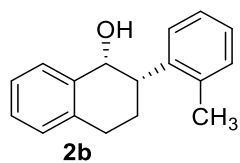
3.4 Substrate scope



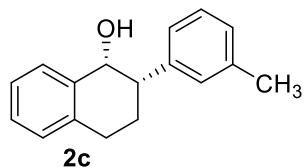
General Procedure: The substrate **1a** (0.3 mmol), (*S,S*)-RuPHOX-Ru (1.04 mg, 0.2 mol%) and *t*BuONa (0.2 equiv) were placed in a 5.0 mL tube equipped with a magnetic stirrer bar, which was then put into an autoclave. The pre-prepared solution of catalyst was added under a nitrogen atmosphere. After purging with hydrogen three times, the hydrogen pressure was finally pressurized to 2 bar. The reaction mixture was vigorously stirred at room temperature for 2 h. The conversion of the product and dr value were determined by ^1H NMR spectroscopic analysis of the crude reaction mixture and the yield was calculated after isolation by flash chromatography (PE/EtOAc = 10/1). The ee value was determined by chiral HPLC using Chiral column IA, IB-3, IE, OJ-H, OD-H, AD-H or OX columns with *n*-hexane/*i*-PrOH as eluent.



(1*R*,2*S*)-2-Phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2a):^[2] White solid (98%, 99.1% ee, >20:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 7.38–7.16 (m, 9H), 4.74 (t, $J = 3.6\text{ Hz}$, 1H), 3.08 (dt, $J = 12.9\text{ Hz}$, 2.6 Hz, 1H), 3.04–2.98 (m, 1H), 2.93–2.85 (m, 1H), 2.43–2.38 (m, 1H), 1.96–1.88 (m, 1H), 1.62 (d, $J = 4.0\text{ Hz}$, 1H). $[\alpha]_{\text{D}}^{25} = +162.00$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 12.425\text{ min}$, $t_{\text{minor}} = 25.540\text{ min}$.

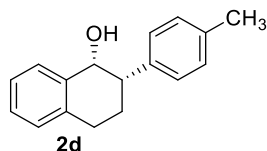


(1*R*,2*S*)-2-(2-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2b):^[2] White solid (98%, 99% ee, >20:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 7.31–7.07 (m, 8H), 4.73 (d, $J = 4.0\text{ Hz}$, 1H), 3.05–2.97 (m, 2H), 2.92–2.84 (m, 1H), 2.44–2.33 (m, 4H), 1.93–1.89 (m, 1H), 1.66 (brs, 1H). $[\alpha]_{\text{D}}^{25} = +171.33$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IC-3, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 0.5 mL/min), 25 °C, $t_{\text{major}} = 33.738\text{ min}$, $t_{\text{minor}} = 45.440\text{ min}$.

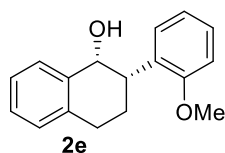


(1*R*,2*S*)-2-(3-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2c): White solid (96%, 99.3% ee, >20:1 dr). Mp: 77–78 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.32–7.15 (m, 8H), 4.70 (d, $J = 2.0\text{ Hz}$, 1H), 3.30

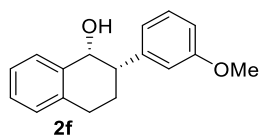
(dt, $J = 12.8, 2.4$ Hz, 1H), 3.05–2.99 (m, 1H), 2.96–2.87 (m, 1H), 2.54–2.43 (m, 1H), 2.35 (s, 3H), 1.84–1.79 (m, 1H), 1.67 (brs, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 140.5, 137.8, 136.9, 136.0, 130.8, 130.6, 129.2, 128.2, 127.9, 126.7, 126.3, 126.2, 68.9, 42.1, 30.2, 22.2, 19.6. IR (KBr) (v/cm^{-1}): 3801, 3734, 2924, 1649, 1463, 1084, 764. $[\alpha]_{\text{D}}^{25} = +192.73$ (c 0.22, CH_2Cl_2). HRMS (ESI): m/z for $\text{C}_{17}\text{H}_{18}\text{ONa}$ $[\text{M}+\text{Na}]^+$ calcd 261.1255, found 261.1259. HPLC (Chiralpak IC-3, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 0.8 mL/min), 25 °C, $t_{\text{major}} = 10.840$ min, $t_{\text{minor}} = 14.518$ min.



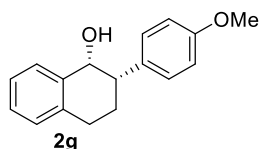
(1R,2S)-2-(4-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2d):^[2] Colorless oil (95%, 99% ee, >20:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 7.29 (d, $J = 8.0$ Hz, 1H), 7.25–7.15 (m, 7H), 4.71 (d, $J = 2.0$ Hz, 1H), 3.06–2.96 (m, 2H), 2.92–2.83 (m, 1H), 2.43–2.32 (m, 4H), 1.92–1.87 (m, 1H), 1.64 (s, 1H). $[\alpha]_{\text{D}}^{25} = +150.31$ (c 0.64, CH_2Cl_2). HPLC (Chiralpak IC, n -hexane/ i -PrOH = 99/1, UV = 220 nm, flow rate = 0.5 mL/min), 25 °C, $t_{\text{major}} = 39.550$ min, $t_{\text{minor}} = 51.361$ min.



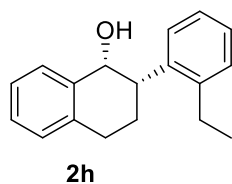
(1R,2S)-2-(2-Methoxyphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2e):^[9] Colorless oil. (96%, 93% ee, >20:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 7.31 (d, $J = 6.4$ Hz, 1H), 7.29–7.12 (m, 5H), 7.00–6.96 (m, 1H), 6.91–6.84 (m, 1H), 4.83 (d, $J = 3.2$ Hz, 1H), 3.79 (s, 3H), 3.57–3.52 (m, 1H), 3.05–2.95 (m, 1H), 3.02–2.97 (m, 1H), 2.46–2.36 (m, 1H), 1.82–1.73 (m, 1H), 1.63 (s, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 157.1, 138.1, 136.9, 130.8, 130.6, 129.1, 128.7, 128.0, 127.8, 126.1, 120.7, 110.2, 69.0, 55.3, 39.1, 30.1, 21.4. $[\alpha]_{\text{D}}^{25} = +179.77$ (c 0.88, CH_2Cl_2). HPLC (Chiralpak IB-3, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 10.716$ min, $t_{\text{minor}} = 14.971$ min.



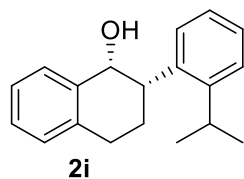
(1R,2S)-2-(3-Methoxyphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2f):^[2] White solid (97%, 99% ee, >20:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 7.35–7.18 (m, 5H), 6.95–6.90 (m, 2H), 6.84–6.82 (m, 1H), 4.78 (s, 1H), 3.82 (s, 3H), 3.10–3.00 (m, 2H), 2.95–2.87 (m, 1H), 2.41 (ddd, $J = 24.0, 12.0, 4.0$ Hz, 1H), 1.97–1.93 (m, 1H), 1.65 (brs, 1H). $[\alpha]_{\text{D}}^{25} = +141.46$ (c 0.82, CH_2Cl_2). HPLC (Chiralpak IA, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 17.737$ min, $t_{\text{minor}} = 29.818$ min.



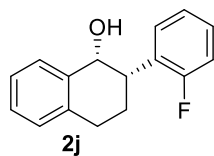
(1R,2S)-2-(4-Methoxyphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2g):^[21] White solid (96%, 98% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.34 (d, J = 4.0 Hz, 1H), 7.28–7.19 (m, 5H), 6.94 (d, J = 8.0 Hz, 2H), 4.74 (s, 1H), 3.83 (s, 3H), 3.08–3.01 (m, 2H), 2.96–2.88 (m, 1H), 2.40 (ddd, J = 20.0, 12.0, 4.0 Hz, 1H), 1.94–1.91 (m, 1H), 1.68 (brs, 1H). [α]_D²⁵ = +122.40 (c 0.58, CH₂Cl₂). HPLC (Chiralpak IC-3, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, t_{major} = 27.139 min, t_{minor} = 35.454 min.



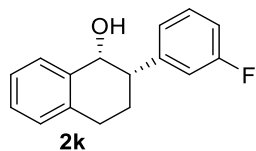
(1R,2S)-2-(2-Ethylphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2h): Yellow oil (conv. 90%, 98% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.37–7.33 (m, 2H), 7.29–7.30 (m, 6H), 4.72 (d, J = 3.2 Hz, 1H), 3.37 (dt, J = 12.8, 2.8 Hz, 1H), 3.06 (ddd, J = 17.1, 5.5, 2.2 Hz, 1H), 2.99–2.90 (m, 1H), 2.82–2.60 (m, 2H), 2.53 (qd, J = 12.6, 5.5 Hz, 1H), 1.88–1.79 (m, 1H), 1.63 (s, 1H), 1.22 (t, J = 7.6 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 142.0, 139.7, 137.7, 136.8, 130.6, 129.1, 128.9, 128.1, 128.0, 126.9, 126.14, 126.12, 69.9, 41.2, 30.2, 25.4, 22.4, 15.8. IR (KBr) (ν/cm^{-1}): 2930, 2361, 1506, 1489, 1457, 957, 771. HRMS (ESI): m/z for C₁₈H₂₀ONa [M+Na]⁺ calcd 275.1412, found 275.1410. [α]_D²⁰ = +130.00 (c 0.20, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, t_{major} = 10.487 min, t_{minor} = 17.084 min.



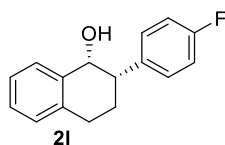
(1R,2S)-2-(2-Isopropylphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2i): Yellow oil (96%, 97% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.42–7.30 (m, 3H), 7.30–7.15 (m, 5H), 4.68 (d, J = 4.0 Hz, 1H), 3.44 (dt, J = 12.8, 2.4 Hz, 1H), 3.26–3.19 (m, 1H), 3.05 (ddd, J = 17.0, 5.5, 2.1 Hz, 1H), 2.98–2.90 (m, 1H), 2.52 (qd, J = 12.6, 5.5 Hz, 1H), 1.85–1.80 (m, 1H), 1.64 (s, 1H), 1.30 (d, J = 6.8 Hz, 3H), 1.19 (d, J = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 146.8, 138.7, 137.7, 136.9, 130.7, 129.2, 128.2, 127.9, 127.0, 126.5, 125.9, 125.7, 70.4, 40.9, 30.1, 28.1, 25.0, 23.7, 22.5. IR (KBr) (ν/cm^{-1}): 2962, 2868, 1603, 1489, 1383, 1080, 773, 757. HRMS (ESI): m/z for C₁₉H₂₂ONa [M+Na]⁺ calcd 289.1568, found 289.1566. [α]_D²⁰ = +164.12 (c 0.68, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, t_{major} = 9.008 min, t_{minor} = 16.204 min.



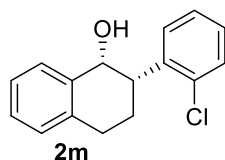
(1R,2S)-2-(2-Fluorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2j): White solid (96%, 96% ee, >20:1 dr). Mp: 53–54 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.36–7.12 (m, 7H), 7.08–7.03 (m, 1H), 4.80 (d, *J* = 3.2 Hz, 1H), 3.45 (dt, *J* = 13.2, 2.8 Hz, 1H), 3.01 (ddd, *J* = 17.2, 6.0, 2.4 Hz, 1H), 2.96–2.87 (m, 1H), 2.47–2.36 (m, 1H), 1.88–1.82 (m, 1H), 1.63 (d, *J* = 8.4 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 160.9 (d, *J* = 243.5 Hz), 137.8, 136.5, 130.6, 129.7 (dd, *J* = 4.3, 8.9 Hz), 129.2, 128.3, 128.2 (d, *J* = 8.3 Hz), 126.3, 124.2 (d, *J* = 3.4 Hz), 115.3 (d, *J* = 22.5 Hz), 69.7, 38.7 (d, *J* = 1.6 Hz), 29.7, 21.2. ¹⁹F NMR (376 MHz, CDCl₃) δ –118.4. IR (KBr) (ν/cm⁻¹): 3754, 3651, 3307, 2928, 1487, 1192, 1092, 959, 736. HRMS (ESI): *m/z* for C₁₆H₁₄F [M–OH]⁺ calcd 225.1080, found 225.1086. [α]_D²⁵ = +146.40 (*c* 0.30, CH₂Cl₂). HPLC (Chiralcel OJ-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 2.0 mL/min), 25 °C, *t*_{minor} = 8.673 min, *t*_{major} = 13.282 min.



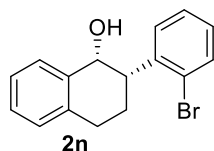
(1R,2S)-2-(3-Fluorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2k): White solid (97%, 99.6% ee, >20:1 dr). Mp: 86–87 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.36–7.19 (m, 5H), 7.11–6.96 (m, 3H), 4.71 (s, 1H), 3.08–2.99 (m, 2H), 2.95–2.87 (m, 1H), 2.35 (ddd, *J* = 20.0, 12.0, 4.0 Hz, 1H), 1.94–1.90 (m, 1H), 1.81 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 163.1 (d, *J* = 244.2 Hz), 145.6 (d, *J* = 6.9 Hz), 137.6 (d, *J* = 106.7 Hz), 130.5, 130.0 (d, *J* = 8.2 Hz), 129.2, 128.4, 126.4, 123.9 (d, *J* = 2.9 Hz), 115.3 (d, *J* = 21.1 Hz), 113.6 (d, *J* = 20.9 Hz), 71.2, 45.9 (d, *J* = 1.7 Hz), 29.6, 21.7. ¹⁹F NMR (376 MHz, CDCl₃) δ –113.1. IR (KBr) (ν/cm⁻¹): 3750, 3674, 2928, 1600, 1456, 1269, 1050, 772. HRMS (ESI): *m/z* for C₁₆H₁₅FONa [M+Na]⁺ calcd 265.1005, found 265.1015. [α]_D²⁵ = +161.20 (*c* 0.20, CH₂Cl₂). HPLC (Chiralcel AD-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 17.274 min, *t*_{minor} = 26.296 min.



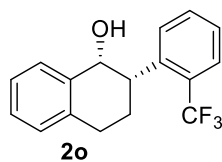
(1R,2S)-2-(4-Fluorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2l):^[21] White solid (96%, 99% ee, >20:1 dr). Mp: 99–100 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.37–7.17 (m, 6H), 7.10 (t, *J* = 8.0 Hz, 2H), 4.75 (s, 1H), 3.05–3.00 (m, 1H), 2.97–2.96 (m, 1H), 2.89–2.84 (m, 1H), 2.33 (ddd, *J* = 20.0, 12.0, 4.0 Hz, 1H), 1.90–1.85 (m, 1H), 1.71 (s, 1H). [α]_D²⁵ = +156.93 (*c* 0.30, CH₂Cl₂). HPLC (Chiralcel OJ-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 2.0 mL/min), 25 °C, *t*_{minor} = 17.275 min, *t*_{major} = 32.154 min.



(1R,2S)-2-(2-Chlorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2m): White solid (97%, 95% ee, >20:1 dr). Mp: 53–56 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.40 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.35–7.33 (m, 1H), 7.31–7.15 (m, 6H), 4.86 (d, *J* = 3.2 Hz, 1H), 3.56 (dt, *J* = 13.0, 2.8 Hz, 1H), 3.07–2.87 (m, 2H), 2.42 (qd, *J* = 12.5, 5.8 Hz, 1H), 1.84–1.78 (m, 1H), 1.62 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 139.8, 137.8, 136.5, 134.0, 130.6, 129.8, 129.6, 129.2, 128.2, 127.9, 126.8, 126.2, 68.5, 42.5, 29.9, 21.7. IR (KBr) (v/cm⁻¹): 2930, 1490, 1474, 1057, 958, 703. HRMS (ESI): *m/z* for C₁₆H₁₅ONaCl [M+Na]⁺ calcd 281.0709, found 281.0705. [α]_D²⁰ = +195.83 (*c* 0.24, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 0.5 mL/min), 25 °C, *t*_{major} = 61.153 min, *t*_{minor} = 174.827 min.

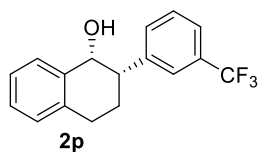


(1R,2S)-2-(2-Bromophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2n): White solid (97%, 86% ee, >20:1 dr). Mp: 51–52 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.67–7.60 (m, 1H), 7.44–7.34 (m, 3H), 7.32–7.20 (m, 3H), 7.19–7.13 (m, 1H), 4.96 (d, *J* = 3.2 Hz, 1H), 3.58 (dt, *J* = 13.0, 2.7 Hz, 1H), 3.18–2.92 (m, 2H), 2.52 (qd, *J* = 12.5, 5.7 Hz, 1H), 1.94–1.85 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 141.3, 137.7, 136.6, 132.9, 130.6, 130.0, 129.2, 128.3, 128.2, 127.5, 126.3, 124.9, 68.6, 45.0, 29.9, 22.0. HRMS (ESI): *m/z* for C₁₆H₁₅BrONa [M+Na]⁺ calcd 325.0204, found 325.0204. [α]_D²⁵ = +169.20 (*c* 0.20, CH₂Cl₂). HPLC (Chiralcel OZ-H, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 20.678 min, *t*_{minor} = 34.755 min.

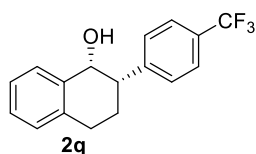


(1R,2S)-2-(2-(Trifluoromethyl)phenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2o): Pale yellow oil (conv. 70%, 90% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.70 (d, *J* = 8.0 Hz, 1H), 7.58 (t, *J* = 7.6 Hz, 1H), 7.45–7.37 (m, 2H), 7.31–7.27 (m, 2H), 7.22–7.16 (m, 1H), 7.10–7.08 (m, 1H), 4.42 (d, *J* = 2.8 Hz, 1H), 3.38 (d, *J* = 12.8 Hz, 1H), 2.91 (dd, *J* = 9.0, 3.7 Hz, 2H), 2.24–2.13 (m, 1H), 1.72–1.62 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 141.9, 137.2 (d, *J* = 183.0 Hz), 134.3, 131.4, 130.8 (d, *J* = 23.6 Hz), 129.2, 128.6, 128.3, 128.2, 126.5, 126.1, 125.8 (d, *J* = 6.0 Hz), 123.4, 69.7, 41.4, 30.0, 22.9. ¹⁹F NMR (376 MHz, CDCl₃) δ –58.1. IR (KBr) (v/cm⁻¹): 2933, 1607, 1491, 1347, 1117, 1035,

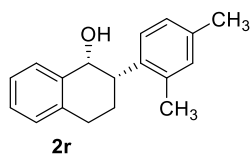
768. HRMS (ESI): m/z for $C_{17}H_{15}ONaF_3$ $[M+Na]^+$ calcd 315.0973, found 315.0965. $[\alpha]_D^{20} = +85.00$ (c 0.24, CH_2Cl_2). HPLC (Chiralpak IA, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{major} = 11.185$ min, $t_{minor} = 20.465$ min.



(1R,2S)-2-(3-(Trifluoromethyl)phenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2p): White solid (97%, 99.5% ee, >20:1 dr). Mp: 96–97°C. 1H NMR (400 MHz, $CDCl_3$) δ 7.59 (s, 1H), 7.56–7.45 (m, 3H), 7.32 (dd, $J = 7.4, 1.7$ Hz, 1H), 7.29–7.18 (m, 3H), 4.79 (d, $J = 2.8$ Hz, 1H), 3.13 (dt, $J = 12.8, 2.8$ Hz, 1H), 3.05 (ddd, $J = 17.2, 5.7, 2.1$ Hz, 1H), 2.93 (ddd, $J = 17.4, 12.0, 5.8$ Hz, 1H), 2.46 (qd, $J = 12.7, 5.7$ Hz, 1H), 2.00–1.90 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.9, 137.0 (d, $J = 152.0$ Hz), 131.7, 130.9, 130.5, 130.3, 129.2, 128.5 (d, $J = 34.0$ Hz), 126.3, 125.1 (q, $J = 3.9$ Hz), 125.7, 123.5 (q, $J = 3.9$ Hz), 123.0, 71.0, 45.9, 29.5, 21.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ –62.2; IR (KBr) (ν/cm^{-1}): 3732, 3566, 2928, 1457, 1161, 823. IR (KBr) (ν/cm^{-1}): 3754, 3651, 3307, 2928, 1487, 1192, 1092, 959, 736. HRMS (ESI): m/z for $C_{17}H_{15}F_3ONa$ $[M+Na]^+$ calcd 315.0973, found 315.0988. $[\alpha]_D^{25} = +139.83$ (c 0.24, CH_2Cl_2). HPLC (Chiralpak IA, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{major} = 10.302$ min, $t_{minor} = 17.739$ min.

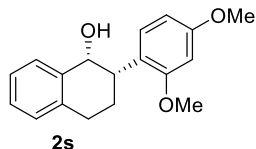


(1R,2S)-2-(4-(Trifluoromethyl)phenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2q): White solid (96%, 99.5% ee, >20:1 dr). Mp: 112–113 °C. 1H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, $J = 8.0$ Hz, 2H), 7.41 (d, $J = 7.9$ Hz, 2H), 7.32–7.14 (m, 4H), 4.71 (d, $J = 2.8$ Hz, 1H), 3.10 (dt, $J = 13.0, 3.0$ Hz, 1H), 3.01 (ddd, $J = 17.2, 5.8, 2.2$ Hz, 1H), 2.90 (ddd, $J = 17.3, 12.0, 5.8$ Hz, 1H), 2.38 (qd, $J = 12.6, 5.7$ Hz, 1H), 1.92 (ddd, $J = 12.7, 5.8, 2.7$ Hz, 1H), 1.68 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.0, 137.5 (d, $J = 121.4$ Hz), 130.3, 129.2, 129.0 (d, $J = 32.1$ Hz), 128.7, 128.4, 126.3, 125.3 (q, $J = 3.7$ Hz), 123.0, 71.0, 45.9, 29.5, 21.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ –62.4. IR (KBr) (ν/cm^{-1}): 3766, 3566, 2922, 1325, 1119, 1068. HRMS (ESI): m/z for $C_{17}H_{15}F_3ONa$ $[M+Na]^+$ calcd 315.0973, found 315.0978. $[\alpha]_D^{25} = +135.33$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IA, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{major} = 11.927$ min, $t_{minor} = 16.645$ min.

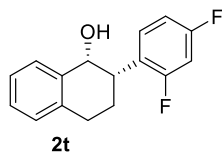


(1R,2S)-2-(2,4-Dimethylphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2r): White solid (98%, 99.1% ee, >20:1 dr). Mp: 86–87 °C. 1H NMR (400 MHz, $CDCl_3$) δ 7.22 (dd, $J = 7.2, 2.0$ Hz, 1H), 7.17–7.04 (m, 3H), 6.85 (s, 2H), 6.82 (s, 1H), 4.64 (s, 1H), 2.96–2.86 (m, 2H), 2.83–2.74 (m, 1H),

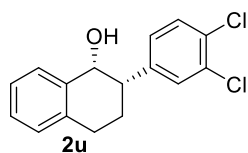
2.35–2.27 (m, 1H), 2.24 (s, 6H), 1.85–1.78 (m, 1H), 1.55 (s, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 142.6, 138.2, 137.8, 136.8, 130.6, 129.1, 128.6, 128.1, 126.2, 126.0, 71.4, 45.9, 29.9, 21.53, 21.52. IR (KBr) (v/cm^{-1}): 3766, 3566, 2922, 1325, 1119, 1068. IR (KBr) (v/cm^{-1}): 3736, 3647, 2916, 1692, 1502, 1457. HRMS (ESI): m/z for $\text{C}_{18}\text{H}_{20}\text{ONa}$ $[\text{M}+\text{Na}]^+$ calcd 275.1412, found 275.1417. $[\alpha]_{\text{D}}^{25} = +160.80$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IE, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 9.115$ min, $t_{\text{minor}} = 18.318$ min.



(1R,2S)-2-(2,4-Dimethoxyphenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2s): White solid (97%, >99.9% ee, >20:1 dr). Mp: 82–93 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.20 (dd, $J = 7.2, 2.0$ Hz, 1H), 7.16–6.96 (m, 3H), 6.38 (d, $J = 2.0$ Hz, 2H), 6.27 (t, $J = 2.4$ Hz, 1H), 4.61 (t, $J = 2.0$ Hz, 1H), 3.66 (s, 6H), 2.97–2.80 (m, 2H), 2.80–2.71 (m, 1H), 2.28–2.18 (m, 1H), 1.83–1.67 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 161.0, 145.2, 137.7, 136.7, 130.5, 129.1, 128.1, 126.2, 106.4, 98.5, 71.3, 55.3, 46.4, 29.7, 21.6. HRMS (ESI): m/z for $\text{C}_{18}\text{H}_{20}\text{O}_3\text{Na}$ $[\text{M}+\text{Na}]^+$ calcd 307.1310, found 307.1314. $[\alpha]_{\text{D}}^{25} = +147.33$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IB-3, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 26.876$ min, $t_{\text{minor}} = 35.298$ min.

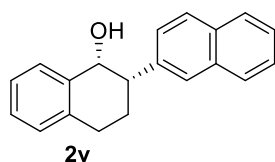


(1R,2S)-2-(2,4-Difluorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2t): White solid (96%, 99.4% ee, >20:1 dr). Mp: 100–101 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.27–7.10 (m, 4H), 6.80–6.72 (m, 2H), 6.67 (dt, $J = 8.8, 2.4$ Hz, 1H), 4.45 (d, $J = 2.8$ Hz, 1H), 3.00–2.76 (m, 3H), 2.26 (s, 1H), 2.13–2.03 (m, 1H), 1.80–1.74 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.0 (dd, $J = 246.1, 12.8$ Hz), 147.2 (d, $J = 8.6$ Hz), 137.5, 136.2, 130.5, 129.1, 128.4, 126.4, 111.2 (dd, $J = 18.1, 6.4$ Hz), 102.2 (d, $J = 25.2$ Hz), 70.7, 45.9 (d, $J = 2.0$ Hz), 29.5, 21.5. ^{19}F NMR (376 MHz, CDCl_3) δ –110.2. IR (KBr) (v/cm^{-1}): 3742, 3651, 2934, 1627, 1463, 1123, 981, 851. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{14}\text{F}_2\text{Na}$ $[\text{M}+\text{Na}]^+$ calcd 243.0985, found 243.0991. $[\alpha]_{\text{D}}^{25} = +145.87$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IB-3, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 10.056$ min, $t_{\text{minor}} = 12.247$ min.

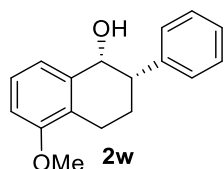


(1R,2S)-2-(3,4-Dichlorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2u): White solid (98%, 99.3% ee, >20:1 dr). Mp: 55–56 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.40–7.32 (m, 2H), 7.29–7.12 (m, 4H),

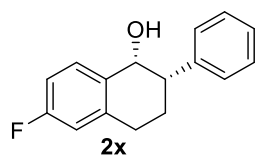
7.07 (dd, $J = 8.3, 2.1$ Hz, 1H), 4.53 (d, $J = 2.8$ Hz, 1H), 2.99–2.77 (m, 3H), 2.16 (qd, $J = 12.6, 5.9$ Hz, 1H), 1.98 (s, 1H), 1.85–1.71 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 143.4, 137.6, 136.3, 132.3, 130.5, 130.4, 130.35, 130.3, 129.2, 128.4, 127.8, 126.4, 70.8, 45.4, 29.5, 21.6; IR (KBr) (v/cm^{-1}): 3750, 3568, 2928, 1731, 1621, 1456. HRMS (ESI): m/z for $\text{C}_{16}\text{H}_{14}\text{Cl}_2\text{ONa}$ $[\text{M}+\text{Na}]^+$ calcd 315.0319, found 315.0328. $[\alpha]_{\text{D}}^{25} = +106.27$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IA, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 16.034$ min, $t_{\text{minor}} = 23.345$ min.



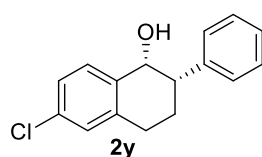
(1R,2S)-1,2,3,4-Tetrahydro-[2,2'-binaphthalen]-1-ol (2v): White solid (98%, 99% ee, >20:1 dr). Mp: 121–122 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.89–7.86 (m, 3H), 7.80 (t, $J = 1.2$ Hz, 1H), 7.54–7.46 (m, 3H), 7.38 (dd, $J = 7.2, 1.6$ Hz, 1H), 7.33–7.22 (m, 3H), 4.90 (d, $J = 3.2$ Hz, 1H), 3.29 (dt, $J = 12.8, 3.2$ Hz, 1H), 3.11 (ddd, $J = 17.1, 5.7, 2.2$ Hz, 1H), 2.99 (ddd, $J = 17.2, 12.0, 5.6$ Hz, 1H), 2.58 (qd, $J = 12.6, 5.6$ Hz, 1H), 2.12–2.06 (m, 1H), 1.62 (s, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 140.2, 137.7, 136.8, 133.6, 132.6, 130.6, 129.2, 128.3, 128.2, 127.9, 127.7, 126.9, 126.6, 126.2, 126.2, 125.7, 71.2, 46.2, 29.8, 21.7. IR (KBr) (v/cm^{-1}): 3752, 3027, 2922, 1656, 1457, 1036, 817. HRMS (ESI): m/z for $\text{C}_{20}\text{H}_{18}\text{ONa}$ $[\text{M}+\text{Na}]^+$ calcd 297.1255, found 297.1264. $[\alpha]_{\text{D}}^{25} = +155.00$ (c 0.20, CH_2Cl_2). HPLC (Chiralpak IB-3, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 22.067$ min, $t_{\text{minor}} = 25.443$ min.



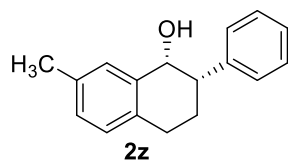
(1R,2S)-5-Methoxy-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2w): Colorless oil (98%, 99.5% ee, >20:1 dr). ^1H NMR (400 MHz, CDCl_3) δ 7.36–7.19 (m, 5H), 7.11–6.96 (m, 3H), 4.71 (s, 1H), 3.08–3.00 (m, 2H), 2.95–2.87 (m, 1H), 2.40–2.29 (m, 1H), 1.94–1.90 (m, 1H), 1.71 (s, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 198.5, 156.8, 139.7, 134.0, 133.1, 128.6, 128.5, 127.1, 127.0, 119.4, 114.3, 55.8, 53.9, 30.4, 22.3. IR (KBr) (v/cm^{-1}): 3756, 3570, 2932, 1710, 1463, 1256, 1088, 788. HRMS (ESI): m/z for $\text{C}_{17}\text{H}_{18}\text{O}_2\text{Na}$ $[\text{M}+\text{Na}]^+$ calcd 277.1204, found 277.1210. $[\alpha]_{\text{D}}^{25} = +161.22$ (c 0.82, CH_2Cl_2). HPLC (Chiralpak IE, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 15.601$ min, $t_{\text{minor}} = 45.323$ min.



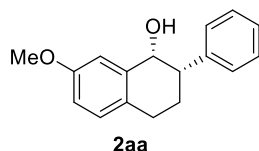
(1*R*,2*S*)-6-Fluoro-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2x): White solid (96%, 97% ee, >20:1 dr). Mp: 69–70 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.41–7.37 (m, 2H), 7.33–7.24 (m, 4H), 6.94–6.86 (m, 2H), 4.73 (s, 1H), 3.08 (dt, *J* = 12.8, 2.8 Hz, 1H), 3.04–2.89 (m, 1H), 2.93–2.85 (m, 1H), 2.42 (ddd, *J* = 12.0, 8.0, 4.0 Hz, 1H), 1.96–1.91 (m, 1H), 1.64 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 162.4 (d, *J* = 244.8 Hz), 142.3, 139.1 (d, *J* = 7.6 Hz), 133.5 (d, *J* = 2.9 Hz), 132.2 (d, *J* = 8.5 Hz), 128.7, 128.2, 126.9, 115.2 (d, *J* = 21.0 Hz), 113.4 (d, *J* = 21.0 Hz), 70.7, 46.0, 30.0, 21.2. ¹⁹F NMR (376 MHz, CDCl₃) δ –114.4. IR (KBr) (ν/cm⁻¹): 3902, 3720, 3568, 2932, 1611, 1502, 1250, 965. HRMS (ESI): *m/z* for C₁₆H₁₄F [M-OH]⁺ calcd 225.1080, found 225.1087. [α]_D²⁵ = +158.33 (*c* 0.24, CH₂Cl₂). HPLC (Chiralcel AD-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 12.639 min, *t*_{minor} = 20.838 min.



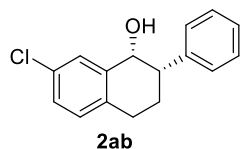
(1*R*,2*S*)-6-Chloro-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2y): White solid (97%, 98% ee, >20:1 dr). Mp: 87–88 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.42–7.38 (m, 2H), 7.32–7.29 (m, 3H), 7.24–7.19 (m, 3H), 4.65 (s, 1H), 3.06–3.02 (m, 1H), 2.99–2.94 (m, 1H), 2.90–2.82 (m, 1H), 2.34 (ddd, *J* = 20.0, 16.0, 8.0 Hz, 1H), 1.94–1.89 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 142.3, 138.7, 136.2, 133.7, 131.9, 128.8, 128.7, 128.3, 127.0, 126.4, 70.7, 46.0, 30.0, 21.3. IR (KBr) (ν/cm⁻¹): 3734, 3560, 2934, 1694, 1629, 1489, 1076, 859. HRMS (ESI): *m/z* for C₁₆H₁₃Cl [M-OH]⁺ calcd 241.0784, found 241.0792. [α]_D²⁵ = +150.17 (*c* 0.24, CH₂Cl₂). HPLC (Chiralcel AD-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 14.543 min, *t*_{minor} = 30.996 min.



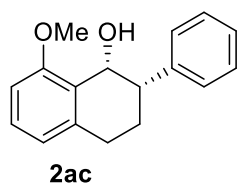
(1*R*,2*S*)-7-Methyl-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2z): White solid (95%, 99% ee, >20:1 dr). Mp: 74–75 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.39–7.31 (m, 4H), 7.29–7.25 (m, 1H), 7.14 (s, 1H), 7.07 (d, *J* = 1.2 Hz, 2H), 4.72 (d, *J* = 2.0 Hz, 1H), 3.07 (dt, *J* = 13.2, 2.8 Hz, 1H), 2.98 (ddd, *J* = 17.2, 5.6, 2.0 Hz, 1H), 2.90–2.81 (m, 1H), 2.41 (ddd, *J* = 25.2, 12.8, 5.6 Hz, 1H), 2.33 (s, 3H), 1.96–1.89 (m, 1H), 1.58 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 142.8, 137.5, 135.7, 133.7, 130.9, 129.2, 129.1, 128.7, 128.3, 126.9, 71.5, 46.2, 29.4, 21.7, 21.1. IR (KBr) (ν/cm⁻¹): 3734, 3655, 2934, 1718, 1631, 1455, 1076, 963. HRMS (ESI): *m/z* for C₁₇H₁₈ONa [M+Na]⁺ calcd 261.1255, found 261.1251. [α]_D²⁵ = +138.64 (*c* 0.56, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 12.382 min, *t*_{minor} = 21.635 min.



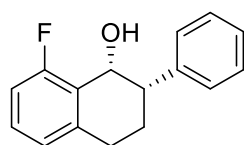
(1R,2S)-7-Methoxy-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2aa): White solid (97%, 99.5% ee, >20:1 dr). Mp: 76–77 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.42–7.28 (m, 5H), 7.12 (d, *J* = 8.0 Hz, 1H), 6.89–6.85 (m, 2H), 4.72 (s, 1H), 3.81 (s, 3H), 3.09 (dt, *J* = 12.8, 2.8 Hz, 1H), 3.00–2.94 (m, 1H), 2.89–2.81 (m, 1H), 2.45–2.34 (m, 1H), 1.97–1.92 (m, 1H), 1.77 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 158.0, 142.6, 138.7, 130.1, 128.8, 128.7, 128.3, 126.9, 115.0, 114.5, 71.6, 55.4, 46.1, 28.9, 22.0. IR (KBr) (ν/cm⁻¹): 3766, 3572, 2938, 1747, 1558, 1451, 1256, 1068, 861. HRMS (ESI): *m/z* for C₁₇H₁₈O₂Na [M+Na]⁺ calcd 277.1199, found 277.1194. [α]_D²⁵ = +145.33 (*c* 0.30, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 32.415 min, *t*_{minor} = 56.880 min.



(1R,2S)-7-Chloro-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2ab): White solid (97%, 99.3% ee, >20:1 dr). Mp: 93–94 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.38–7.34 (m, 2H), 7.28–7.19 (m, 4H), 7.20 (d, *J* = 8.0 Hz, 1H), 7.08 (d, *J* = 8.0 Hz, 1H), 4.63 (s, 1H), 3.04–3.00 (m, 1H), 2.97–2.91 (m, 1H), 2.85–2.76 (m, 1H), 2.33 (ddd, *J* = 28.0, 12.0, 4.0 Hz, 1H), 1.92–1.88 (m, 1H), 1.89 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 142.1, 139.4, 135.2, 131.5, 130.4, 130.3, 128.7, 128.3, 128.2, 127.0, 70.8, 45.8, 30.0, 21.5. IR (KBr) (ν/cm⁻¹): 3744, 3568, 2930, 1649, 1461, 1026. HRMS (ESI): *m/z* for C₁₆H₁₅ClNa [M+Na]⁺ calcd 281.0709, found 281.0715. [α]_D²⁵ = +125.00 (*c* 0.24, CH₂Cl₂). HPLC (Chiralcel AD-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 18.916 min, *t*_{minor} = 21.155 min.

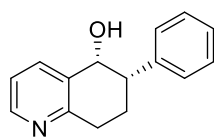


(1R,2S)-8-Methoxy-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2ac):^[2] White solid (95%, 99% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.44–7.32 (m, 4H), 7.31–7.18 (m, 2H), 6.81 (d, *J* = 7.6 Hz, 1H), 6.73 (d, *J* = 8.4 Hz, 1H), 5.11 (dd, *J* = 3.2, 0.8 Hz, 1H), 3.83 (s, 3H), 3.10–2.83 (m, 3H), 2.44 (qd, *J* = 12.7, 5.4 Hz, 1H), 2.00 (s, 1H), 1.96–1.88 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 157.9, 143.1, 138.2, 128.6, 128.36, 128.31, 127.1, 126.5, 121.5, 107.6, 65.5, 55.5, 45.8, 30.3, 21.3. [α]_D²⁰ = +142.16 (*c* 0.50, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 14.881 min, *t*_{minor} = 21.984 min.



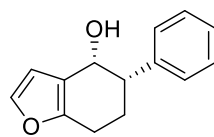
2ad

(1R,2S)-8-Fluoro-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (2ad): Colorless oil (92%, 98% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.43–7.31 (m, 4H), 7.32–7.24 (m, 1H), 7.23–7.18 (m, 1H), 6.97 (d, *J* = 7.7 Hz, 1H), 6.90 (ddt, *J* = 9.5, 8.3, 1.2 Hz, 1H), 5.08 (d, *J* = 3.6 Hz, 1H), 3.11–2.94 (m, 2H), 2.95–2.82 (m, 1H), 2.46 (qd, *J* = 12.8, 5.4 Hz, 1H), 2.00–1.88 (m, 1H), 1.71 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 161.7 (d, *J* = 245.0 Hz), 142.3, 139.3 (d, *J* = 4.0 Hz), 129.1 (d, *J* = 9.0 Hz), 128.5 (d, *J* = 33.0 Hz), 126.9, 125.5 (d, *J* = 48.0 Hz), 124.6 (d, *J* = 4.0 Hz), 112.7, 112.5, 64.7 (d, *J* = 4.0 Hz), 45.7, 29.8 (d, *J* = 2.0 Hz), 20.9. ¹⁹F NMR (376 MHz, CDCl₃) δ –120.7. IR (KBr) (v/cm⁻¹): 2924, 1583, 1495, 1233, 966, 718, 700. HRMS (ESI): *m/z* for C₁₆H₁₅ONaF [M+Na]⁺ calcd 265.1005, found 265.0999. [α]_D²⁰ = +166.55 (*c* 0.58, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 0.5 mL/min), 25 °C, *t*_{major} = 42.914 min, *t*_{minor} = 83.026 min.



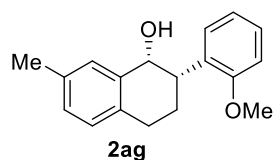
2ae

(5R,6S)-6-Phenyl-5,6,7,8-tetrahydroquinolin-5-ol (2ae):^[21] Pale yellow solid (96%, 98% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 8.40 (d, *J* = 2.4 Hz, 1H), 7.58 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.34–7.30 (m, 2H), 7.28–7.17 (m, 3H), 7.09 (dd, *J* = 7.6, 4.8 Hz, 1H), 4.72 (d, *J* = 2.4 Hz, 1H), 3.17–3.02 (m, 2H), 3.00–2.88 (m, 1H), 2.51–2.40 (m, 1H), 2.15–1.90 (m, 3H). [α]_D²⁵ = +95.83 (*c* 0.05, CH₂Cl₂). HPLC (Chiralpak IB-3, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 42.093 min, *t*_{minor} = 54.537 min.

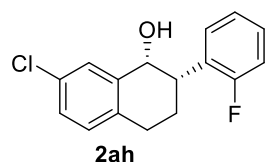


2af

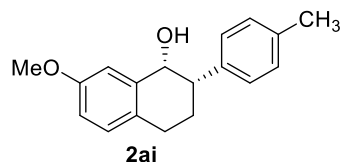
(4R,5S)-5-Phenyl-4,5,6,7-tetrahydrobenzofuran-4-ol (2af):^[21] Colorless oil (90%, 95% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.46–7.18 (m, 6H), 6.40 (d, *J* = 1.6 Hz, 1H), 4.68 (d, *J* = 3.2 Hz, 1H), 3.03 (dt, *J* = 13.0, 2.9 Hz, 1H), 2.87–2.82 (m, 1H), 2.68 (ddd, *J* = 16.9, 11.6, 5.8 Hz, 1H), 2.44 (qd, *J* = 12.4, 5.7 Hz, 1H), 1.99–1.94 (m, 1H), 1.46 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 152.8, 142.1, 141.4, 128.7, 128.3, 126.9, 119.3, 109.9, 66.5, 46.7, 23.7, 22.1. [α]_D²⁰ = +157.27 (*c* 0.22, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 0.5 mL/min), 25 °C, *t*_{major} = 53.347 min, *t*_{minor} = 97.326 min.



(1R,2S)-2-(2-Methoxyphenyl)-7-methyl-1,2,3,4-tetrahydronaphthalen-1-ol (2ag): White solid (98%, 91% ee, >20:1 dr). Mp: 88–89 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.40–7.36 (m, 1H), 7.37–7.32 (m, 1H), 7.26 (s, 1H), 7.19–7.15 (m, 2H), 7.09 (dt, *J* = 13.6, 1.2 Hz, 1H), 7.00 (dd, *J* = 8.4, 1.2 Hz, 1H), 4.93 (dd, *J* = 2.8, 0.8 Hz, 1H), 3.91 (s, 3H), 3.65 (dt, *J* = 13.2, 2.8 Hz, 1H), 3.12–3.06 (m, 1H), 2.58–2.47 (m, 1H), 2.43 (s, 3H), 1.93–1.87 (m, 1H), 1.66 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 157.1, 137.8, 135.5, 133.8, 131.2, 130.7, 129.0, 128.9, 128.7, 127.7, 120.7, 110.2, 69.1, 55.3, 39.2, 29.7, 21.5, 21.0. IR (KBr) (ν/cm⁻¹): 3752, 3645, 2926, 1631, 1500, 1234, 1021, 758. HRMS (ESI): *m/z* for C₁₈H₂₀O₂Na [M+Na]⁺ calcd 291.1361, found 291.1369. [α]_D²⁵ = +181.46 (*c* 0.30, CH₂Cl₂). HPLC (Chiralpak IB-3, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 9.438 min, *t*_{minor} = 13.011 min.

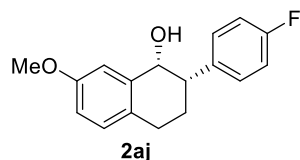


(1R,2S)-6-Chloro-2-(2-fluorophenyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2ah): White solid (98%, 96% ee, >20:1 dr). Mp: 121–122 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.31–7.18 (m, 5H), 7.15–7.06 (m, 2H), 4.62 (d, *J* = 3.2 Hz, 1H), 3.40 (dt, *J* = 13.2, 2.8 Hz, 1H), 2.99–2.93 (m, 1H), 2.90–2.81 (m, 1H), 2.33–2.22 (m, 1H), 2.12 (brs, 1H), 1.84–1.78 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 161.7 (d, *J* = 243.6 Hz), 139.4, 134.9, 131.6, 130.4 (d, *J* = 11.0 Hz), 129.6 (d, *J* = 4.5 Hz), 129.0 (d, *J* = 14.1 Hz), 128.2 (t, *J* = 2.7 Hz), 124.2, 124.1, 115.4, 115.1, 69.0, 38.3 (d, *J* = 1.6 Hz), 29.3, 21.0. ¹⁹F NMR (376 MHz, CDCl₃) δ -118.8; IR (KBr) (ν/cm⁻¹): 3756, 3679, 3568, 2926, 1631, 1457, 1228, 1086, 959. HRMS (ESI): *m/z* for C₁₆H₁₄ClFONa [M+Na]⁺ calcd 299.0615, found 299.0623. [α]_D²⁵ = +102.27 (*c* 0.30, CH₂Cl₂). HPLC (Chiralpak IE, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 9.291 min, *t*_{minor} = 16.847 min.

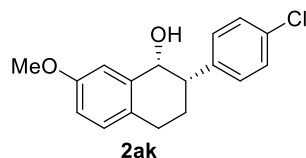


(1R,2S)-7-Methoxy-2-(4-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2ai): White solid (98%, 99% ee, >20:1 dr). Mp: 84–85 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.19–7.14 (m, 4H), 7.06 (d, *J* = 8.4 Hz, 1H), 6.84–6.80 (m, 2H), 4.65 (d, *J* = 4.8 Hz, 1H), 3.76 (s, 3H), 3.01 (dt, *J* = 12.4, 3.2 Hz, 1H), 2.94–2.87 (m, 1H), 2.83–2.74 (m, 1H), 2.37–2.28 (m, 4H), 1.90–1.84 (m, 1H), 1.71 (s, 1H). ¹³C NMR

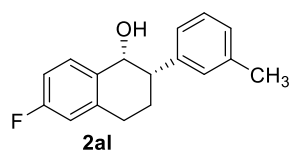
(100 MHz, CDCl₃) δ 157.9, 139.5, 138.7, 136.3, 130.0, 129.3, 128.8, 128.1, 114.9, 114.5, 71.5, 55.3, 45.6, 28.9, 22.0, 21.1. IR (KBr) (v/cm⁻¹): 3746, 3572, 2926, 1688, 1031, 1500, 1234, 1026, 823, 758. HRMS (ESI): m/z for C₁₈H₂₀O₂Na [M+Na]⁺ calcd 291.1361, found 291.1368. [α]_D²⁵ = +130.67 (*c* 0.30, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, t_{major} = 25.107 min, t_{minor} = 49.728 min.



(1R,2S)-2-(4-Fluorophenyl)-7-methoxy-1,2,3,4-tetrahydronaphthalen-1-ol (2aj): White solid (96%, 99.1% ee, >20:1 dr). Mp: 75–76 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.25–7.21 (m, 2H), 7.09–6.99 (m, 3H), 6.84–6.80 (m, 2H), 4.61 (d, *J* = 3.2 Hz, 1H), 3.76 (s, 3H), 3.00 (dt, *J* = 12.8, 2.8 Hz, 1H), 2.93–2.87 (m, 1H), 2.84–2.79 (m, 1H), 2.35–2.20 (m, 1H), 1.88–1.82 (m, 1H), 1.80 (brs, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 161.8 (d, *J* = 243.2 Hz), 157.9, 138.7, 138.4 (d, *J* = 3.3 Hz), 130.1, 129.7 (d, *J* = 7.6 Hz), 128.6, 115.3 (d, *J* = 20.2 Hz), 115.0, 114.5, 71.4, 55.4, 45.3, 28.8, 22.2. ¹⁹F NMR (376 MHz, CDCl₃) δ -116.8. IR (KBr) (v/cm⁻¹): 3752, 3644, 2932, 1599, 1508, 1279, 1113, 827. HRMS (ESI): m/z for C₁₇H₁₇FO₂Na [M+Na]⁺ calcd 295.1110, found 295.1115. [α]_D²⁵ = +132.67 (*c* 0.30, CH₂Cl₂). HPLC (Chiralpak IB-3, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, t_{major} = 15.822 min, t_{minor} = 27.449 min.

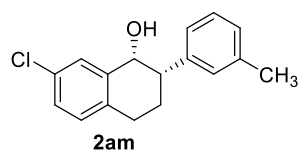


(1R,2S)-2-(4-Chlorophenyl)-7-methoxy-1,2,3,4-tetrahydronaphthalen-1-ol (2ak): White solid (95%, 99.2% ee, >20:1 dr). Mp: 76–77 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.31–7.26 (m, 2H), 7.22–7.17 (m, 2H), 7.06 (d, *J* = 4.8 Hz, 1H), 6.83–6.80 (m, 2H), 4.58 (d, *J* = 3.2 Hz, 1H), 3.76 (s, 3H), 2.97 (dt, *J* = 12.8, 2.8 Hz, 1H), 2.91–2.85 (m, 1H), 2.82–2.74 (m, 1H), 2.30–2.19 (m, 1H), 1.88–1.77 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 158.0, 141.3, 138.7, 132.4, 130.1, 129.7, 128.6, 128.5, 115.0, 114.5, 71.3, 55.4, 45.5, 28.8, 22.1. IR (KBr) (v/cm⁻¹): 3758, 1771, 1523, 1456, 1088. HRMS (ESI): m/z for C₁₇H₁₇ClO₂Na [M+Na]⁺ calcd 311.0815, found 311.0828. [α]_D²⁵ = +121.87 (*c* 0.30, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, t_{major} = 29.506 min, t_{minor} = 50.045 min.

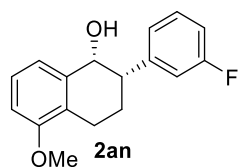


(1R,2S)-6-Fluoro-2-(3-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2al): White solid (97%, 99% ee, >20:1 dr). Mp: 61–62 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.28–7.22 (m, 2H), 7.13–7.05 (m, 3H),

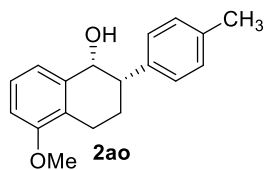
6.94–6.81 (m, 2H), 4.69 (d, $J = 3.2$ Hz, 1H), 3.01 (dt, $J = 13.2, 2.8$ Hz, 1H), 2.96–2.94 (m, 1H), 2.90–2.81 (m, 1H), 2.41–2.31 (m, 4H), 1.92–1.86 (m, 1H) 1.67 (brs, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.4 (d, $J = 244.7$ Hz), 142.3, 139.2 (d, $J = 7.6$ Hz), 138.3, 133.5 (d, $J = 2.9$ Hz), 132.3 (d, $J = 8.4$ Hz), 129.0, 128.6, 127.7, 125.2, 115.1 (d, $J = 20$ Hz), 113.4 (d, $J = 21.4$ Hz), 70.7, 46.0, 29.9 (d, $J = 1.7$ Hz), 21.6, 21.1. ^{19}F NMR (376 MHz, CDCl_3) δ -114.1. IR (KBr) (v/cm^{-1}): 3758, 3574, 2932, 1682, 1455, 1080, 872. HRMS (ESI): m/z for $\text{C}_{17}\text{H}_{17}\text{FONa}$ $[\text{M}+\text{Na}]^+$ calcd 279.1161, found 279.1169. $[\alpha]_{\text{D}}^{25} = +154.72$ (c 1.18, CH_2Cl_2). HPLC (Chiralpak IE, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 8.931$ min, $t_{\text{minor}} = 17.814$ min.



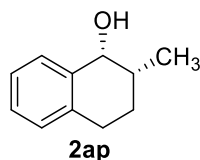
(1R,2S)-7-Chloro-2-(3-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2am): White solid (96%, 99.4% ee, >20:1 dr). Mp: 81–82 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.29–7.28 (m, 1H), 7.25 (d, $J = 8.0$ Hz, 1H), 7.20 (dd, $J = 8.4, 1.6$ Hz, 1H), 7.13–7.06 (m, 4H), 4.62 (d, $J = 3.2$ Hz, 1H), 3.04–2.90 (m, 2H), 2.88–2.75 (m, 1H), 2.38 (s, 3H), 2.36–2.27 (m, 1H), 1.96–1.85 (m, 1H), 1.82 (s, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 142.0, 139.4, 138.3, 135.2, 131.5, 130.4, 130.3, 129.1, 128.7, 128.2, 127.8, 125.2, 70.9, 45.8, 29.2, 21.6, 21.5. IR (KBr) (v/cm^{-1}): 3726, 3675, 2910, 1652, 1590, 1450, 1028, 868, 805. HRMS (ESI): m/z for $\text{C}_{17}\text{H}_{17}\text{ClONa}$ $[\text{M}+\text{Na}]^+$ calcd 295.0866, found 295.0875. $[\alpha]_{\text{D}}^{25} = +124.00$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IB-3, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 8.040$ min, $t_{\text{minor}} = 9.087$ min.



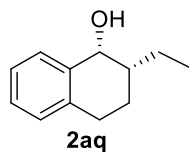
(1R,2S)-2-(3-Fluorophenyl)-5-methoxy-1,2,3,4-tetrahydronaphthalen-1-ol (2an): White solid (96%, 99% ee, >20:1 dr). Mp: 51–52 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.28 (td, $J = 8.0, 6.0$ Hz, 1H), 7.19 (t, $J = 7.6$ Hz, 1H), 7.05 (dt, $J = 7.6, 1.2$ Hz, 1H), 7.00 (dt, $J = 10.0, 2.4$ Hz, 1H), 6.93 (tdd, $J = 8.5, 2.7, 1.0$ Hz, 1H), 6.88 (dd, $J = 7.6, 1.2$ Hz, 1H), 6.78 (dd, $J = 8.4, 1.2$ Hz, 1H), 4.62 (d, $J = 2.4$ Hz, 1H), 3.82 (s, 3H), 3.06–3.00 (m, 1H), 2.95 (dt, $J = 13.3, 2.8$ Hz, 1H), 2.63–2.47 (m, 1H), 2.21 (qd, $J = 12.7, 5.7$ Hz, 1H), 1.92–1.82 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 163.0 (d, $J = 244.0$ Hz), 157.3, 145.8 (d, $J = 6.9$ Hz), 138.9, 129.9, 129.8, 126.8, 125.6, 123.9 (d, $J = 2.8$ Hz), 122.4, 115.3 (d, $J = 21.0$ Hz), 113.3 (d, $J = 21.0$ Hz), 109.3, 71.1, 55.4, 45.4 (d, $J = 1.8$ Hz), 23.7, 20.9. ^{19}F NMR (376 MHz, CDCl_3) δ -113.2. IR (KBr) (v/cm^{-1}): 3752, 3649, 2932, 1715, 1299, 1508, 1155, 1034, 827. HRMS (ESI): m/z for $\text{C}_{17}\text{H}_{17}\text{FO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$ calcd 295.1110, found 295.1112. $[\alpha]_{\text{D}}^{25} = +147.33$ (c 0.30, CH_2Cl_2). HPLC (Chiralpak IA, n -hexane/ i -PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, $t_{\text{major}} = 12.784$ min, $t_{\text{minor}} = 27.327$ min.



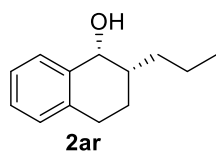
(1R,2S)-5-Methoxy-2-(4-tolyl)-1,2,3,4-tetrahydronaphthalen-1-ol (2ao): Colorless oil (98%, 98% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.20–7.14 (m, 5H), 6.92 (d, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 8.4 Hz, 1H), 4.69 (d, *J* = 2.4 Hz, 1H), 3.81 (s, 3H), 3.09–3.03 (m, 1H), 3.00–2.96 (m, 1H), 2.61–2.52 (m, 1H), 2.36–2.26 (m, 4H), 1.95–1.90 (m, 1H), 1.65 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 157.3, 139.7, 139.0, 136.2, 129.3, 128.1, 126.7, 125.8, 122.5, 109.1, 71.3, 55.4, 45.1, 23.8, 21.1, 21.0. IR (KBr) (ν/cm⁻¹): 3748, 3509, 2930, 1739, 1645, 1400, 1230, 1082, 979, 788. HRMS (ESI): *m/z* for C₁₈H₂₀O₂Na [M+Na]⁺ calcd 291.1361, found 291,1362. [α]_D²⁵ = +126.97 (*c* 1.07, CH₂Cl₂). HPLC (Chiralpak IE, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 15.309 min, *t*_{minor} = 31.626 min.



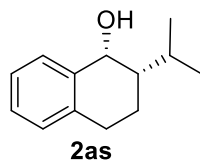
(1R,2S)-2-Methyl-1,2,3,4-tetrahydronaphthalen-1-ol (2ap):^[111] Pale yellow oily (98%, 99.1% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.27–7.22 (m, 1H), 7.15–7.06 (m, 2H), 7.06–7.02 (m, 1H), 4.46 (d, *J* = 3.2 Hz, 1H), 2.82–2.73 (m, 1H), 2.72–2.63 (m, 1H), 1.88–1.75 (m, 1H), 1.72–1.61 (m, 1H), 1.59–1.53 (m, 1H), 1.52 (s, 1H), 1.04 (d, *J* = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 138.7, 136.8, 129.9, 129.1, 127.8, 126.1, 71.5, 34.3, 29.0, 24.8, 17.0. [α]_D²⁵ = +65.83 (*c* 0.24, CH₂Cl₂). SFC (Waters Trefoil CEL2, 98% CO₂, 2% *i*-PrOH, UV = 210 nm, flow rate = 0.8 mL/min), 35 °C, *t*_{minor} = 7.902 min, *t*_{major} = 8.234 min.



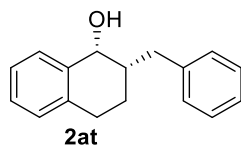
(1R,2S)-2-Ethyl-1,2,3,4-tetrahydronaphthalen-1-ol (2aq):^[16] Pale yellow oily (96%, 99.4% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.36–7.33 (m, 1H), 7.24–7.17 (m, 2H), 7.15–7.11 (m, 1H), 4.67 (d, *J* = 2.8 Hz, 1H), 2.96–2.84 (m, 1H), 2.84–2.72 (m, 1H), 1.79–1.68 (m, 2H), 1.68–1.56 (m, 2H), 1.51–1.40 (m, 2H), 1.05 (t, *J* = 7.2 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 138.7, 137.2, 130.1, 129.1, 127.9, 126.1, 69.7, 41.4, 29.3, 24.4, 22.8, 11.7. [α]_D²⁵ = +79.17 (*c* 0.24, CH₂Cl₂). HPLC (Chiralcel OX-H, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{minor} = 10.136 min, *t*_{major} = 12.606 min.



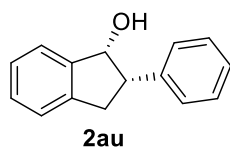
(1R,2S)-2-Propyl-1,2,3,4-tetrahydronaphthalen-1-ol (2ar): Yellow oily (97%, 99.4% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.37–7.33 (m, 1H), 7.25–7.17 (m, 2H), 7.15–7.11 (m, 1H), 4.64 (d, *J* = 2.0 Hz, 1H), 2.95–2.83 (m, 1H), 2.83–2.70 (m, 1H), 1.82–1.66 (m, 3H), 1.65–1.56 (m, 1H), 1.54–1.45 (m, 3H), 1.44–1.36 (m, 1H), 0.97 (t, *J* = 7.2 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 138.8, 137.2, 130.1, 129.1, 127.9, 126.1, 70.1, 39.2, 33.8, 29.2, 23.0, 20.2, 14.4. IR (KBr) (ν/cm⁻¹): 3736, 3651, 3568, 1649, 1512, 1265, 940. HRMS (ESI): *m/z* for C₁₃H₁₈ONa [M+Na]⁺ calcd 213.1255, found 213.1263. [α]_D²⁵ = +66.00 (*c* 0.30, CH₂Cl₂). HPLC (Chiralcel OX-H, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{minor} = 9.160 min, *t*_{major} = 11.129 min.



(1R,2S)-2-Isopropyl-1,2,3,4-tetrahydronaphthalen-1-ol (2as): Yellow oily (97%, 99.6% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.37 (dd, *J* = 6.8, 2.0 Hz, 1H), 7.29–7.21 (m, 2H), 7.18 (dd, *J* = 6.8, 2.0 Hz, 1H), 4.85 (d, *J* = 2.8 Hz, 1H), 2.96 (ddd, *J* = 17.1, 5.6, 2.0 Hz, 1H), 2.83–2.74 (m, 1H), 2.02–1.90 (m, 1H), 1.89–1.80 (m, 1H), 1.71 (qd, *J* = 12.8, 5.5 Hz, 1H), 1.31 (ddt, *J* = 12.3, 9.3, 2.8 Hz, 1H), 1.16 (d, *J* = 6.8 Hz, 3H), 1.09 (d, *J* = 6.8 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 138.9, 137.2, 130.3, 129.02, 128.0, 126.1, 68.9, 46.7, 29.8, 28.7, 21.1, 20.8, 20.5. IR (KBr) (ν/cm⁻¹): 3744, 3564, 2936, 1690, 1542, 1453, 1263, 1076. HRMS (ESI): *m/z* for C₁₃H₁₈ONa [M+Na]⁺ calcd 213.1255, found 213.1262. [α]_D²⁵ = +68.83 (*c* 0.34, CH₂Cl₂). HPLC (Chiralcel OX-H, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{minor} = 8.189 min, *t*_{major} = 9.938 min.



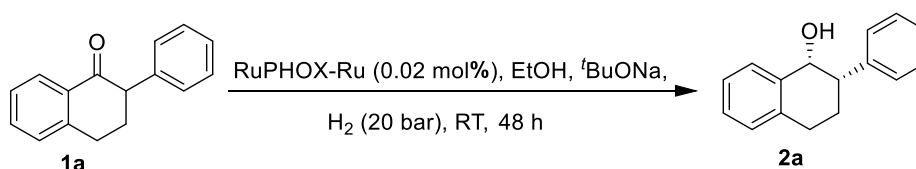
(1R,2S)-2-Benzyl-1,2,3,4-tetrahydronaphthalen-1-ol (2at):^[21] White solid (95%, 99% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.32–7.08 (m, 9H), 4.49 (d, *J* = 2.8 Hz, 1H), 2.99–2.89 (m, 1H), 2.85 (ddd, *J* = 17.2, 5.7, 2.4 Hz, 1H), 2.76–2.68 (m, 2H), 2.05–2.00 (m, 1H), 1.87–1.75 (m, 1H), 1.71–1.65 (m, 1H), 1.59 (dd, *J* = 9.6, 5.2 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 140.8, 138.6, 137.0, 130.1, 129.3, 129.2, 128.4, 128.1, 126.2, 126.0, 69.4, 41.8, 38.3, 29.3, 22.6. [α]_D²⁵ = +83.73 (*c* 0.30, CH₂Cl₂). HPLC (Chiralcel AD-H, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), 25 °C, *t*_{major} = 10.405 min, *t*_{minor} = 12.670 min.



(1R,2S)-2-Phenyl-2,3-dihydro-1H-inden-1-ol (2au):^[17] White solid (98%, 97% ee, >20:1 dr). ¹H NMR (400 MHz, CDCl₃) δ 7.36 (d, *J* = 7.2 Hz, 1H), 7.28–7.11 (m, 8H), 5.14 (d, *J* = 6.0 Hz, 1H), 3.65 (td, *J* = 7.6, 5.8 Hz, 1H), 3.31 (dd, *J* = 15.8, 7.8 Hz, 1H), 3.13 (dd, *J* = 15.8, 7.7 Hz, 1H), 1.41 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 143.8, 143.2, 139.3, 128.9, 128.7, 128.6, 127.1, 127.0, 125.2, 124.8, 77.5, 51.1, 35.8. [α]_D²⁵ = +105.71 (*c* 0.28, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 99.5/0.5, UV = 220 nm, flow rate = 0.5 mL/min), 25 °C, *t*_{major} = 61.442 min, *t*_{minor} = 90.475 min.

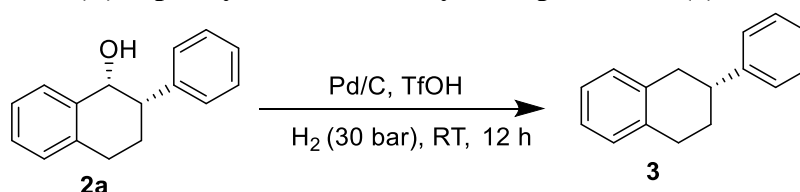
4. Scale-up Synthesis and Transformations

4.1 Scale-up synthesis of 2a



The substrate **1a** (1.24 g, 5.6 mmol), (*S,S*)-RuPHOX-Ru (1.04 mg, 0.02% mmol) and *t*BuONa (1.24 g, 2.8 mmol) were placed in a 50 mL flame-dried round bottom flask equipped with a magnetic stir bar. The mixture was dissolved in anhydrous and degassed EtOH (20 mL) in a glove box. This flask was put into an autoclave. After purging with hydrogen three times, the hydrogen pressure was finally pressurized to 20 bar. The reaction mixture was vigorously stirred at room temperature for 48 h. The reaction mixture was concentrated and purified via silica gel column chromatography (PE/EtOAc = 10/1) to provide **2a** (1.17 g, 94%, 99.1% ee, >20:1 dr). [α]_D²⁵ = +162.00 (*c* 0.30, CH₂Cl₂). HPLC conditions: Chiralpak IA Column, *n*-hexane/*i*-PrOH = 95/5, 220 nm, 1.0 mL/min, *t*_{major} = 12.425 min, *t*_{minor} = 25.540 min, 99.1% ee.

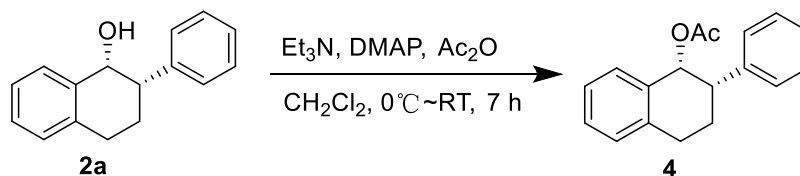
4.2 Synthesis of (*R*)-2-phenyl-1,2,3,4-tetrahydronaphthalene (**3**)^[18]



A hydrogenation tube was charged with a stirring bar, **2a** (0.22 mmol), Pd/C (20% mmol) and TfOH (0.2 equiv). MeOH (2 mL) was then injected into the hydrogenation tube by a syringe. The hydrogenation tube was then put into an autoclave. The autoclave was then charged with hydrogen to 30 bar hydrogen pressure, and the reaction mixture was stirred at RT for 12 h. The solvent was evaporated to afford the crude product and it was purified by a silica gel column chromatography (PE: EtOAc = 10:1) to give pure product **3** as colorless oil (47 mg, 99%).^[19] ¹H NMR (400 MHz,

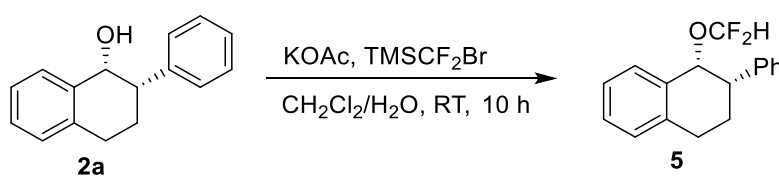
CDCl₃) δ 7.27–7.11 (m, 5H), 7.06–7.00 (m, 4H), 3.00–2.81 (m, 5H), 2.09–2.03 (m, 1H), 1.92–1.78 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 146.7, 136.7, 136.3, 129.1, 129.0, 128.6, 126.9, 126.3, 125.8, 125.7, 40.8, 37.8, 30.4, 29.8. $[\alpha]_D^{25} = +44.11$ (*c* 0.36, CH₂Cl₂); HPLC (Chiralcel OD-H, *n*-hexane/*i*-PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), $t_{\text{minor}} = 6.080$ min and $t_{\text{major}} = 6.732$ min, 99.8% ee.

4.3 Synthesis of (1*R*,2*S*)-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-yl acetate (**4**)^[20]



Et₃N (1.34 mmol) and 4-dimethylaminopyridine (DMAP, cat.) were added to a stirred solution of **2a** (150 mg, 0.67 mmol) in DCM (10 mL), followed by the addition of acetic anhydride (1.68 mmol) at 0 °C. The reaction mixture was stirred at room temperatures for 7 h. Then the reaction mixture was diluted with water, and the aqueous phase was extracted with DCM (10 mL × 3). The combined organic phase was washed with saturated aqueous NaHCO₃ (10 mL × 3) and brine (10 mL × 3) and dried over anhydrous Na₂SO₄. Then the solvent was evaporated to provide crude product, which was then purified via silica gel column chromatography (PE/EtOAc = 20/1) to afford pure **4** as white solid (175 mg, 98%).^[21] ¹H NMR (400 MHz, CDCl₃) δ 7.39 (d, *J* = 7.2 Hz, 1H), 7.35–7.14 (m, 8H), 6.21 (d, *J* = 3.3 Hz, 1H), 3.19 (dt, *J* = 13.0, 3.1 Hz, 1H), 3.08 (ddd, *J* = 17.2, 5.6, 2.2 Hz, 1H), 3.00–2.90 (m, 1H), 2.47 (qd, *J* = 12.7, 5.6 Hz, 1H), 2.09–1.98 (m, 1H), 1.78 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 170.1, 141.9, 137.2, 135.0, 130.7, 129.1, 128.6, 128.2, 128.1, 126.8, 126.3, 72.0, 44.5, 29.5, 22.7, 21.0. $[\alpha]_D^{25} = +284.67$ (*c* 0.24, CH₂Cl₂). HPLC (Chiralcel AD-H, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), $t_{\text{minor}} = 5.208$ min and $t_{\text{major}} = 5.889$ min, >20:1 dr, 99.3% ee.

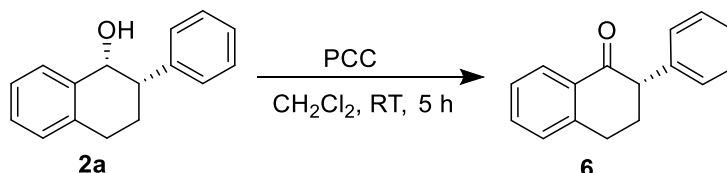
4.4 Synthesis of (1*R*,2*S*)-1-(difluoromethoxy)-2-phenyl-1,2,3,4-tetrahydronaphthalene (**5**)^[22]



To a 10 mL shrek tube were added **2a** (0.5 mmol) and KOAc (3.0 mmol). Then CH₂Cl₂ (0.3 mL) and H₂O (0.3 mL) were added. The reactions were stirred at room temperature and TMSCF₂Br (1.5 mmol) was added. After 10 hours, the mixture was diluted with CH₂Cl₂ (5 mL) and purified via a silica gel column chromatography (PE/EtOAc = 10/1) to afford pure **5** as a white solid (197 mg, 76%). Mp: 64–65 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.35–7.17 (m, 9H), 5.85–5.46 (m, 1H), 5.08 (s, 1H), 3.15–3.12 (m, 1H), 3.09–3.02 (m, 1H), 2.55–2.44 (m, 1H), 2.03–1.97 (m, 1H). ¹³C NMR

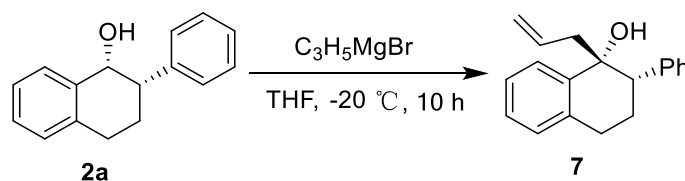
(100 MHz, CDCl₃) δ 141.7, 137.3, 134.2, 130.4, 129.4, 128.9, 128.4 (d, $J = 6.0$ Hz), 127.0, 126.2, 116.5 (dd, $J = 259.0, 253.4$ Hz), 76.2, 45.1, 29.1, 22.3. ¹⁹F NMR (376 MHz, CDCl₃) δ -80.0 (dd, $J = 445.6, 161.7$ Hz, 2F). IR (KBr) (ν/cm^{-1}): 3732, 3647, 3564, 3066, 2934, 2308, 1498, 1455, 1188, 1019, 748. HRMS (ESI): m/z for C₁₆H₁₅ [M-OCF₂H]⁺ calcd 207.1174, found 207.1177. $[\alpha]_{\text{D}}^{25} = +143.83$ (c 0.24, CH₂Cl₂). SFC (Waters Trefoil CEL1, 98% CO₂, 2% EtOH, UV = 210 nm, flow rate = 0.5 mL/min), $t_{\text{major}} = 7.300$ min and $t_{\text{minor}} = 9.486$ min, >20:1 dr, 92% ee.

4.5 Synthesis of (*S*)-2-phenyl-3,4-dihydronaphthalen-1(2*H*)-one (**6**)^[18]



2a (0.45 mmol) was treated with PCC (155 mg) in CH₂Cl₂ (2 mL) at room temperature for 5 h before evaporation of DCM. Then Et₂O (10 mL) was added to the residue. The resulting mixture was filtered through a plug of silica washing with Et₂O (5 mL). The solvent was evaporated to give crude product which was purified by a silica gel column chromatography (PE/EtOAc = 10:1) to give pure product **6** as white solid (99.2mg, 99%). ¹H NMR (400 MHz, CDCl₃) δ 8.10 (dd, $J = 7.6, 0.8$ Hz, 1H), 7.51 (dt, $J = 13.6, 1.2$ Hz, 1H), 7.36–7.33 (m, 3H), 7.29–7.25 (m, 2H), 7.20–7.18 (m, 2H), 3.83–3.79 (m, 1H), 3.17–3.01 (m, 2H), 2.47–2.41 (m, 2H). $[\alpha]_{\text{D}}^{25} = +28.00$ (c 0.30, CH₂Cl₂). HPLC (Chiralpak IA, *n*-hexane/*i*-PrOH = 95/5, UV = 220 nm, flow rate = 1.0 mL/min), $t_{\text{minor}} = 8.874$ min and $t_{\text{major}} = 10.919$ min, 97% ee.

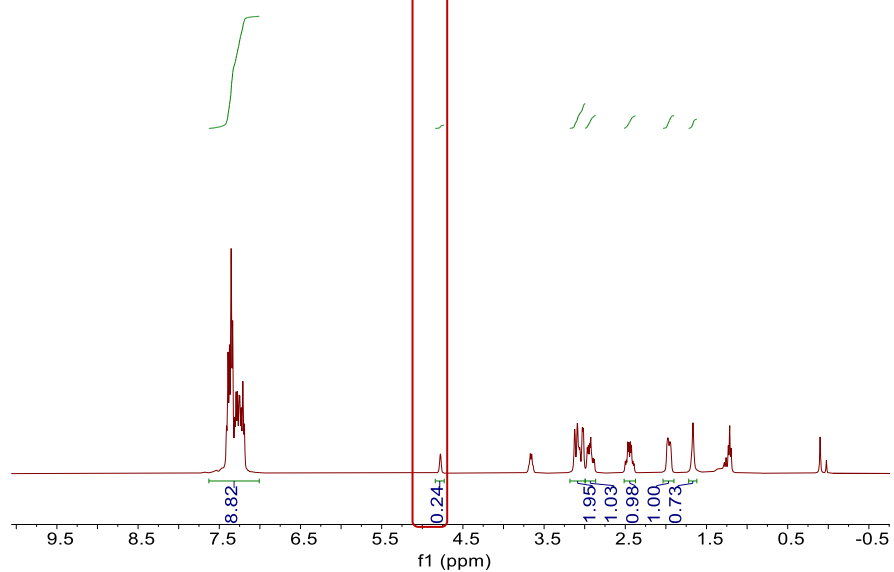
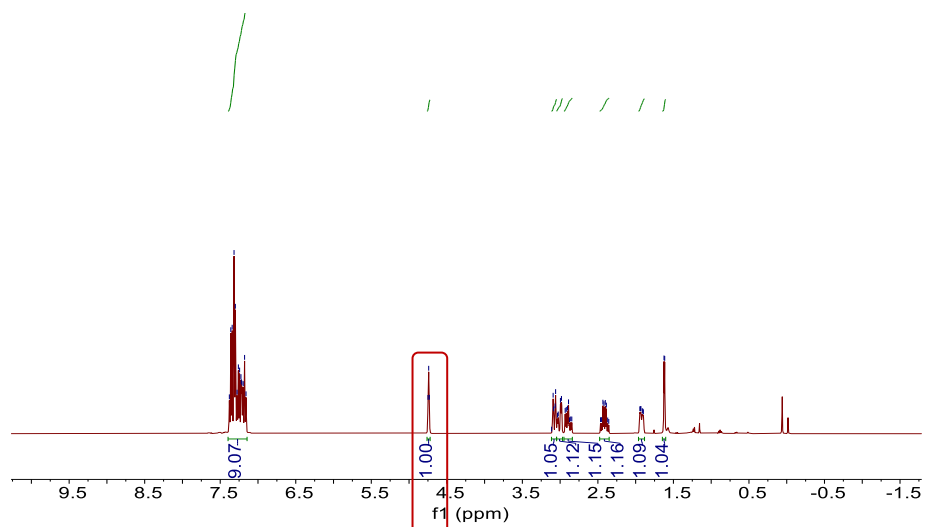
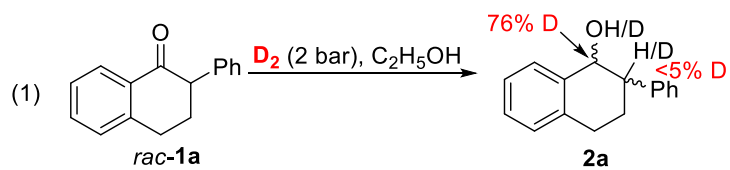
4.6 Synthesis of (1*R*,2*S*)-1-allyl-2-phenyl-1,2,3,4-tetrahydronaphthalen-1-ol (**7**)

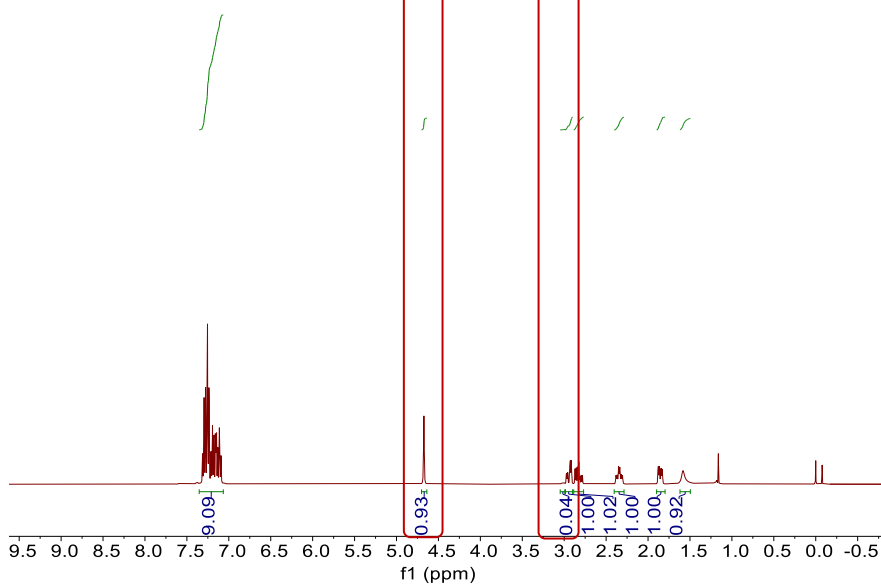
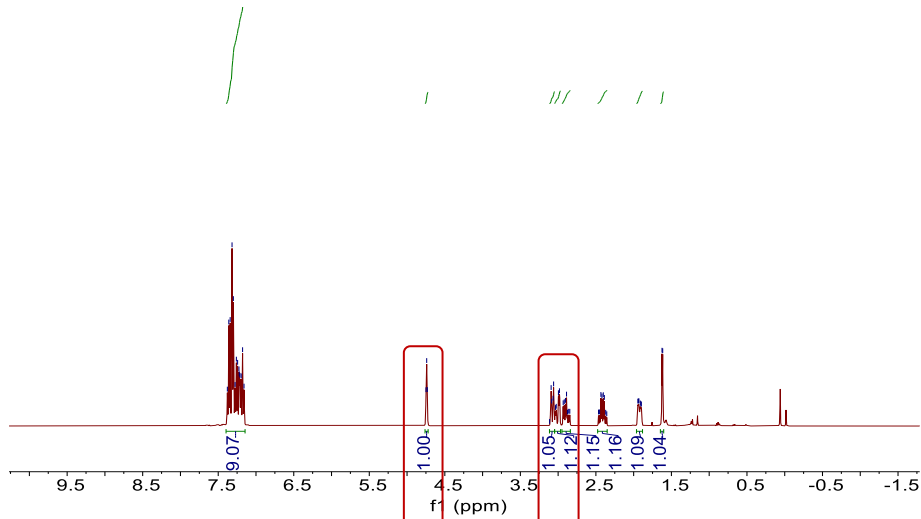
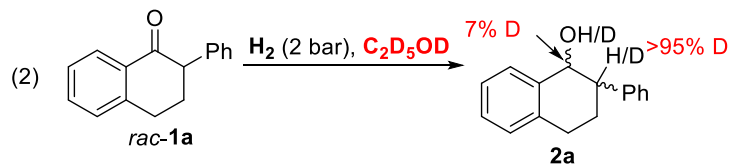


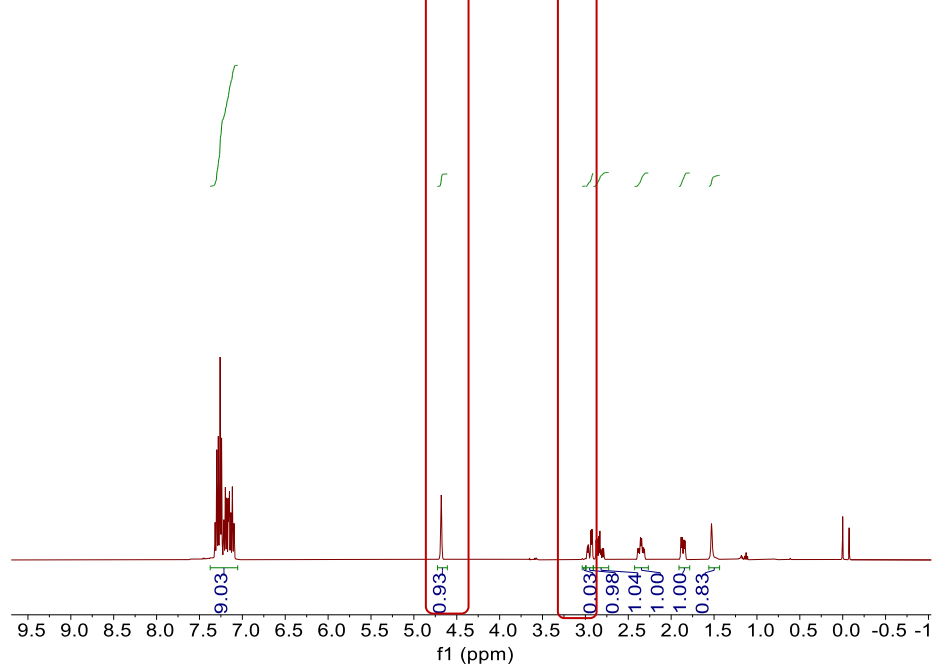
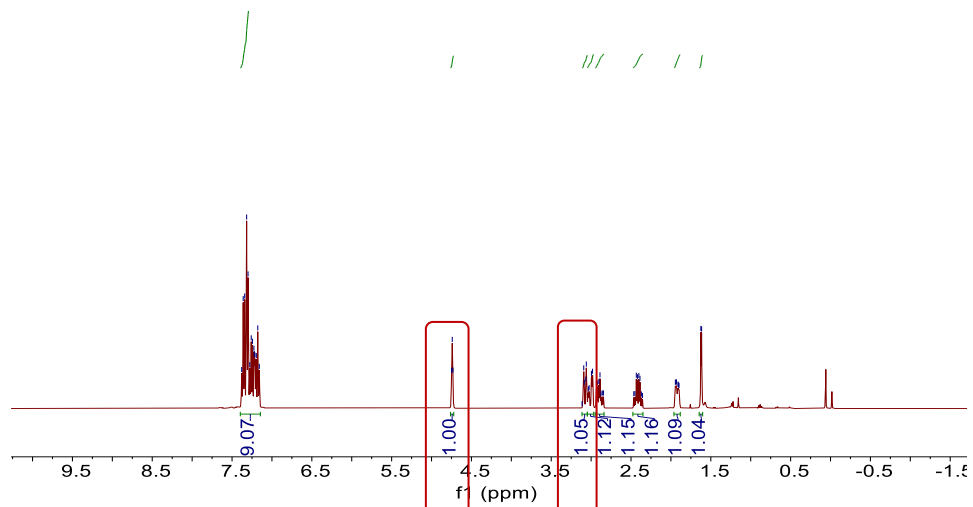
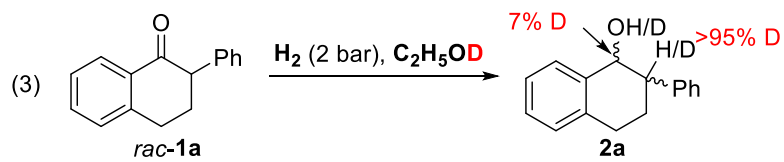
To a 10 mL Shrek tube were added **2a** (0.4 mmol) and THF (2 mL). Then C₃H₅MgBr (0.48 mmol) was added dropwise at -20 °C. After 10 hours, the reaction mixture was diluted with CH₂Cl₂ (5 mL) and then purified via silica gel column chromatography (PE/EtOAc = 10/1) to afford pure **7** as a colorless oil (75 mg, 77%). ¹H NMR (400 MHz, CDCl₃) major diastereomer: δ 7.48 (dd, $J = 7.6, 1.7$ Hz, 1H), 7.28–7.06 (m, 8H), 7.02 (dd, $J = 7.3, 1.8$ Hz, 1H), 5.47–5.36 (m, 1H), 5.03–4.90 (m, 2H), 3.08 (dd, $J = 10.8, 3.2$ Hz, 1H), 2.79–2.70 (m, 2H), 2.37 (dd, $J = 14.4, 8.1$ Hz, 1H), 2.15–2.05 (m, 1H), 1.89–1.86 (m, 1H), 1.72 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 141.8, 140.4, 137.4, 134.6, 129.8, 129.0, 128.4, 127.5, 127.4, 126.9, 126.6, 118.3, 73.6, 48.2, 45.5, 29.6, 26.1. minor diastereomer δ 141.8, 141.2, 135.9, 134.2, 129.7, 128.7, 128.1, 127.4, 125.7, 118.2, 74.5, 51.9, 43.2, 29.2, 25.5. IR (KBr) (ν/cm^{-1}): 3735, 3584, 3070, 2834, 1747, 1623, 1457, 1269, 1082, 912, 768.

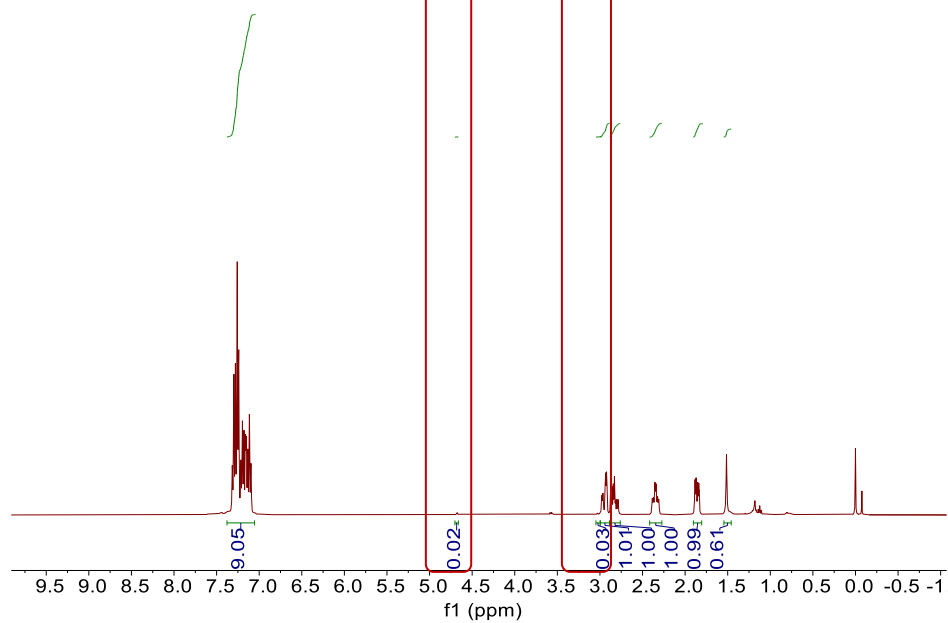
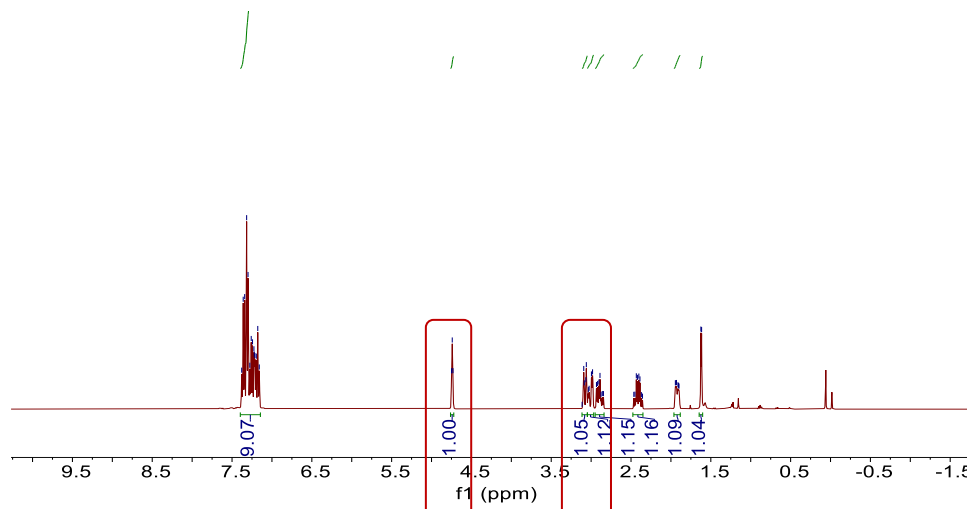
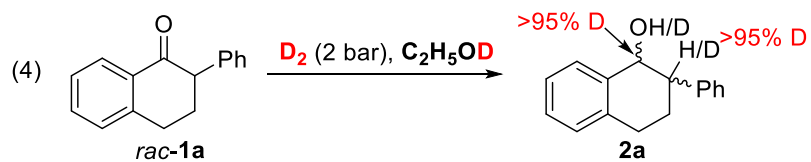
HRMS (ESI): m/z for $C_{19}H_{20}ONa [M+Na]^+$ calcd 287.1412, found 287.1419. $[\alpha]_D^{25} = +87.69$ (c 1.16, CH_2Cl_2); HPLC (Chiralcel OD-H, n -hexane/ i -PrOH = 99/1, UV = 220 nm, flow rate = 1.0 mL/min), $t_{major1} = 12.730$ min and $t_{minor1} = 18.549$ min; $t_{minor2} = 19.923$ min and $t_{major2} = 21.675$ min, dr = 3.2:1, ee = 96%, 98%.

5. Deuterium-Labeling Experiments



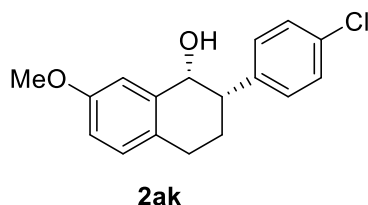
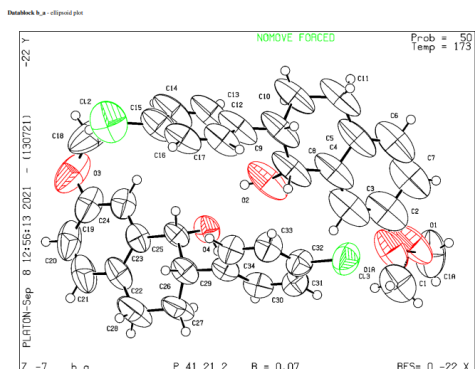






6. X-Ray Analysis

X-Ray Crystallography Data for **2ak** (2126054). A colorless crystal suitable for X-ray crystallography was obtained from a *n*-hexane/DCM solution at room temperature under air.



The ORTEP drawing (50% probability for thermal ellipsoids) of **2ak**

checkCIF/PLATON report

Structure factors have been supplied for datablock(s) b_a

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found. CIF dictionary Interpreting this report

Datablock: b_a

Bond precision: C-C = 0.0109 Å Wavelength=1.54178
Cell: a=12.7413 (4) b=12.7413 (4) c=37.1305 (16)
alpha=90 beta=90 gamma=90
Temperature: 173 K

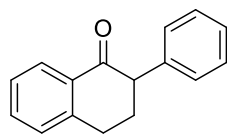
	Calculated	Reported
Volume	6027.8 (5)	6027.8 (5)
Space group	P 41 21 2	P 41 21 2
Hall group	P 4abw 2nw	P 4abw 2nw
Moiety formula	C17 H17 Cl O2	C17 H17 Cl O2
Sum formula	C17 H17 Cl O2	C17 H17 Cl O2
Mr	288.76	288.75
Dx, g cm ⁻³	1.273	1.273
Z	16	16
Mu (mm ⁻¹)	2.226	2.226
F000	2432.0	2432.0
F000'	2444.12	
h, k, lmax	15, 15, 44	15, 15, 44
Nref	5346 [3149]	5332
Tmin, Tmax	0.673, 0.800	0.624, 0.753
Tmin'	0.610	

Correction method= # Reported T Limits: Tmin=0.624 Tmax=0.753
AbsCorr = NONE

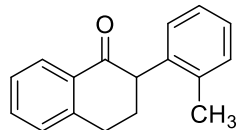
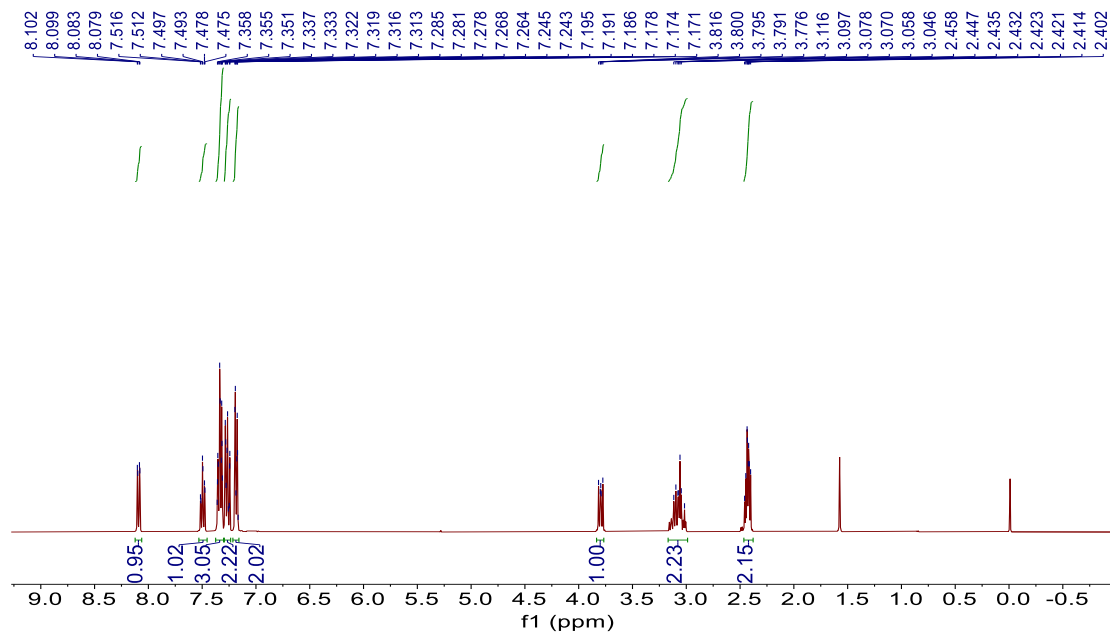
Data completeness= 1.69/1.00 Theta(max)= 66.783

R(reflections)= 0.0706 (4551) wR2(reflections)=
S = 1.098 Npar= 383 0.2100 (5332)

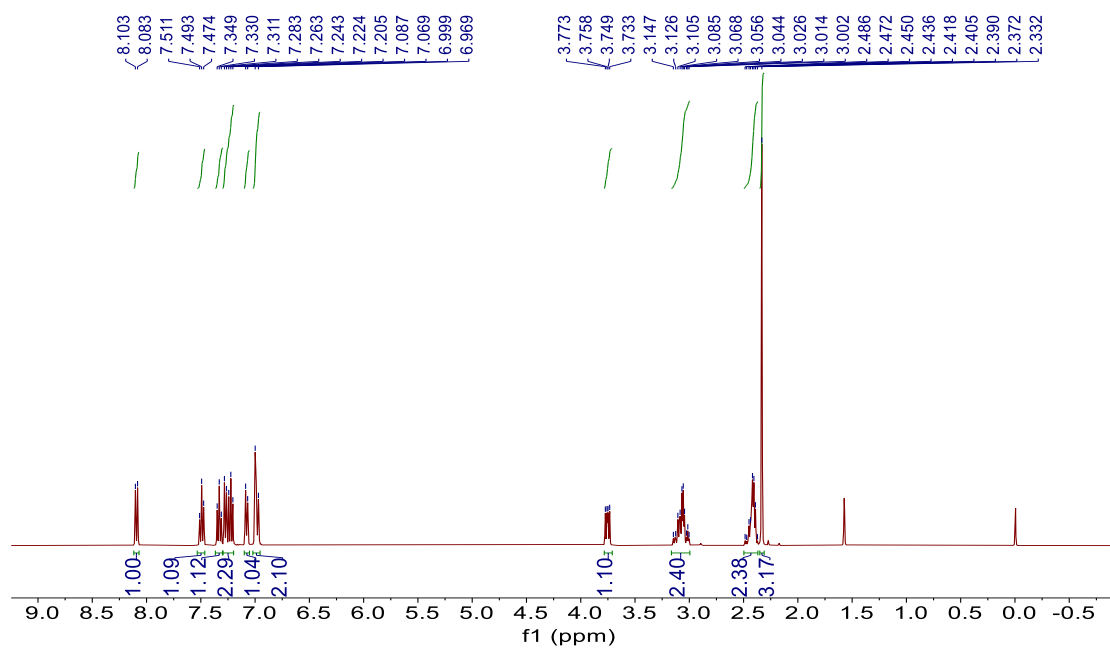
7. NMR Spectra

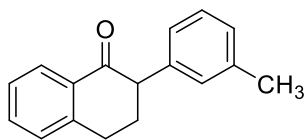


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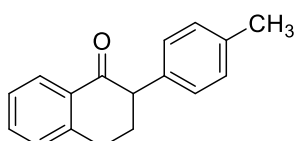
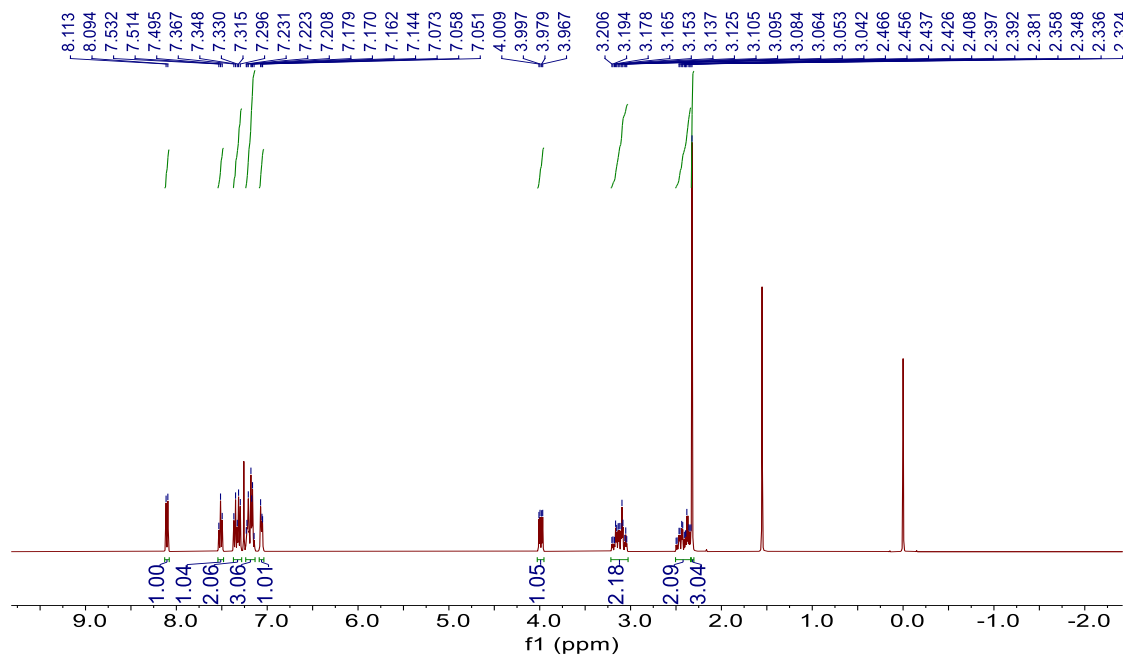


1b

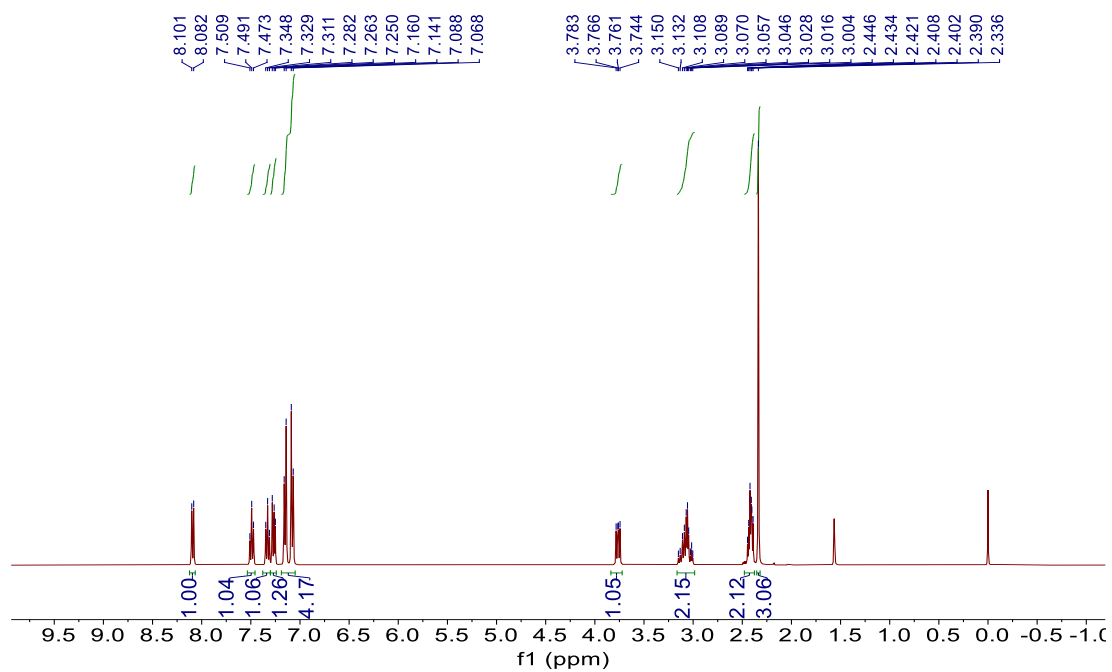


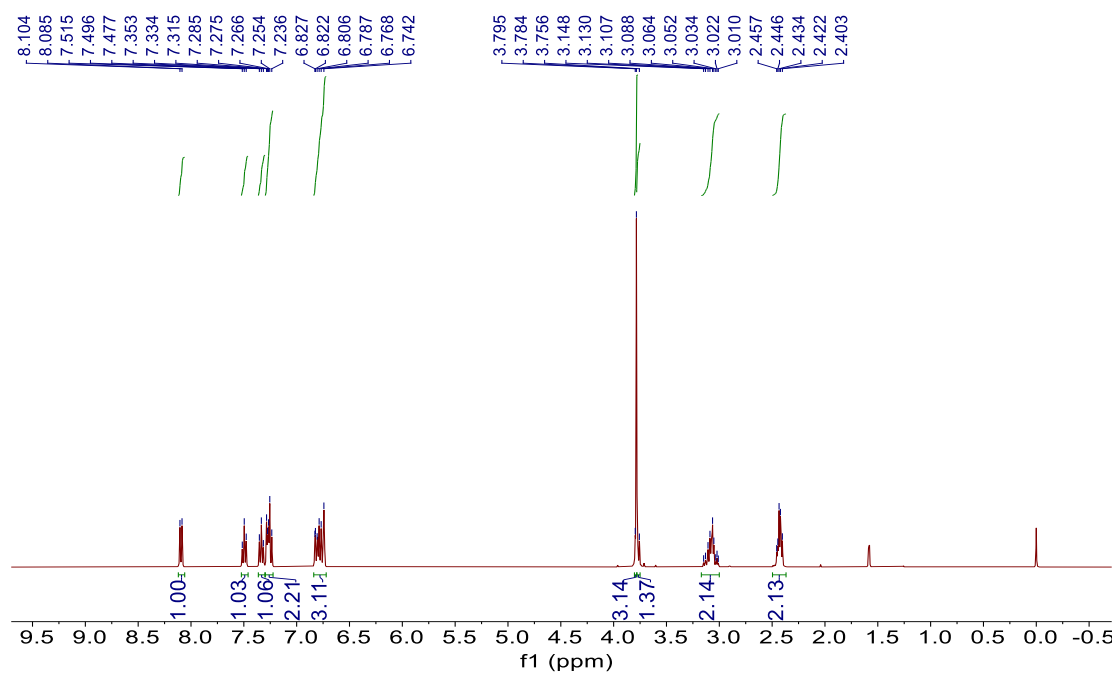
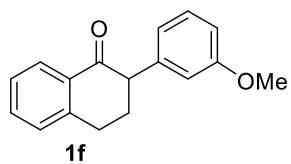
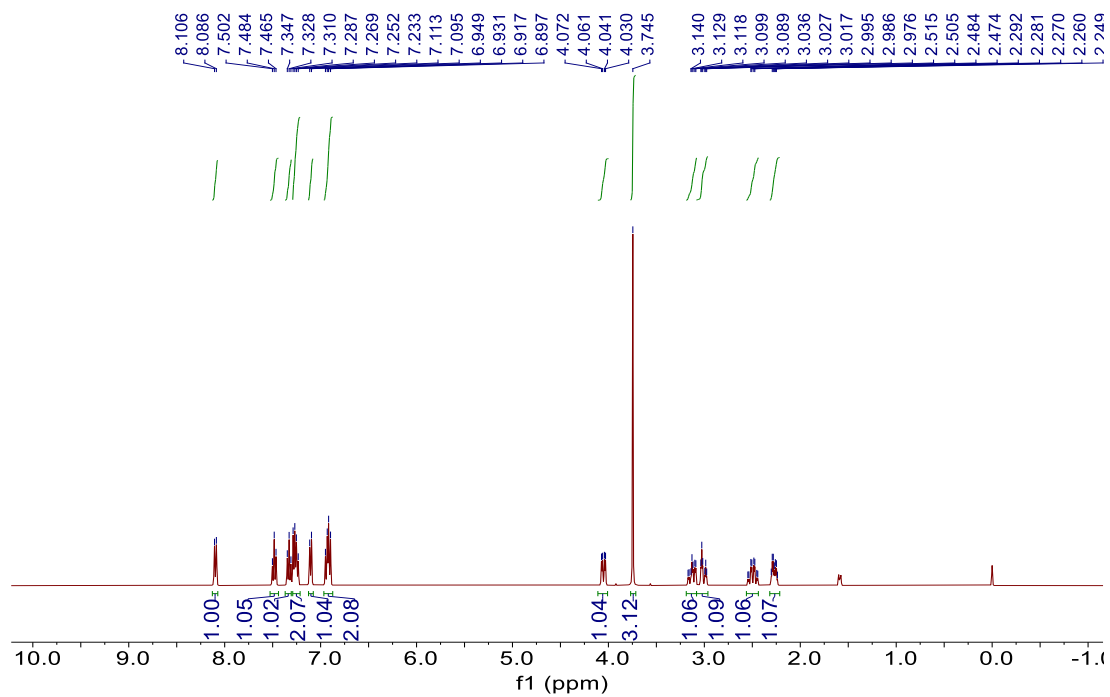
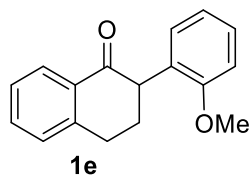


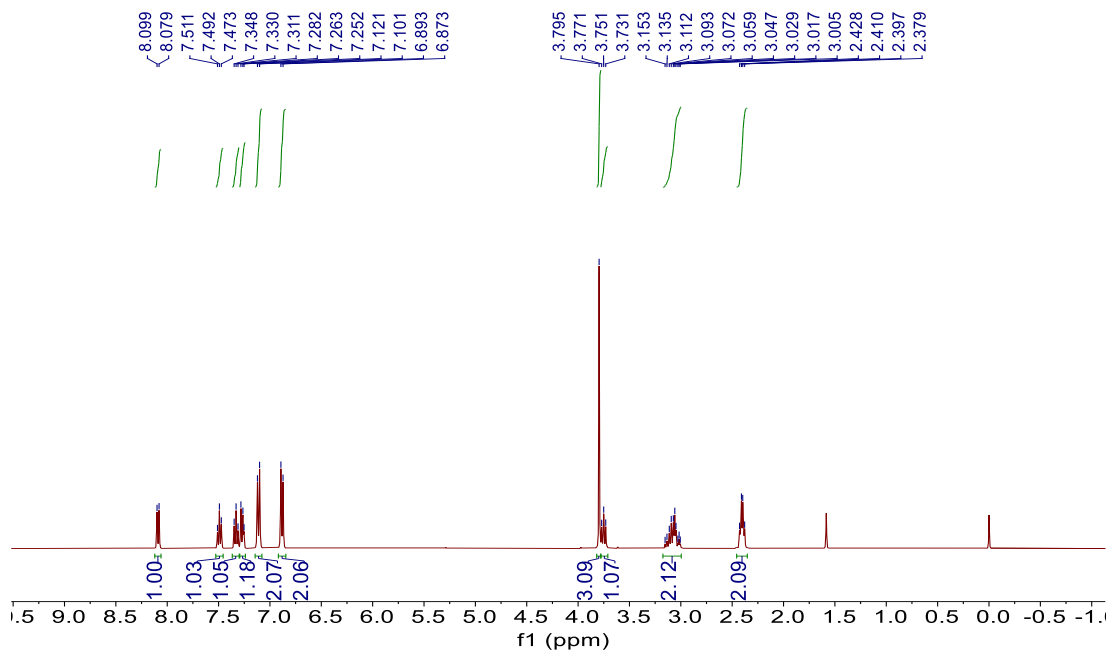
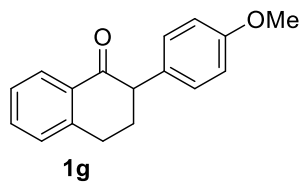
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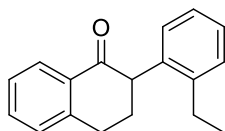


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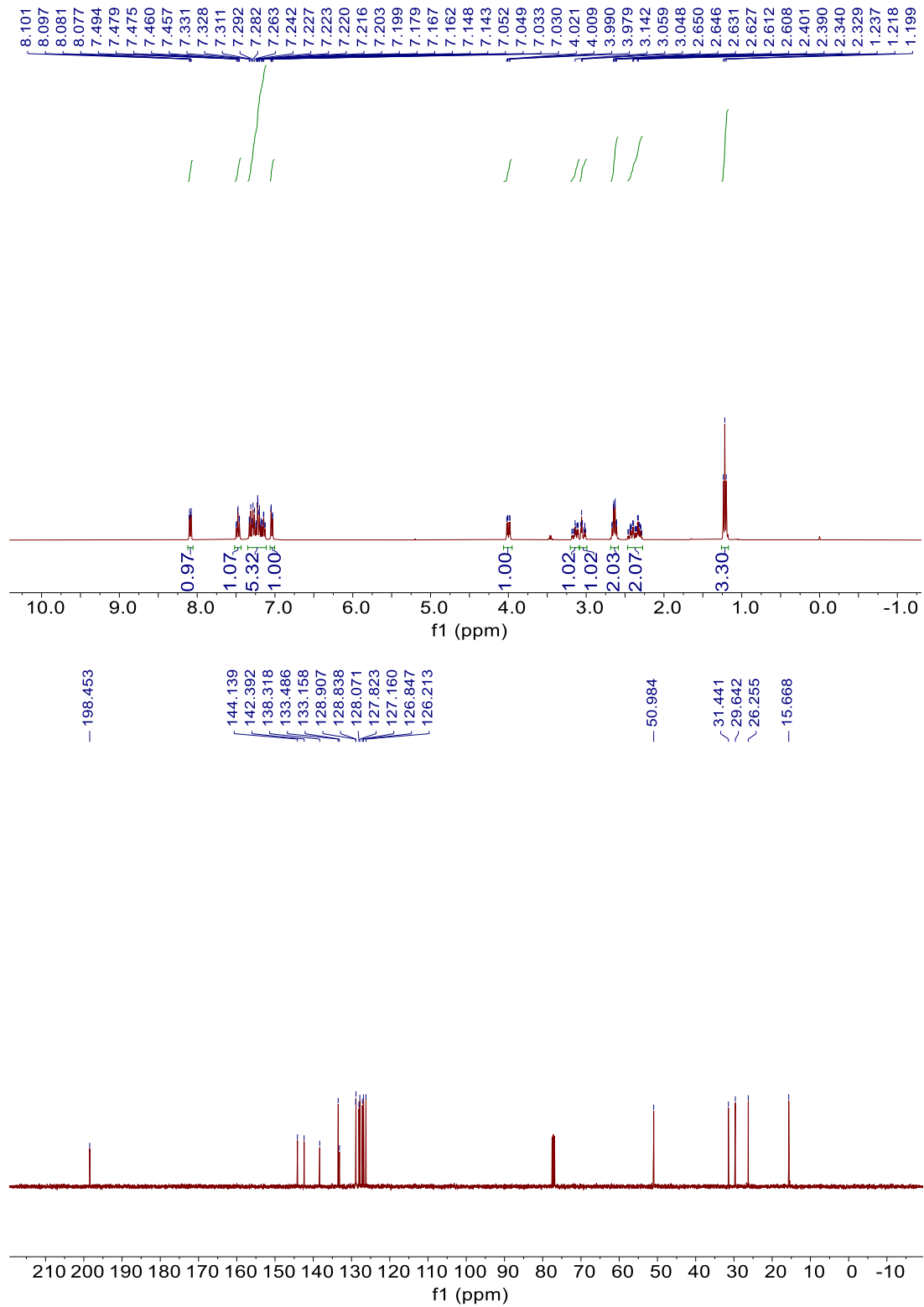


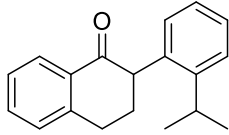




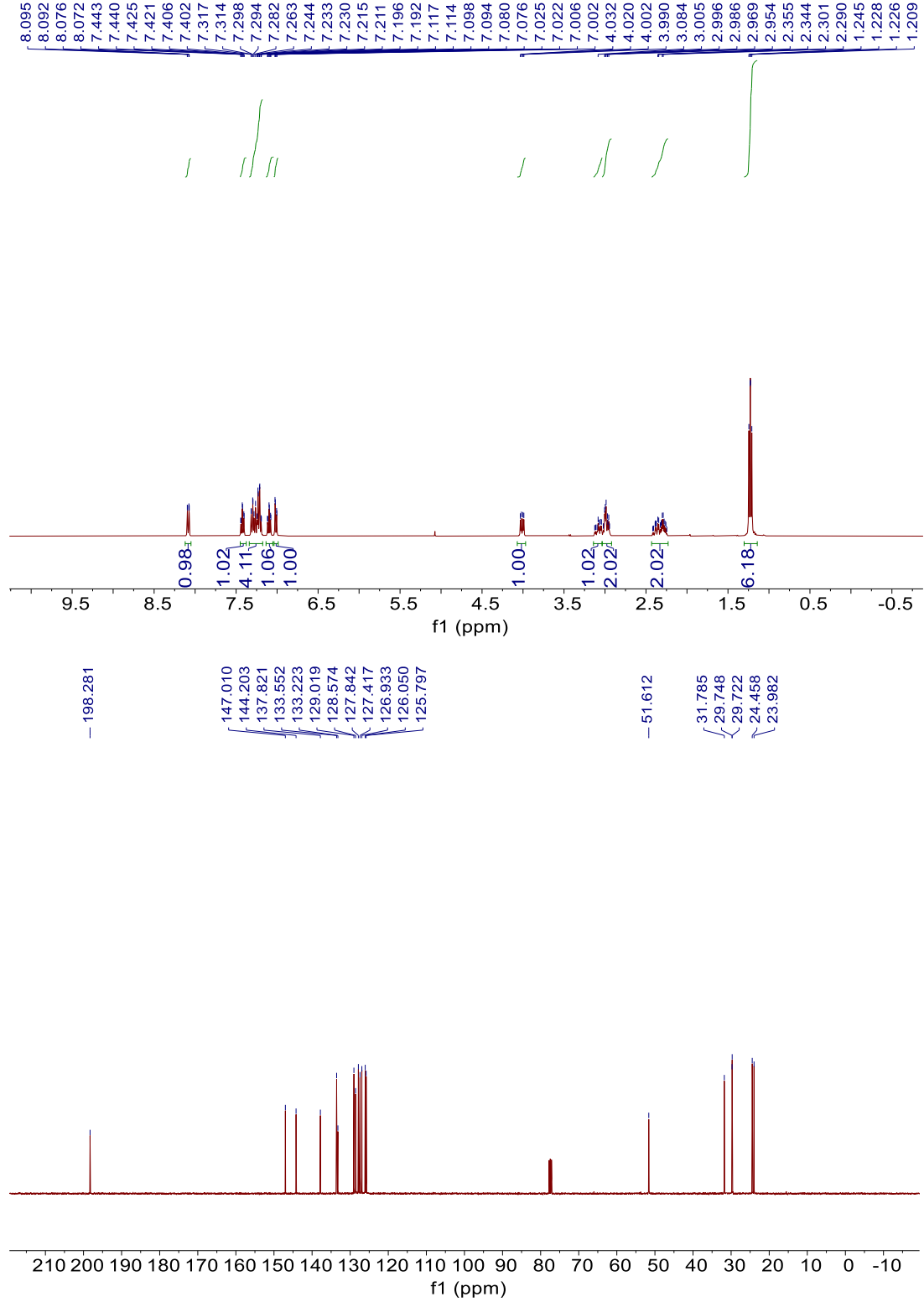


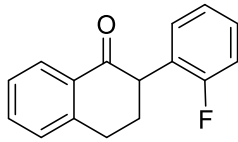
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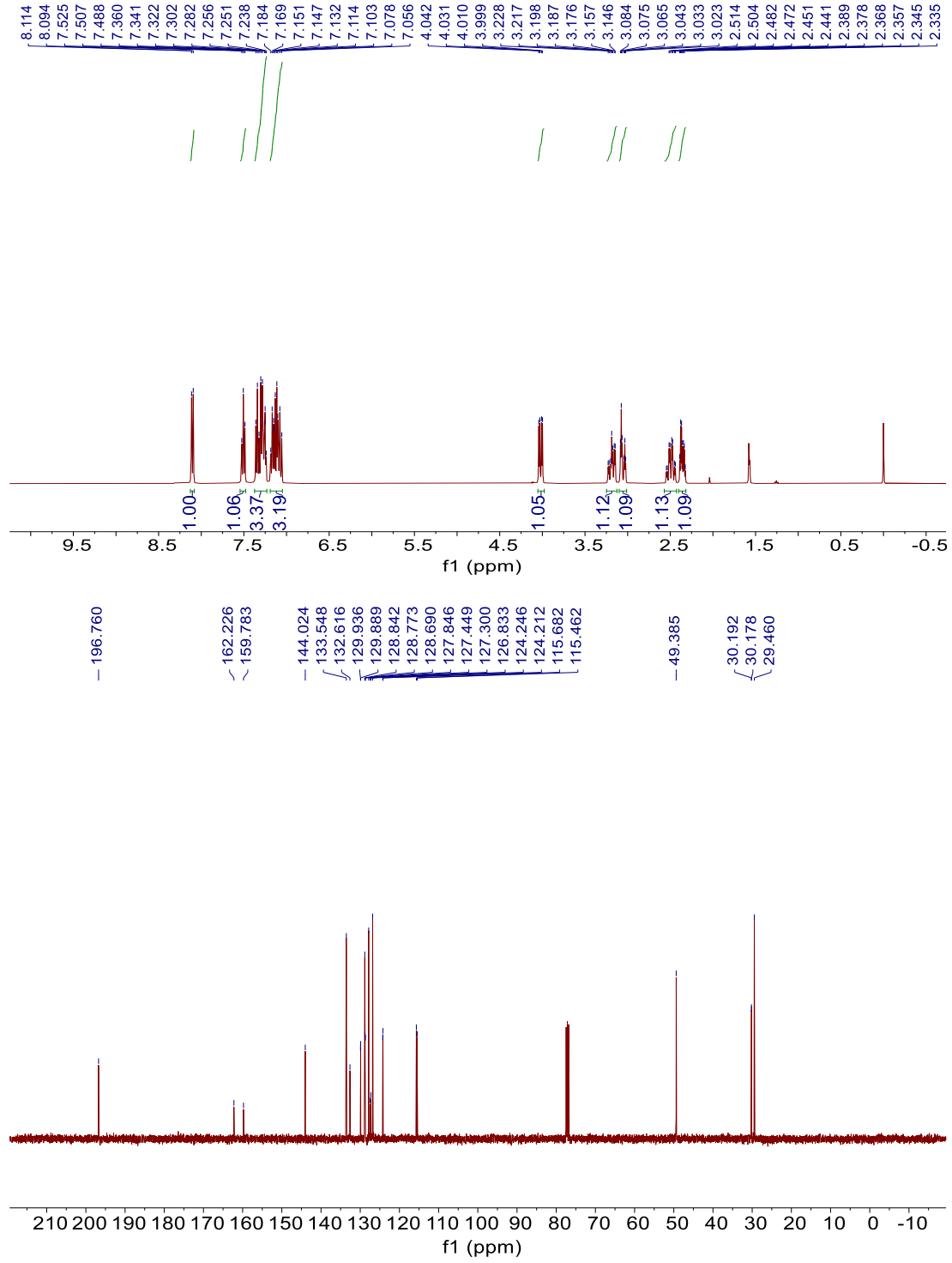


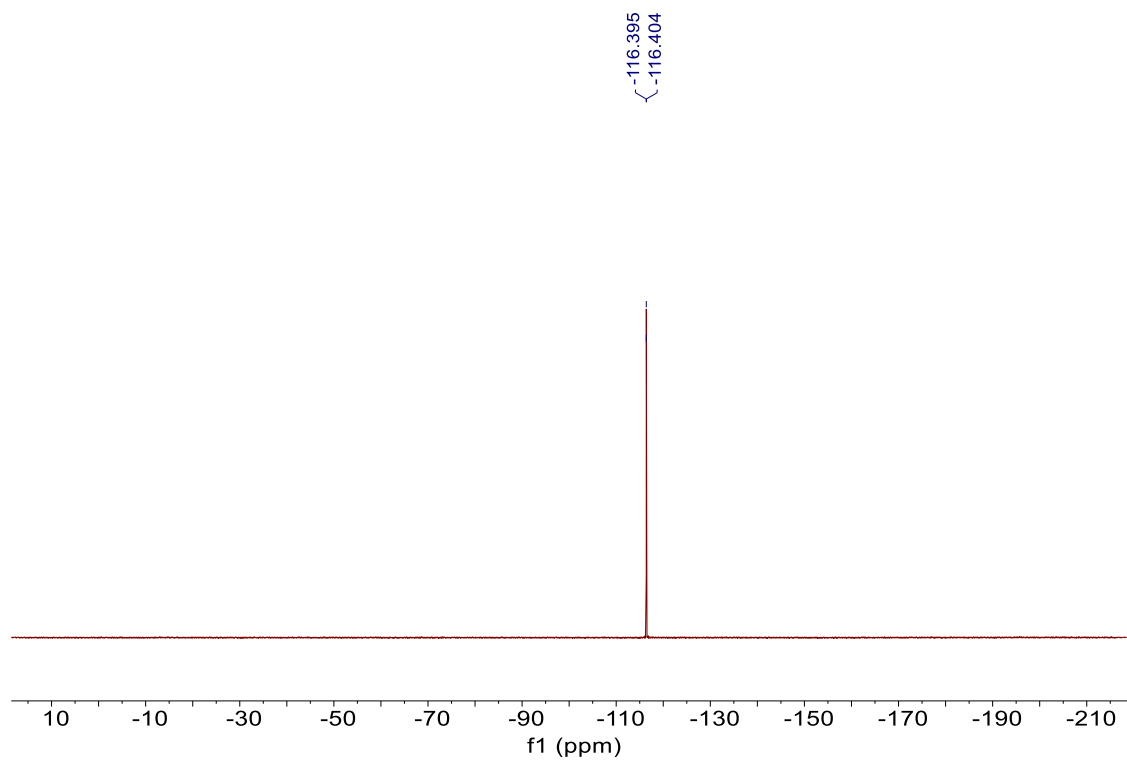
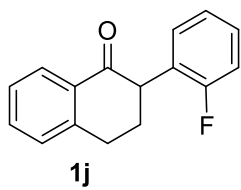
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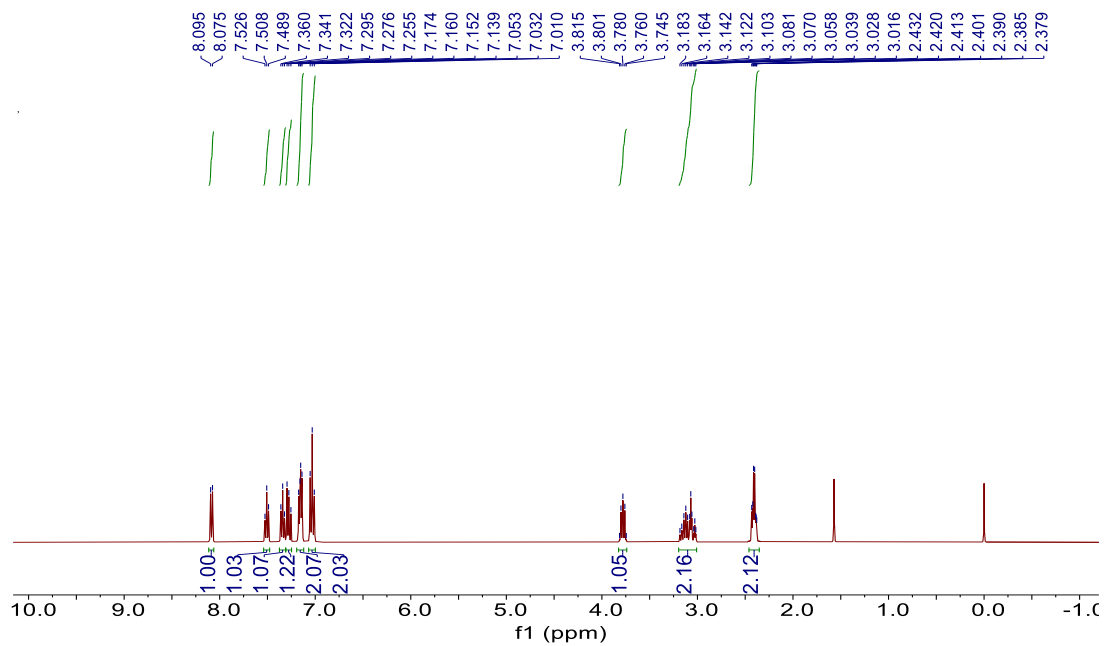
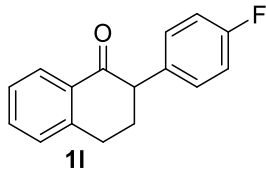
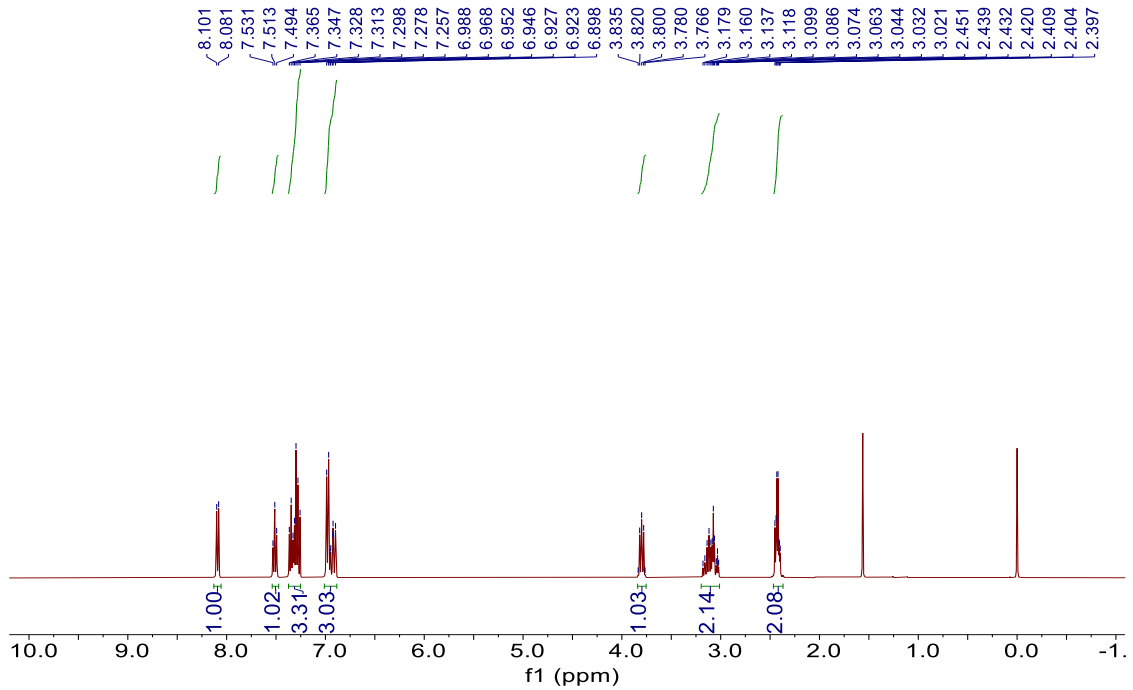
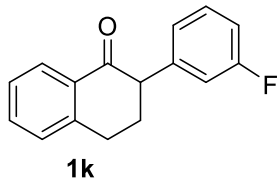


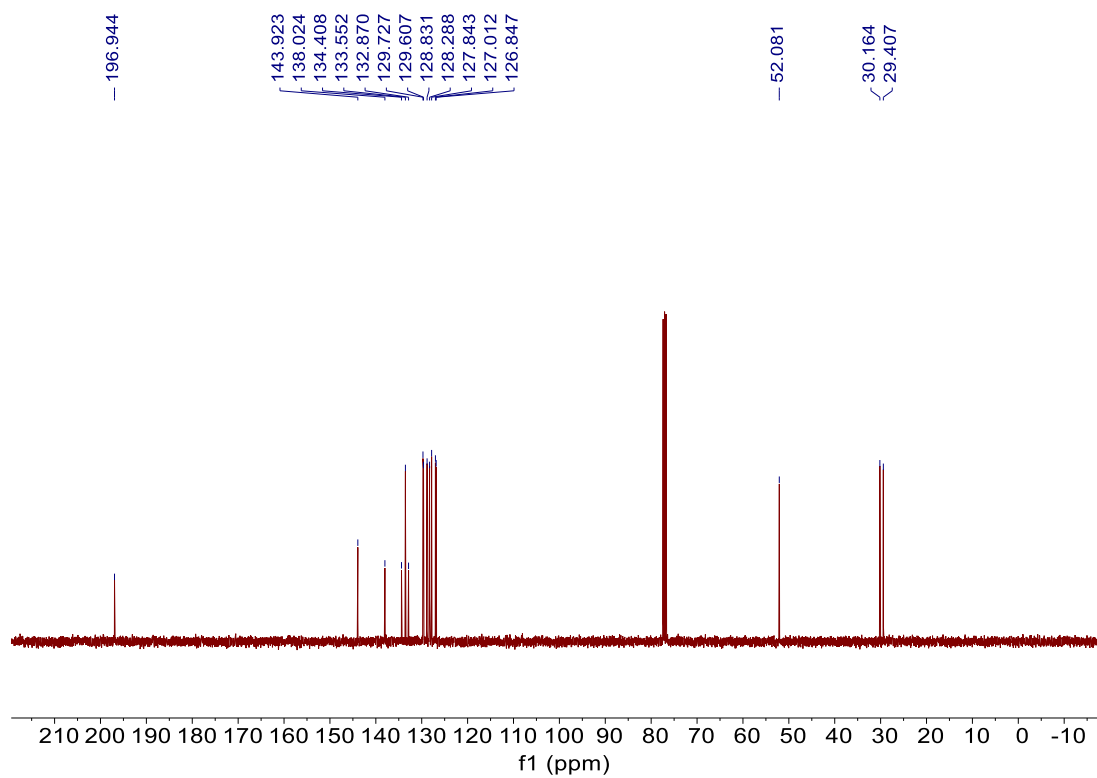
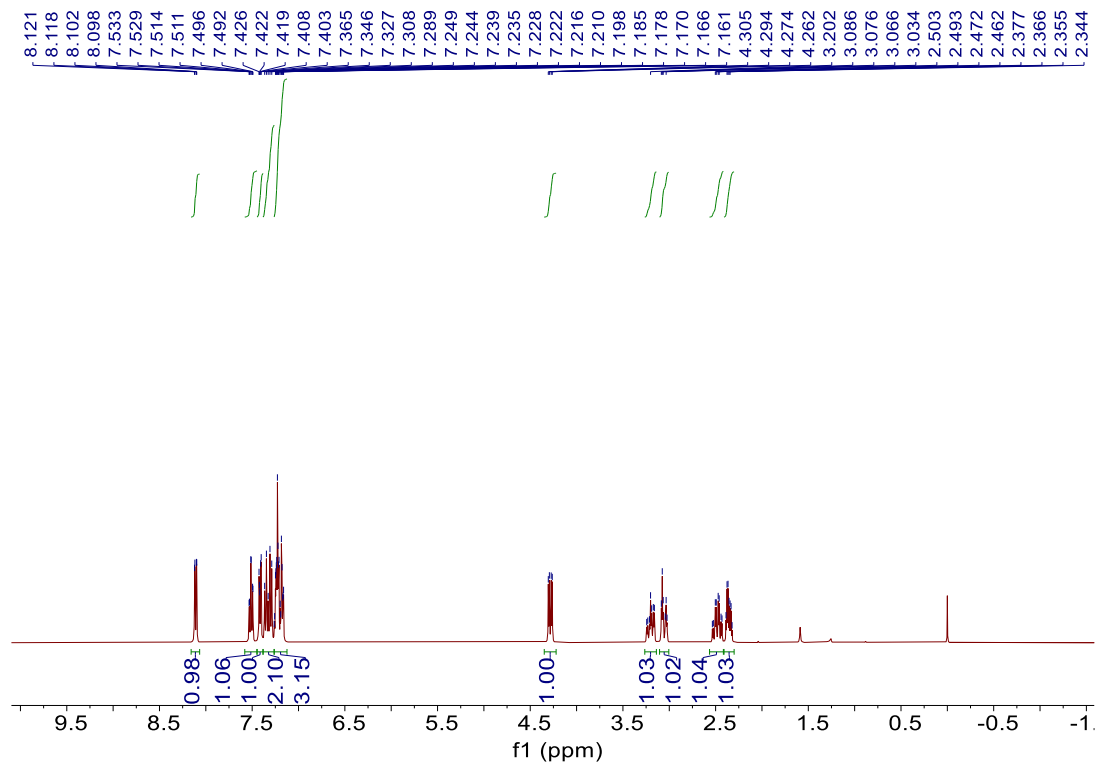
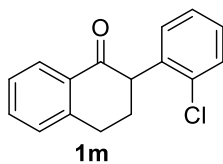


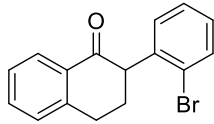
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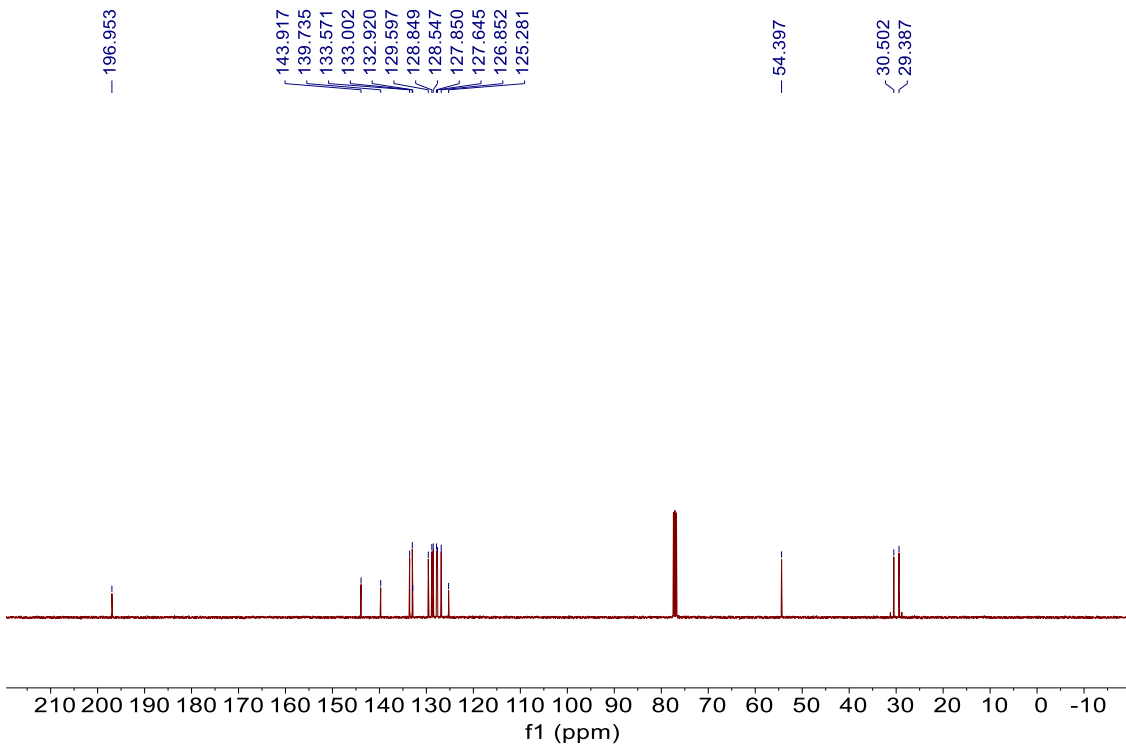
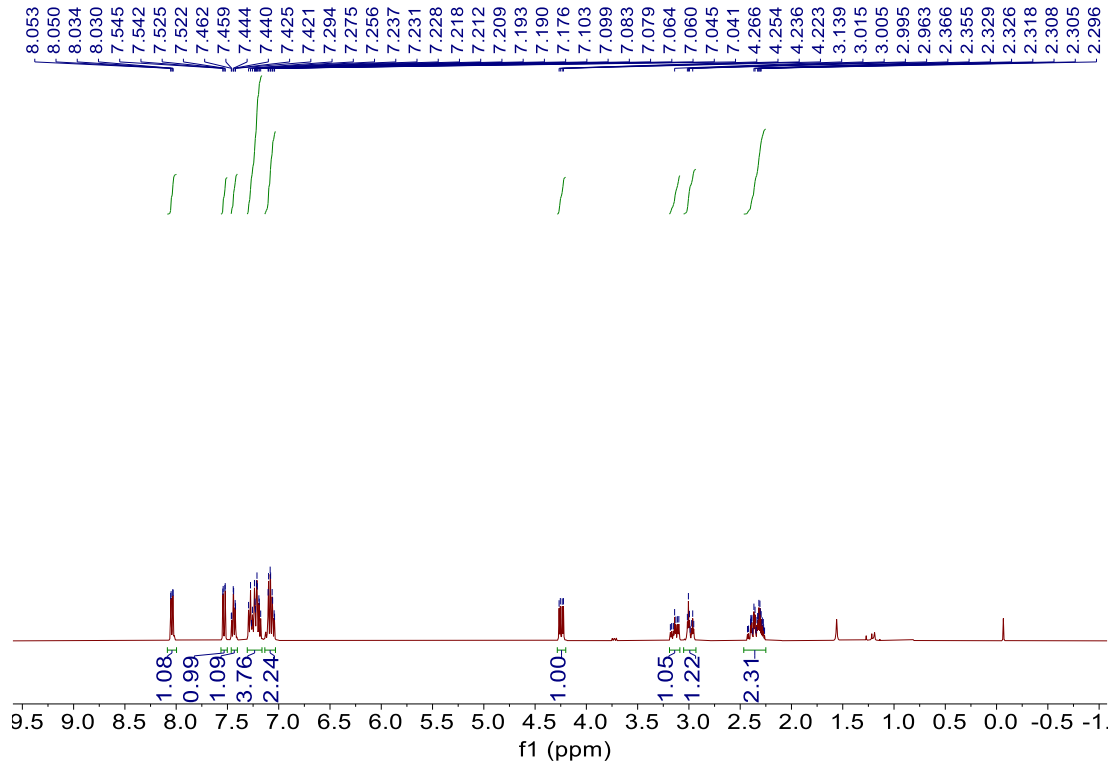


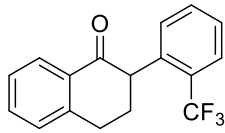




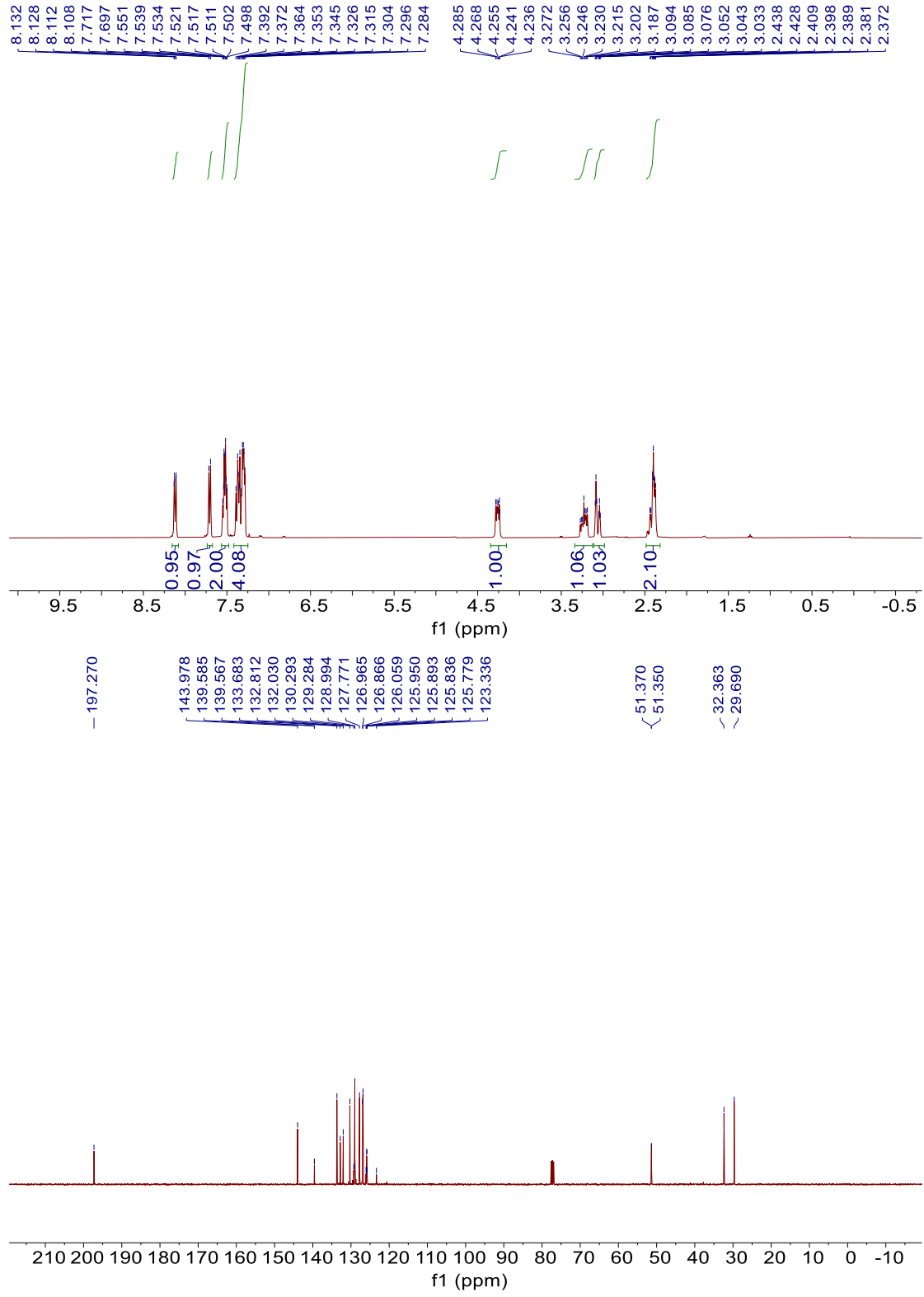


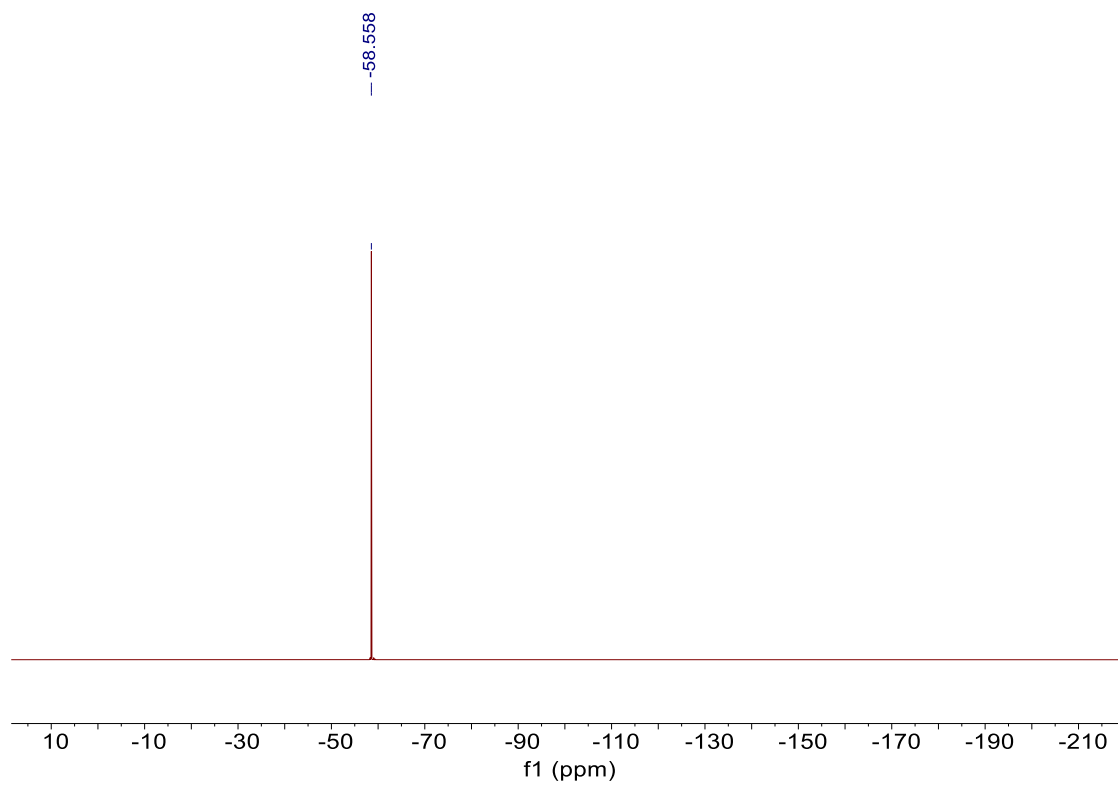
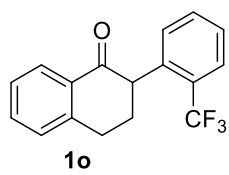
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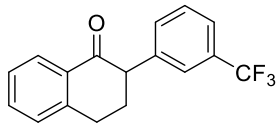




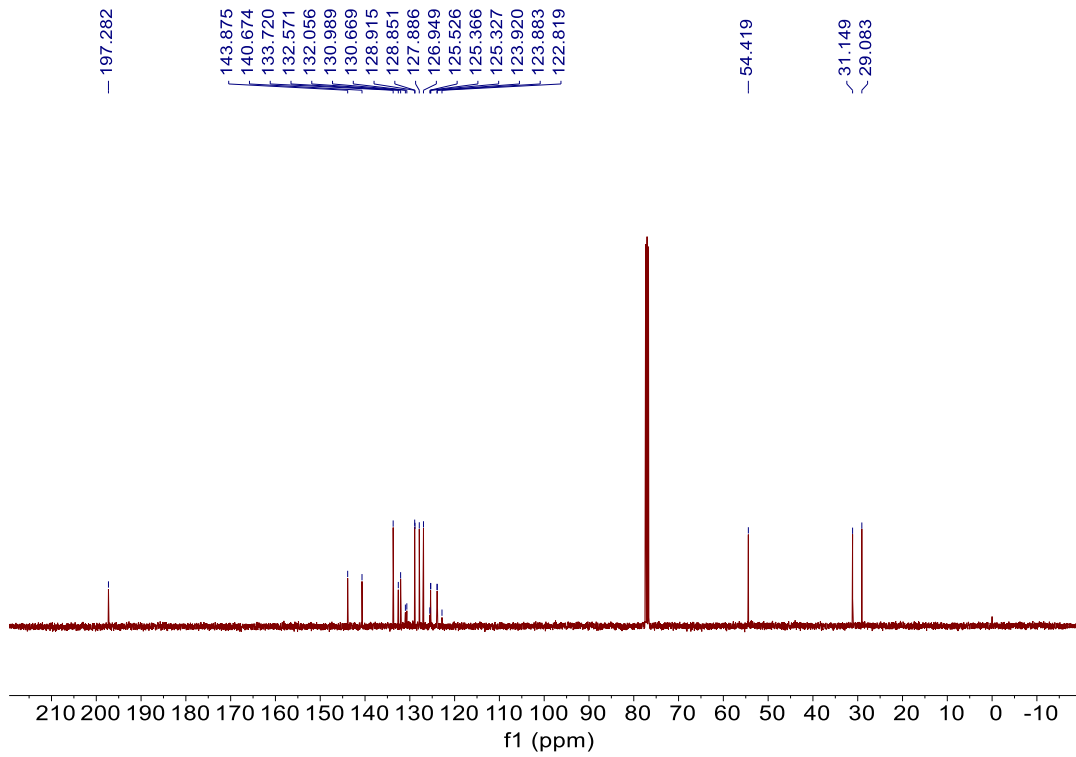
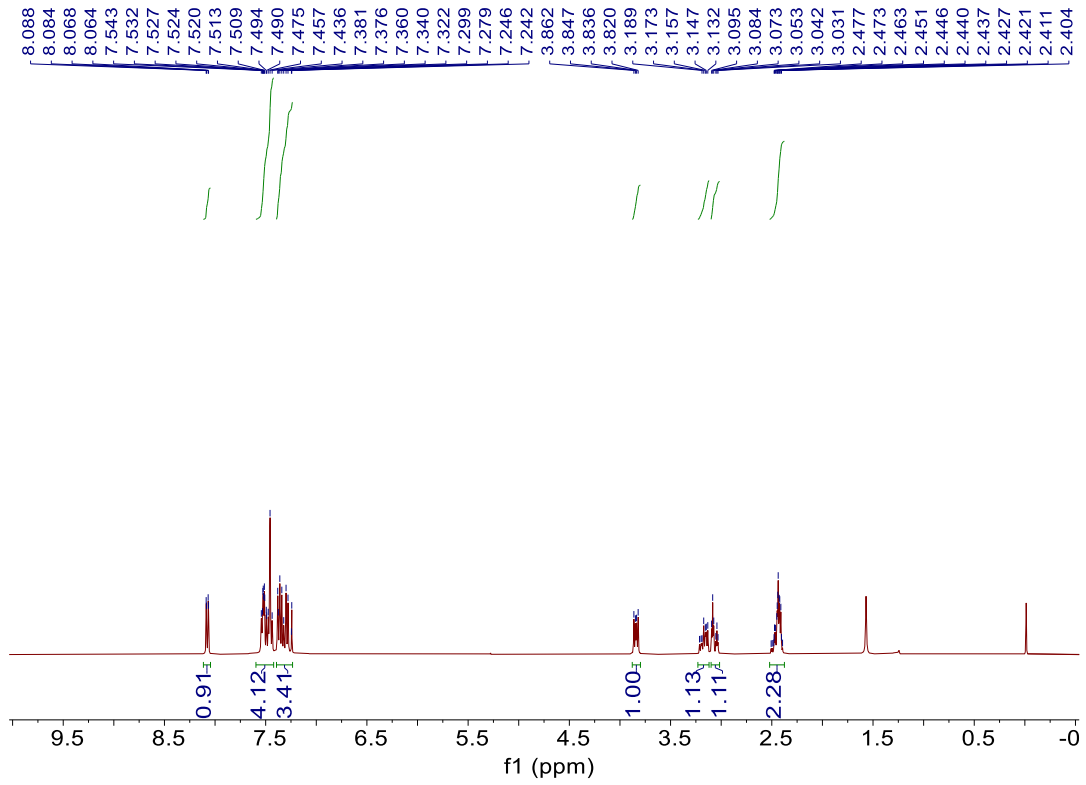
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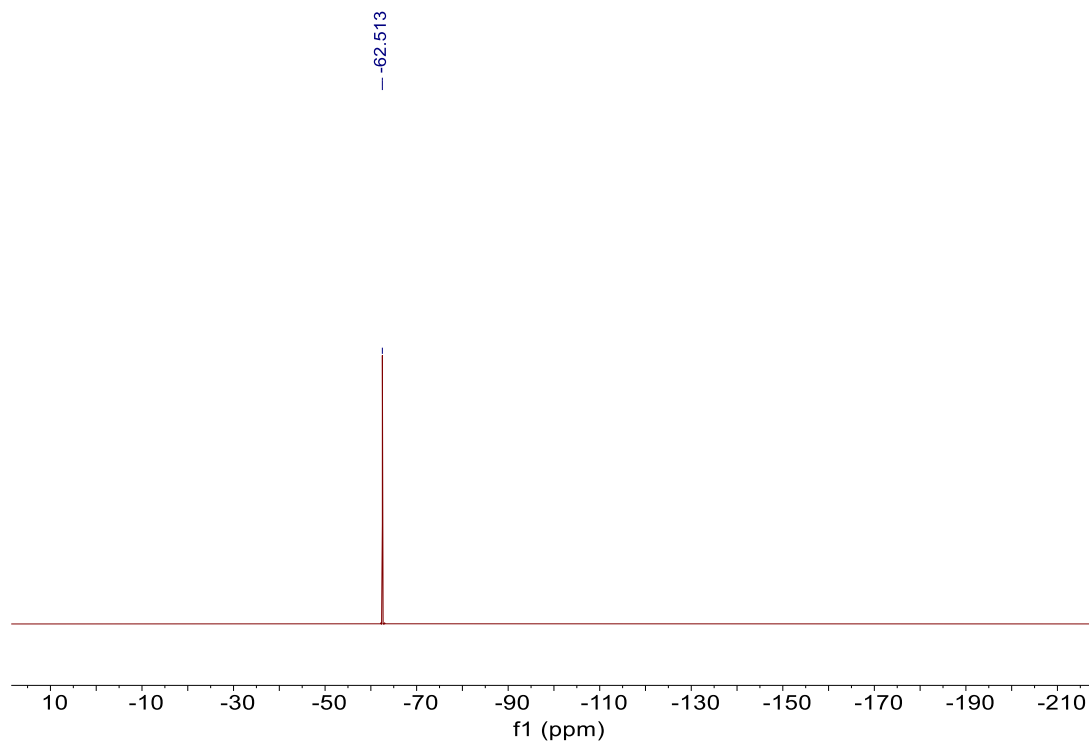
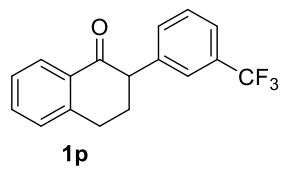


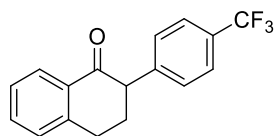




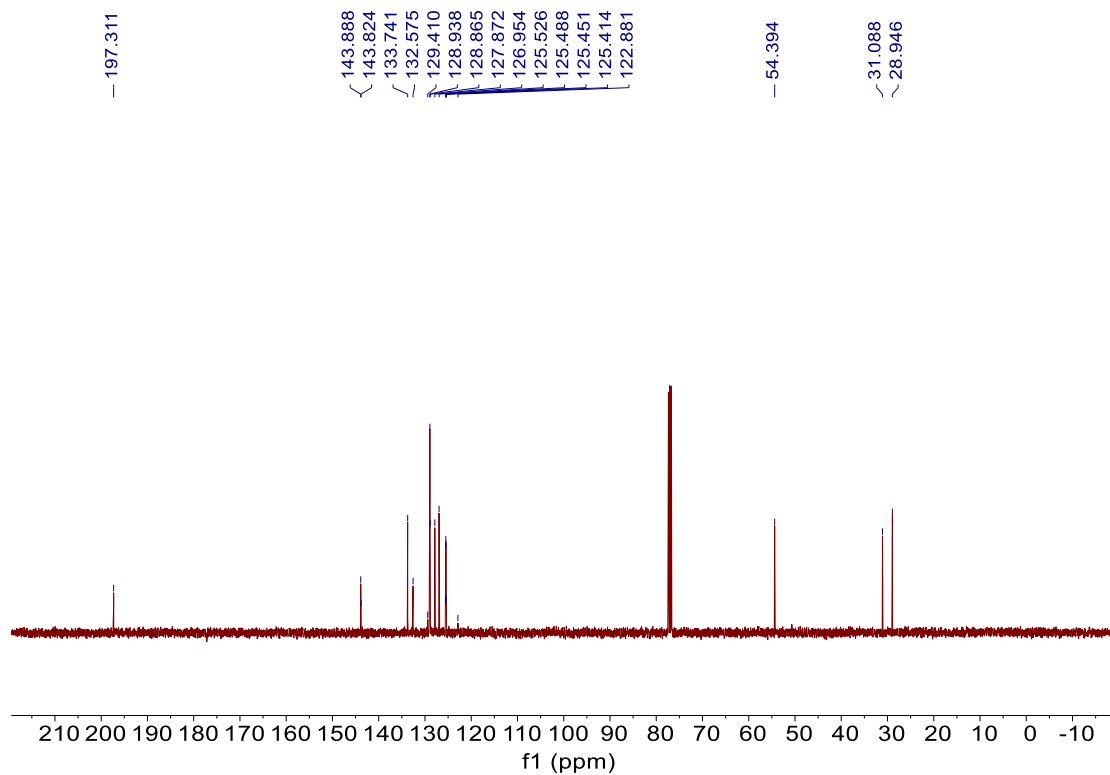
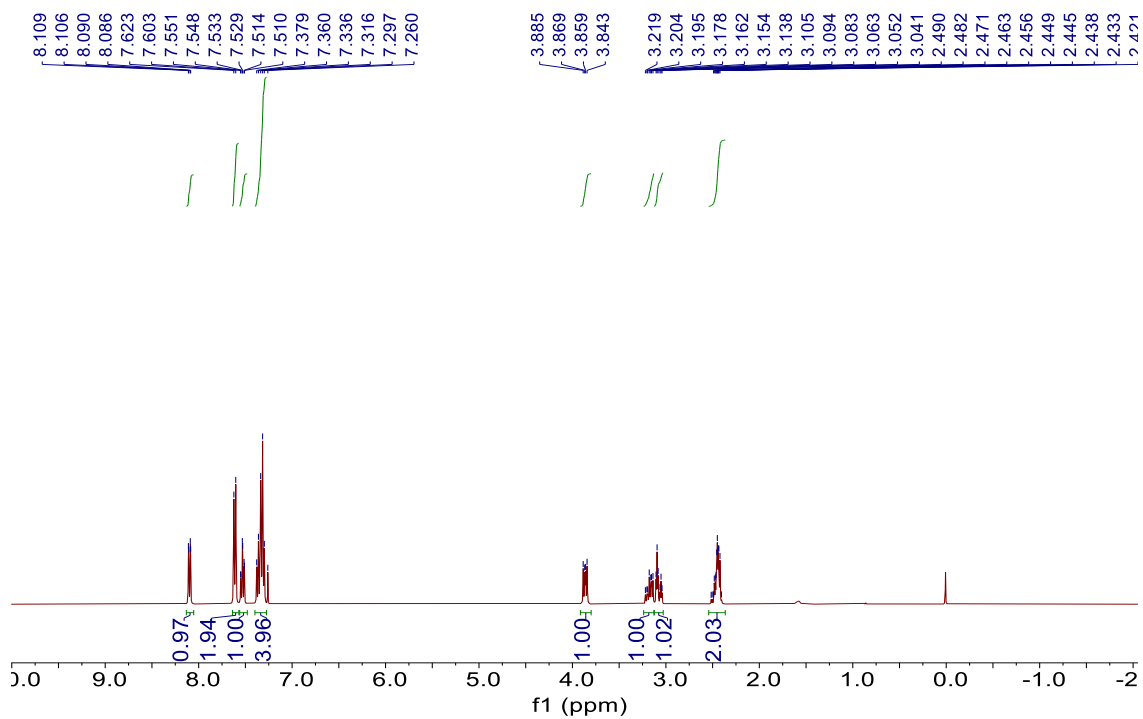
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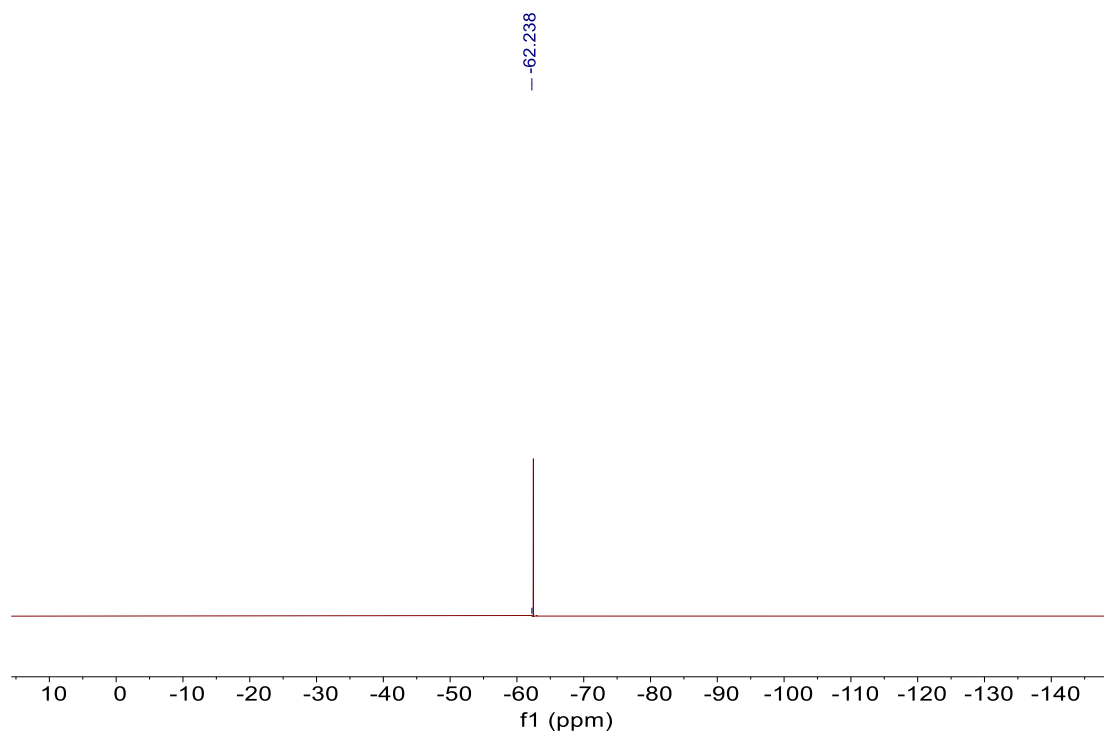
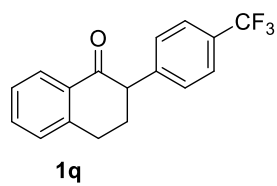


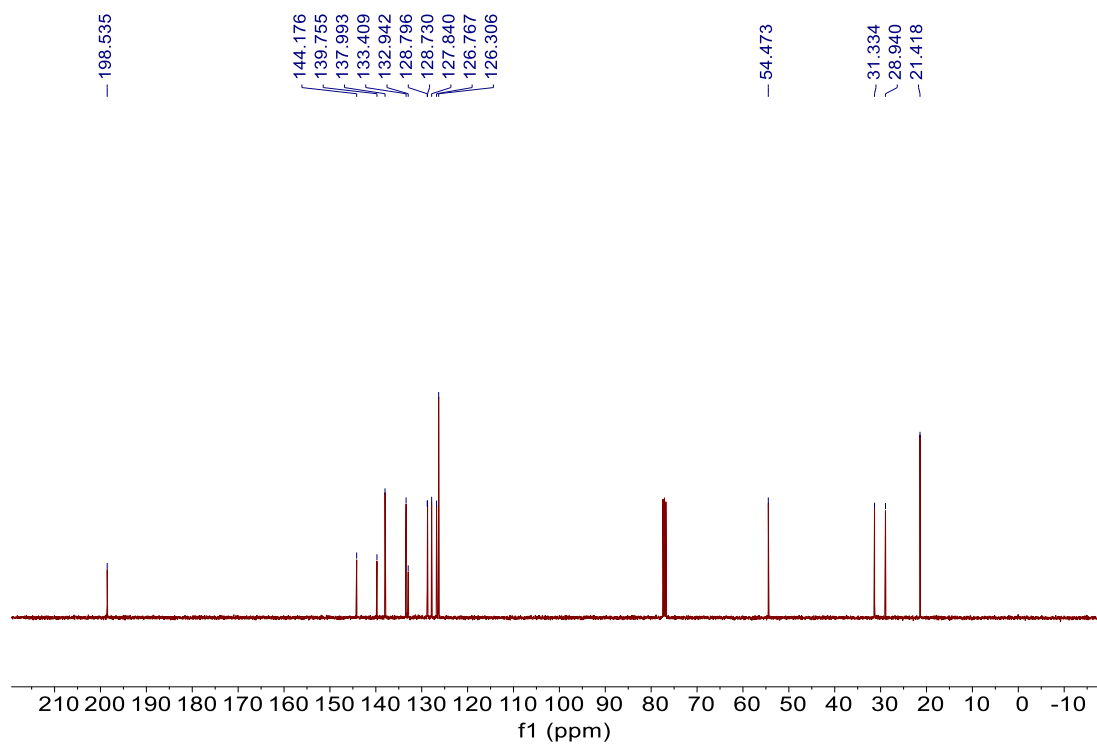
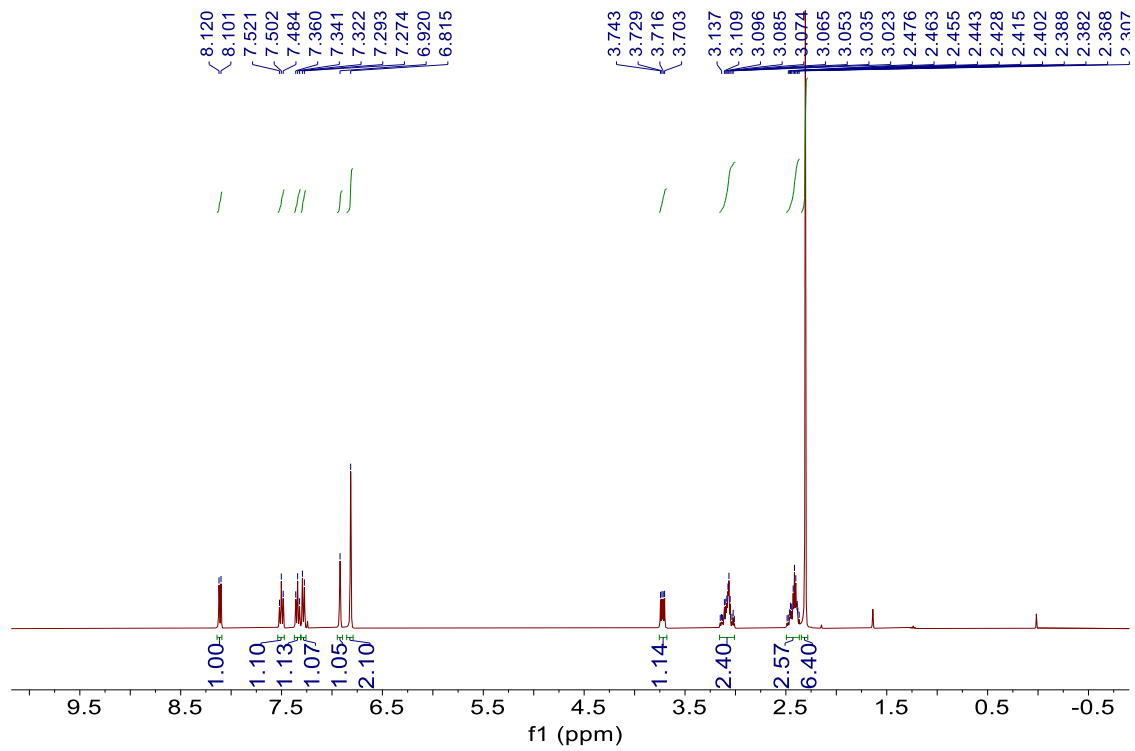
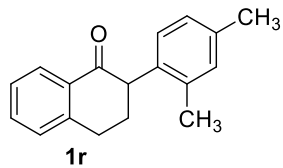


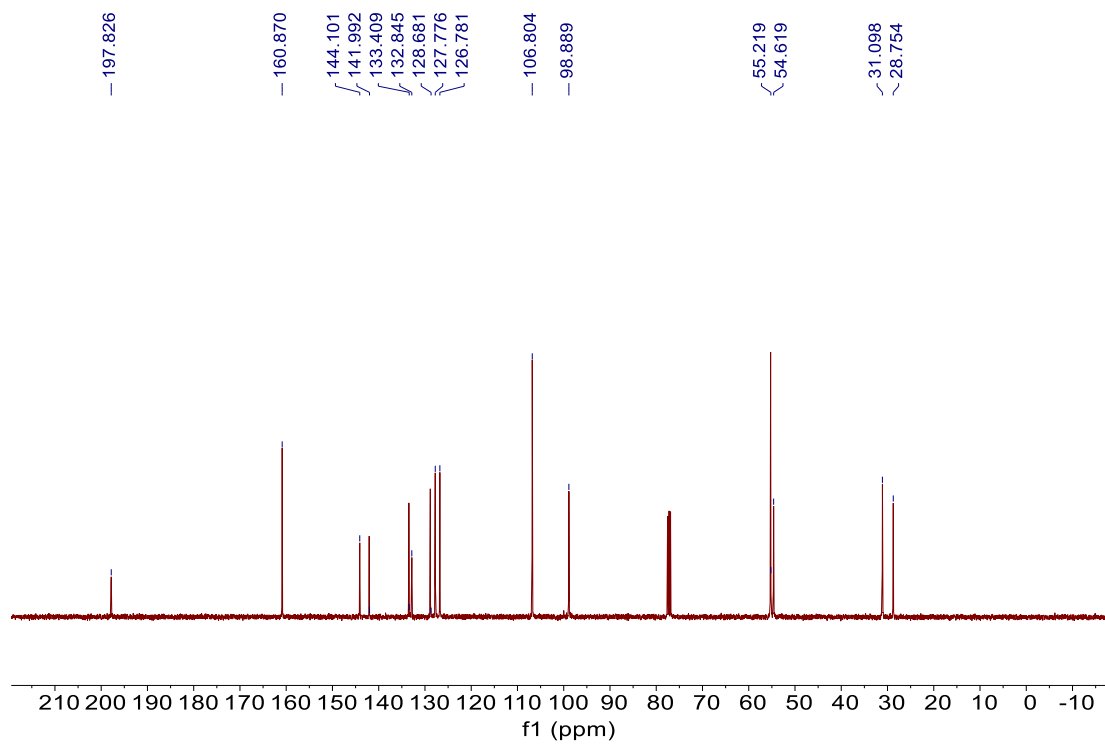
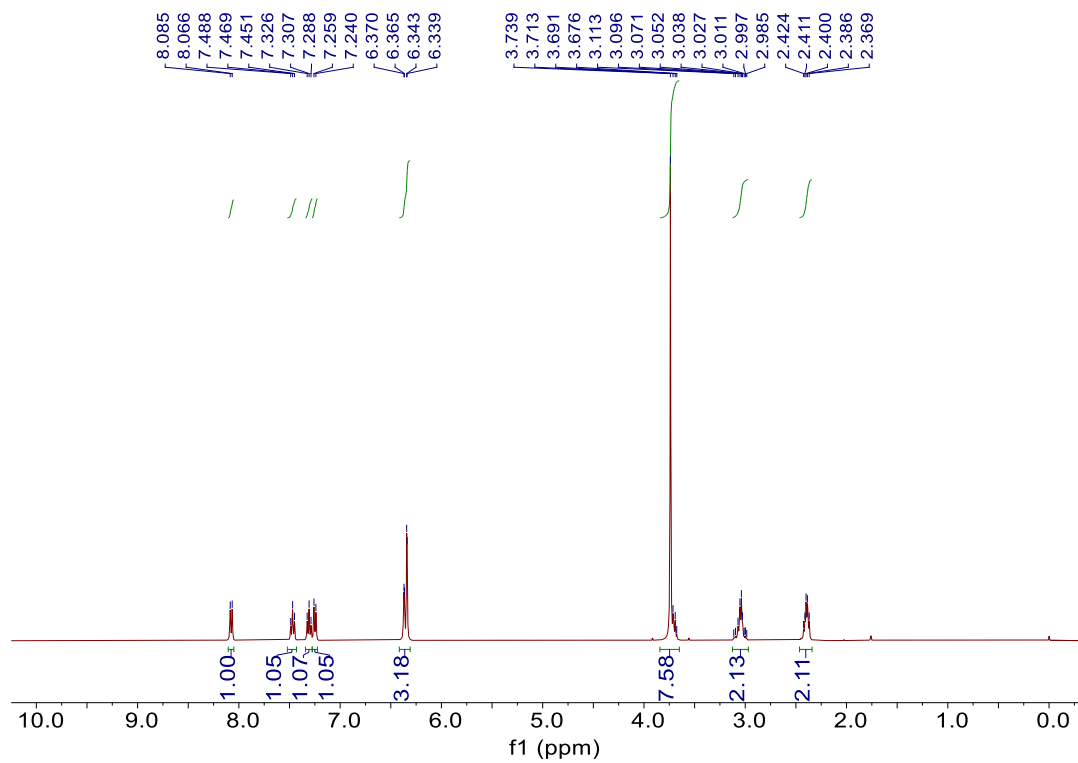
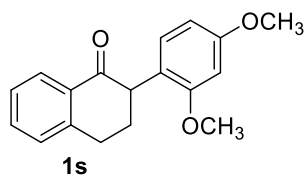


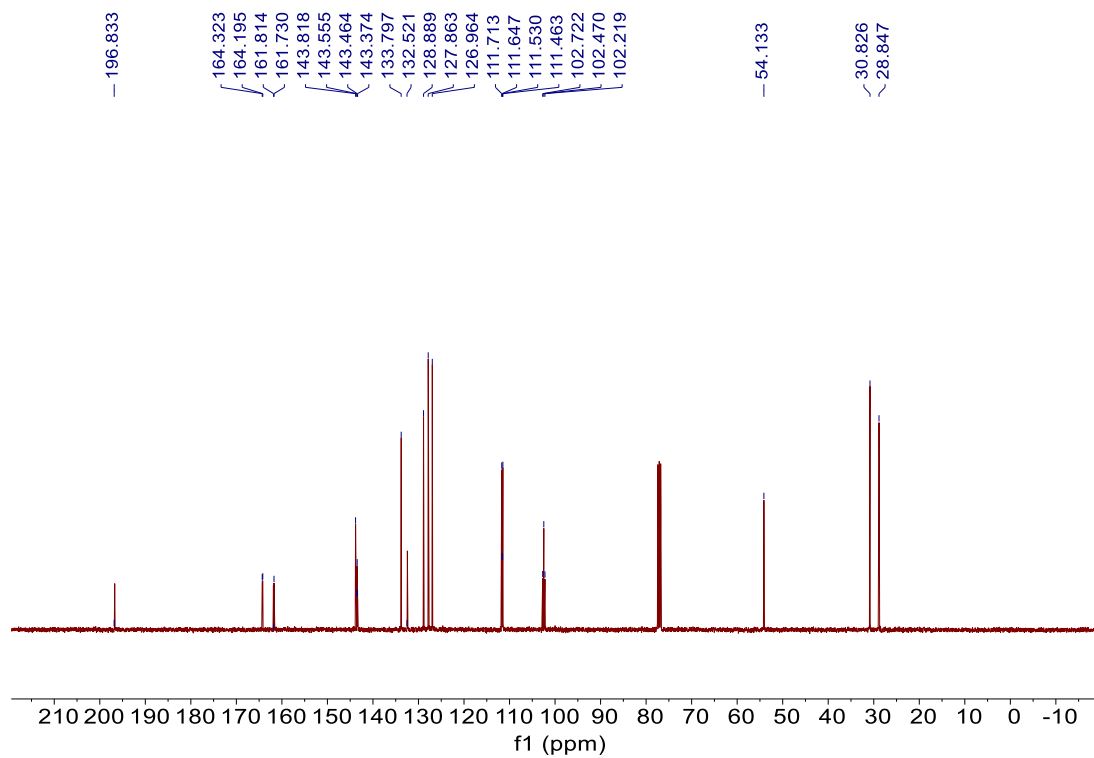
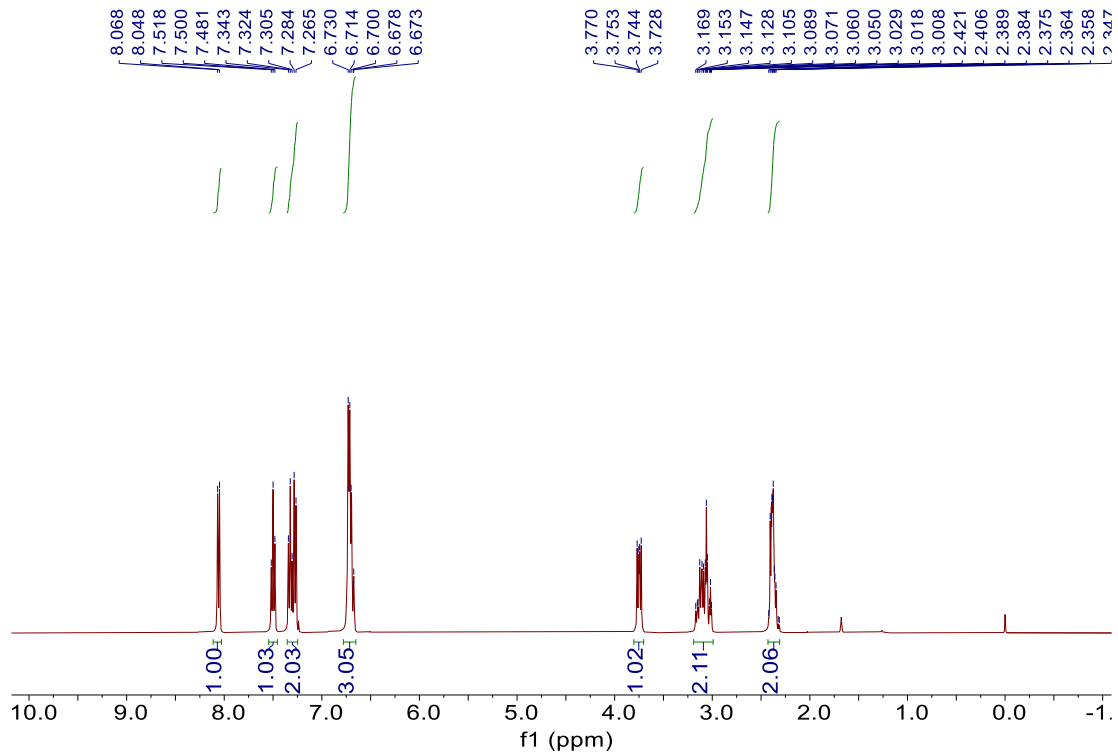
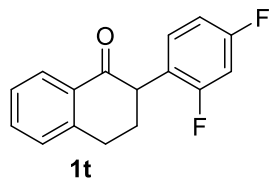
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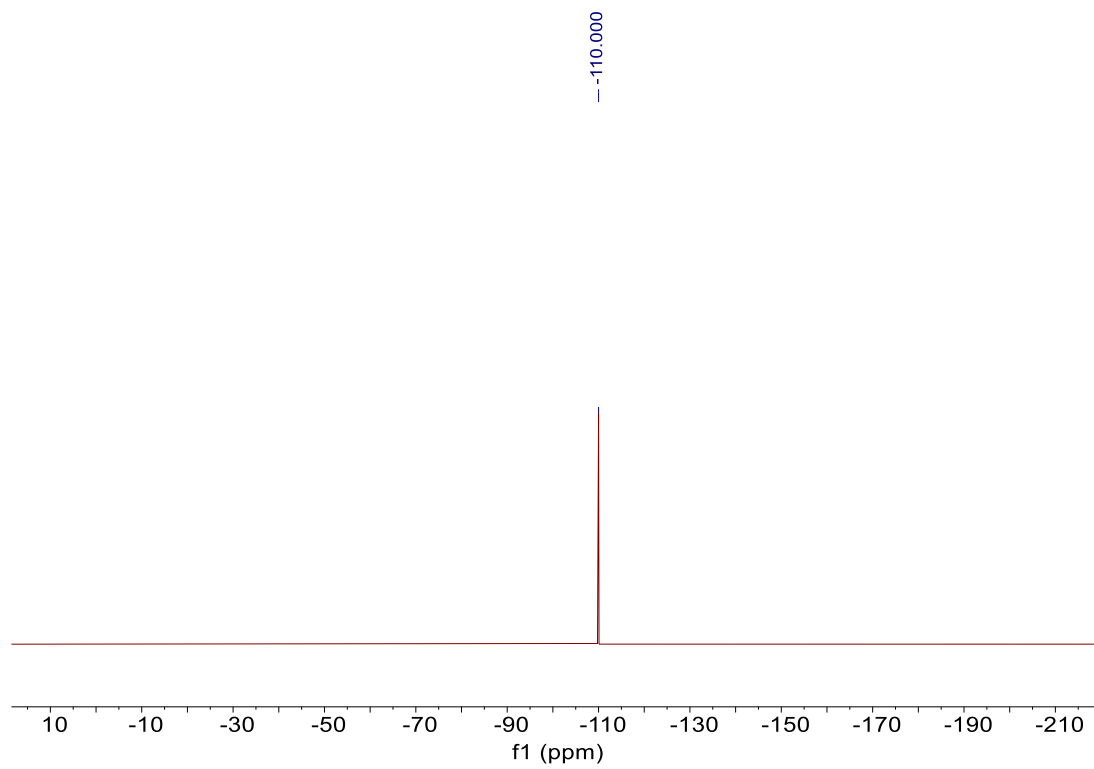
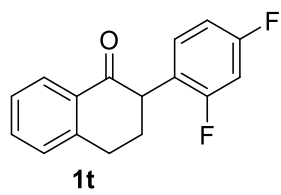


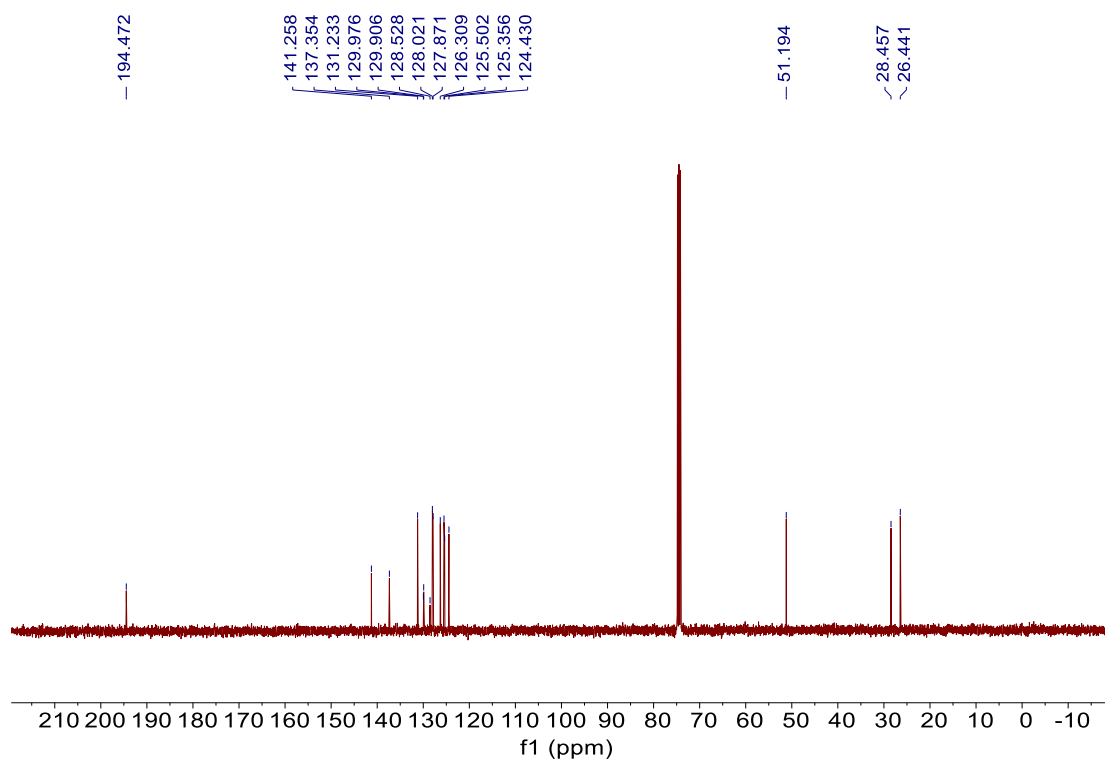
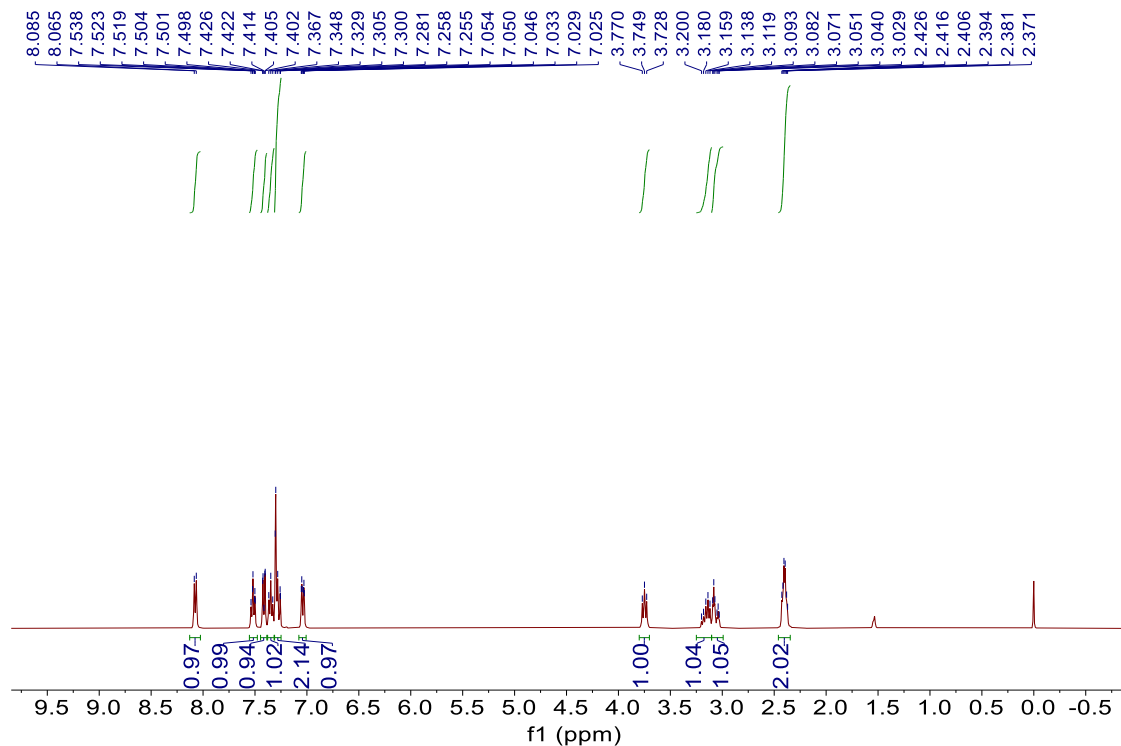
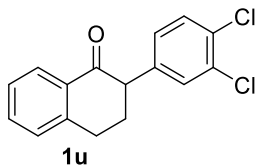


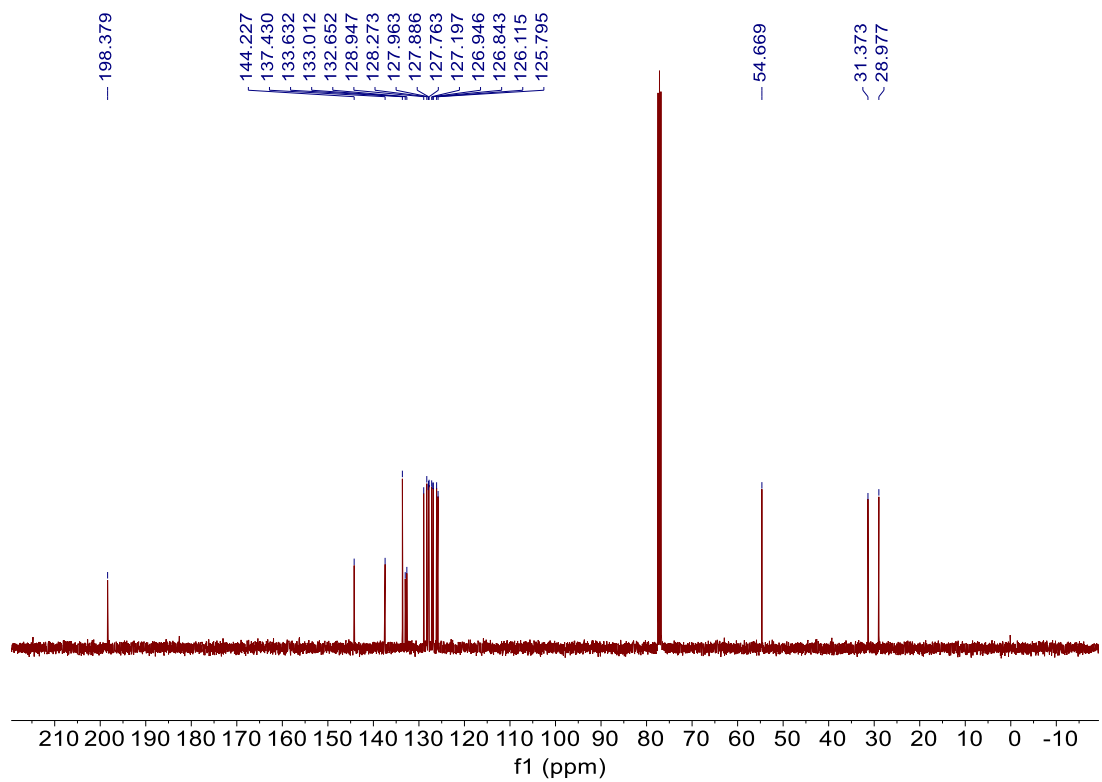
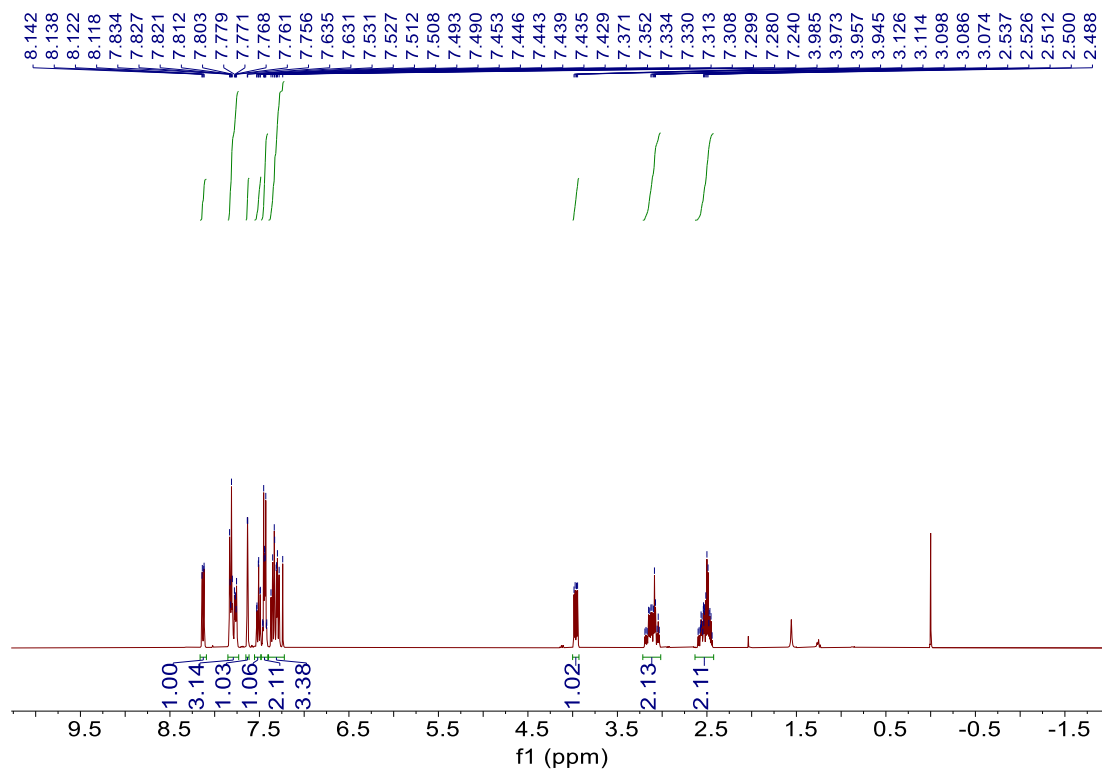
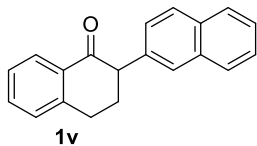


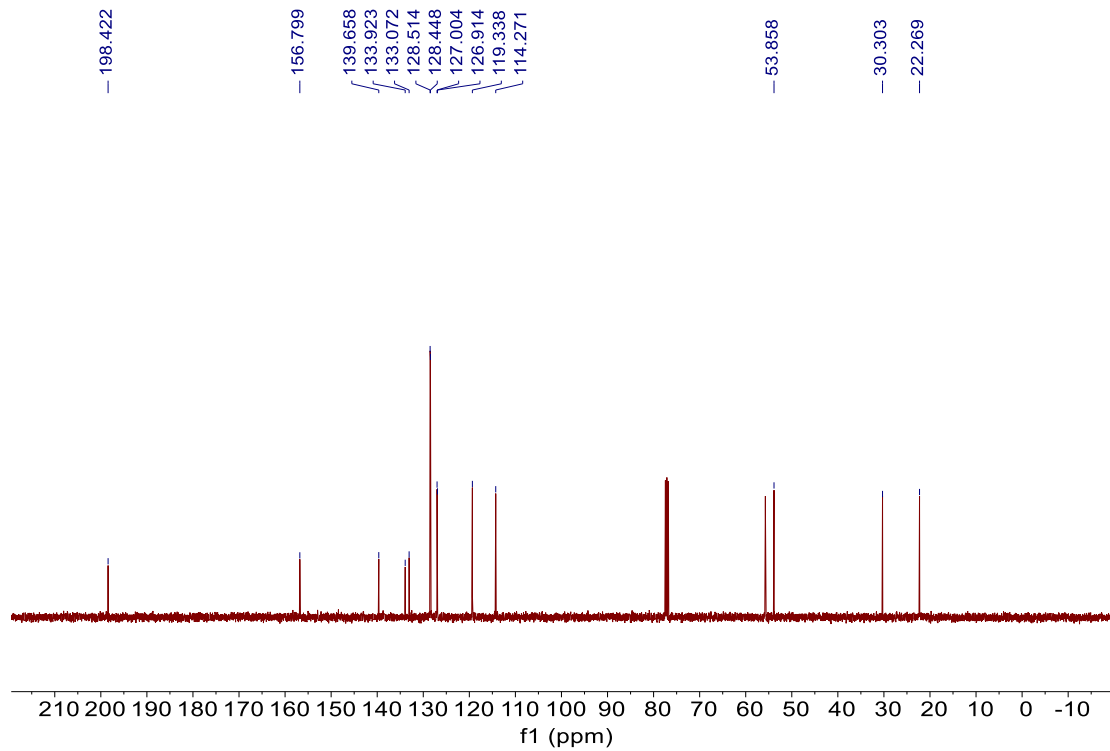
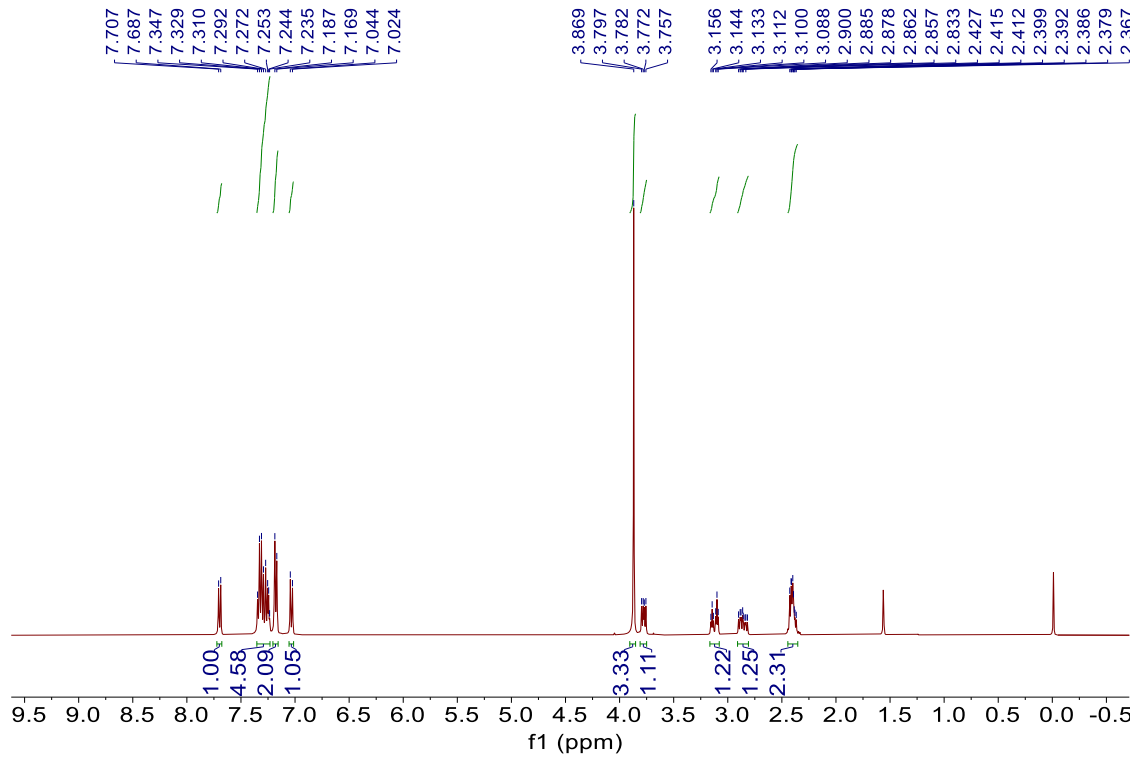
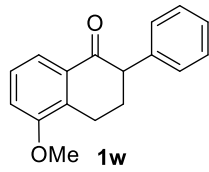


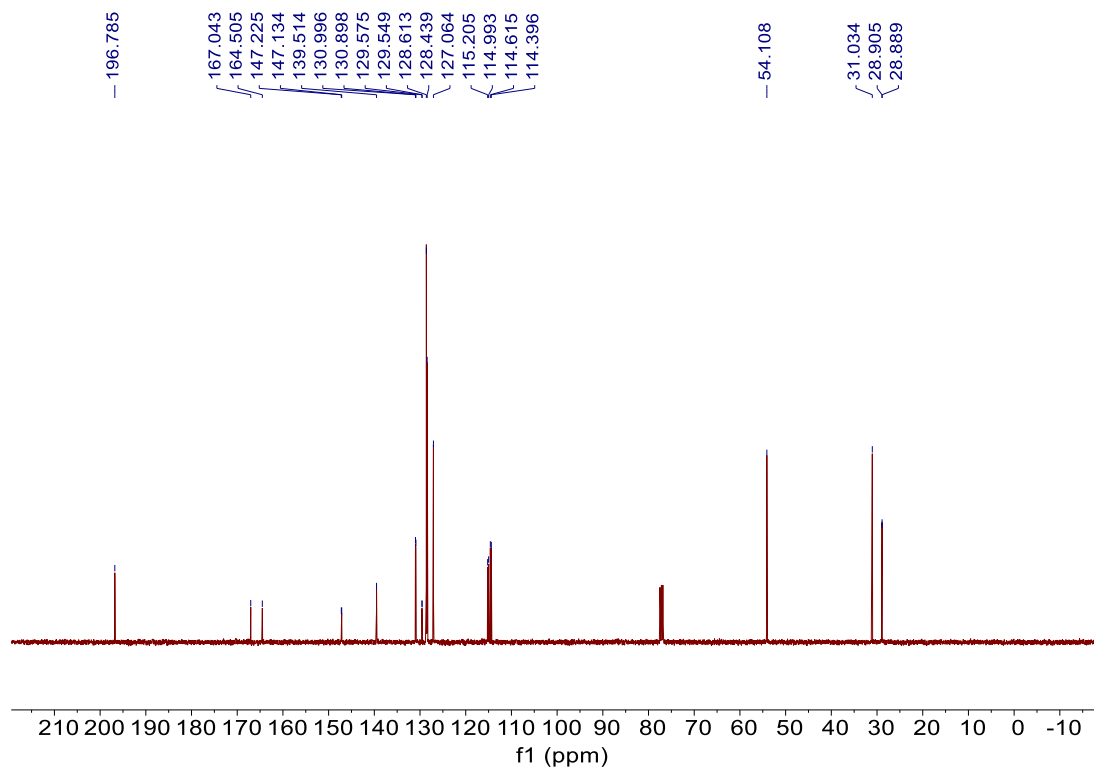
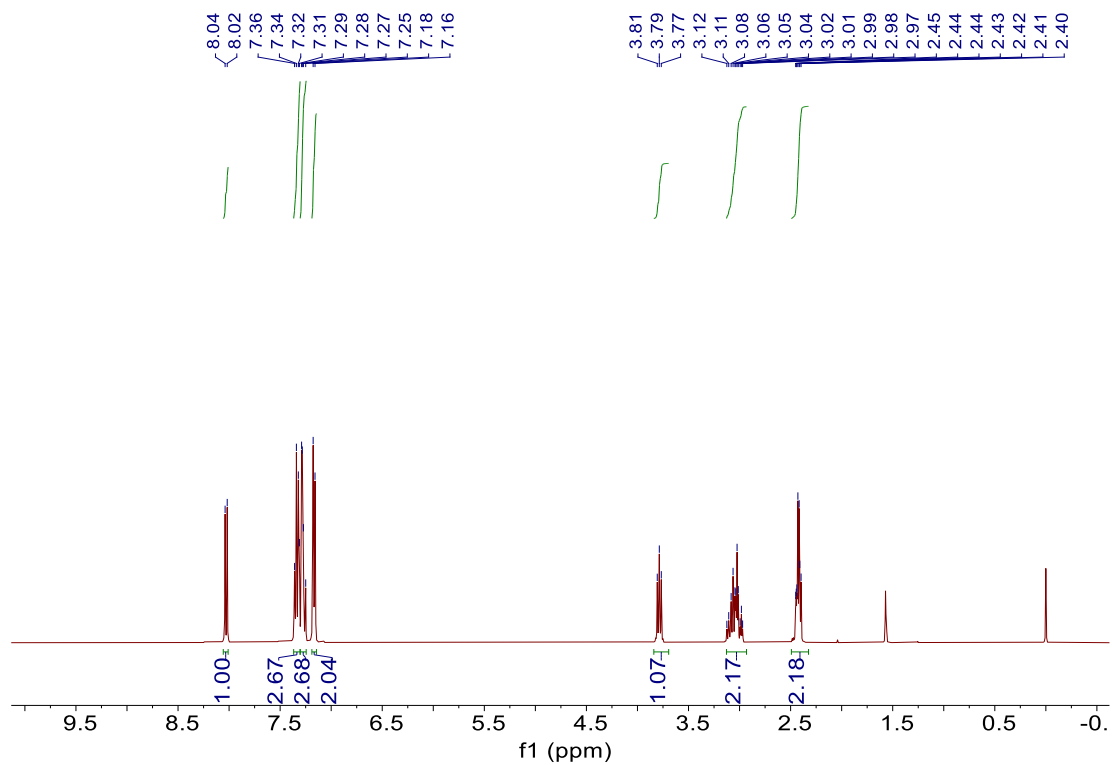
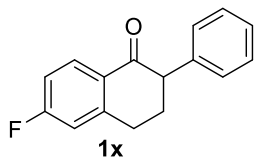


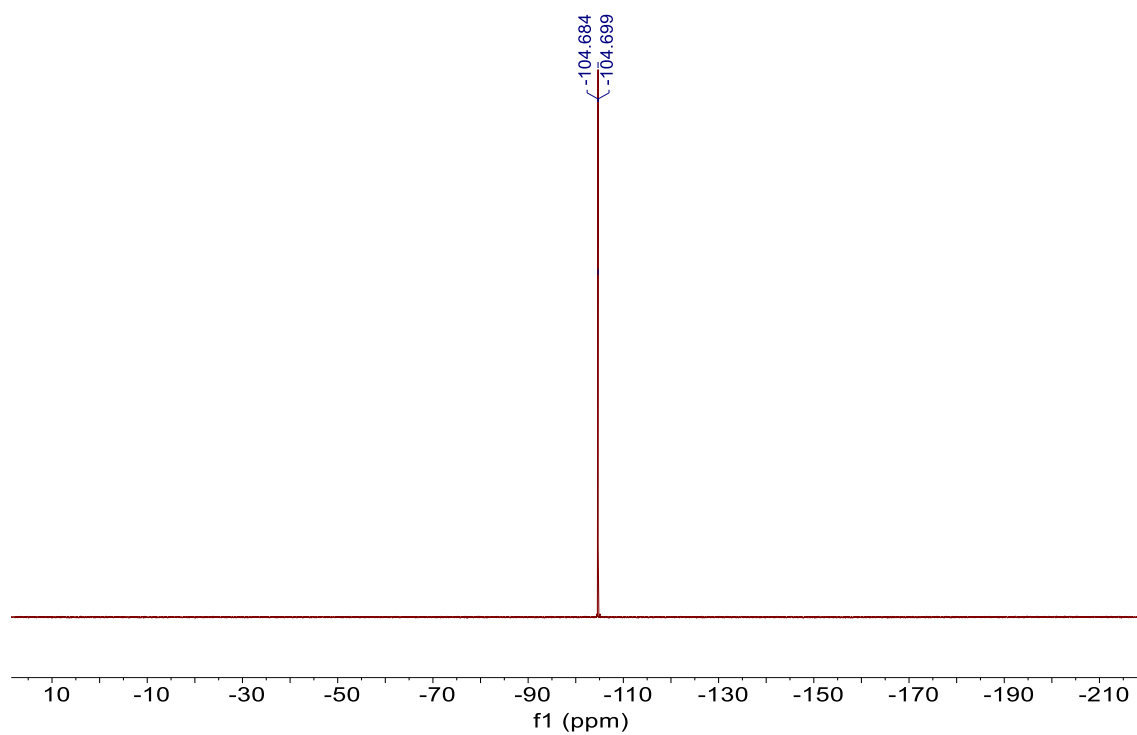
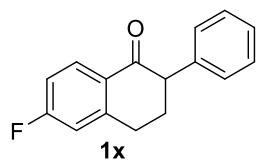


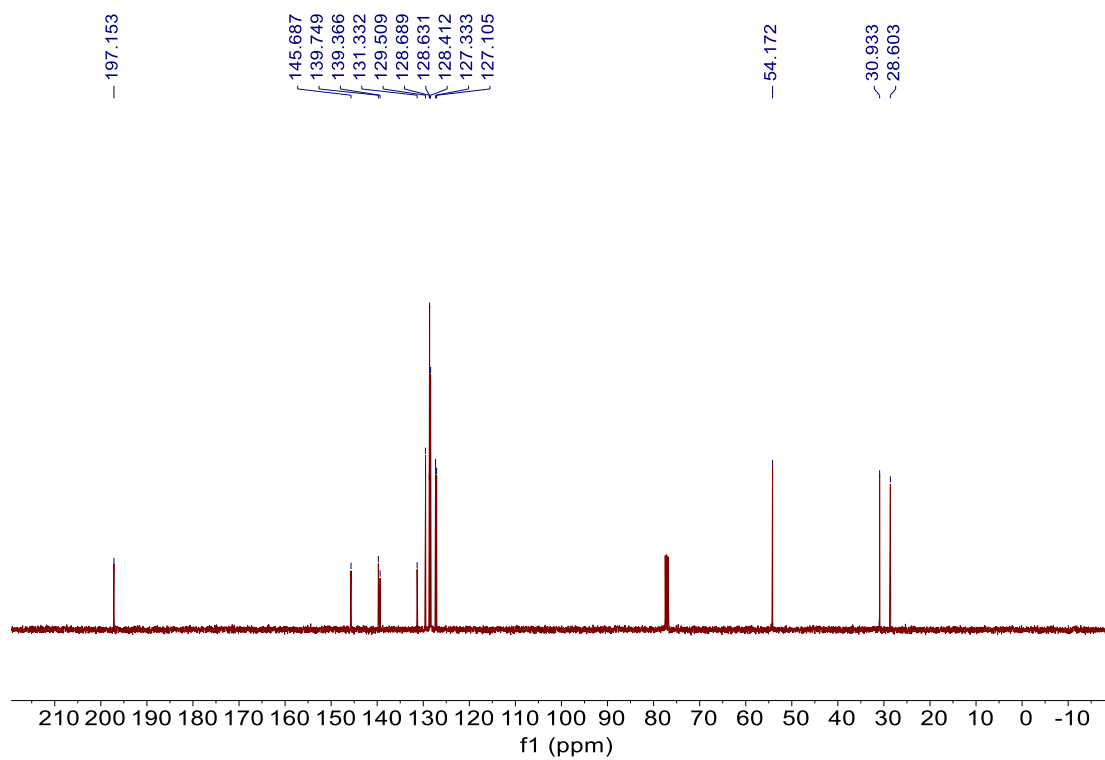
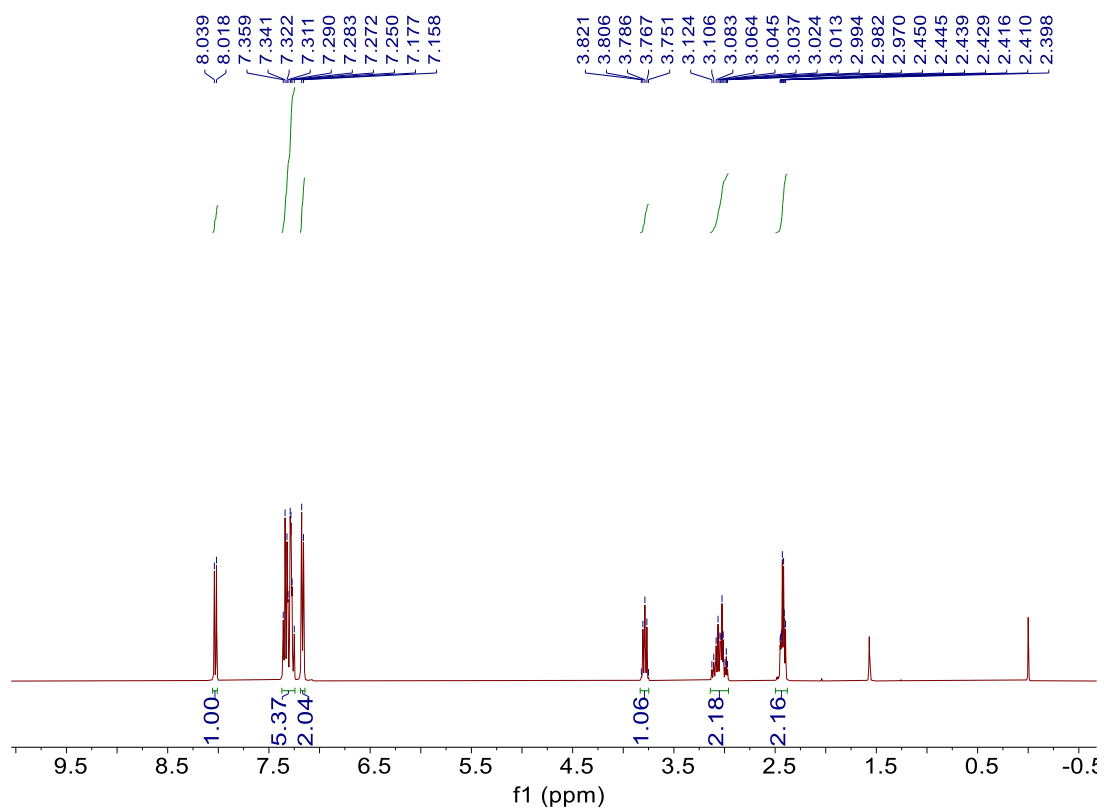
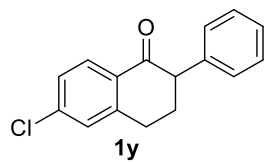


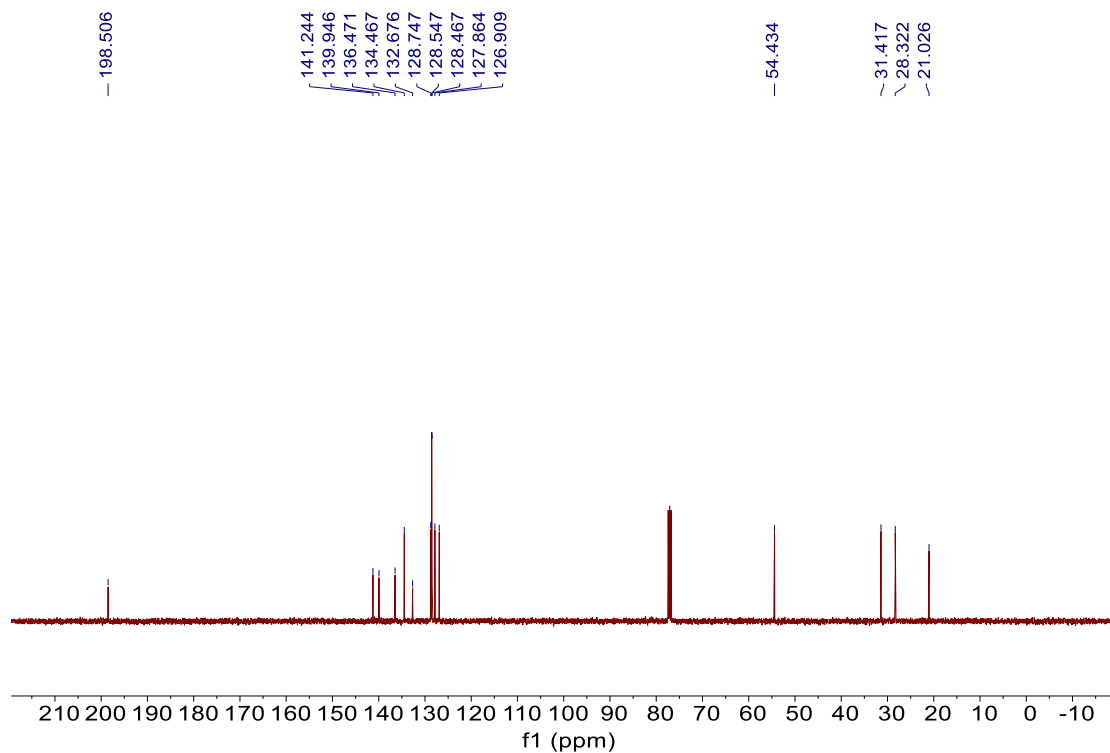
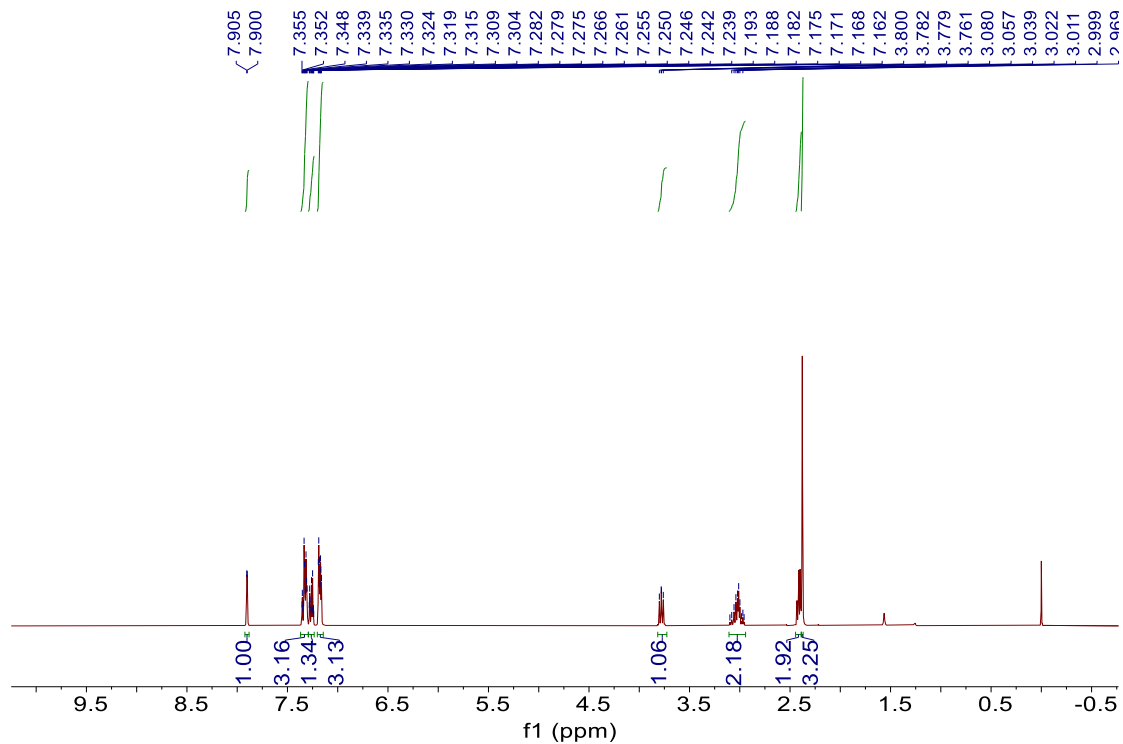
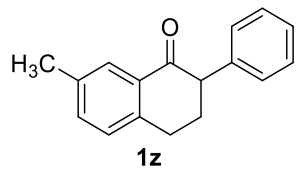


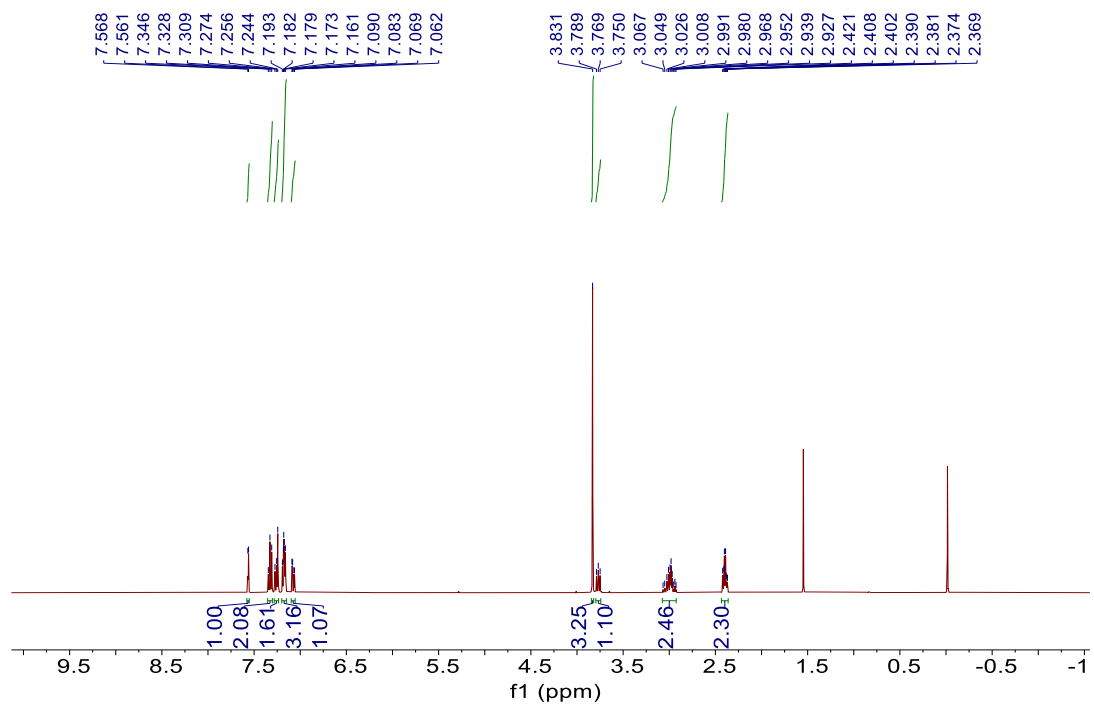
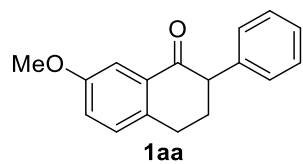


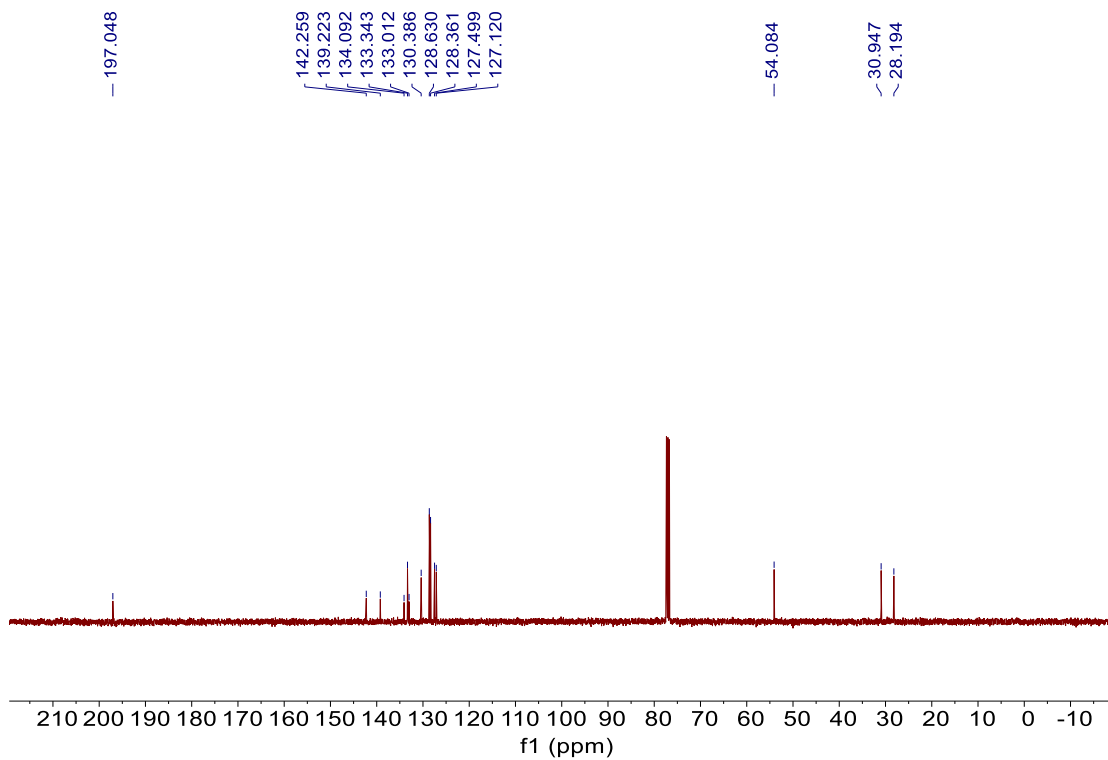
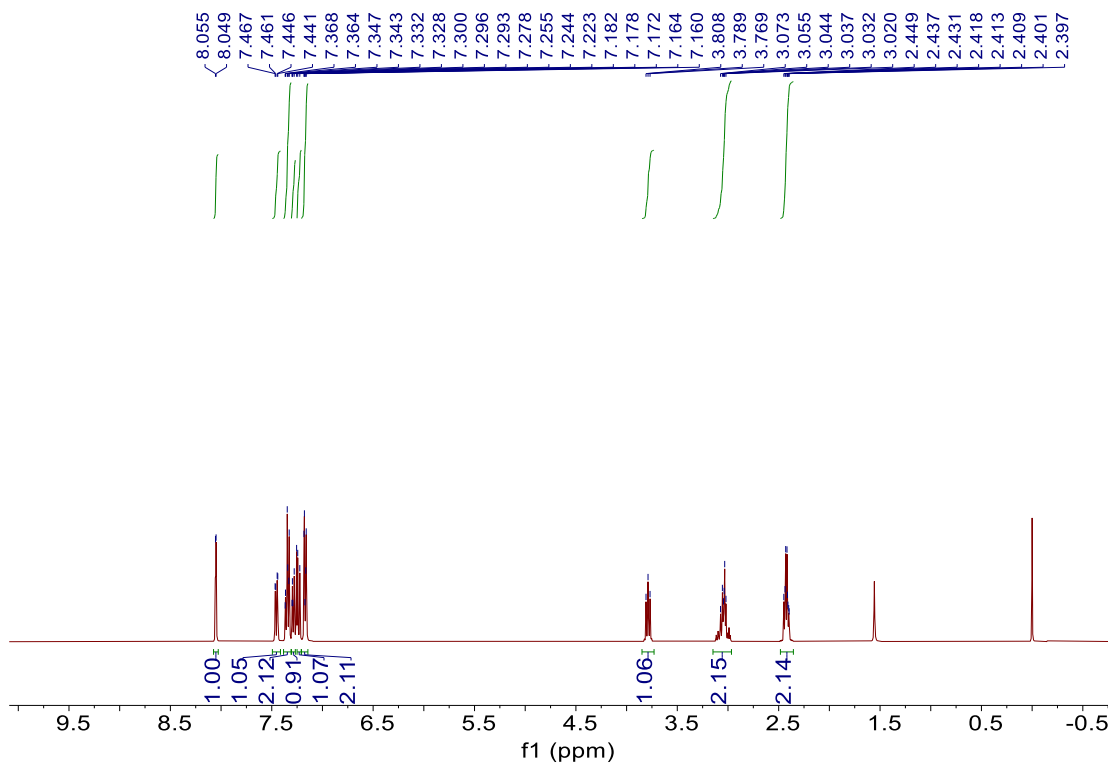
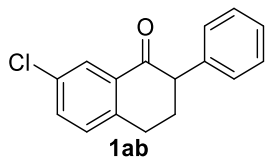


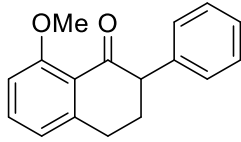




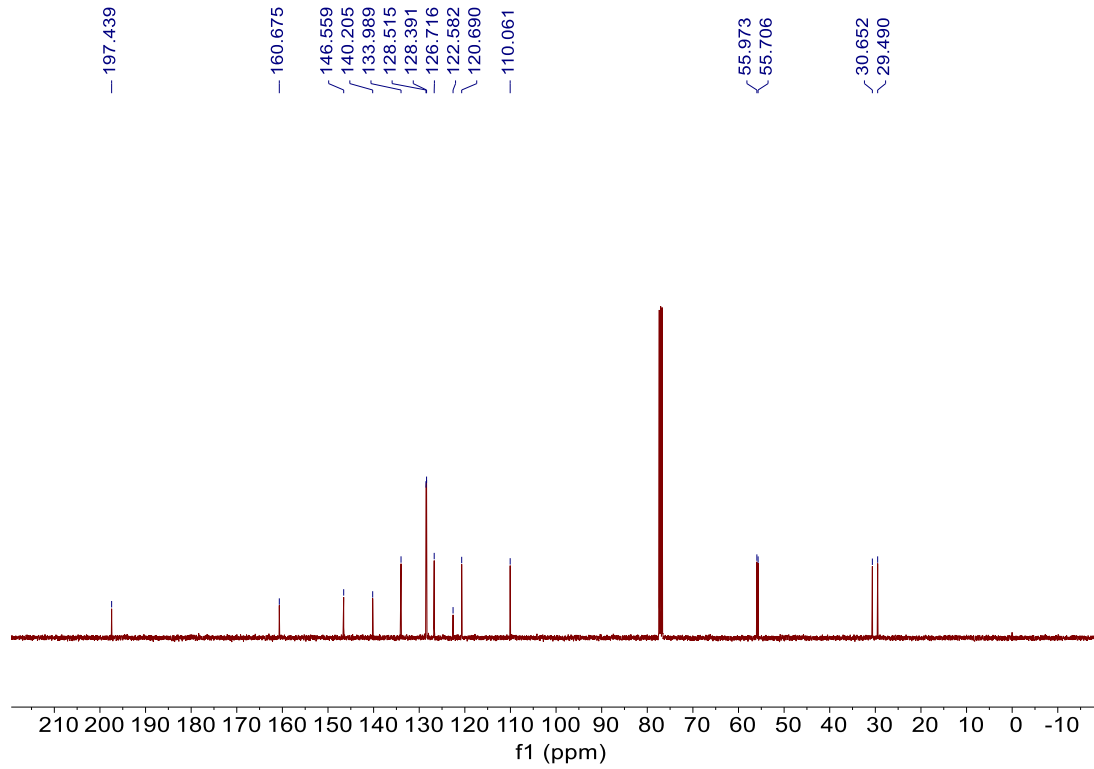
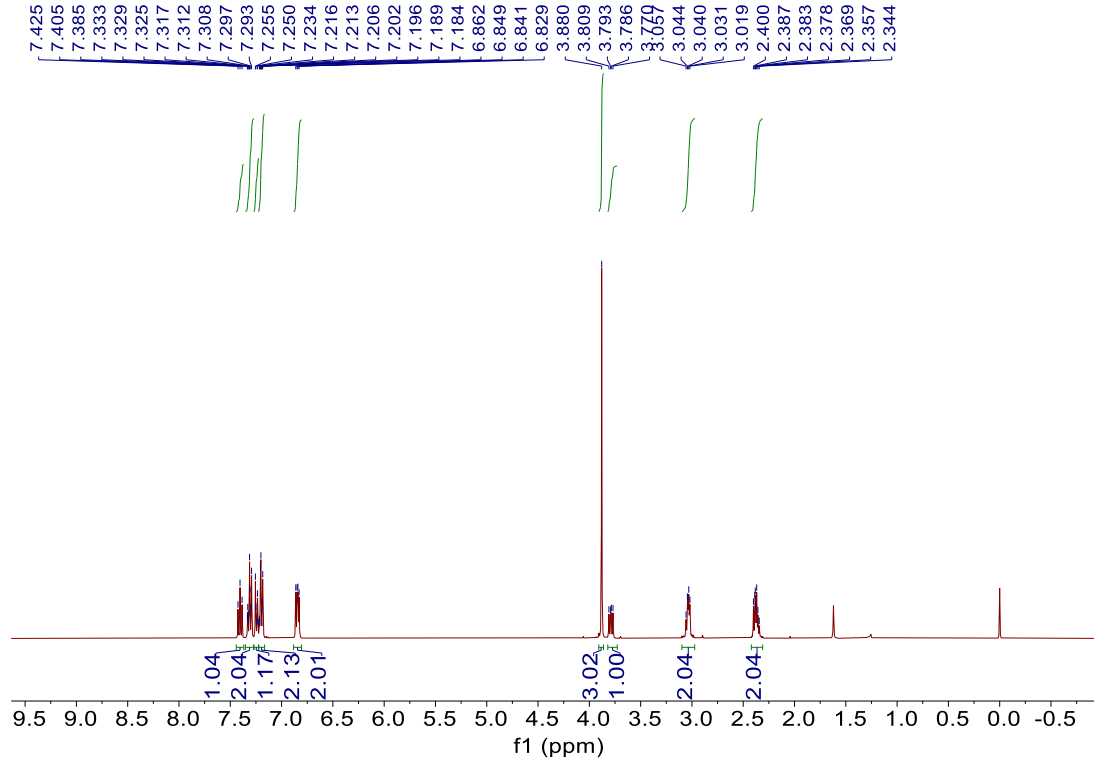


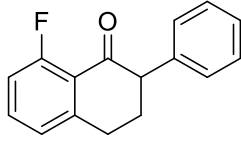




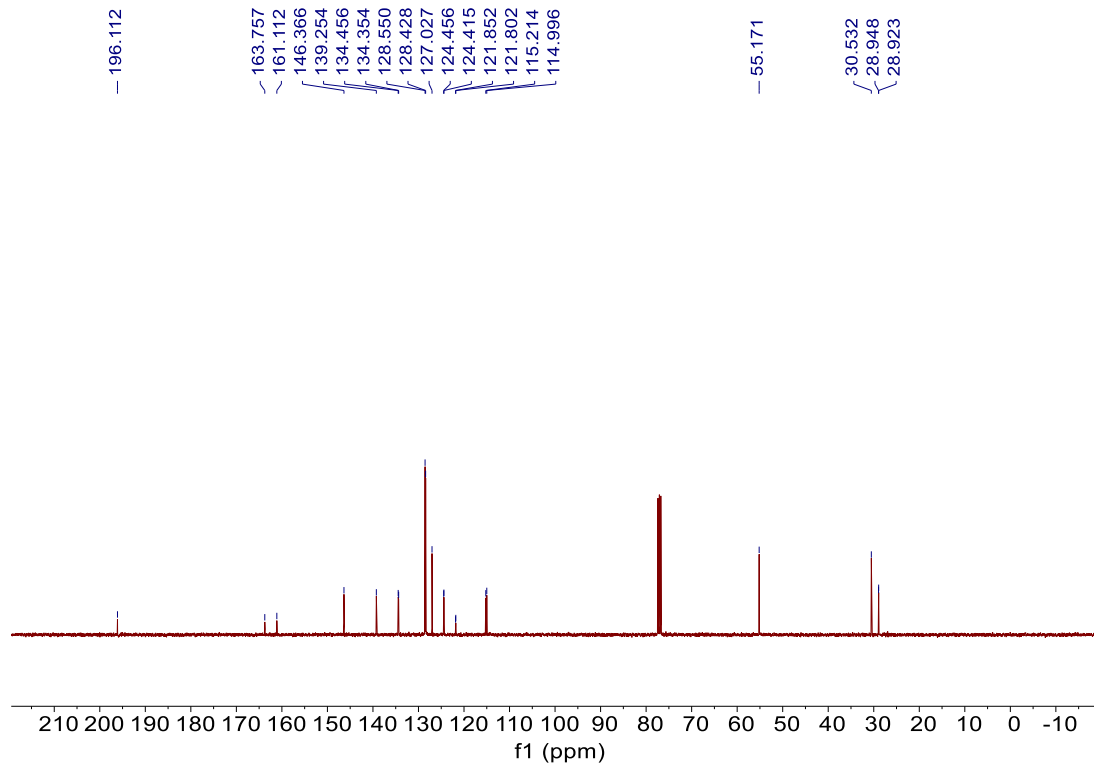
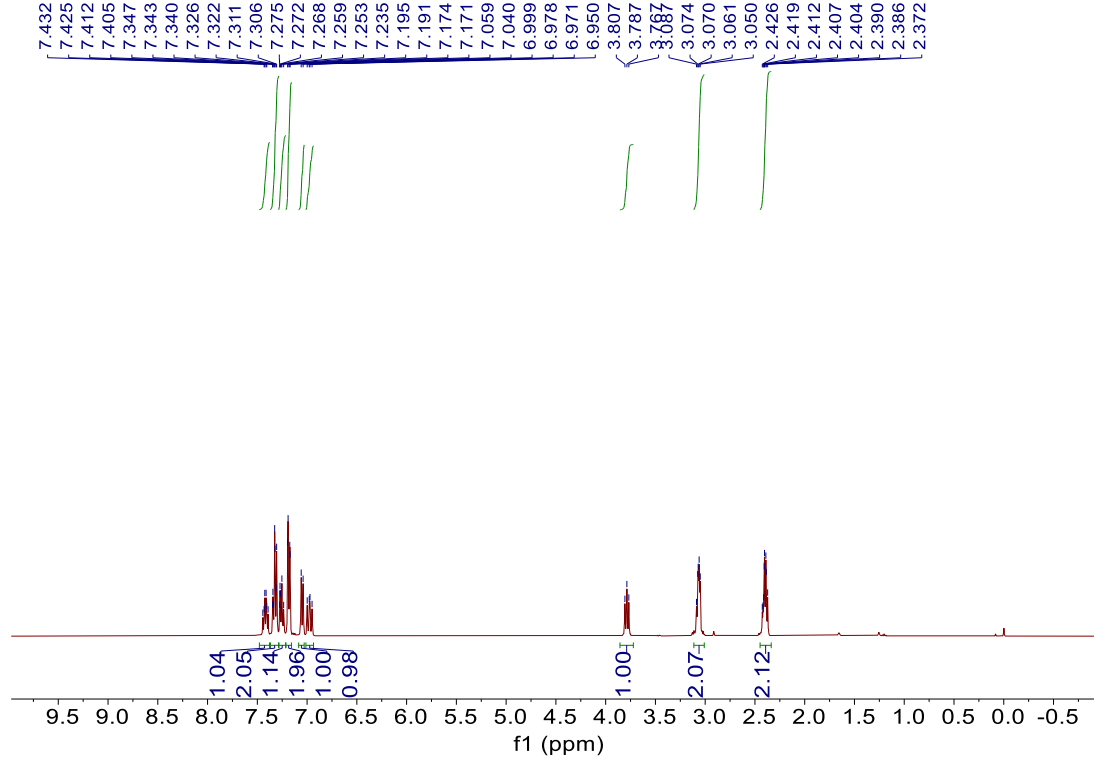


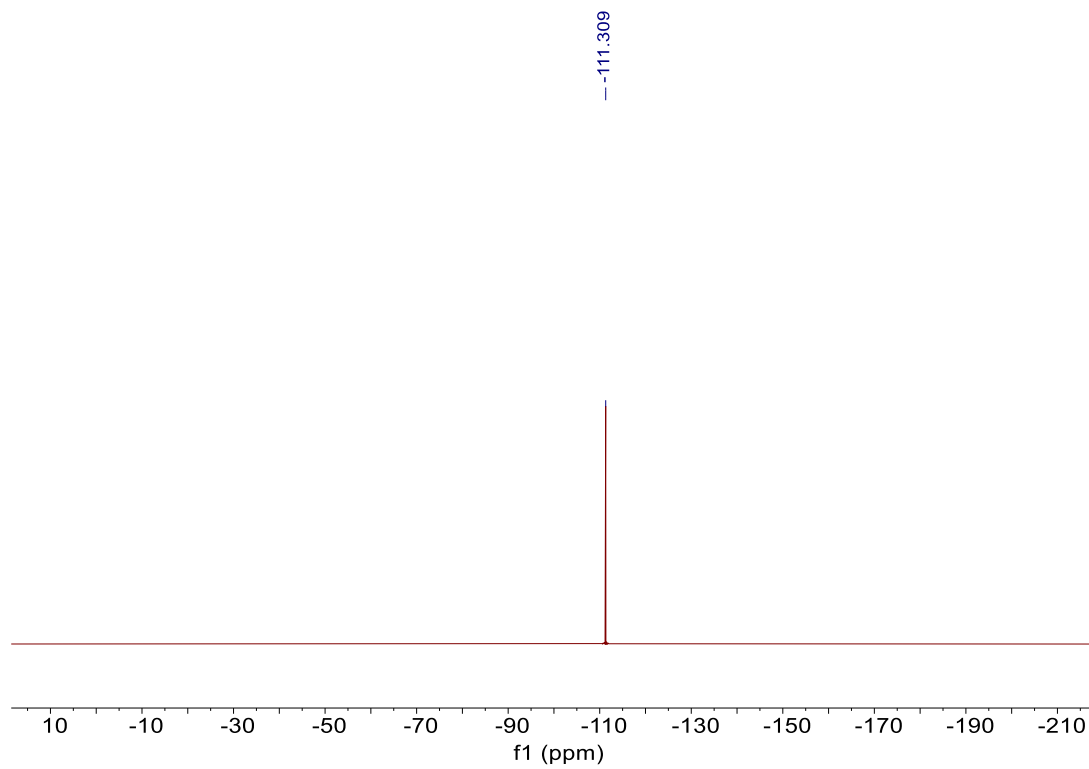
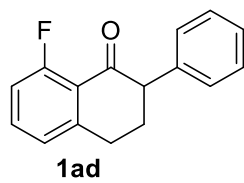
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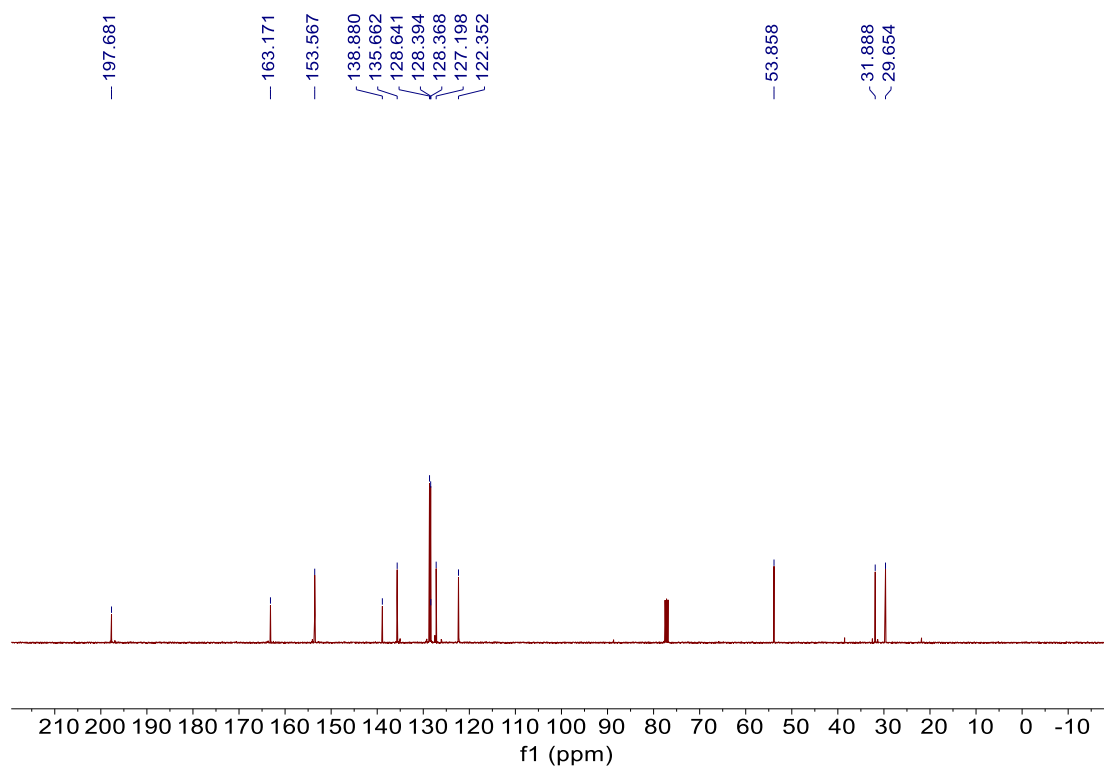
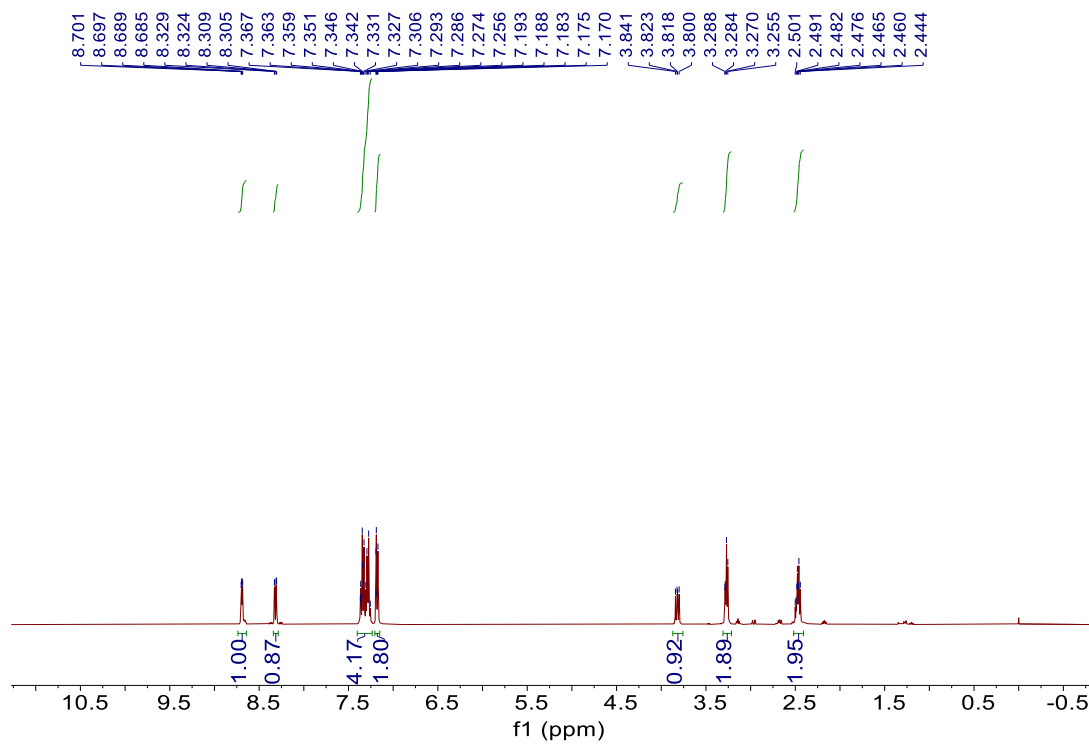
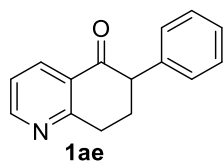


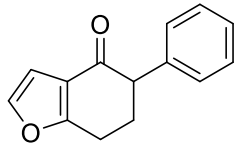


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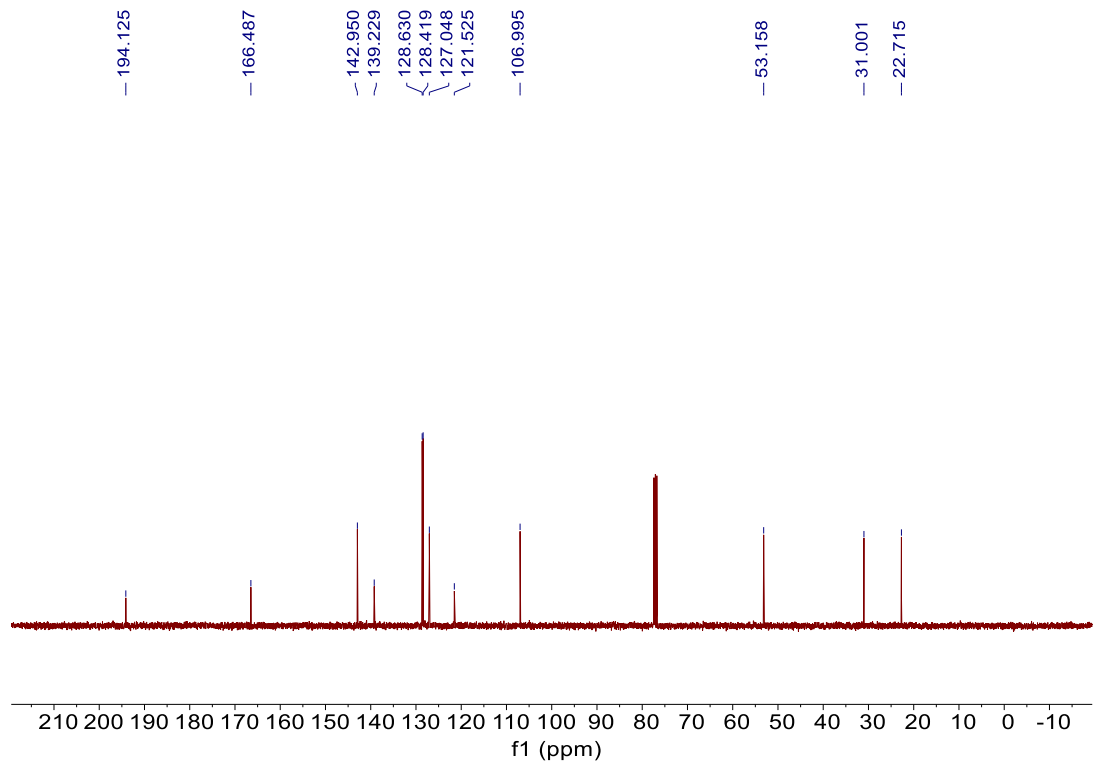
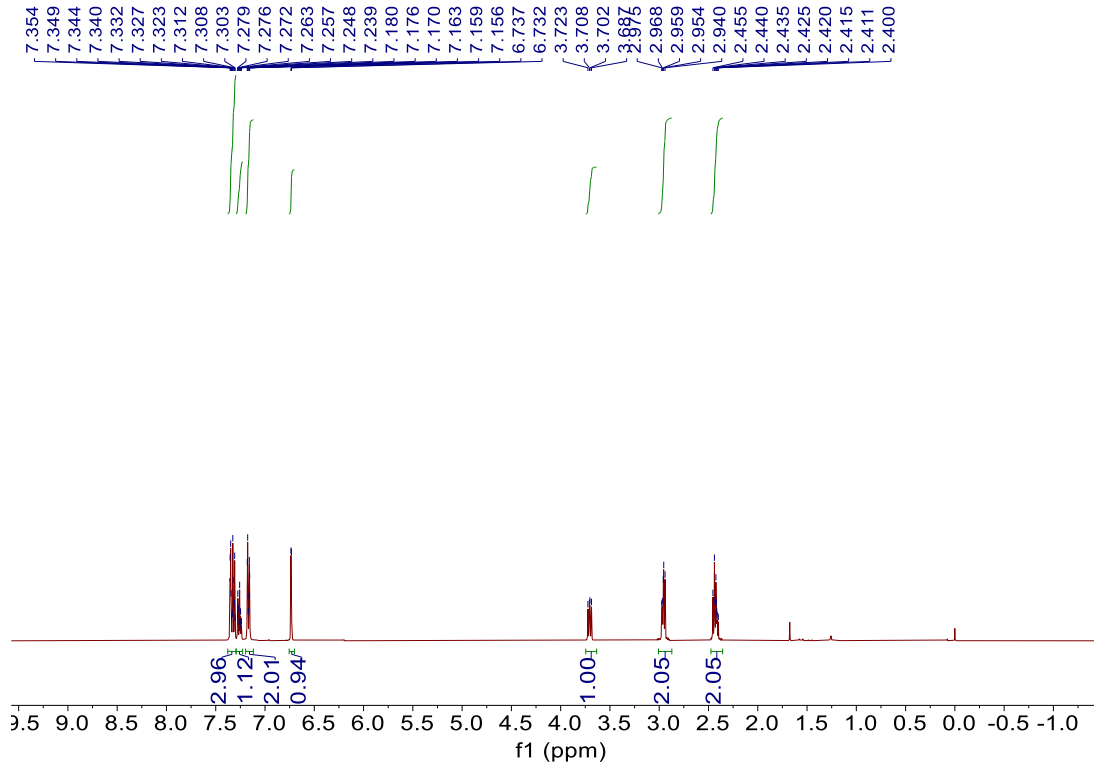


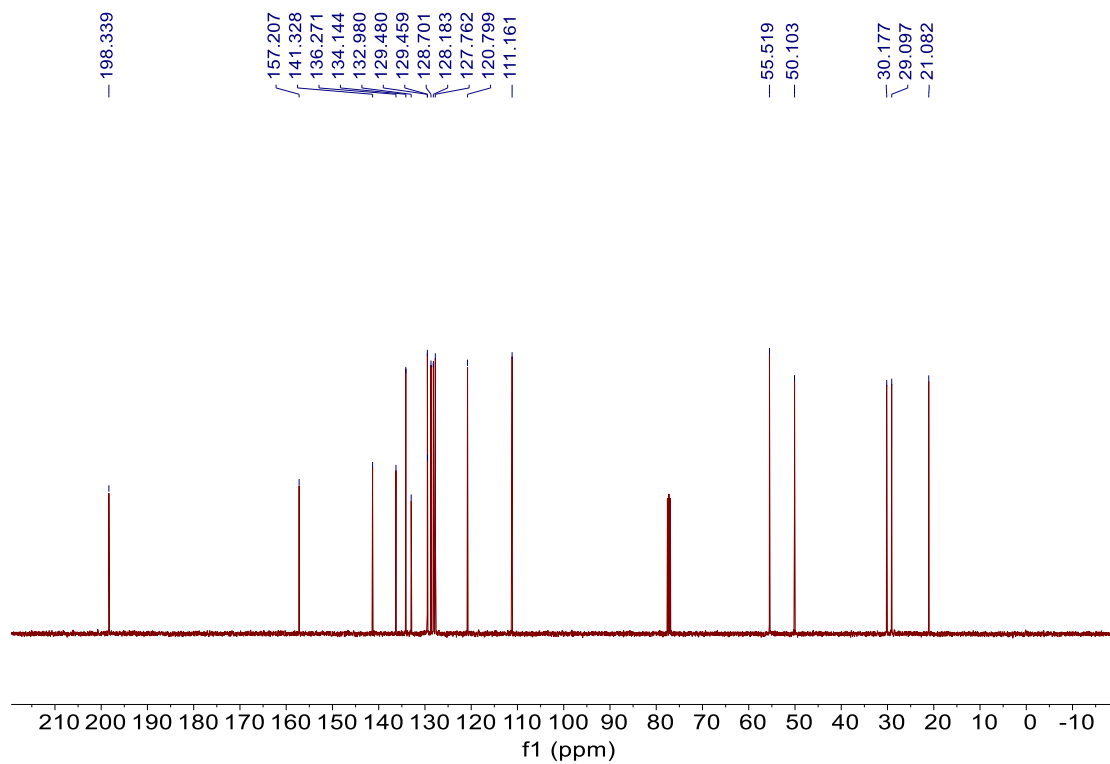
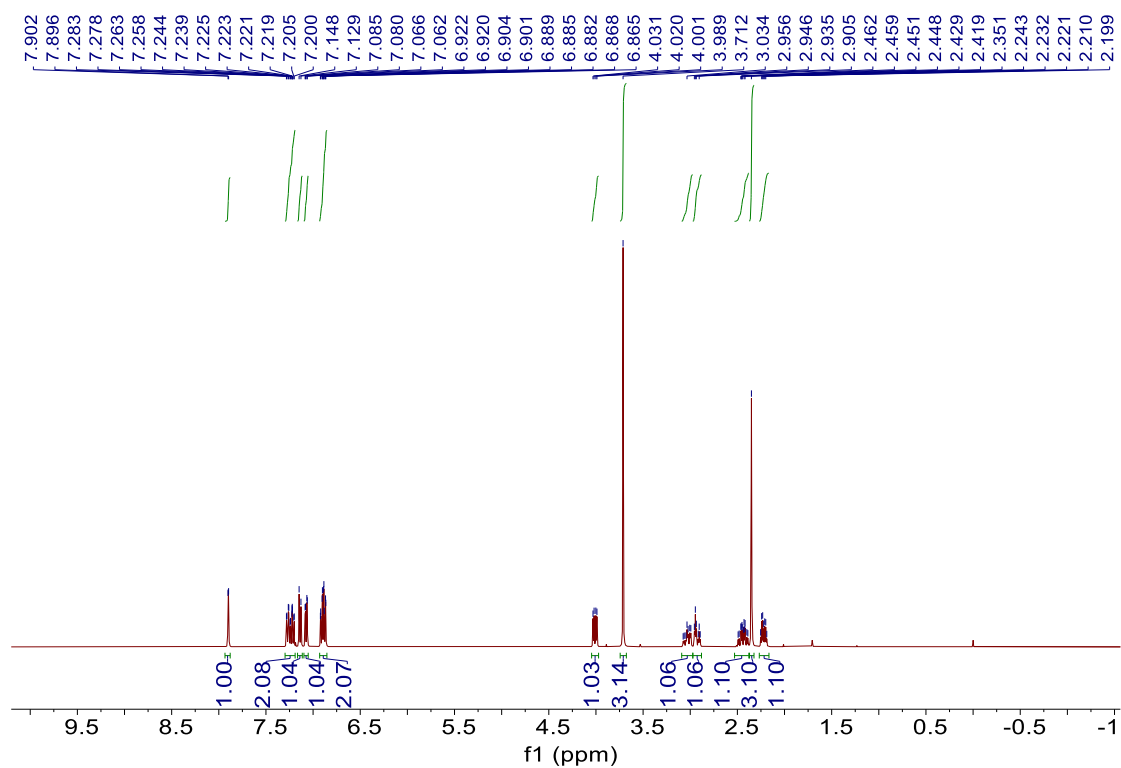
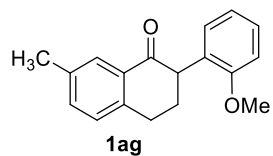


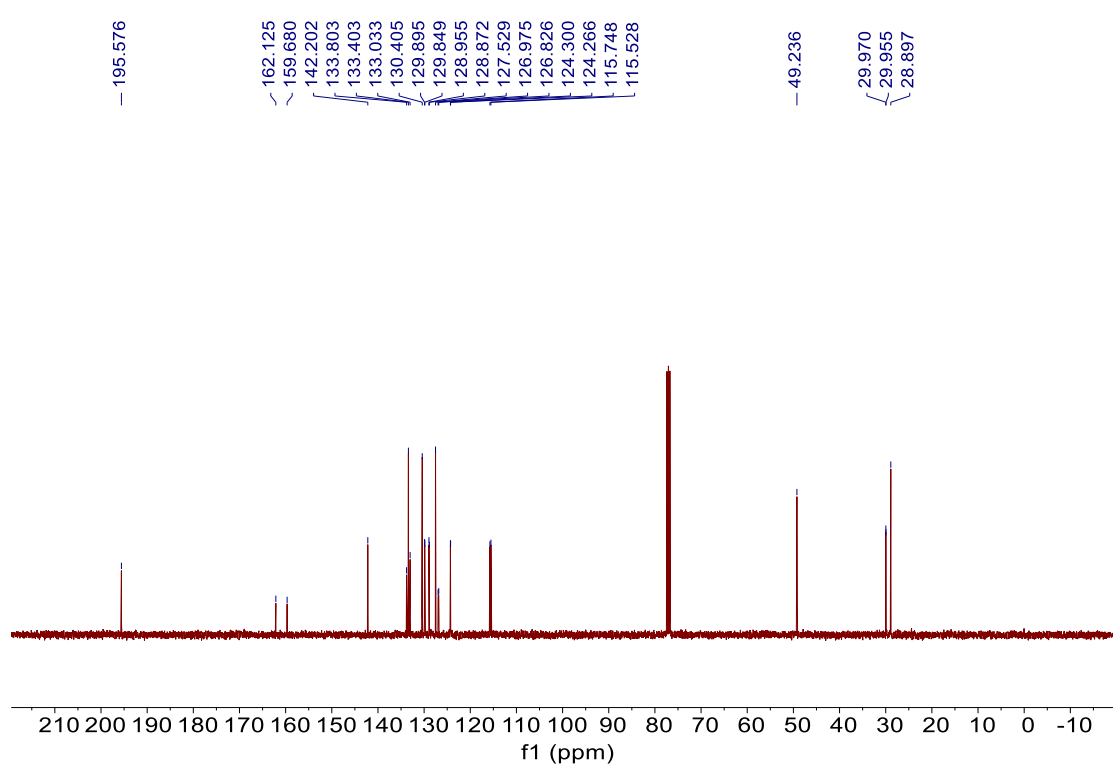
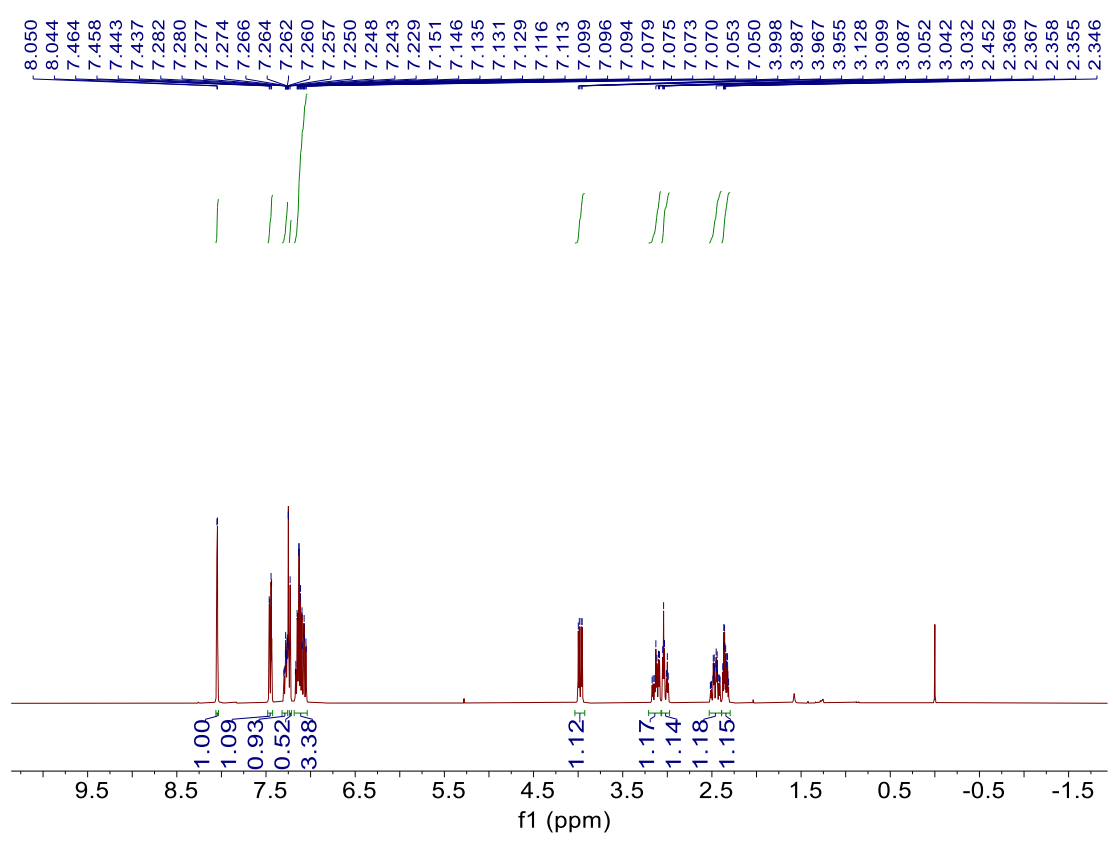
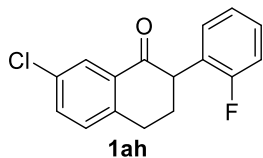


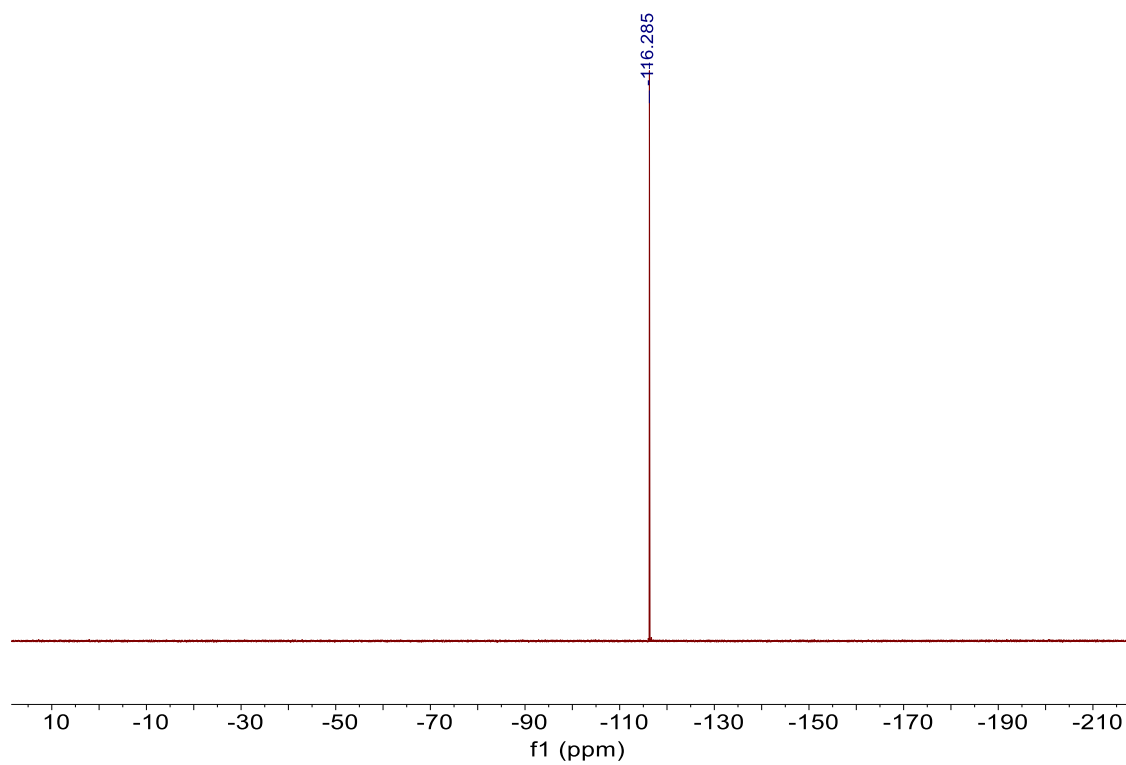
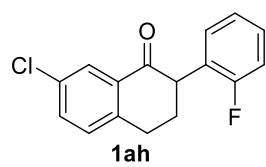


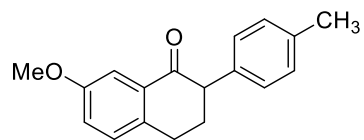
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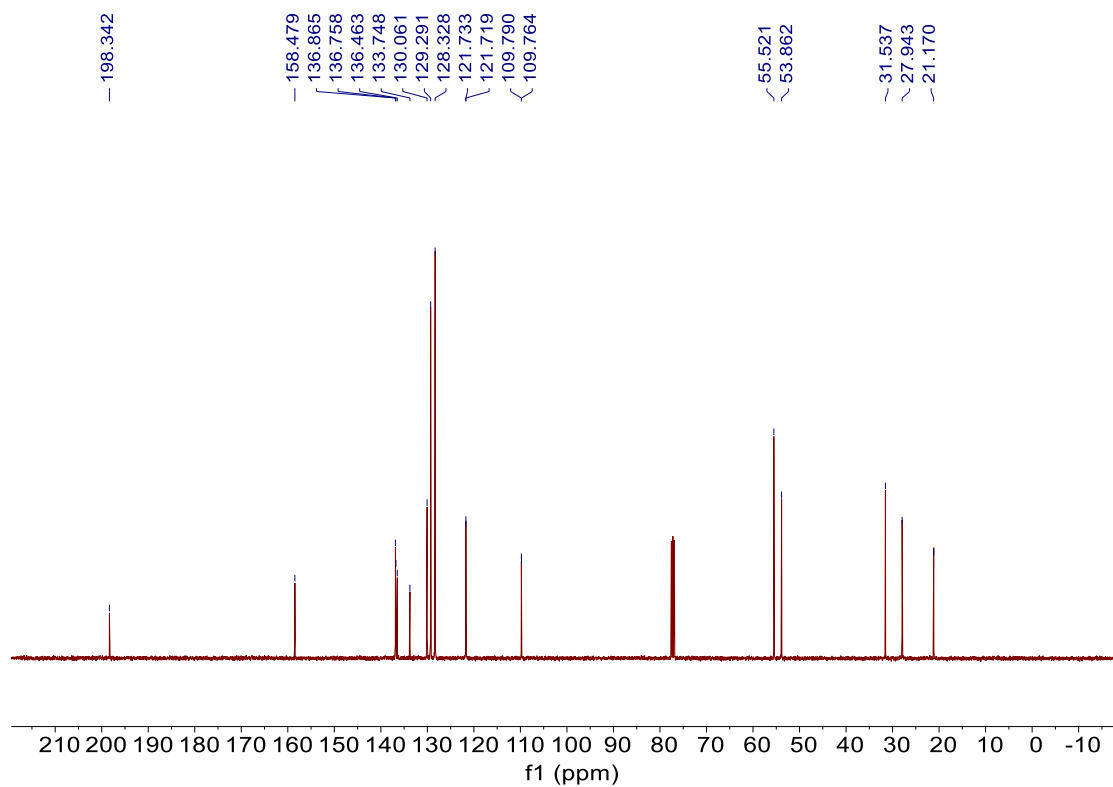
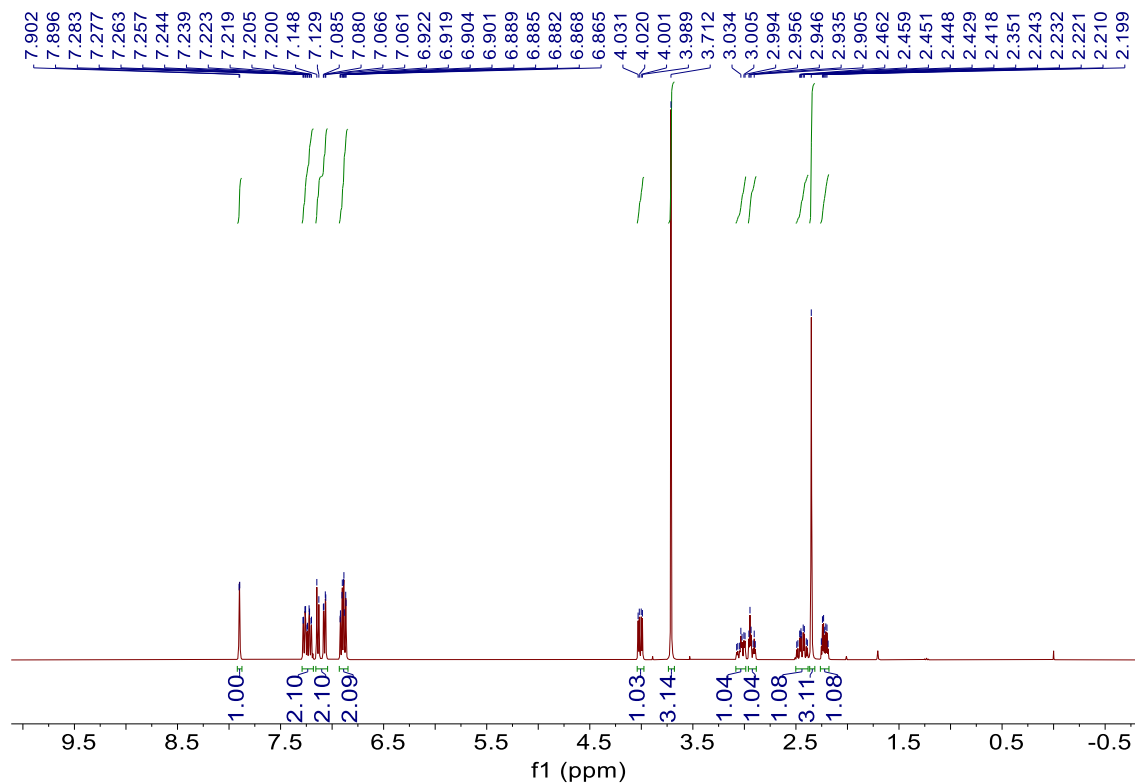


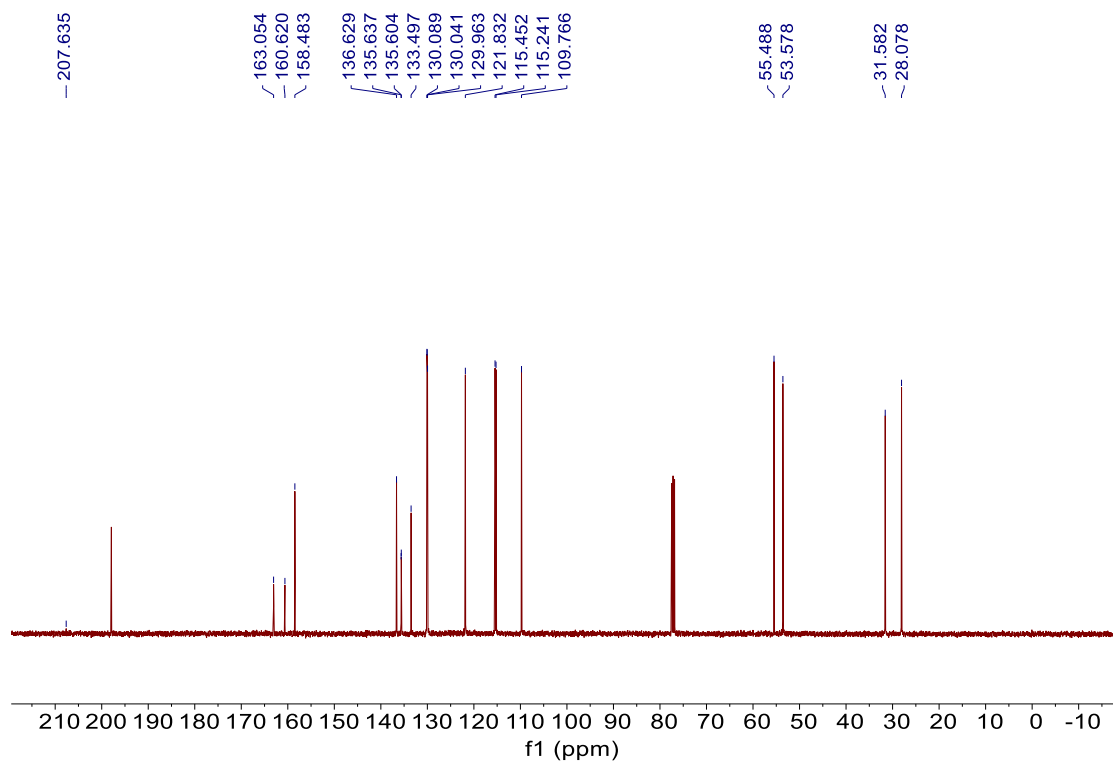
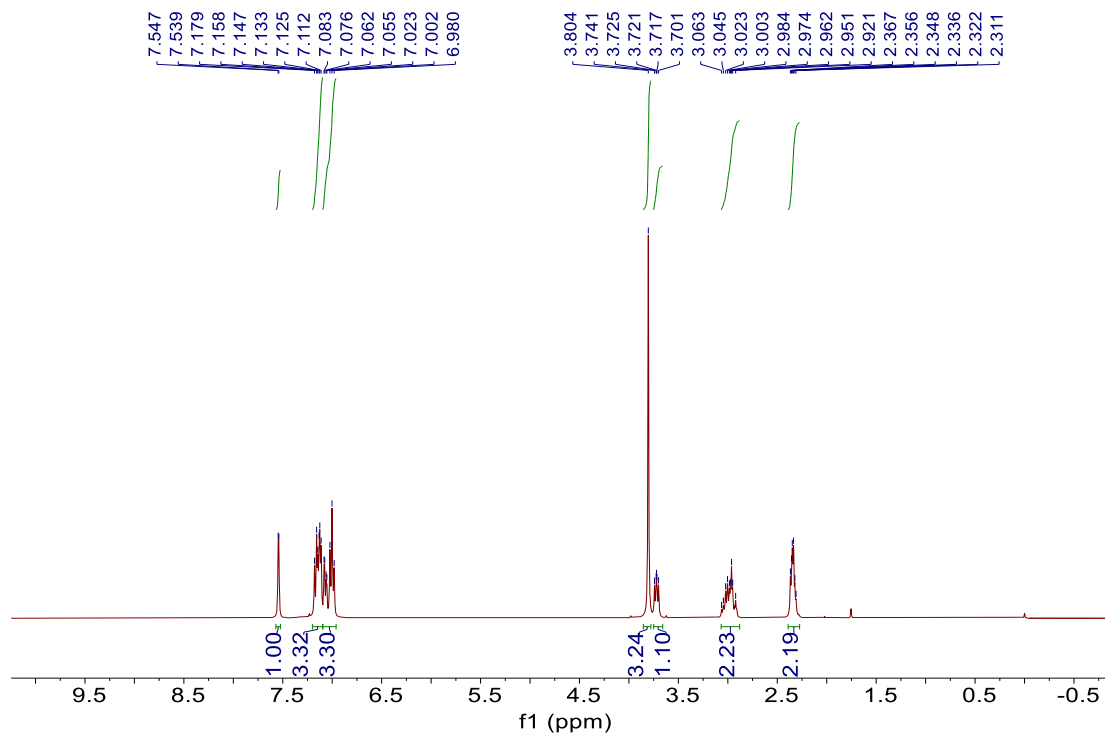
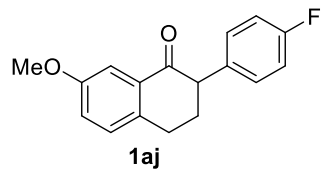


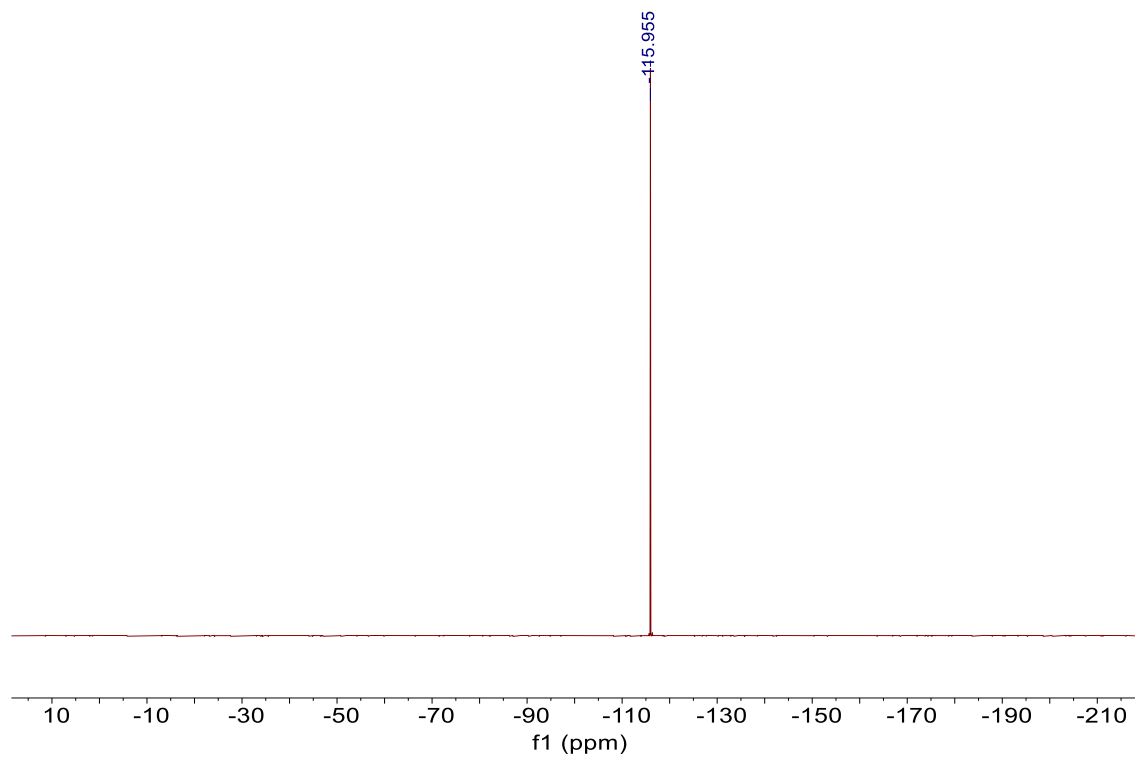
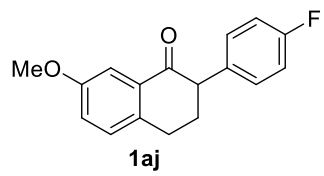


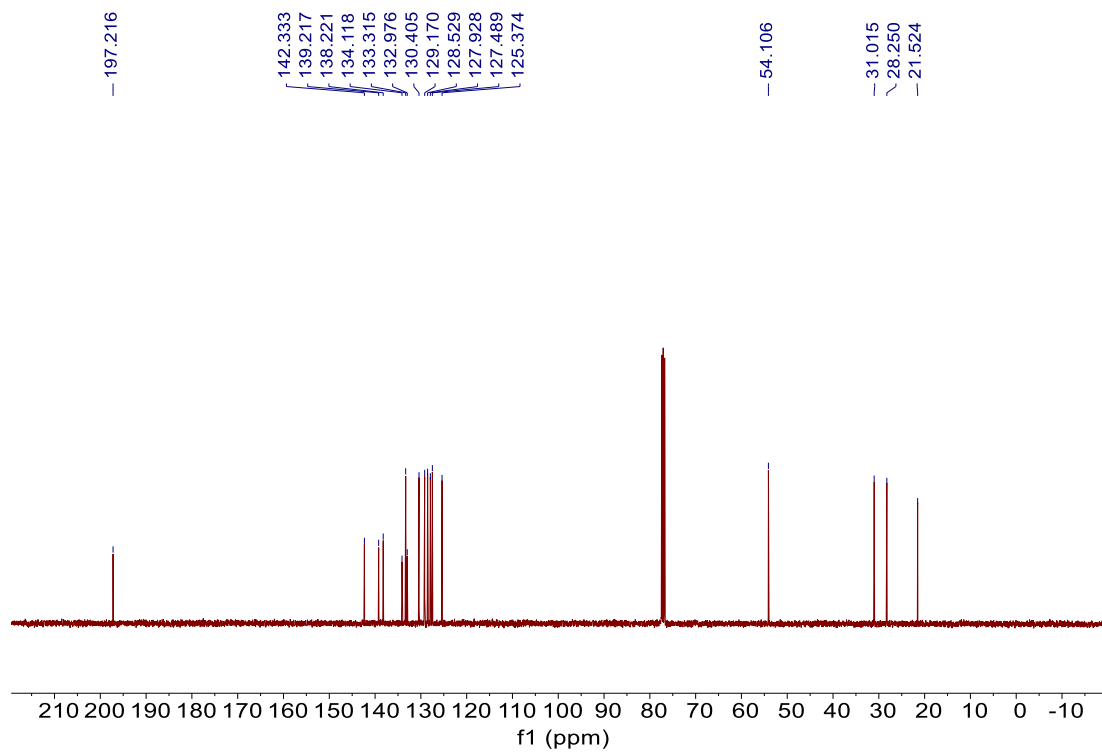
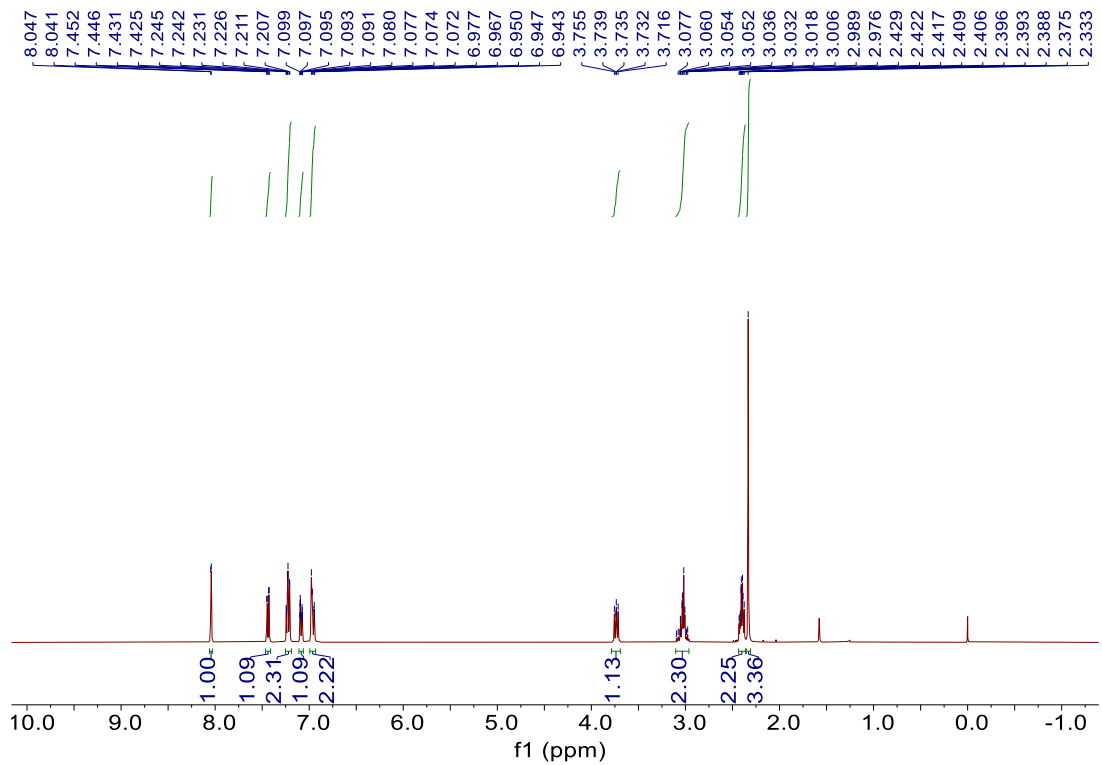
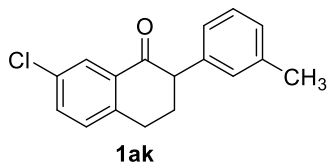


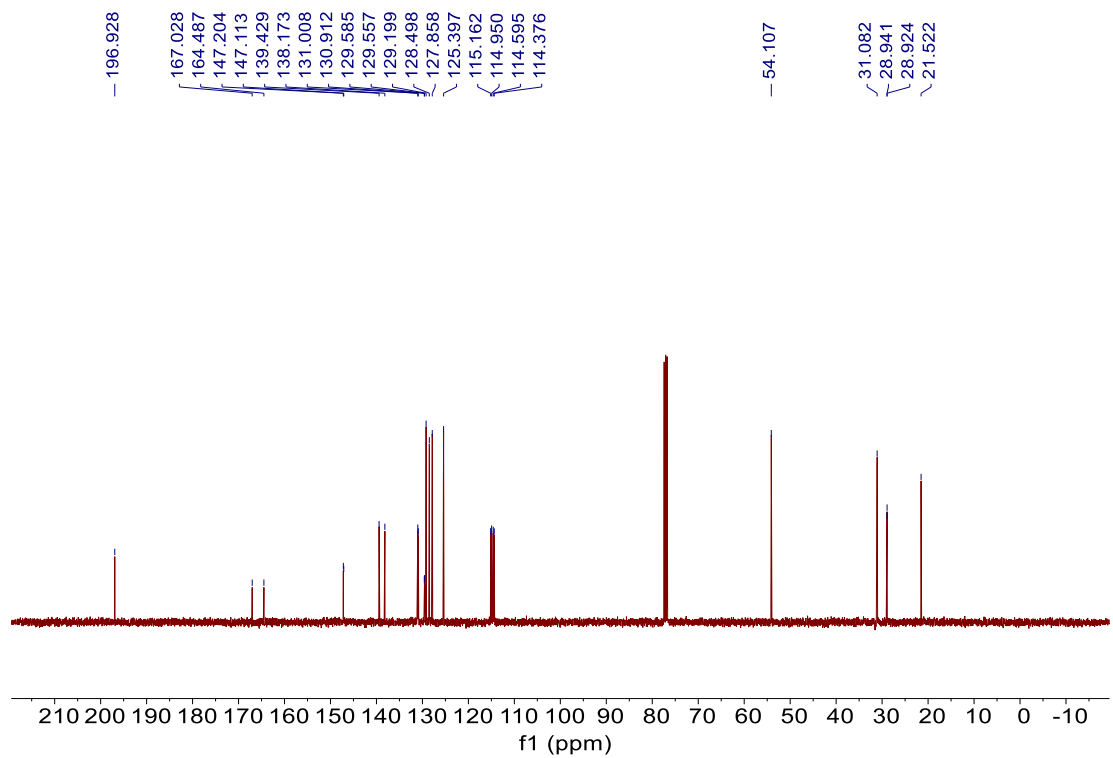
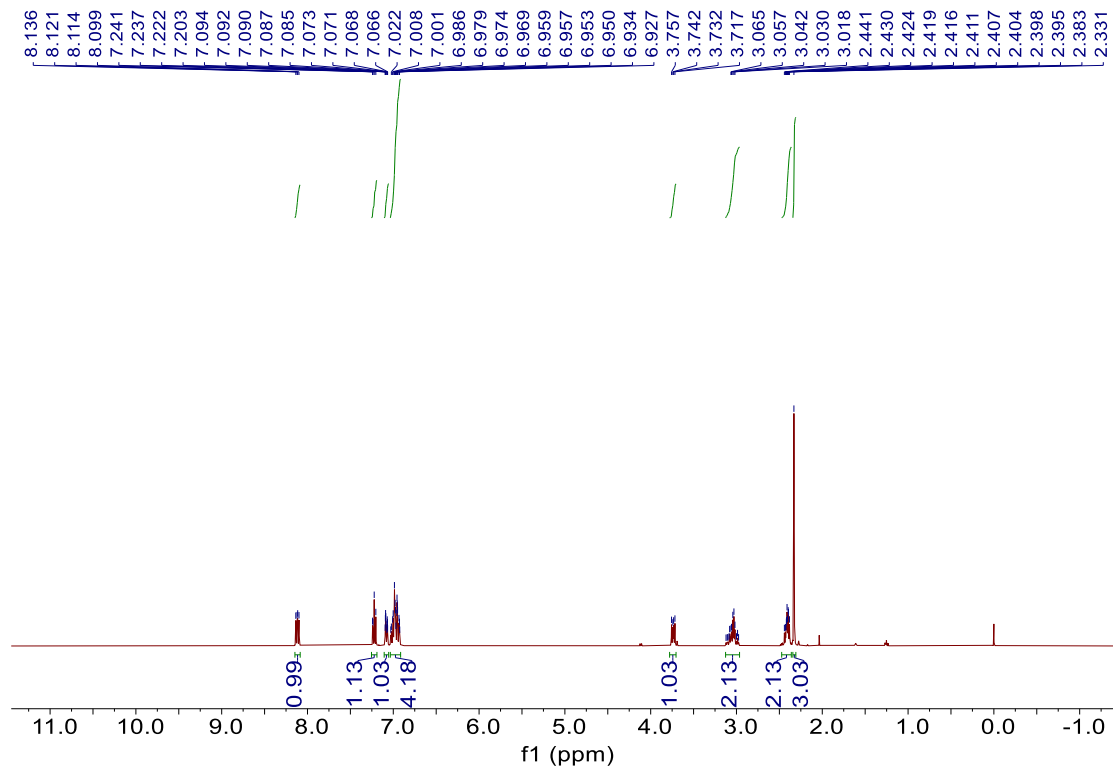
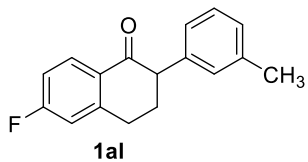
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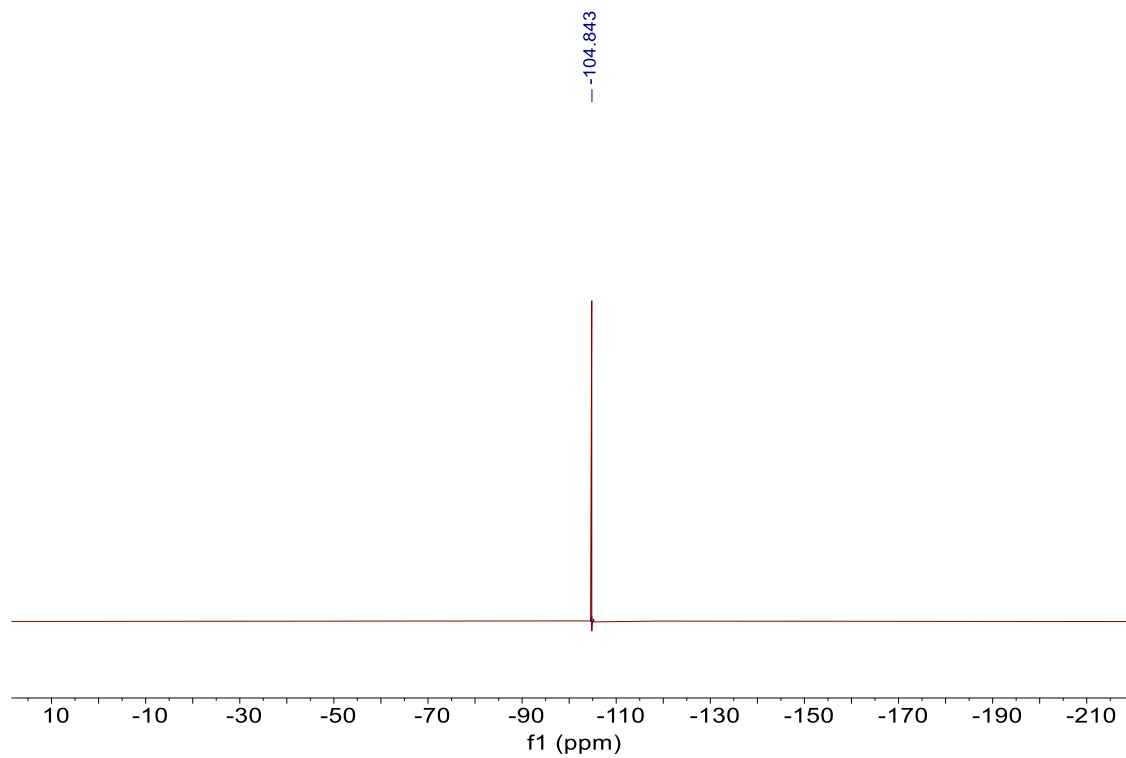
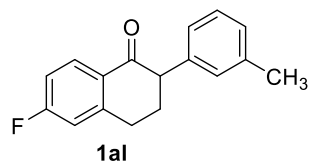


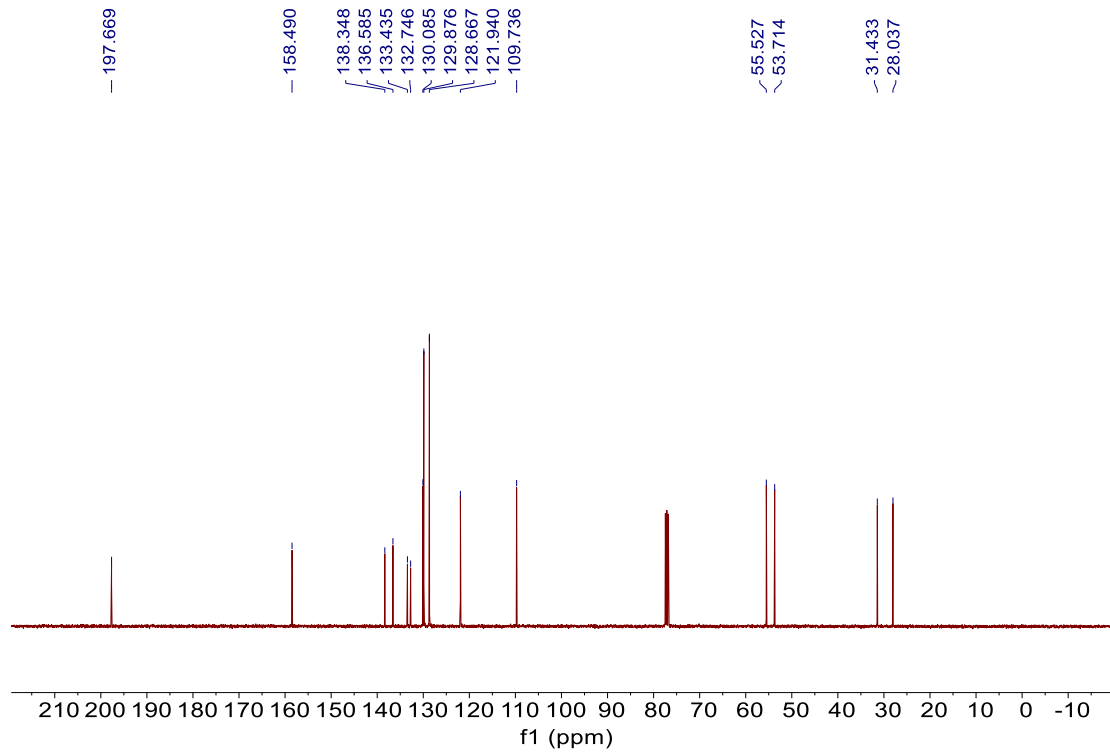
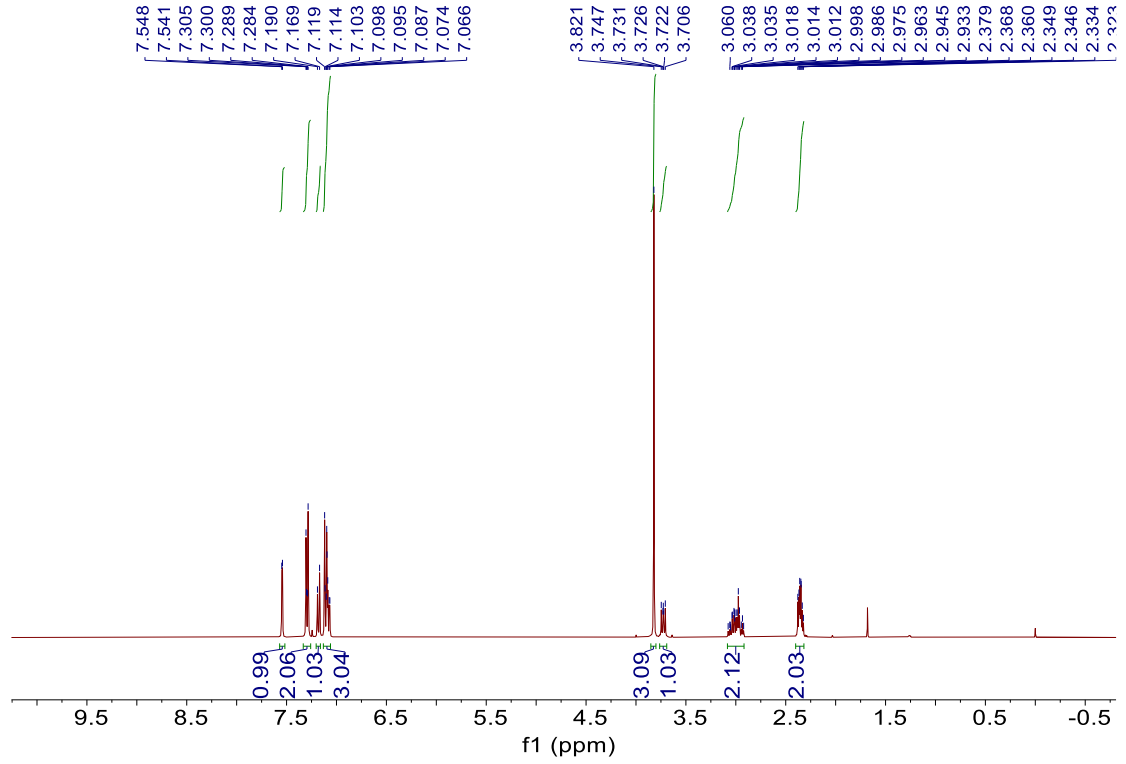
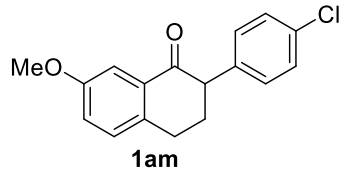


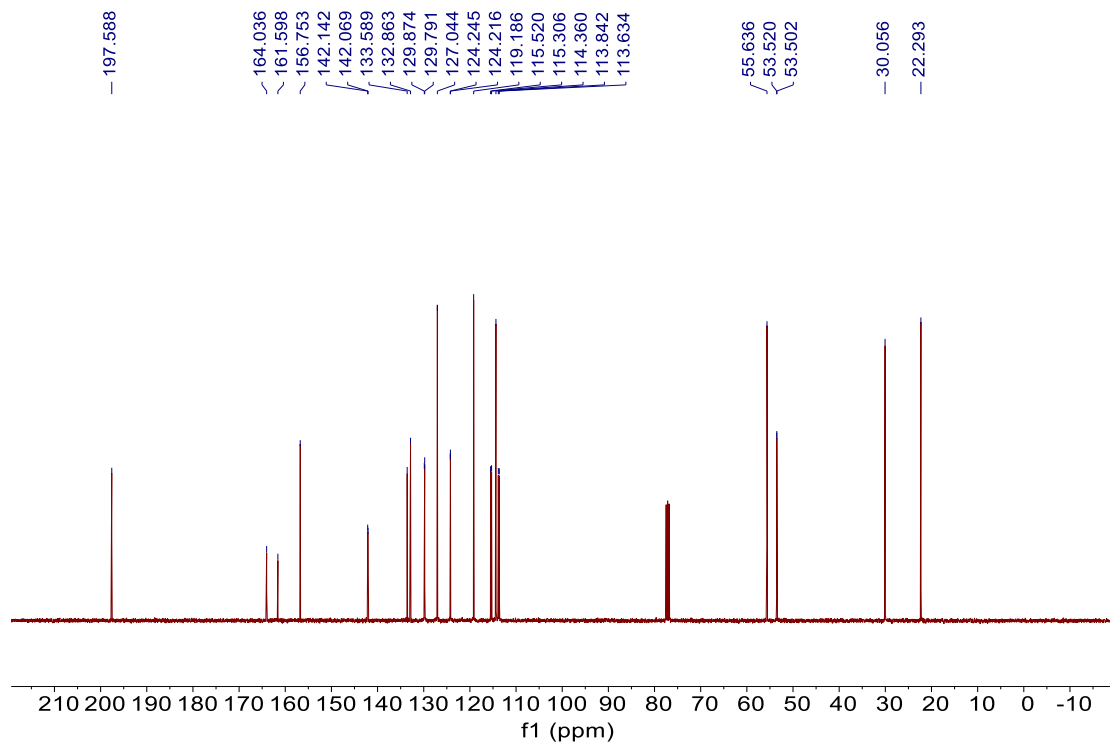
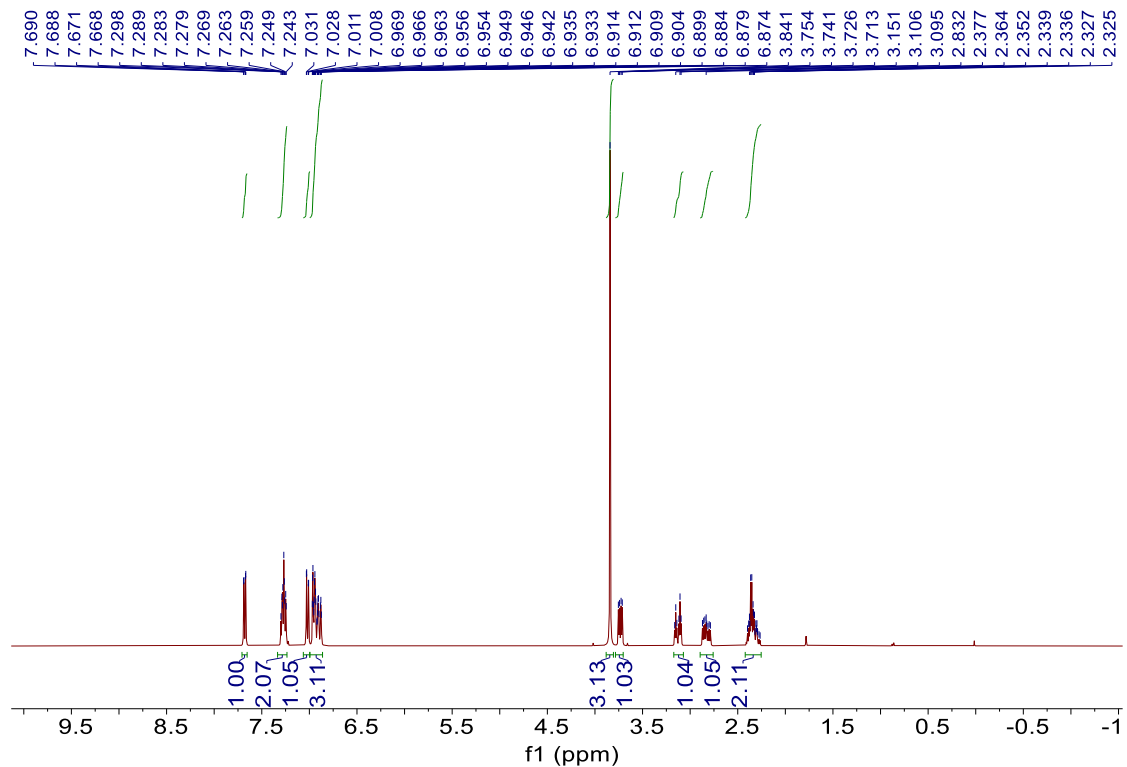
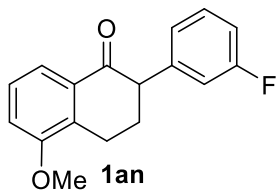


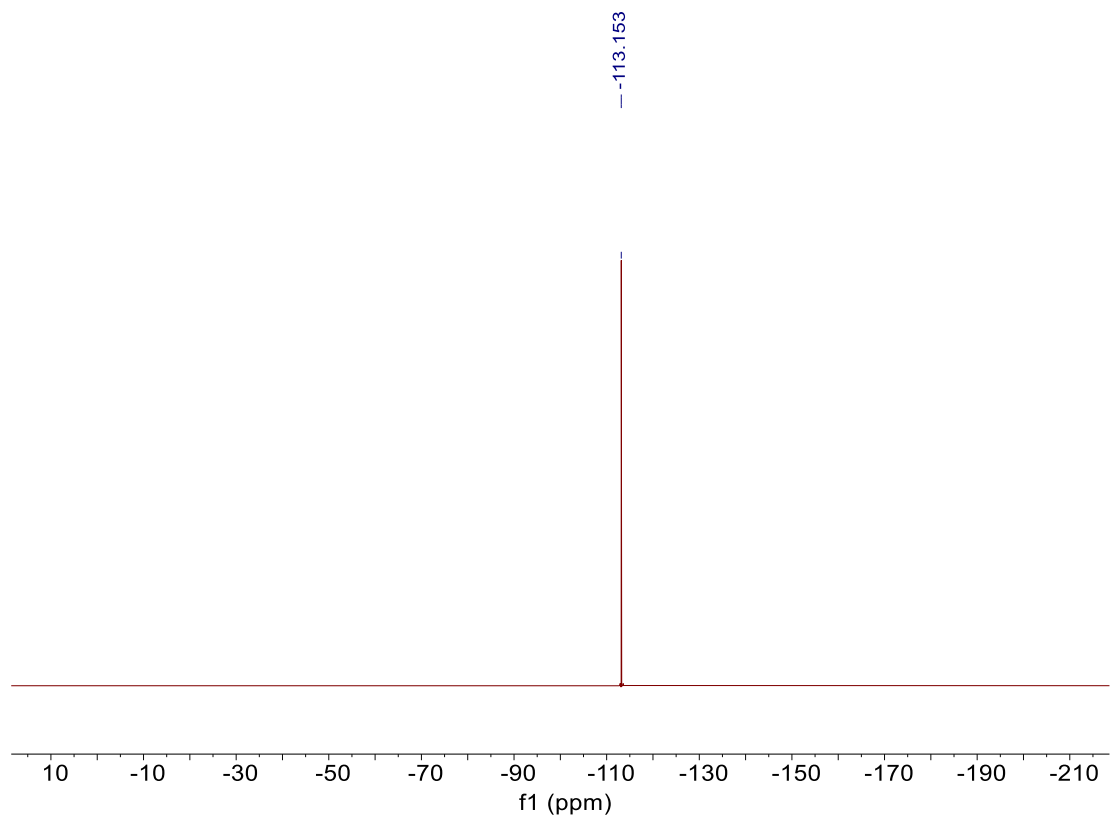
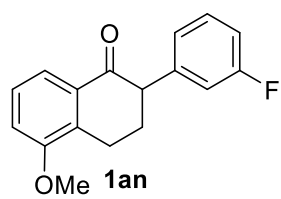


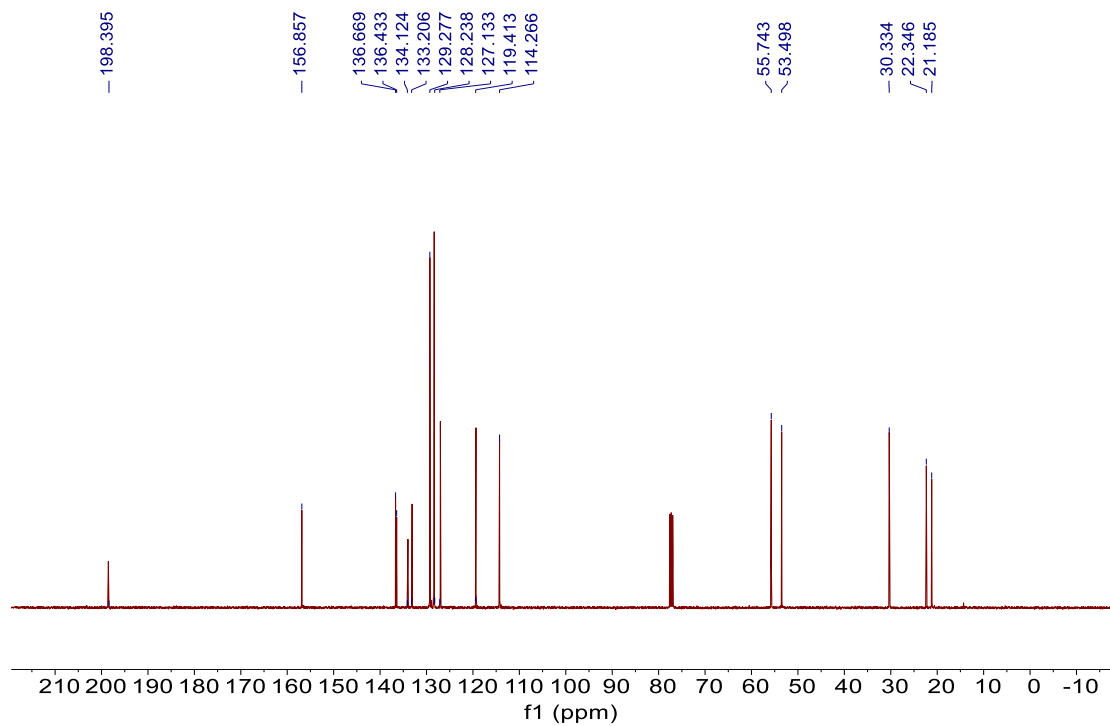
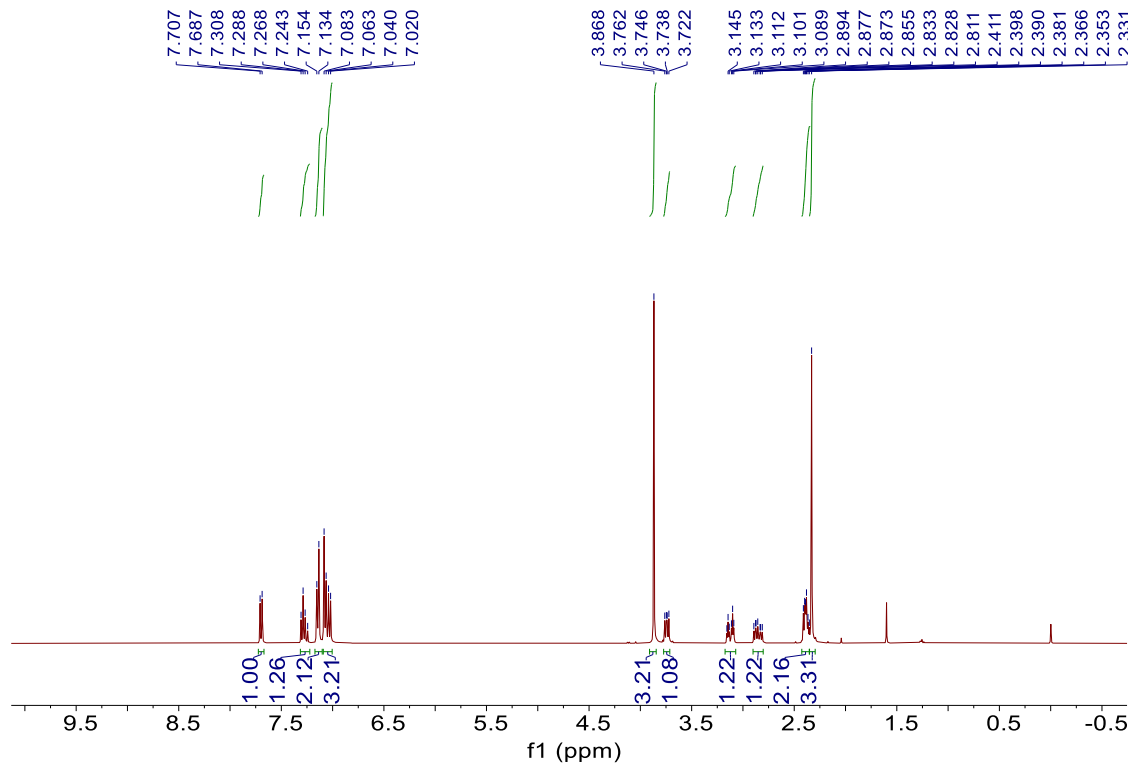
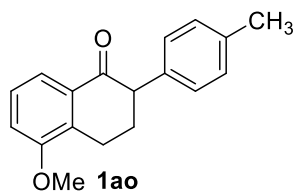


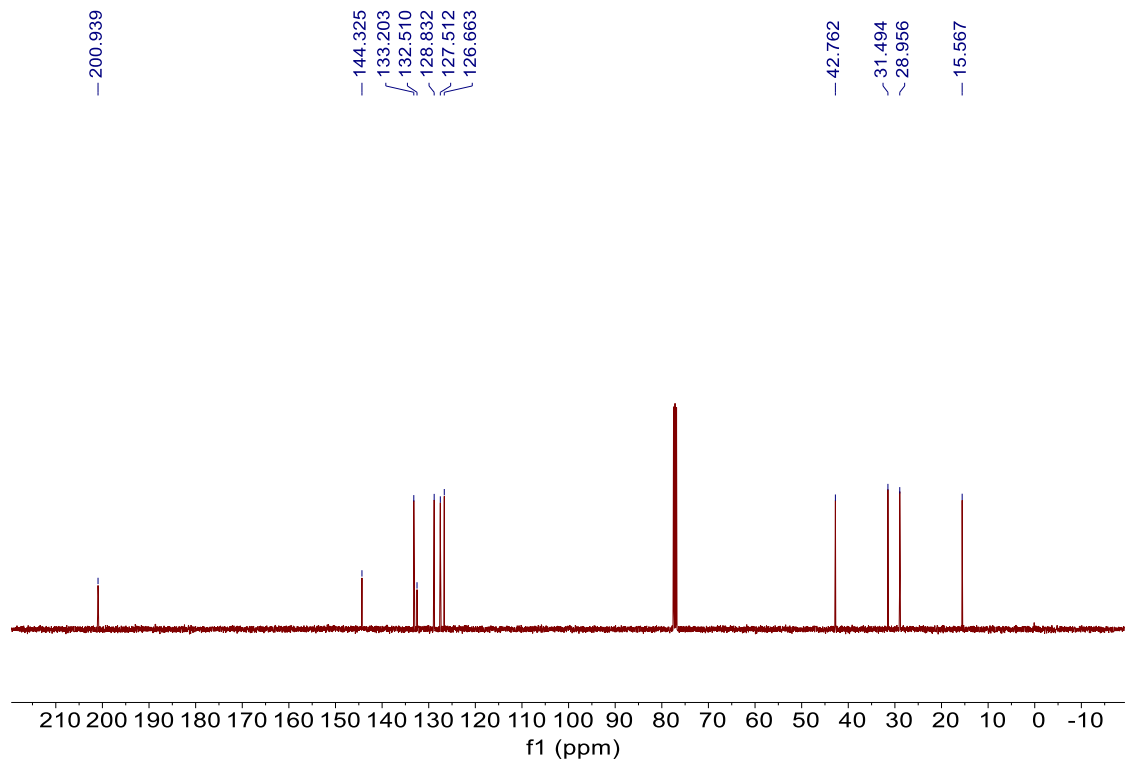
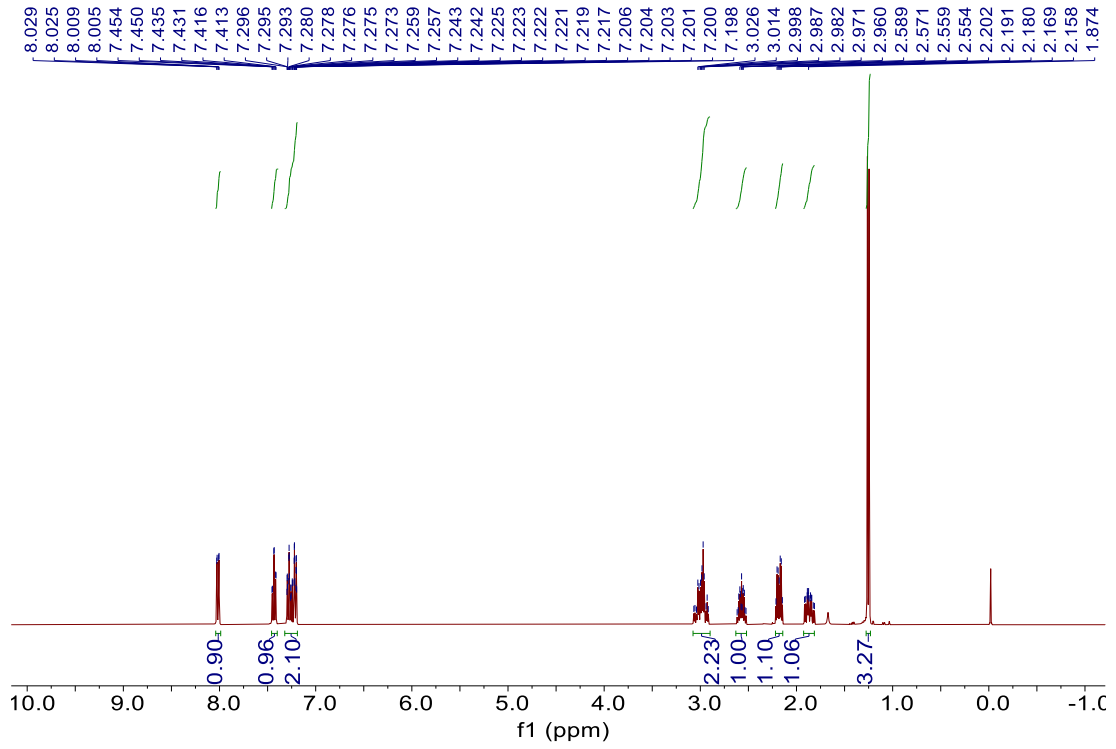
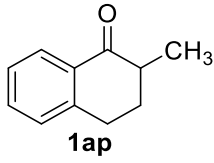


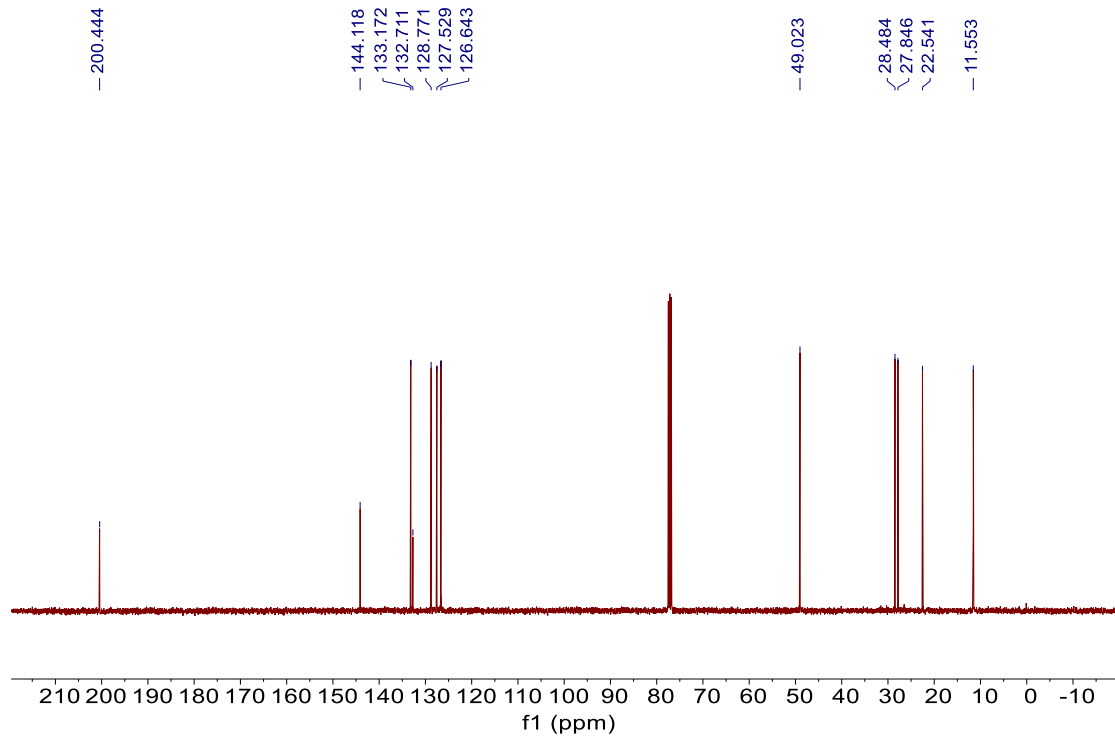
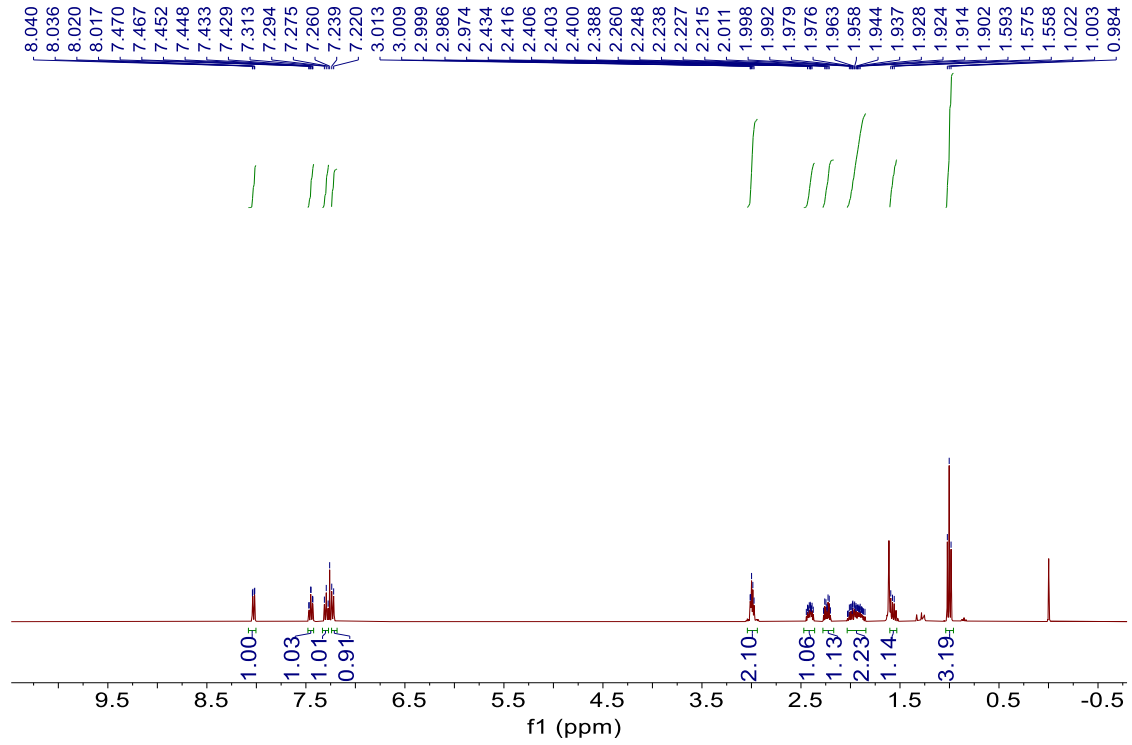
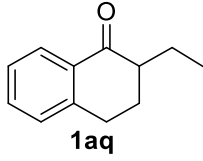


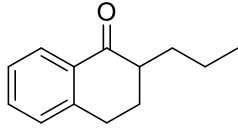




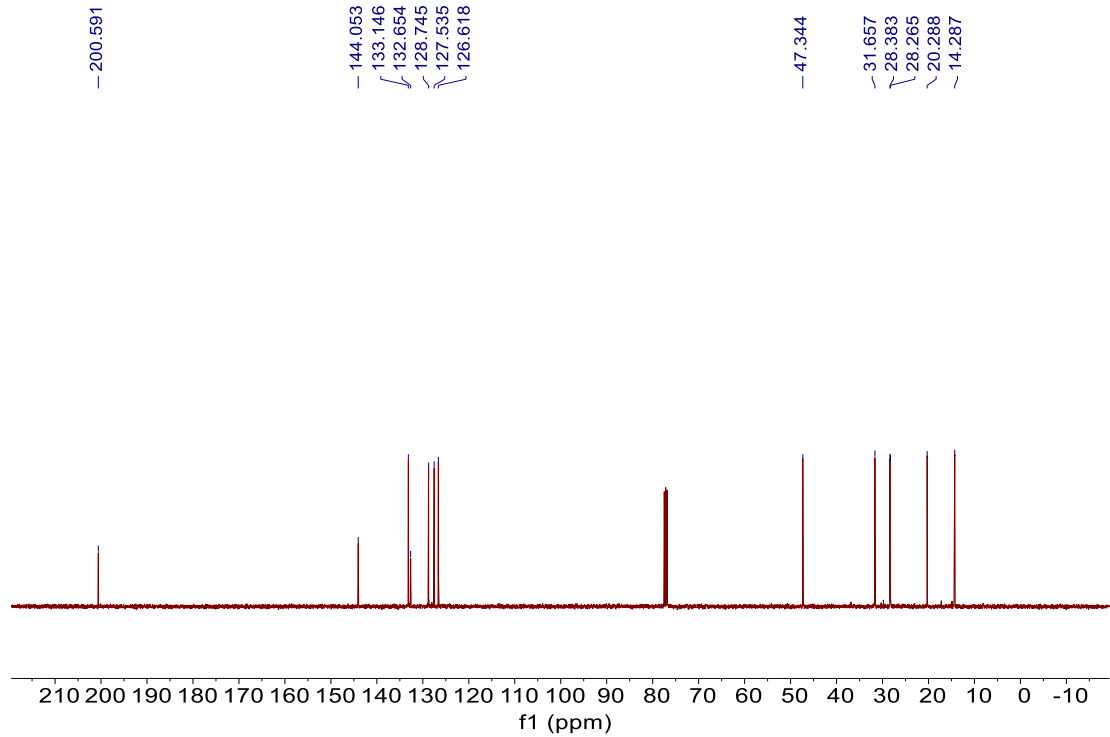
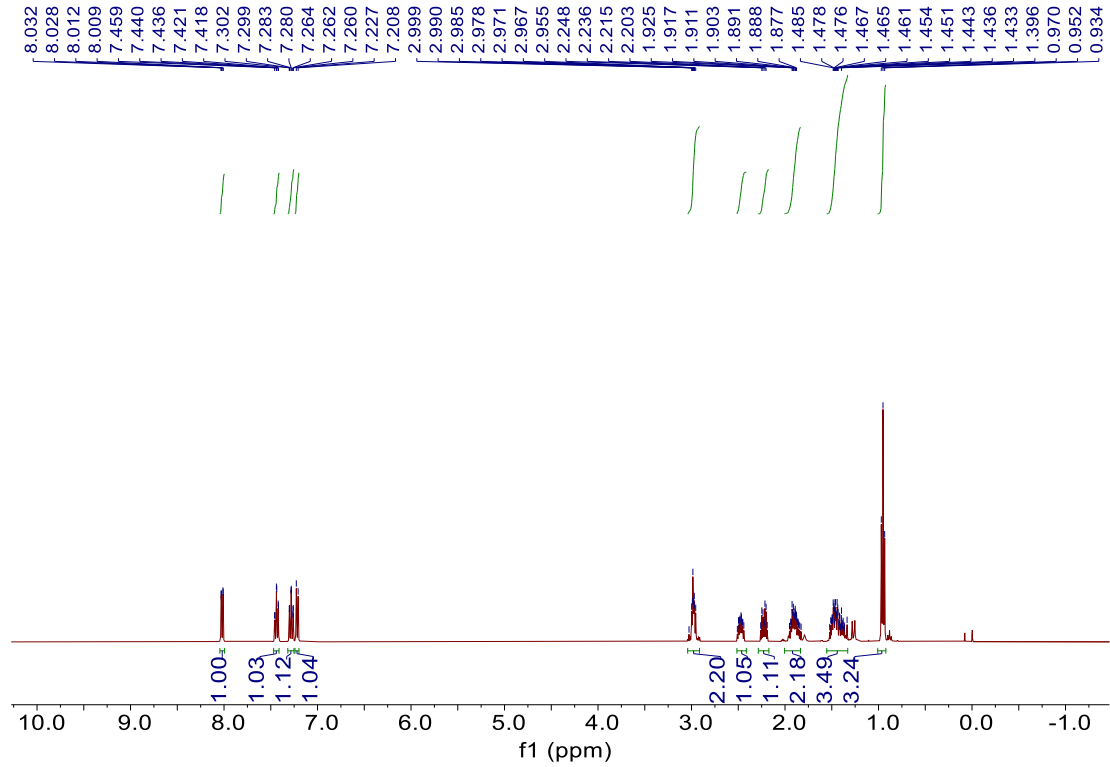


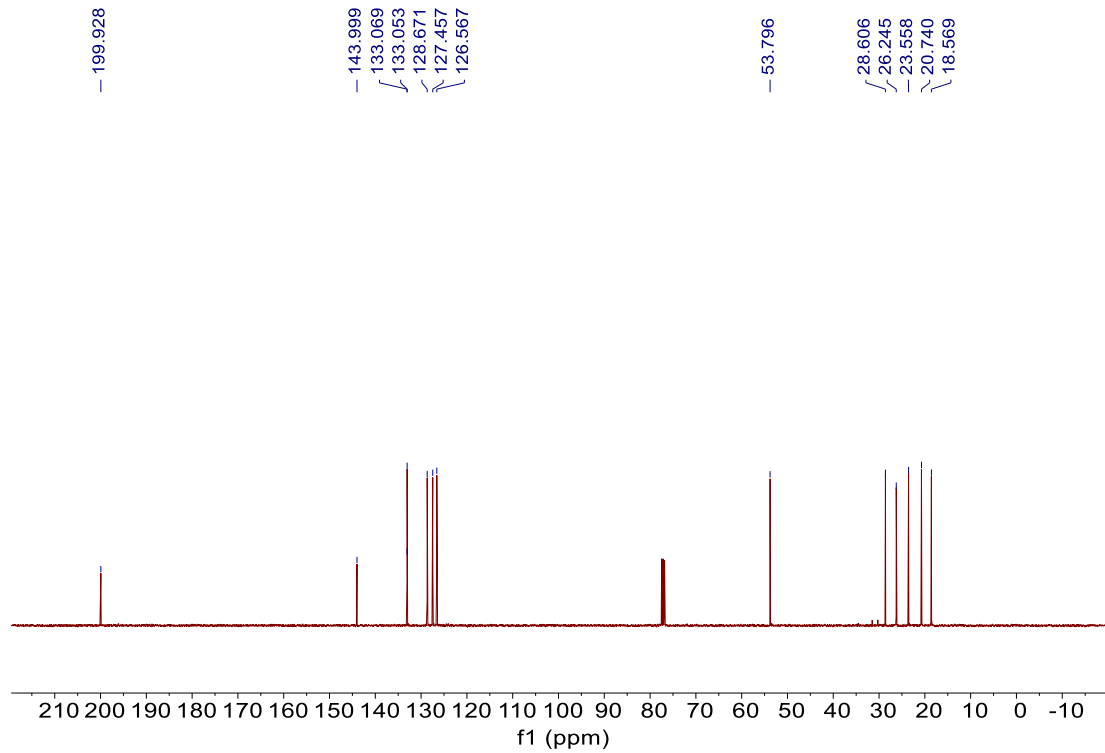
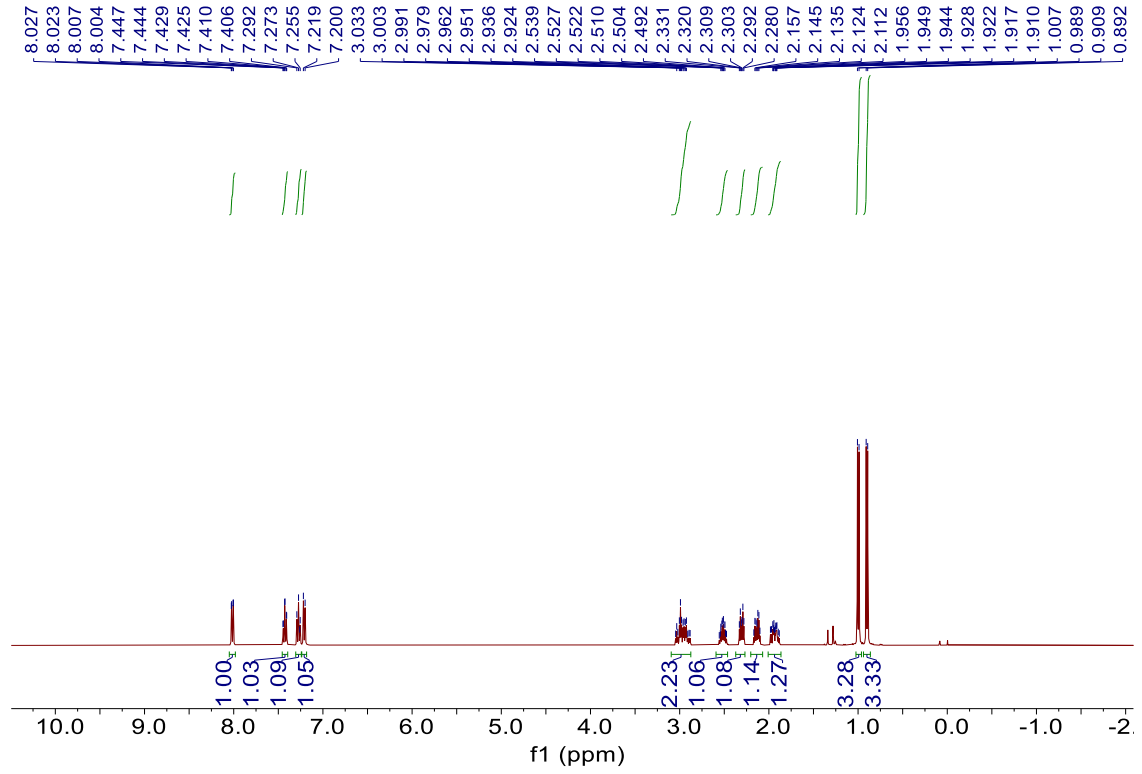
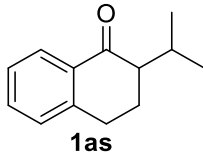


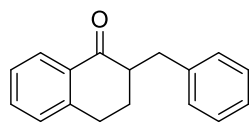




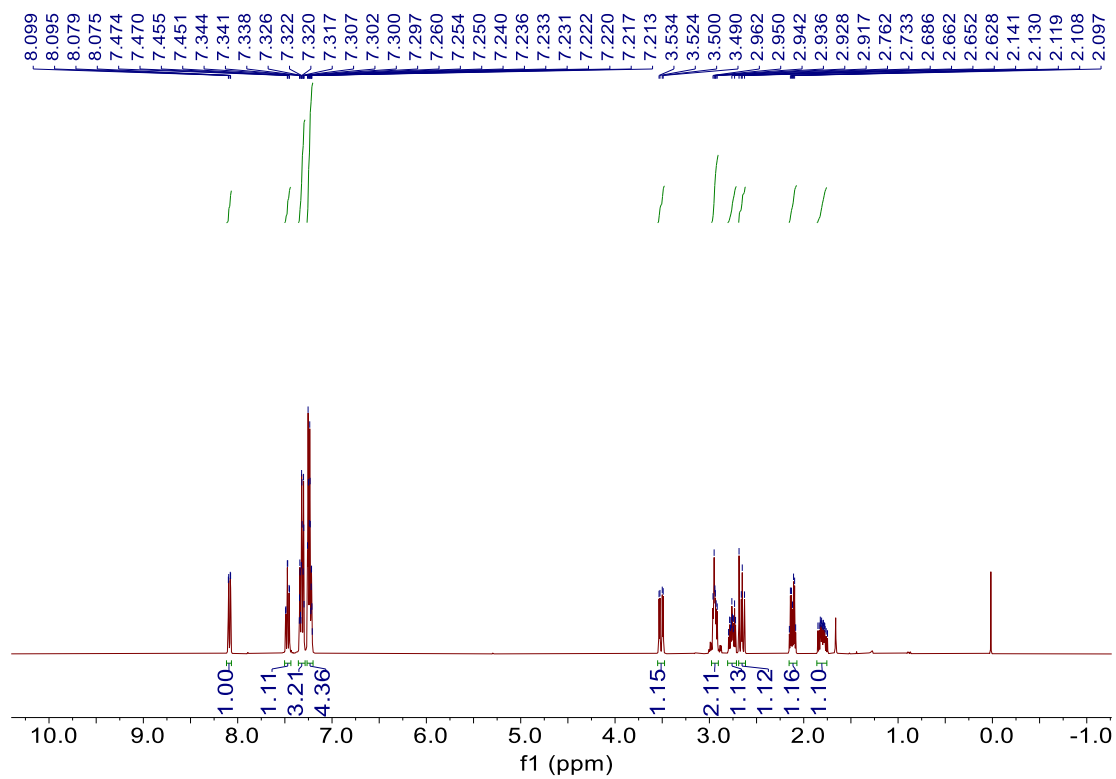
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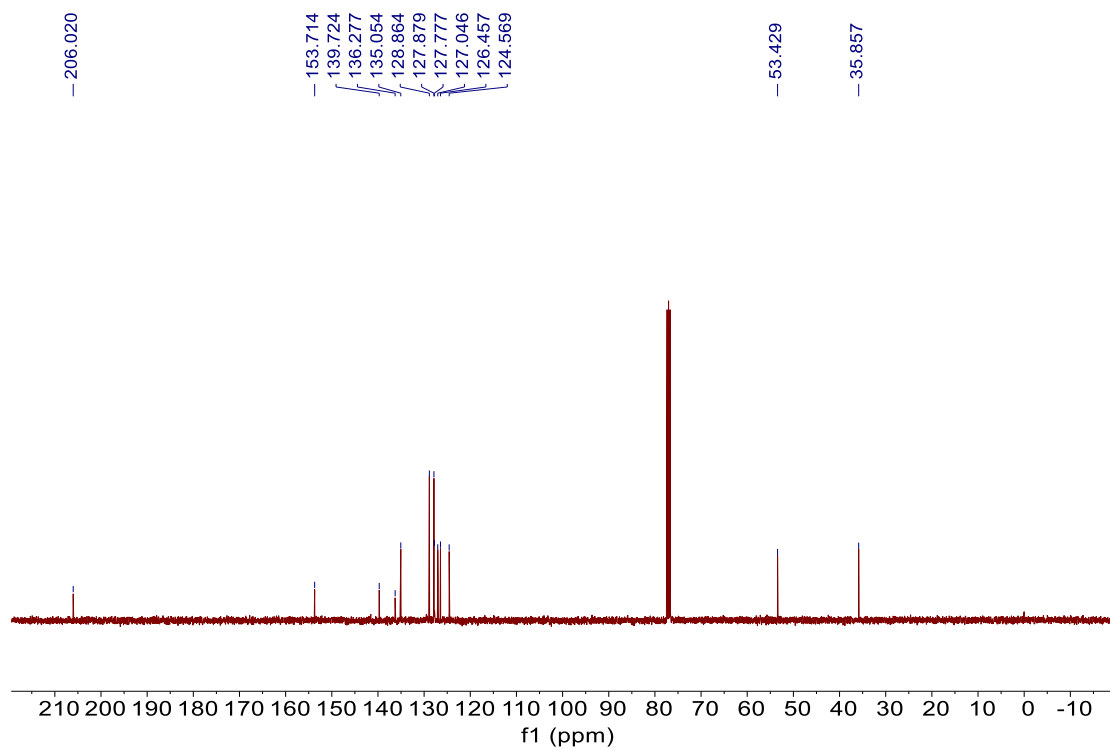
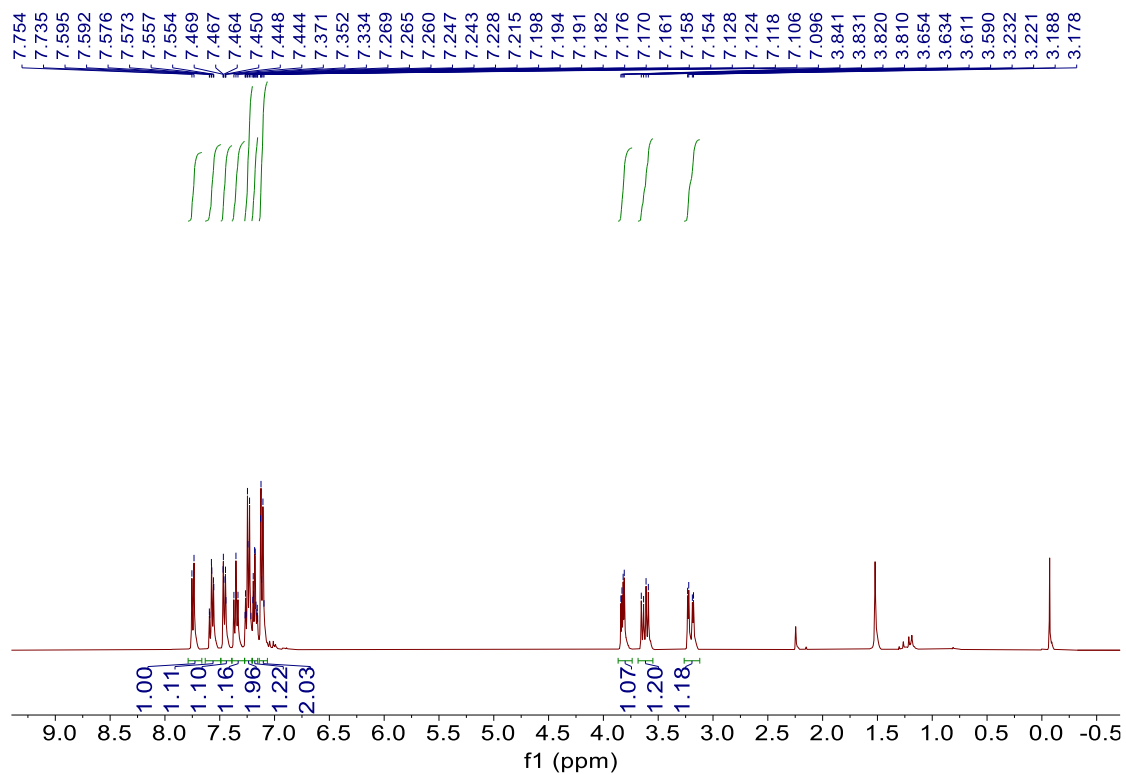
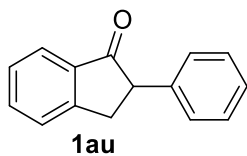


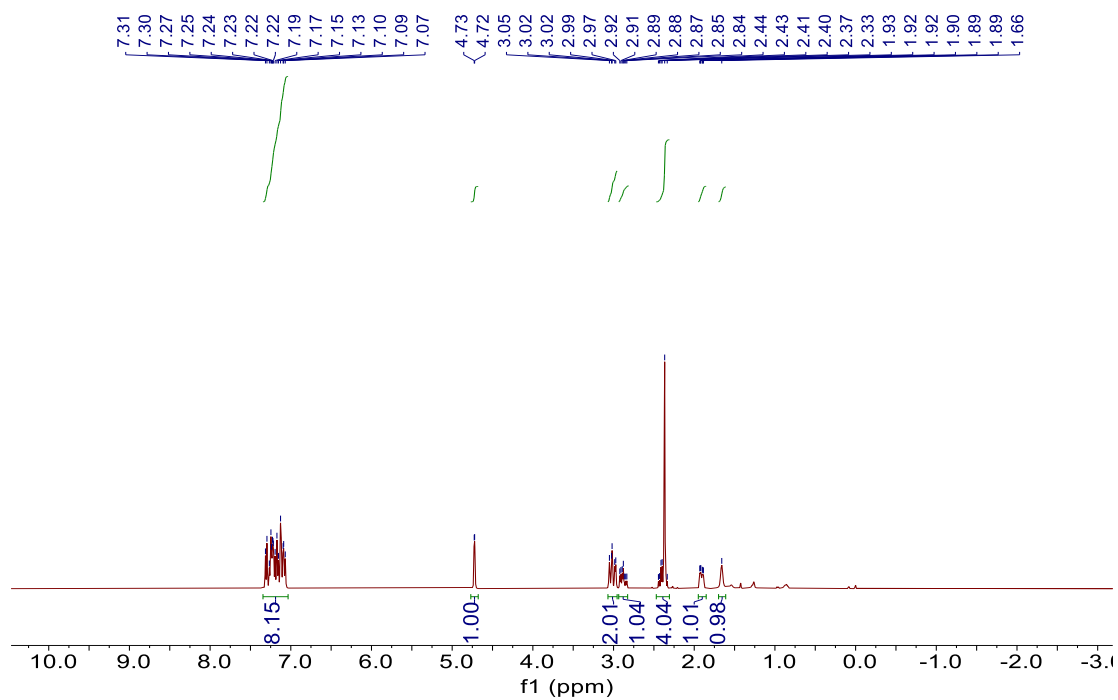
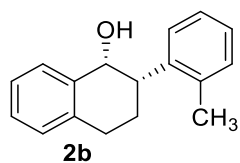
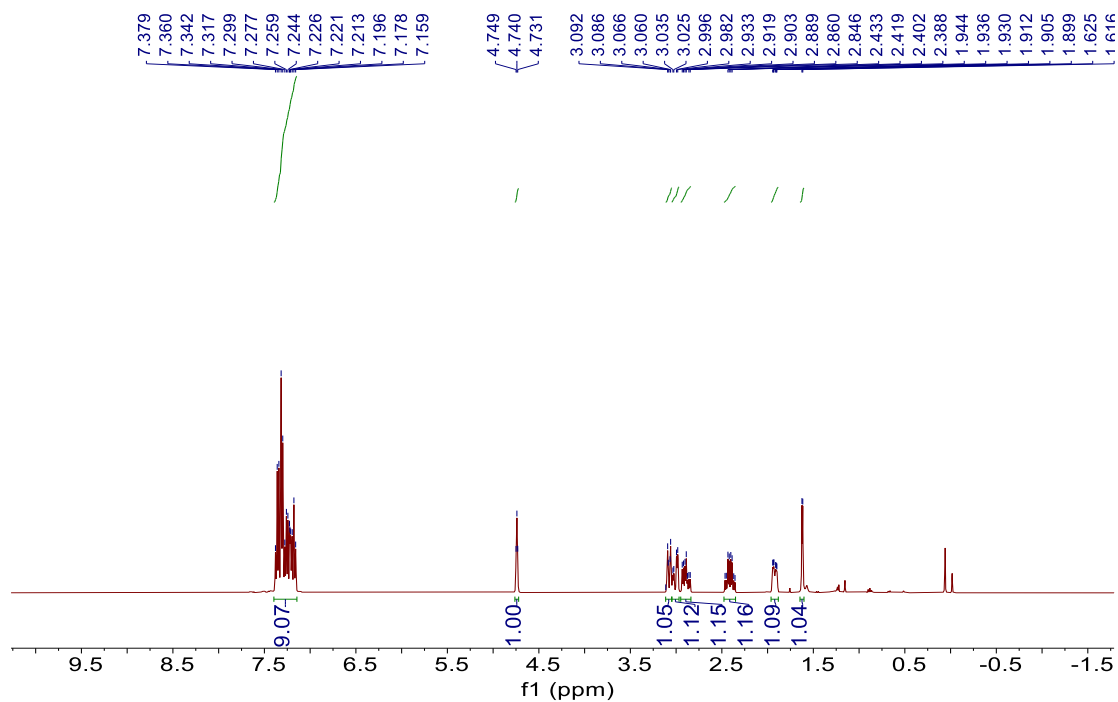
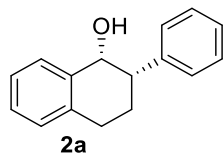


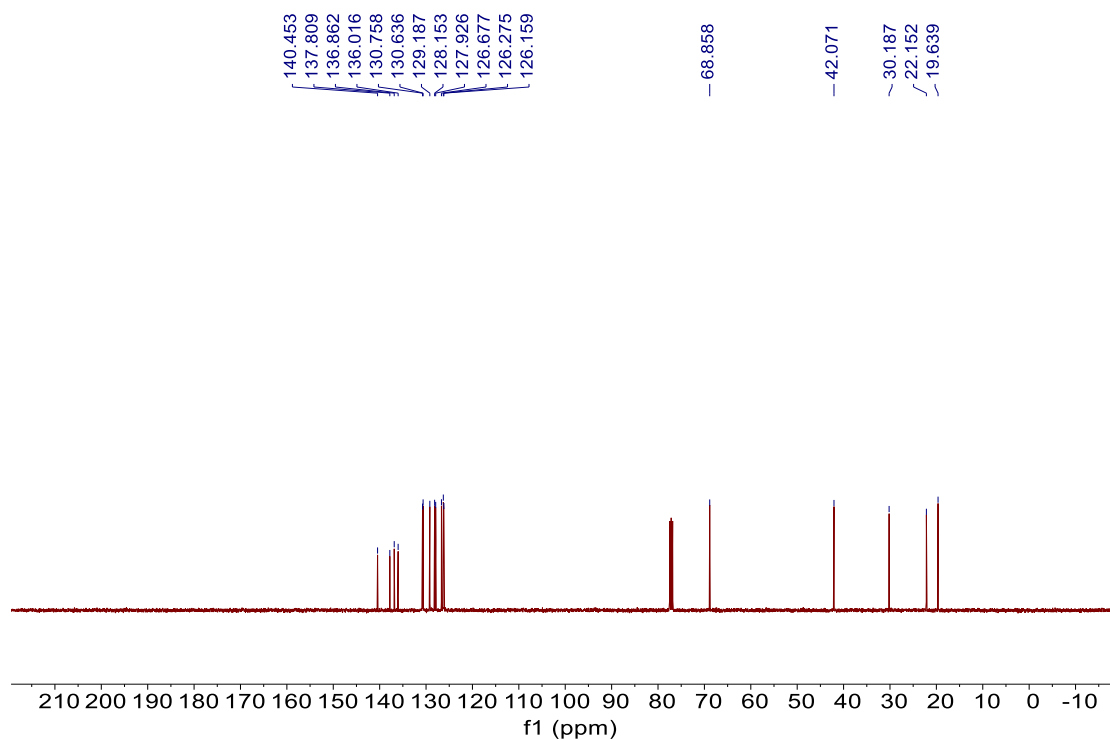
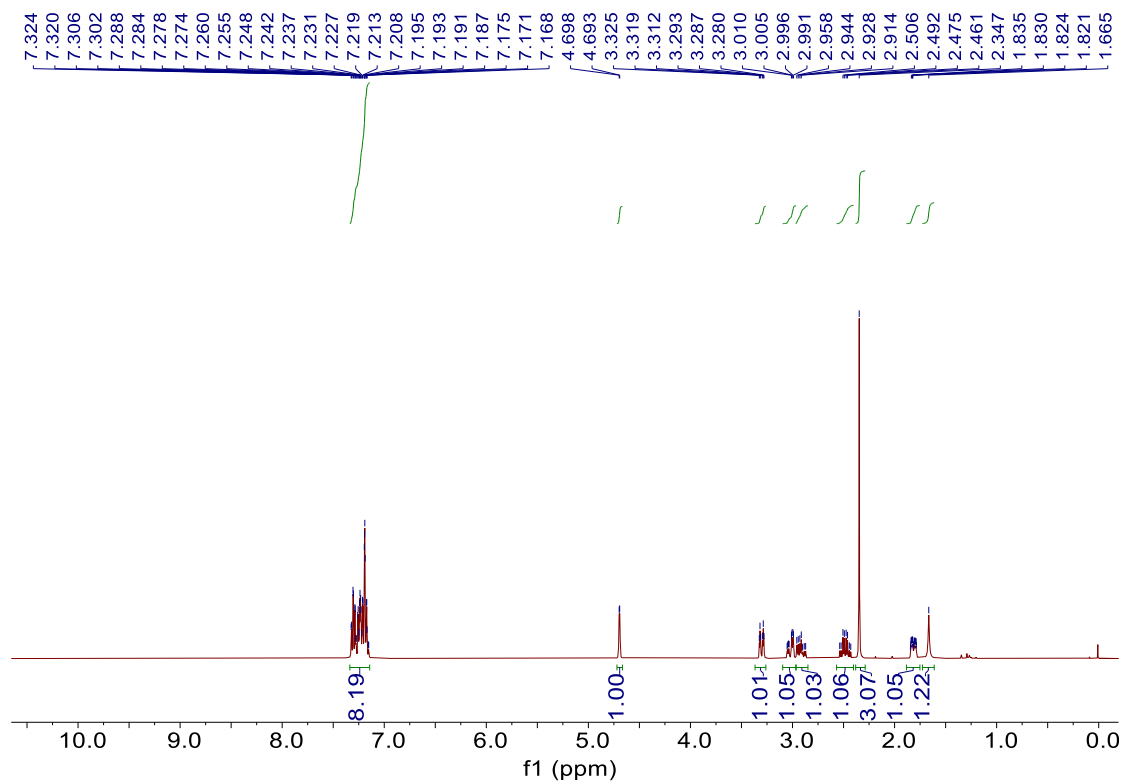
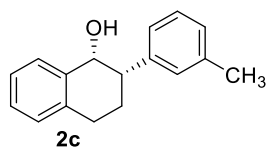


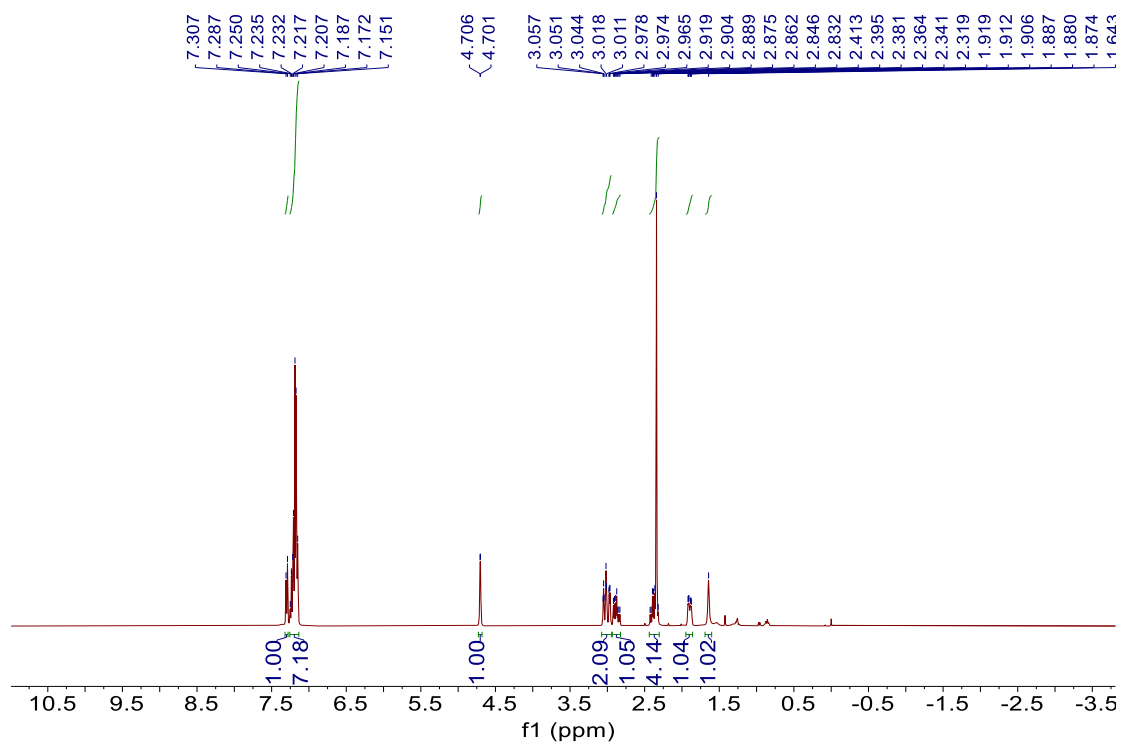
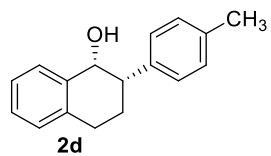
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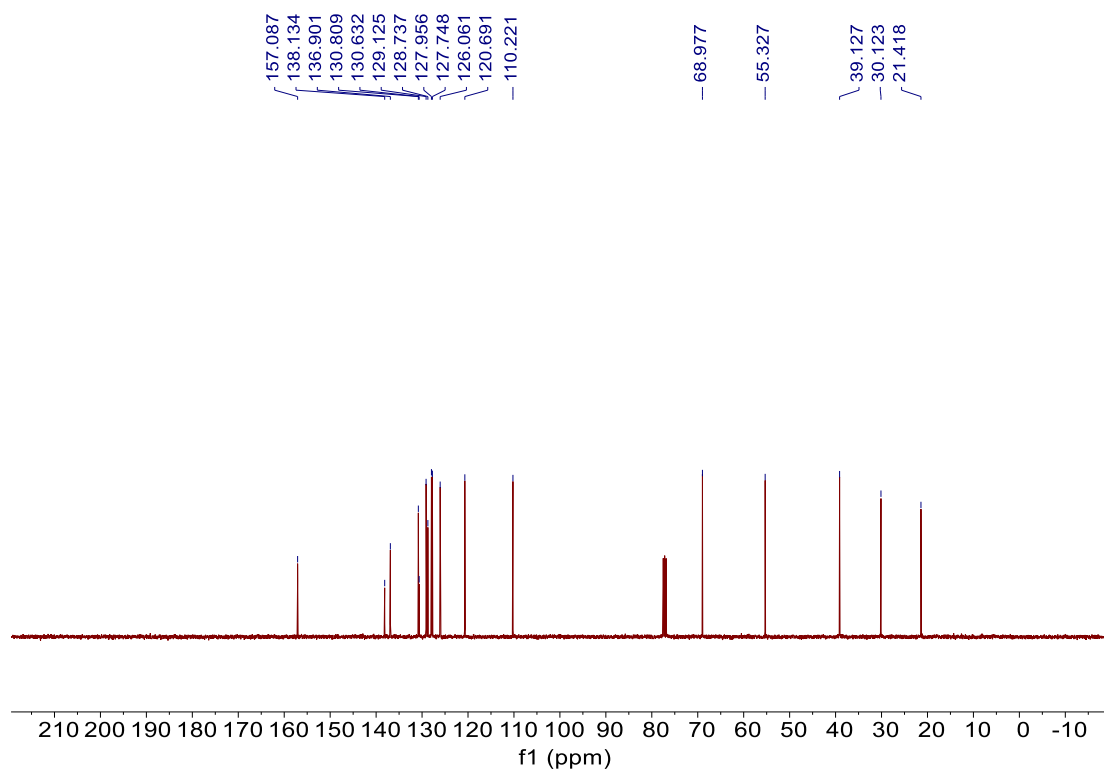
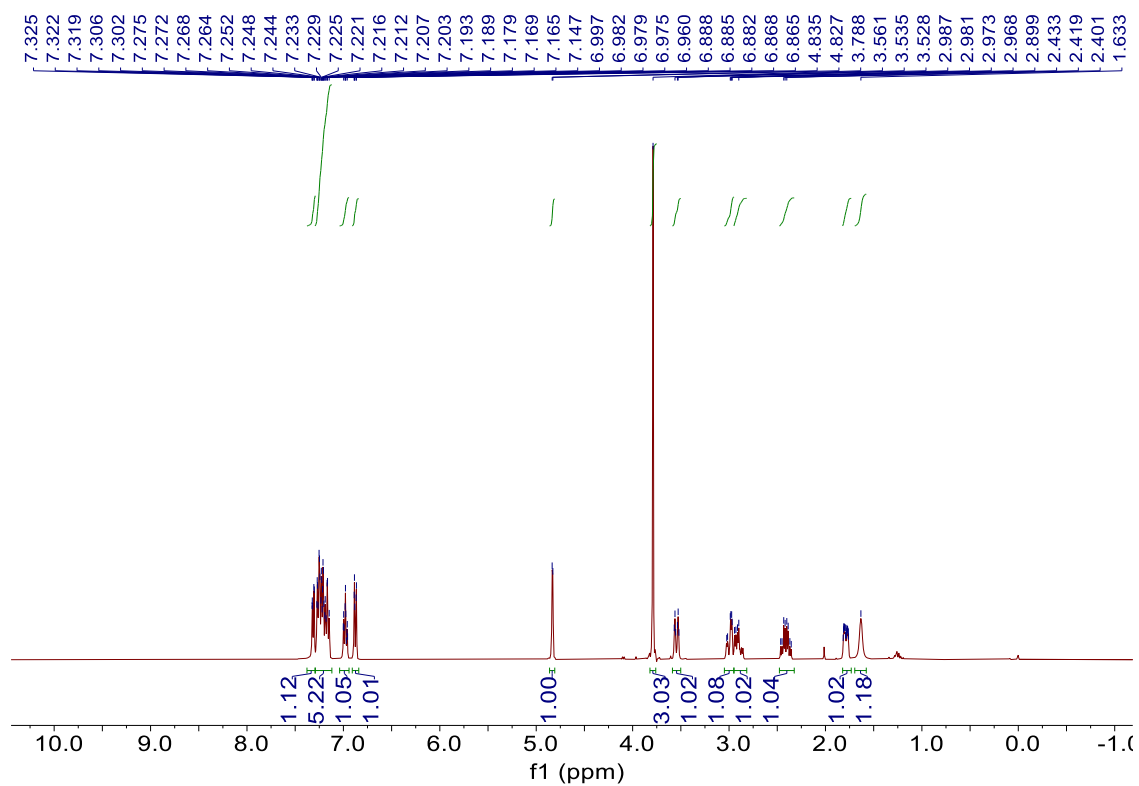
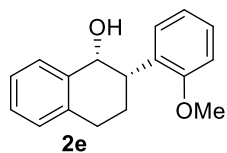


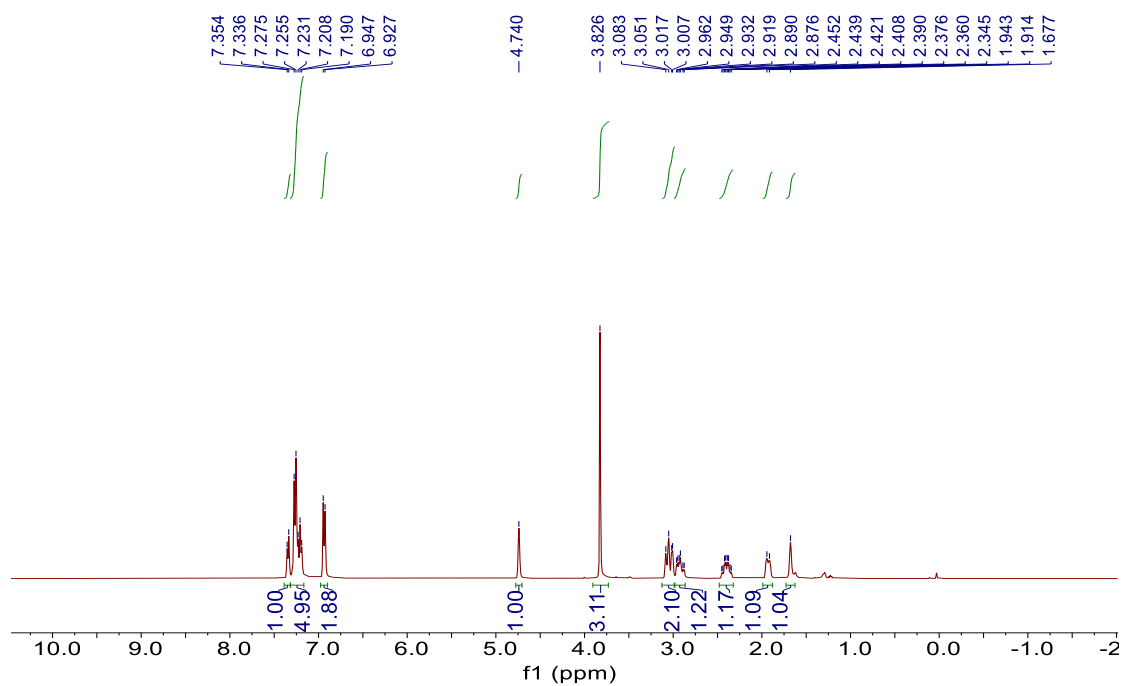
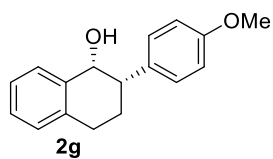
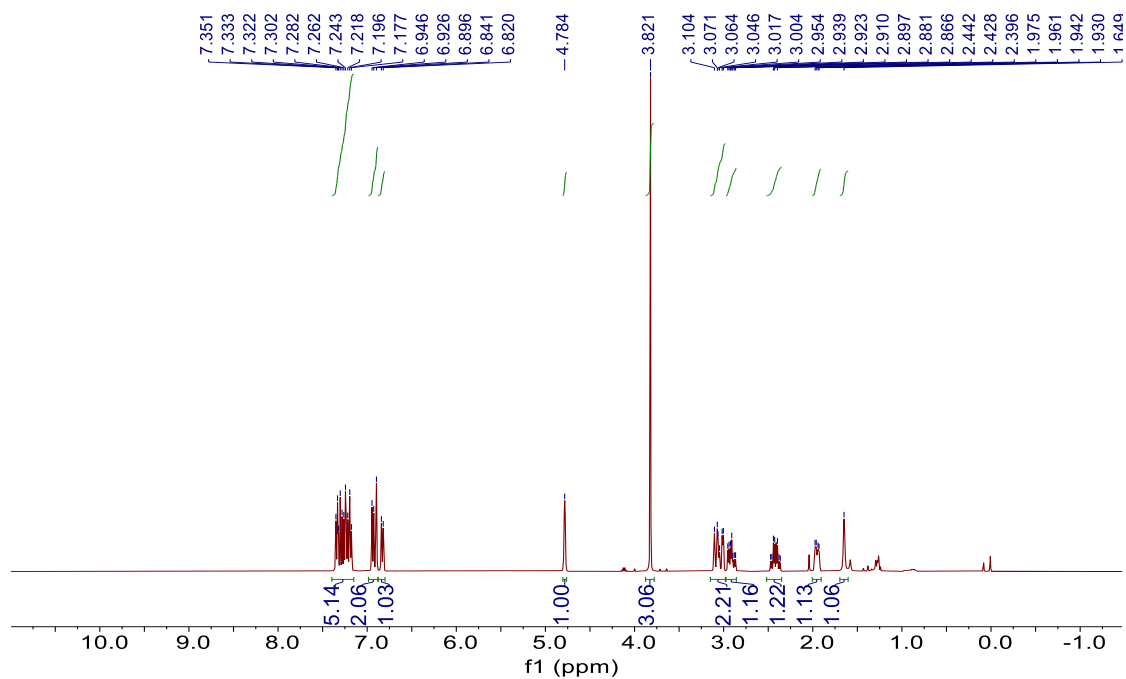
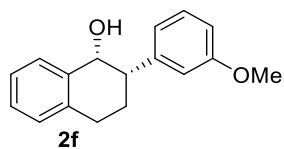


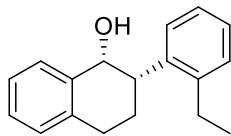




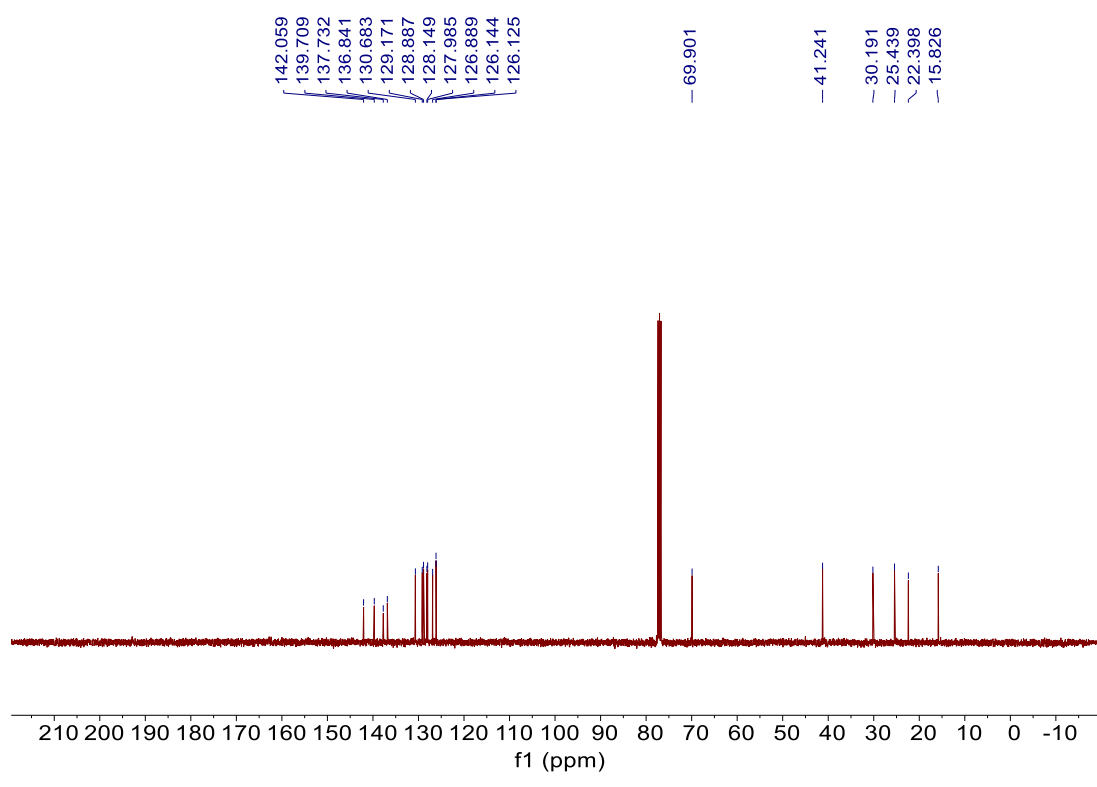
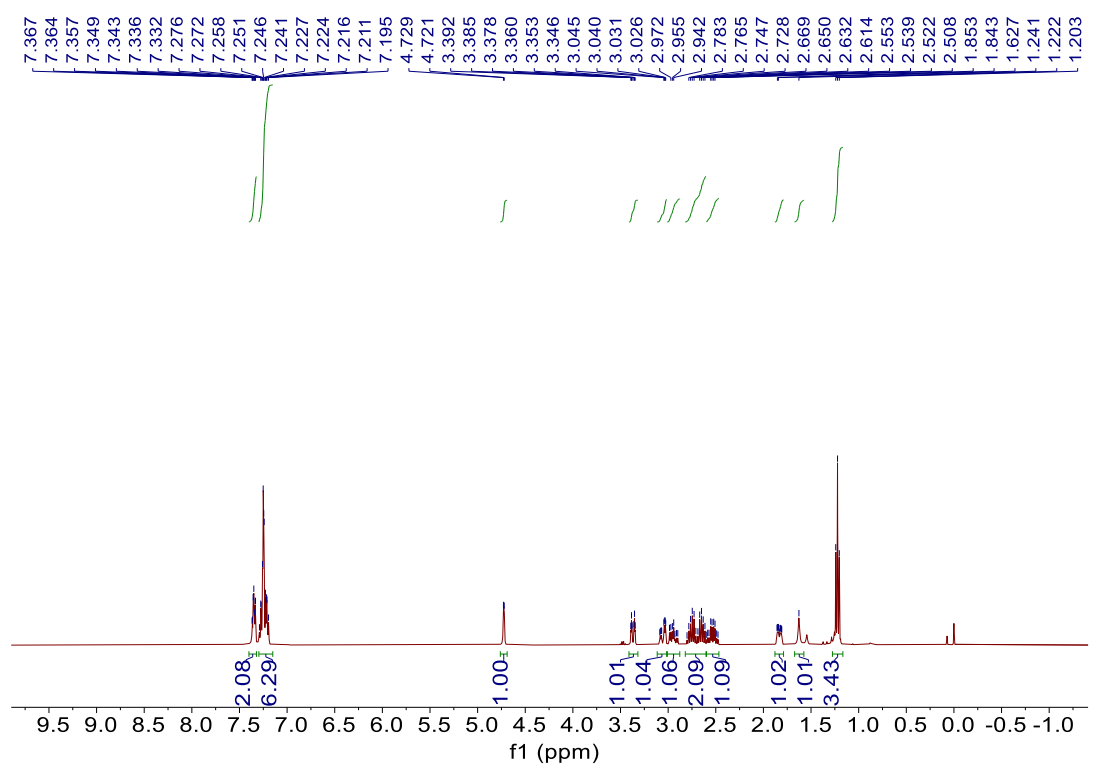


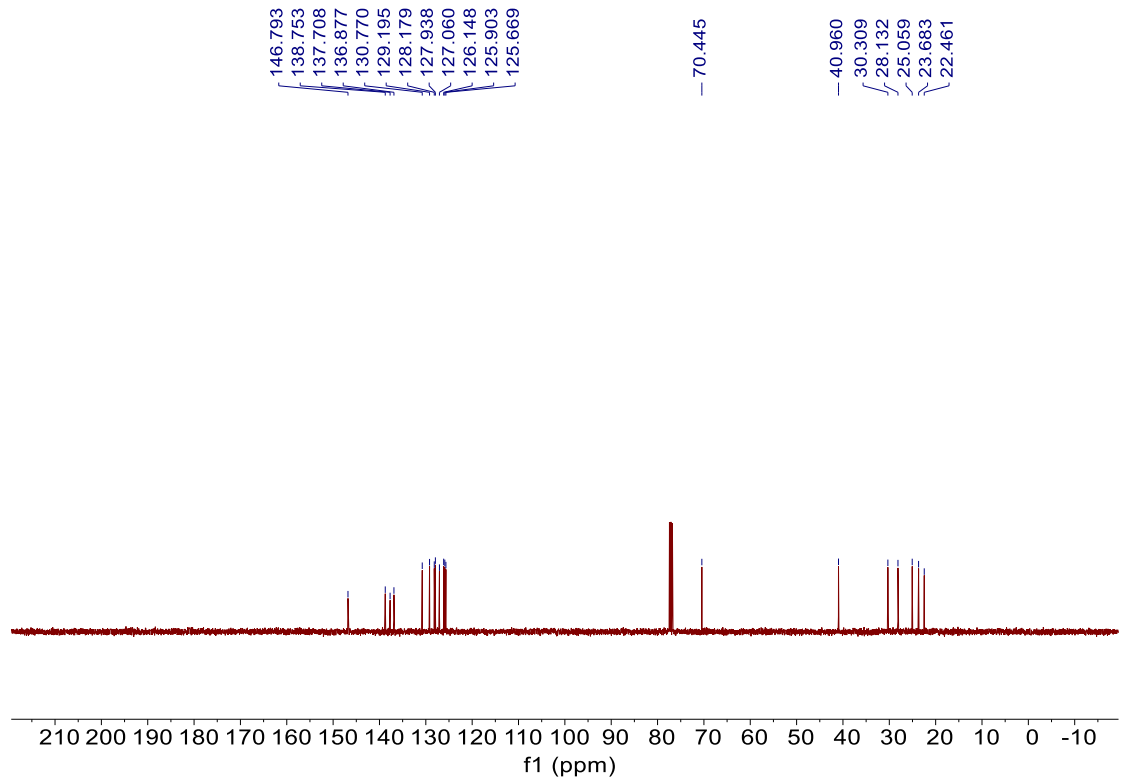
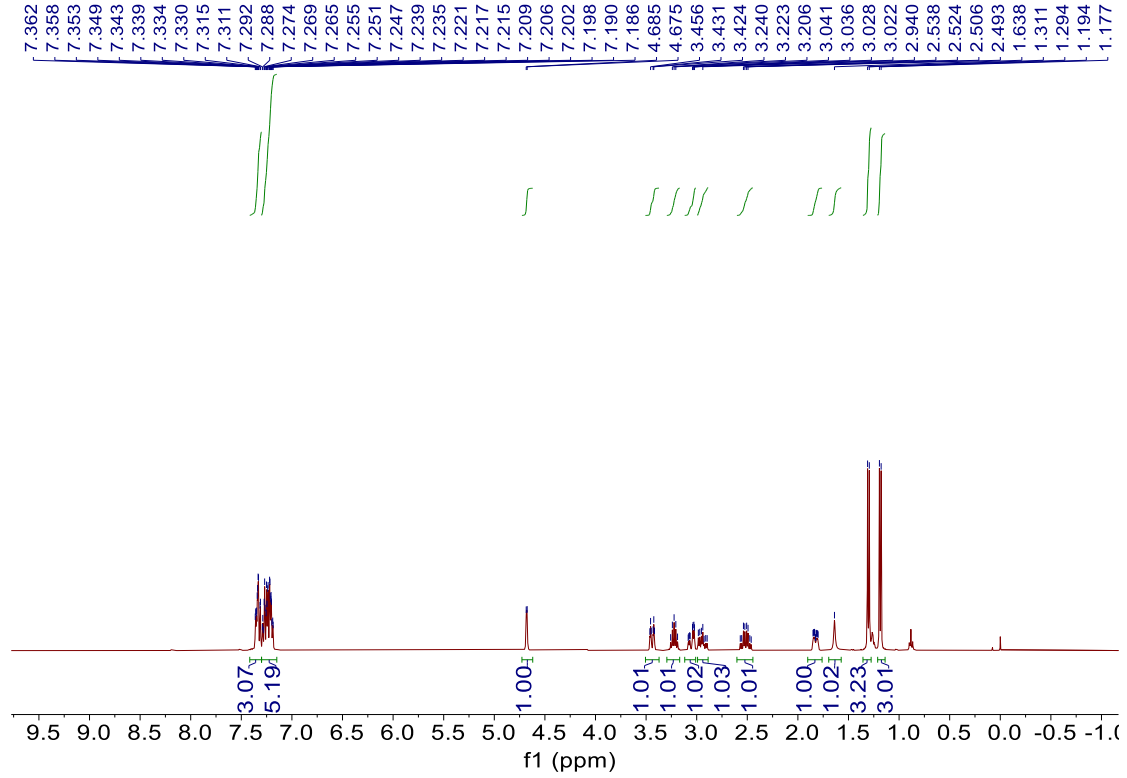
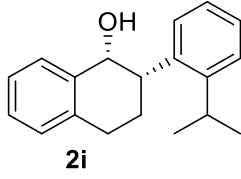


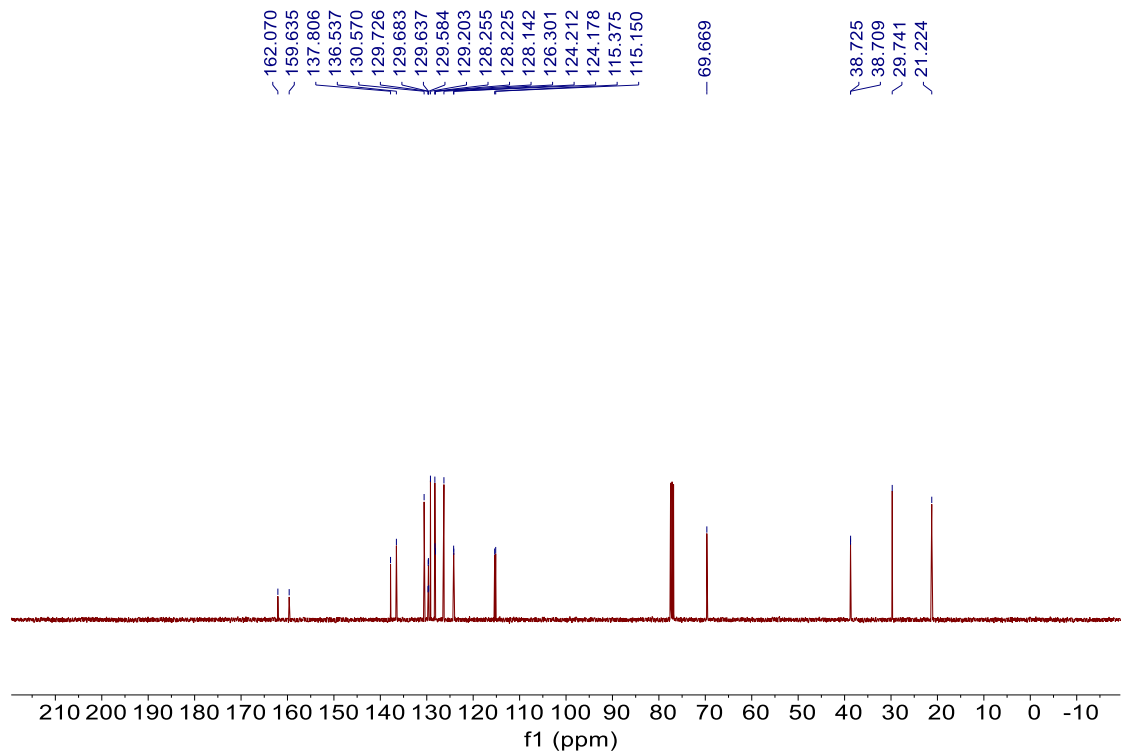
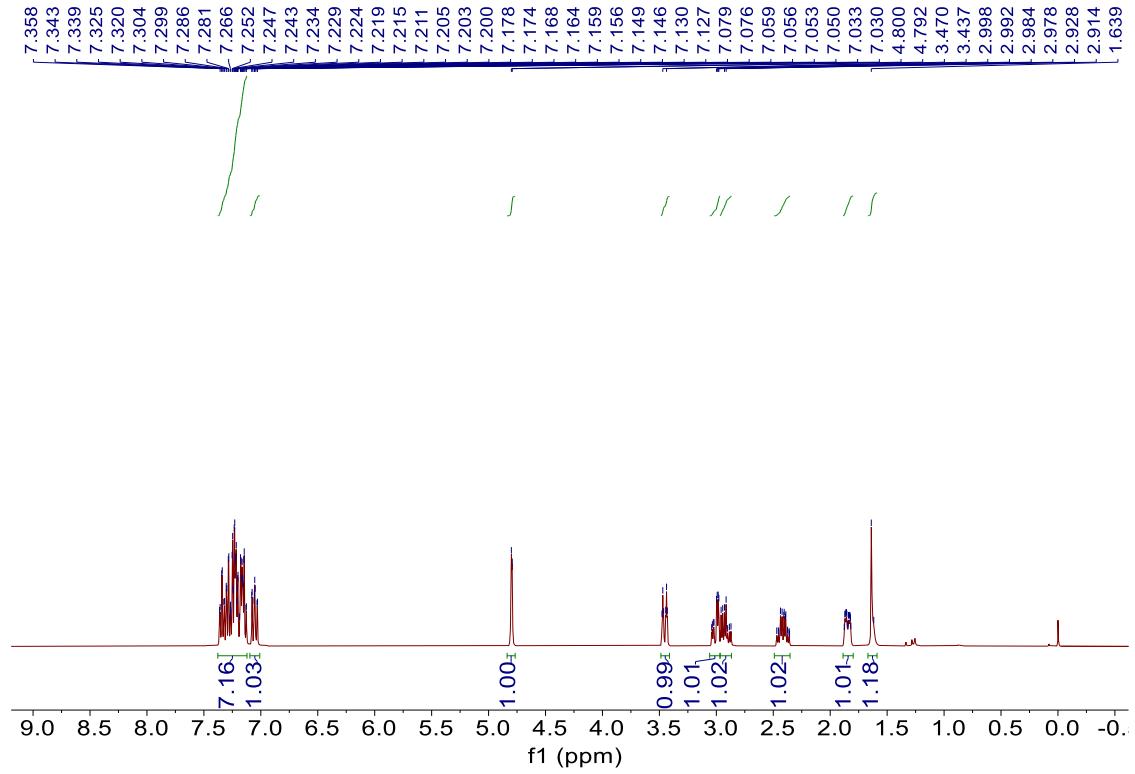
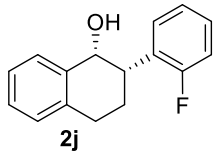


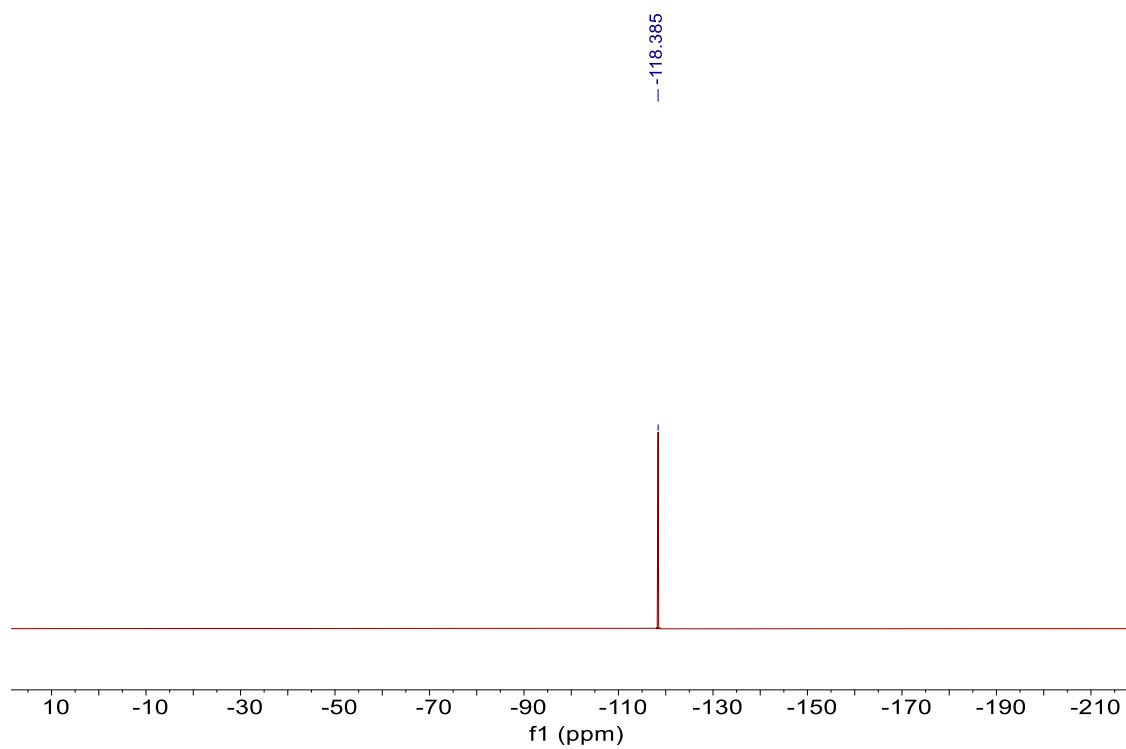
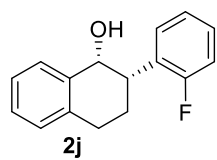


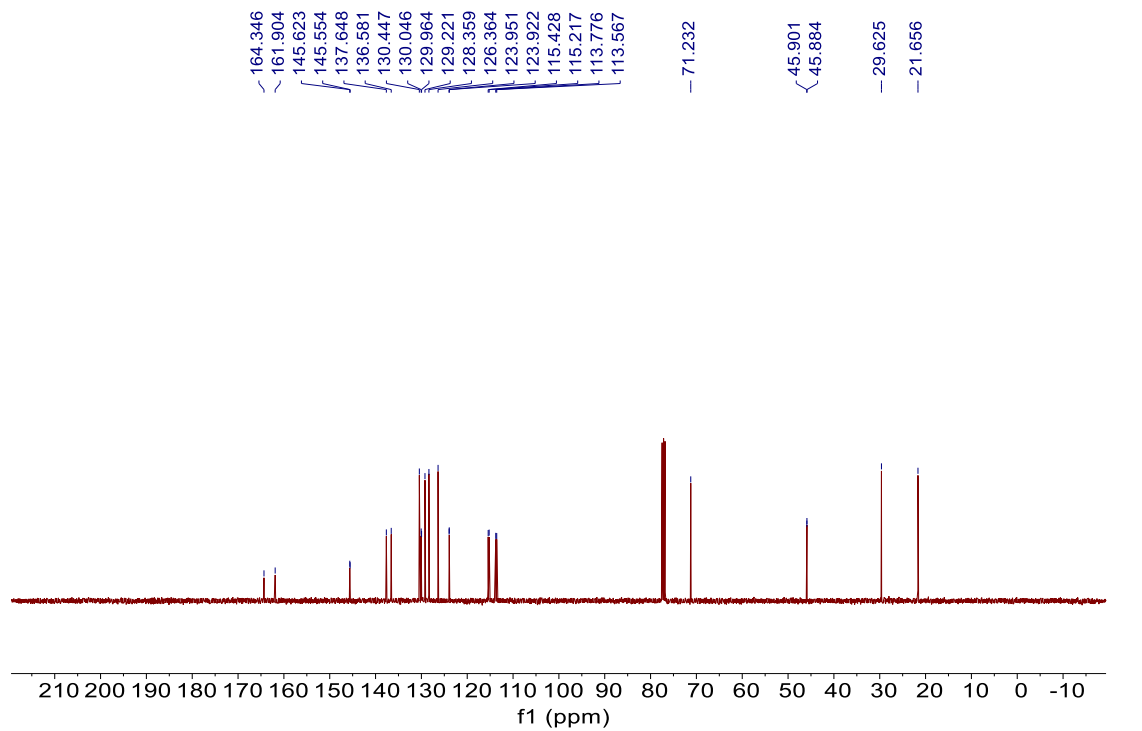
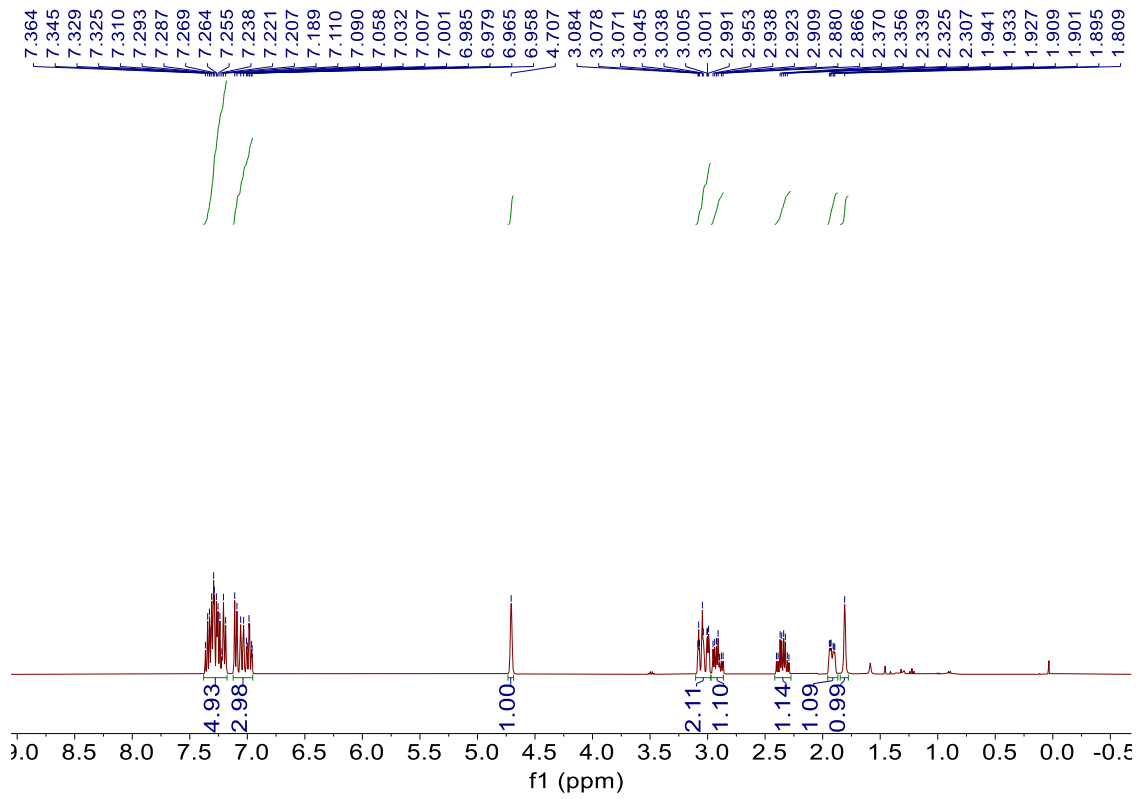
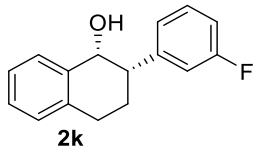
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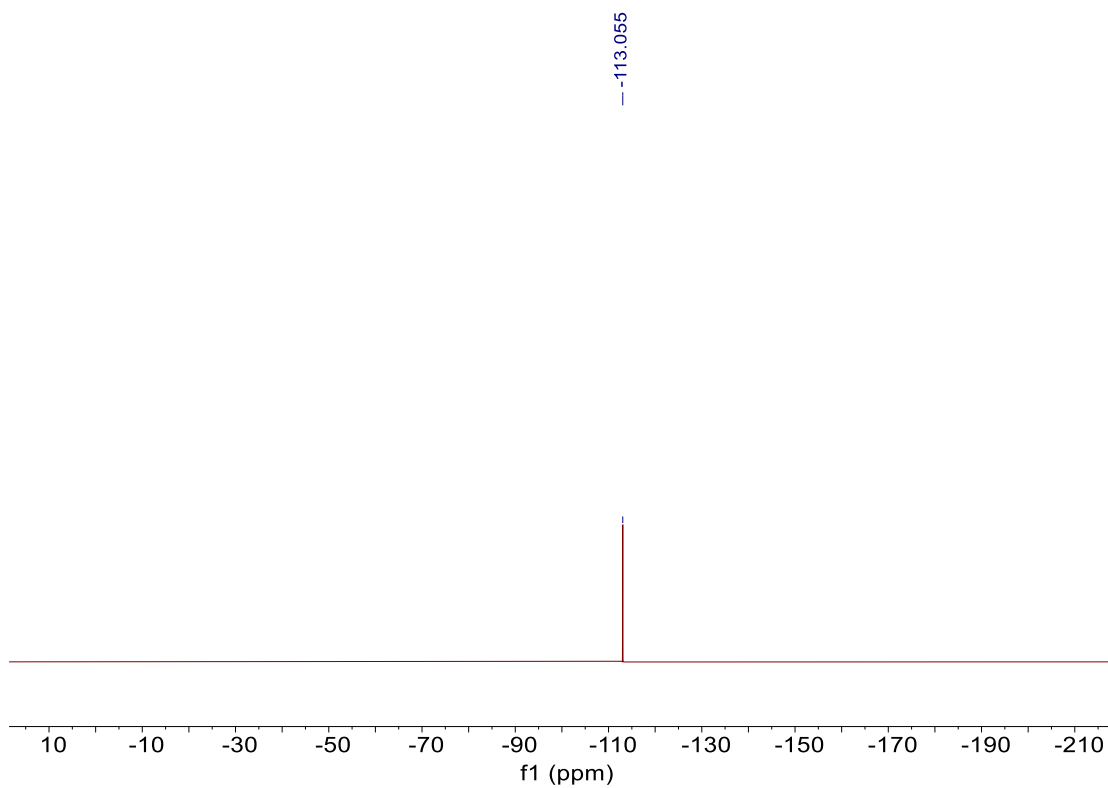
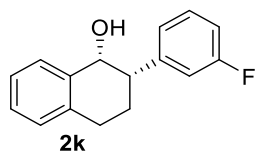


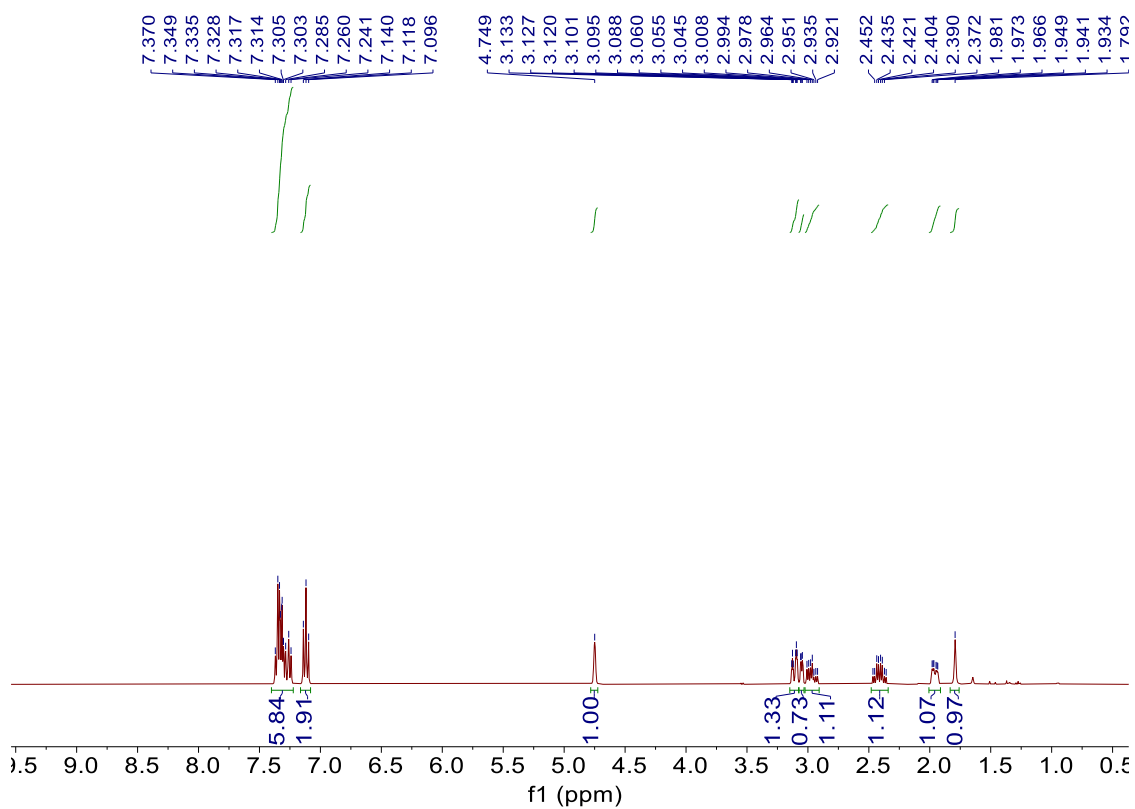
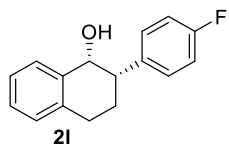


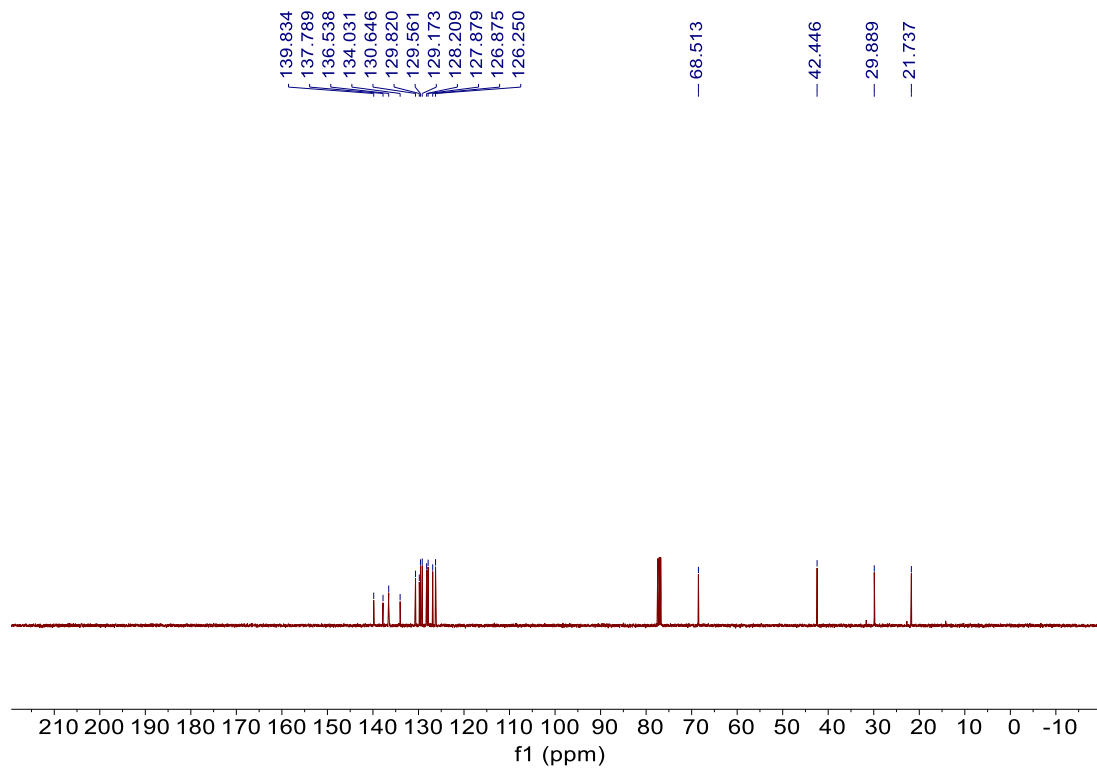
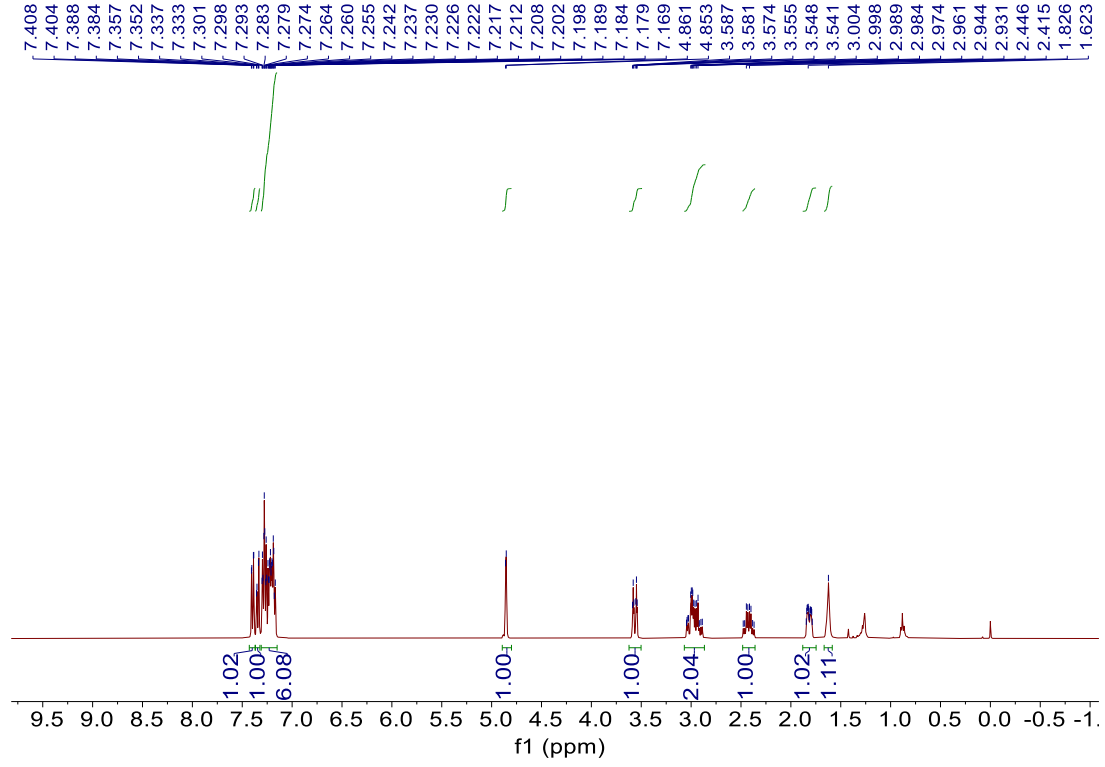
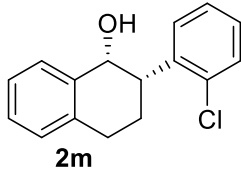


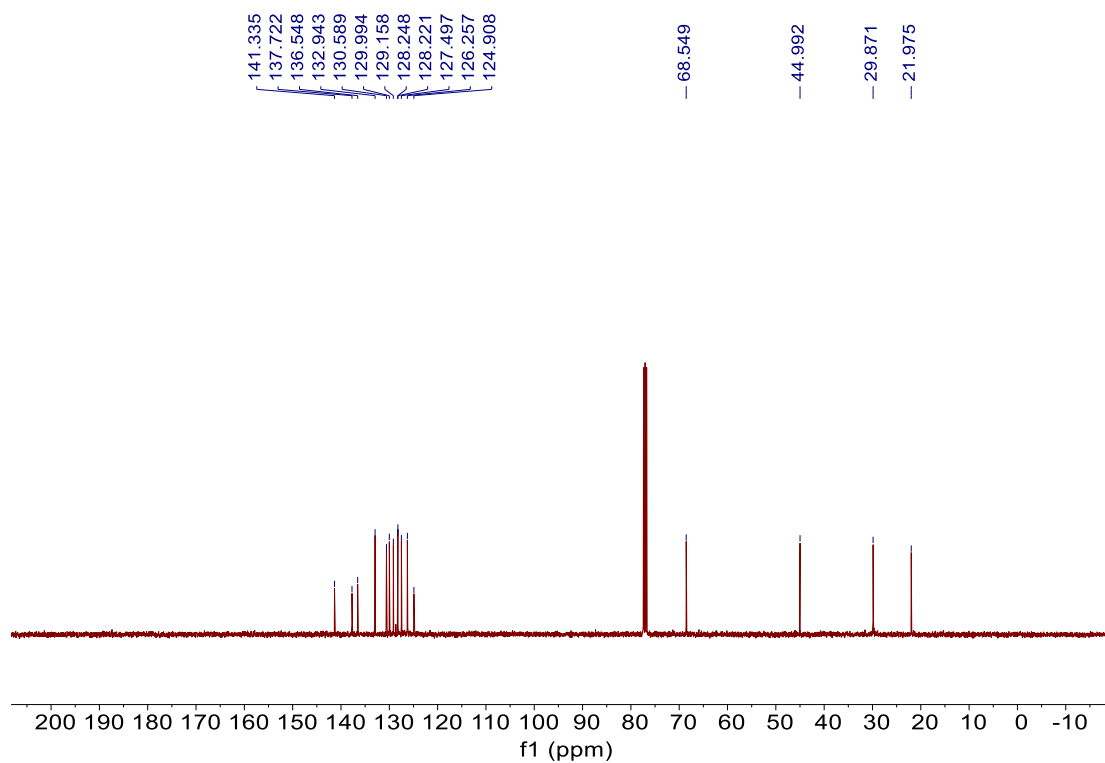
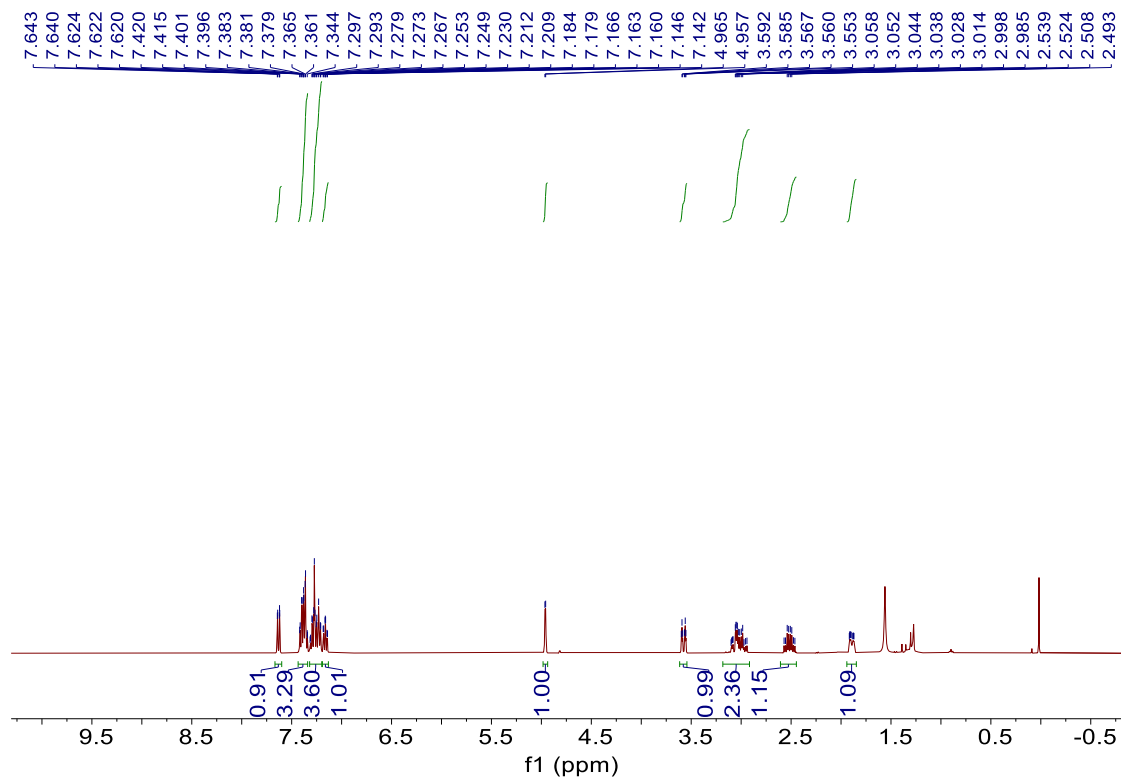
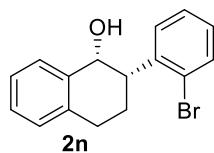


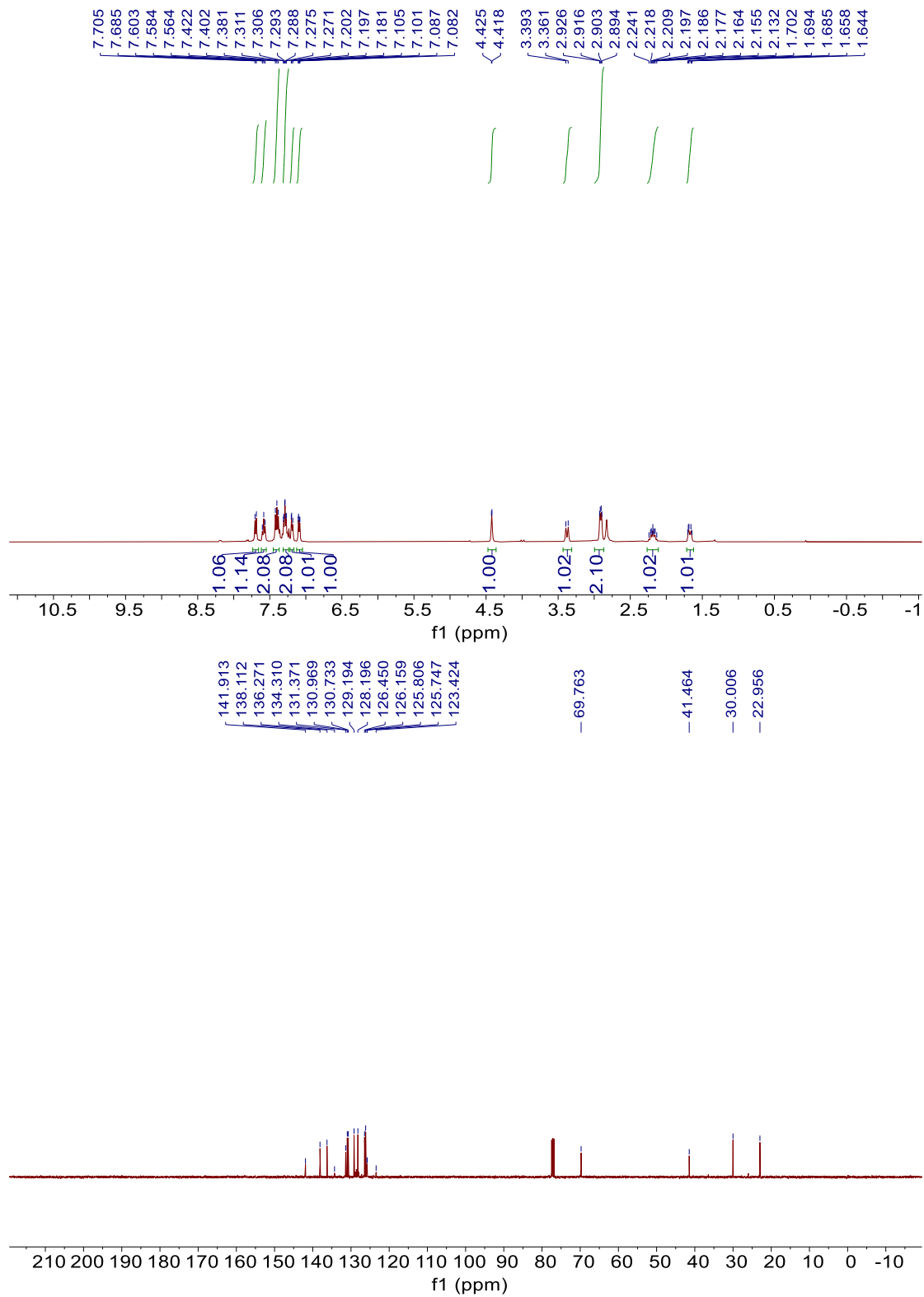
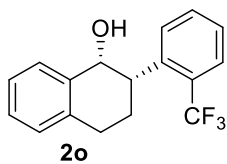


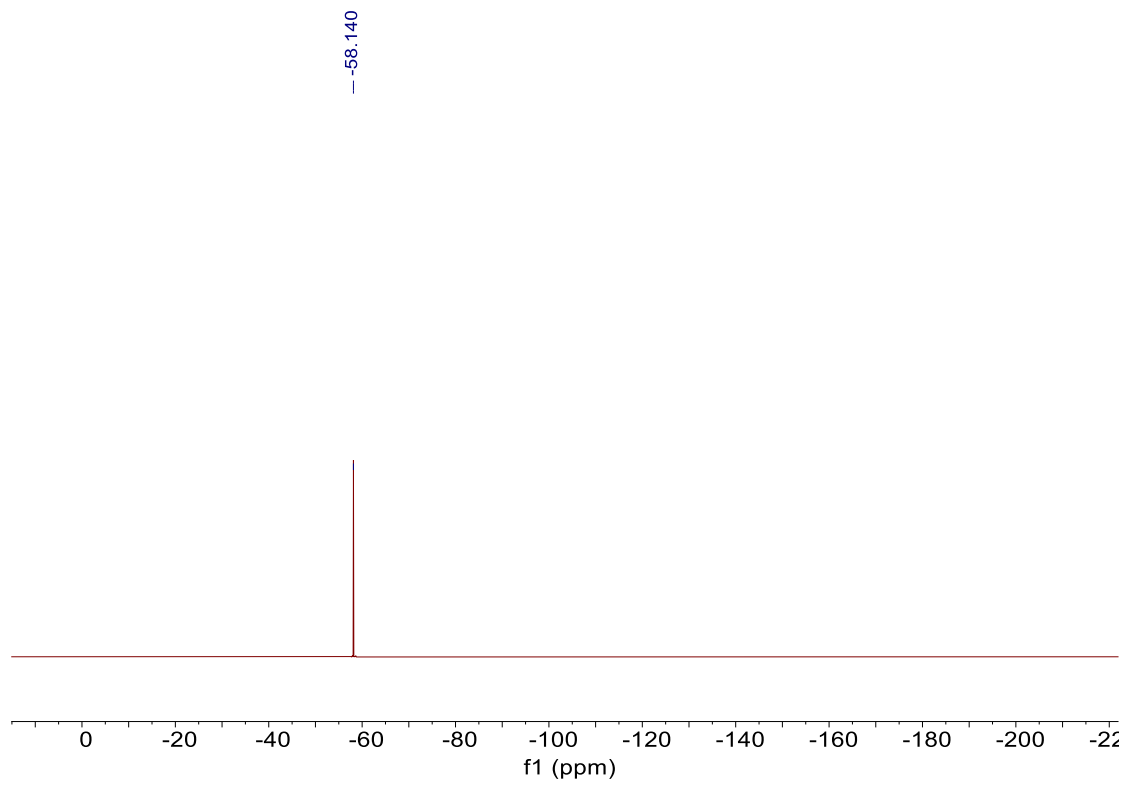
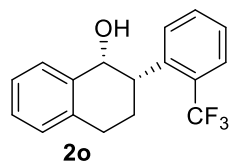


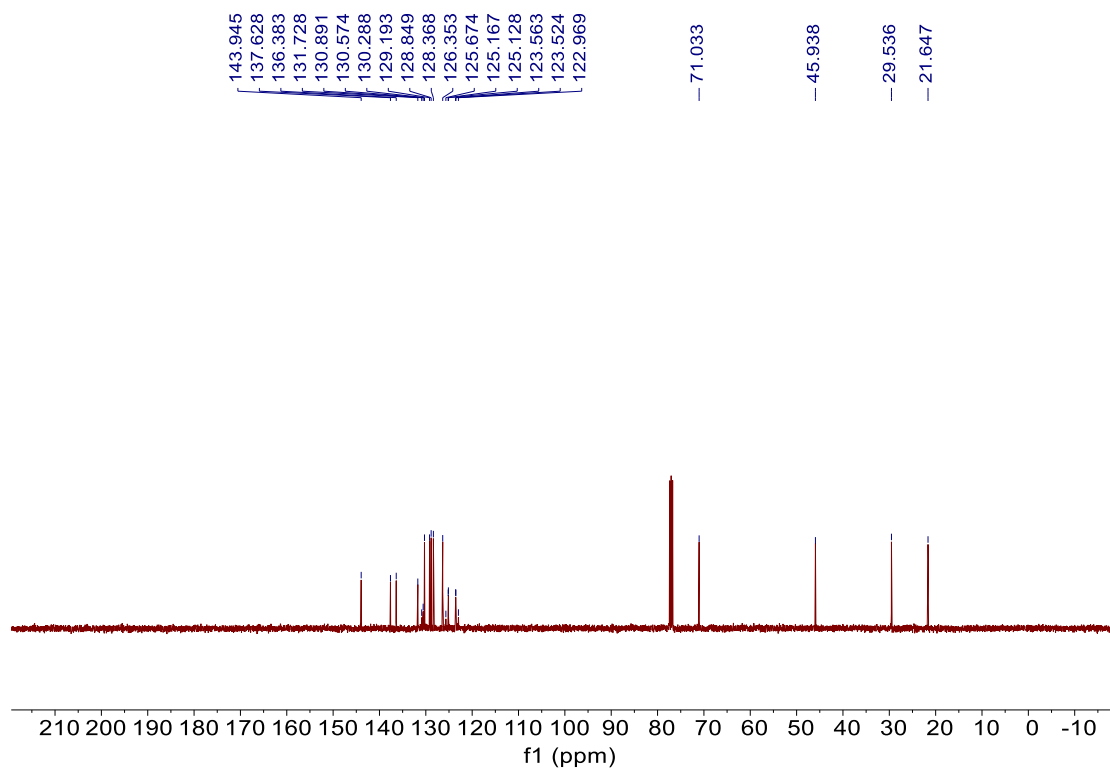
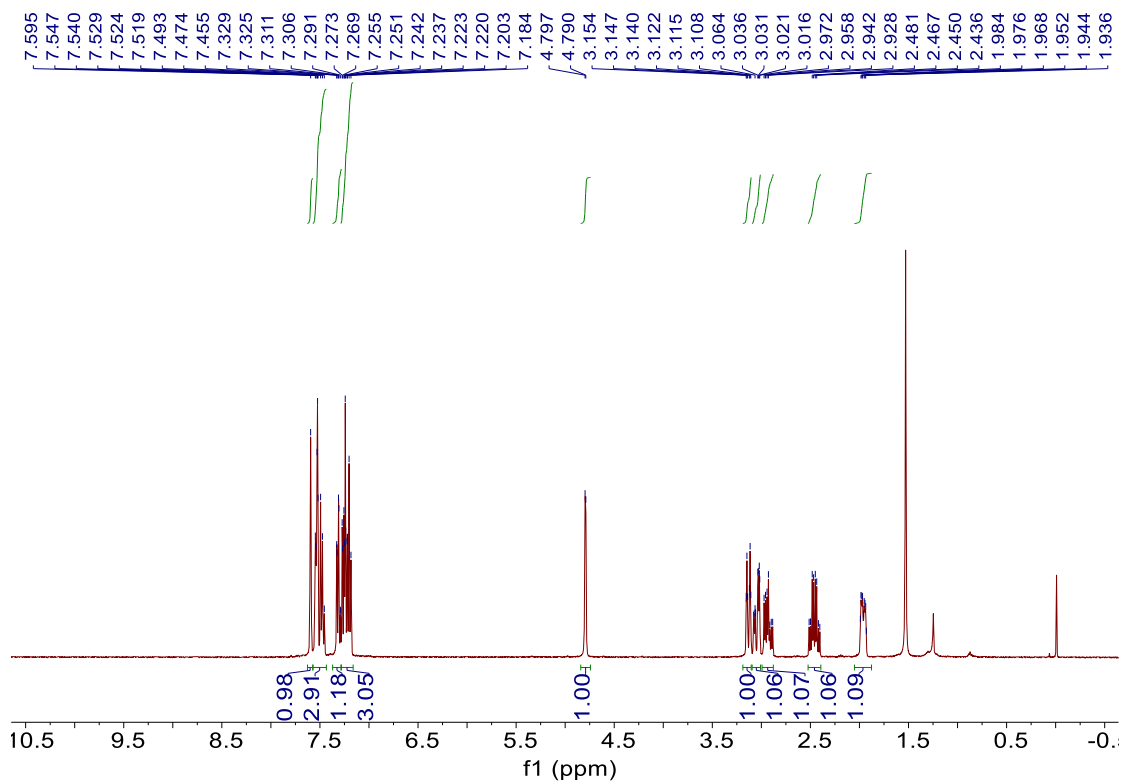
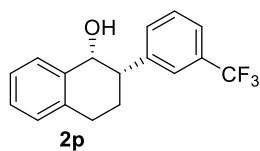


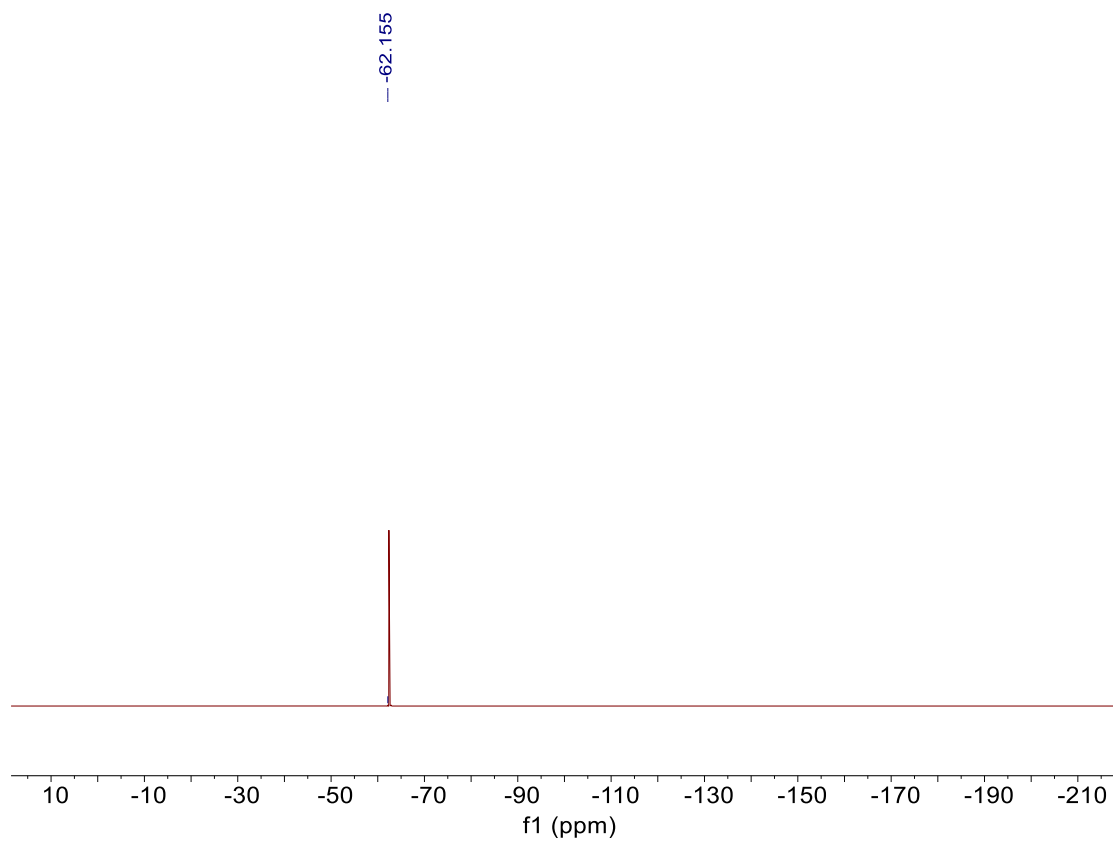
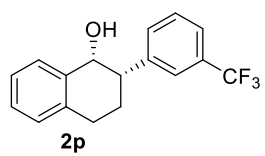


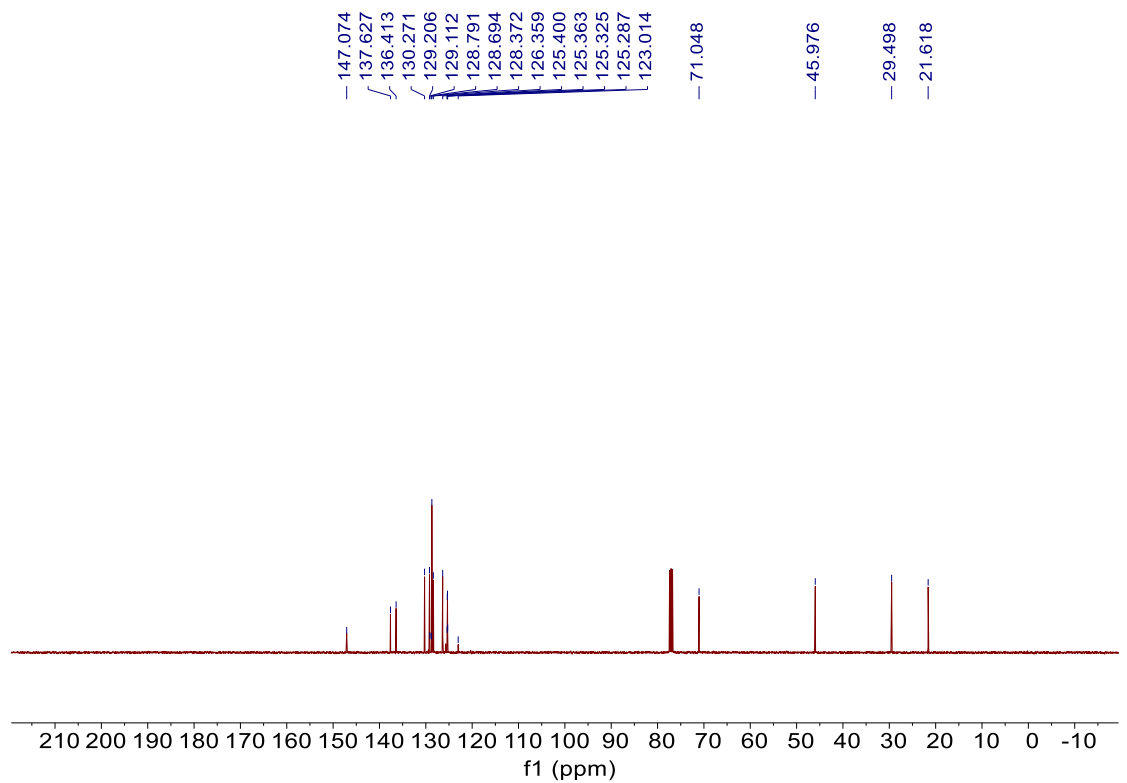
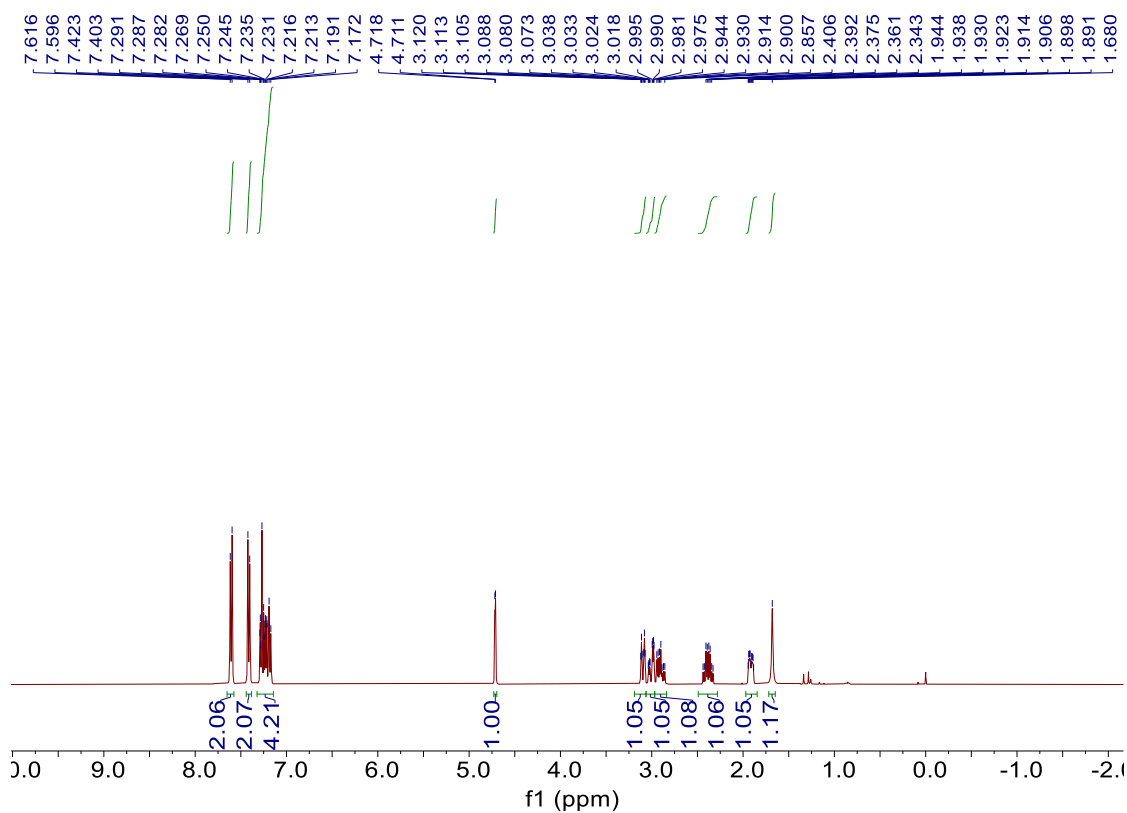
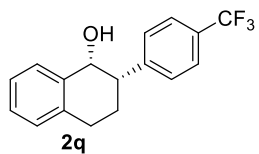


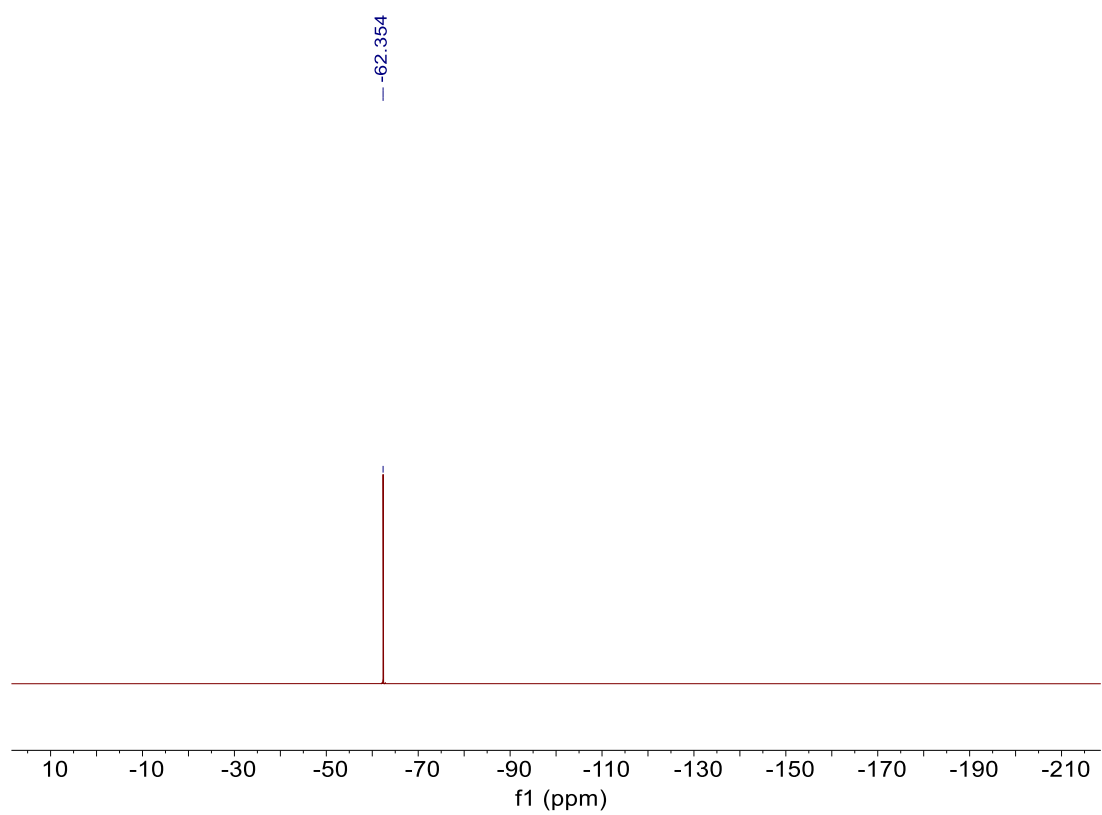
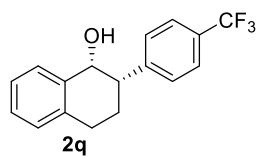


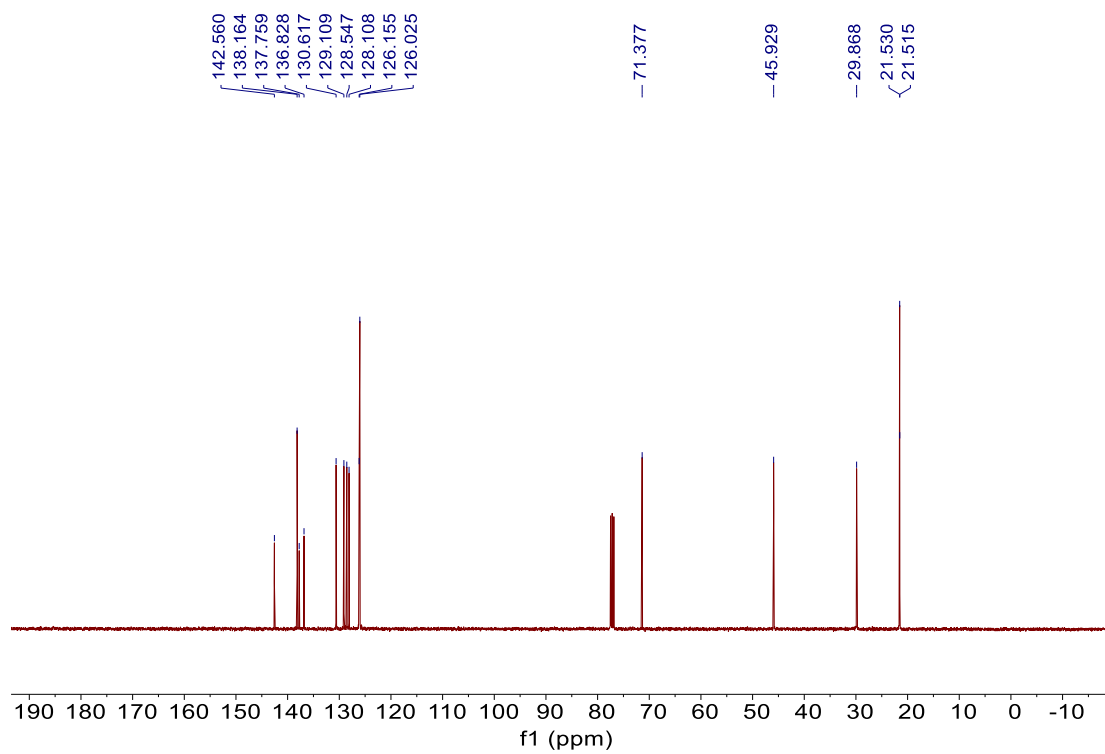
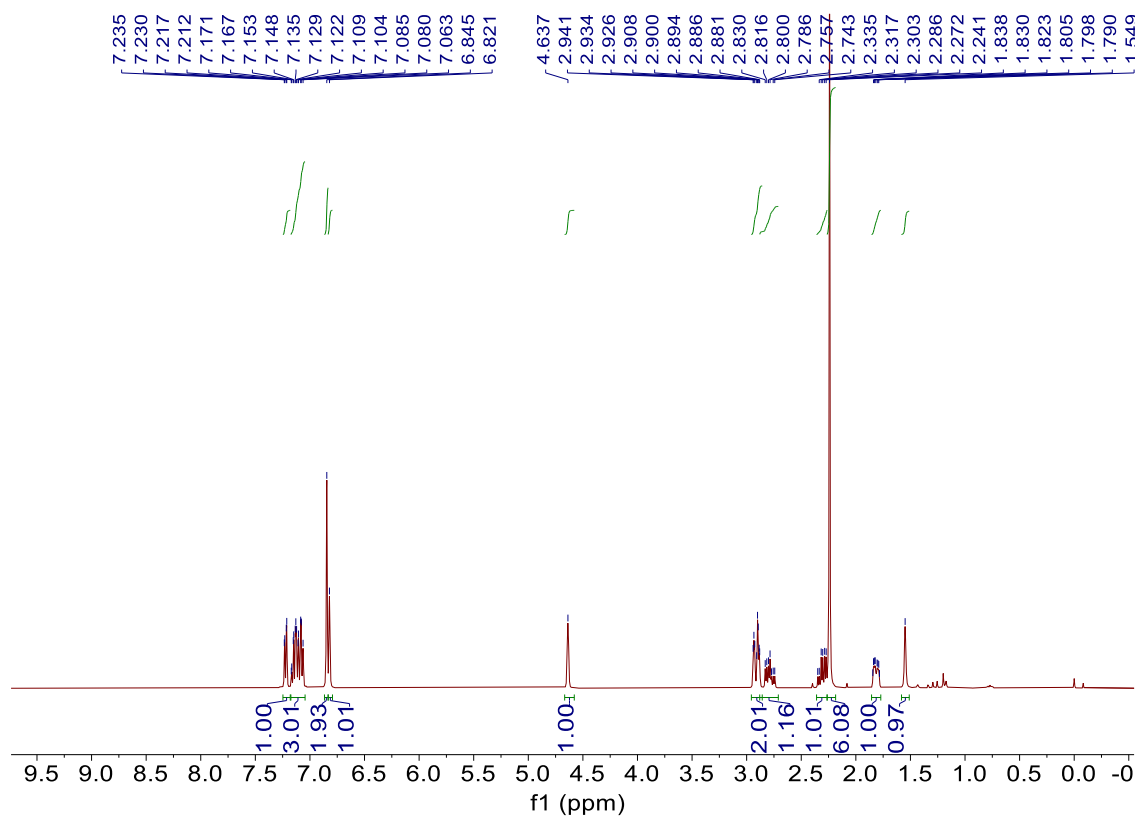
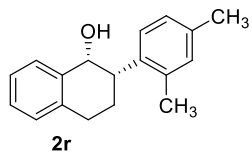


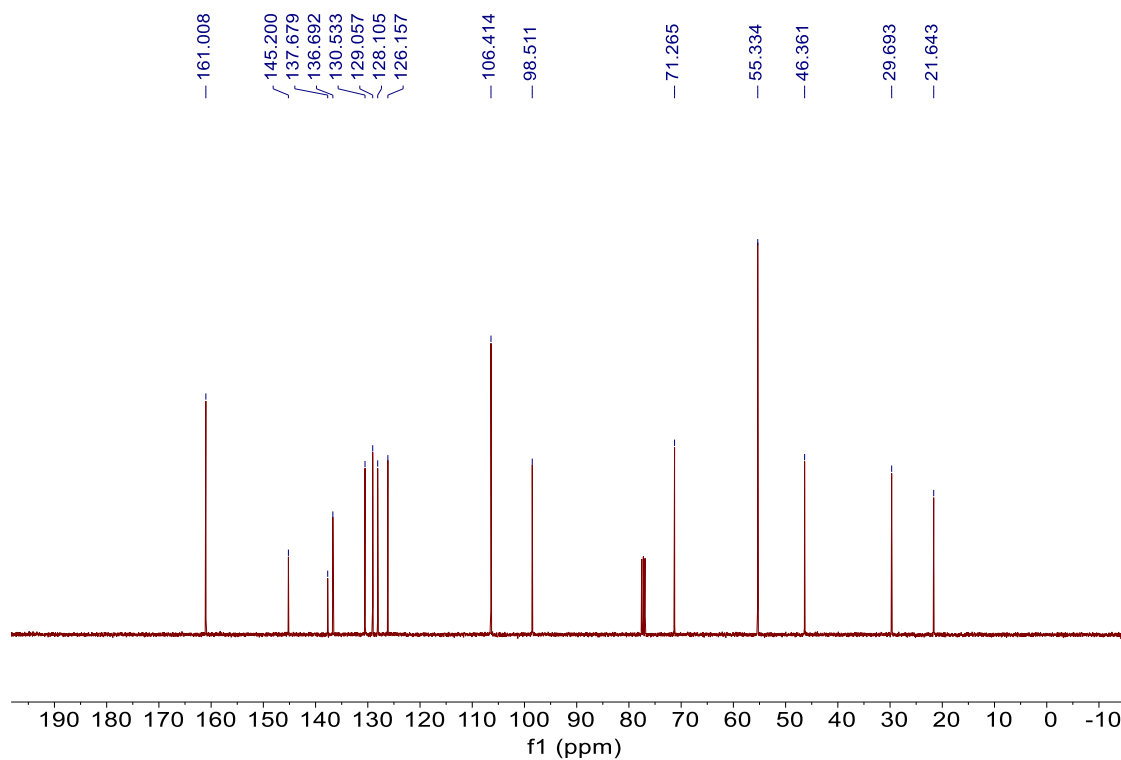
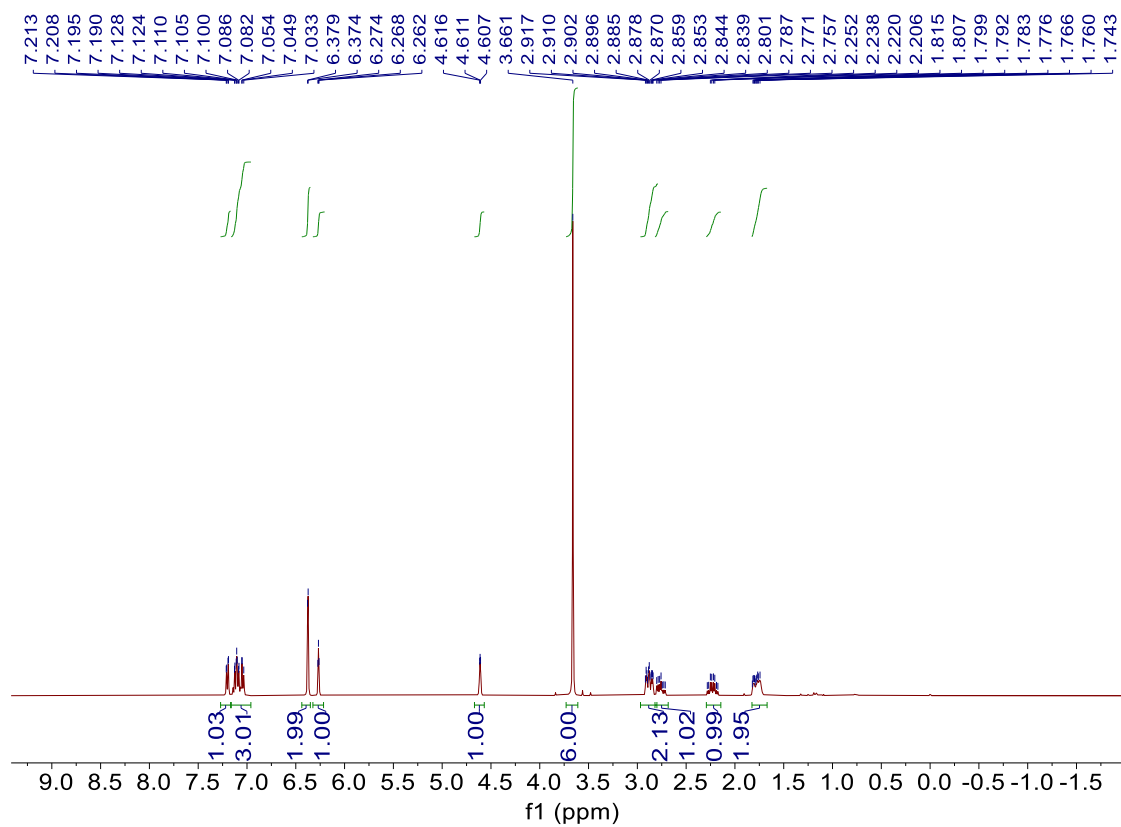
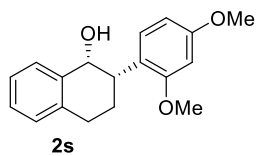


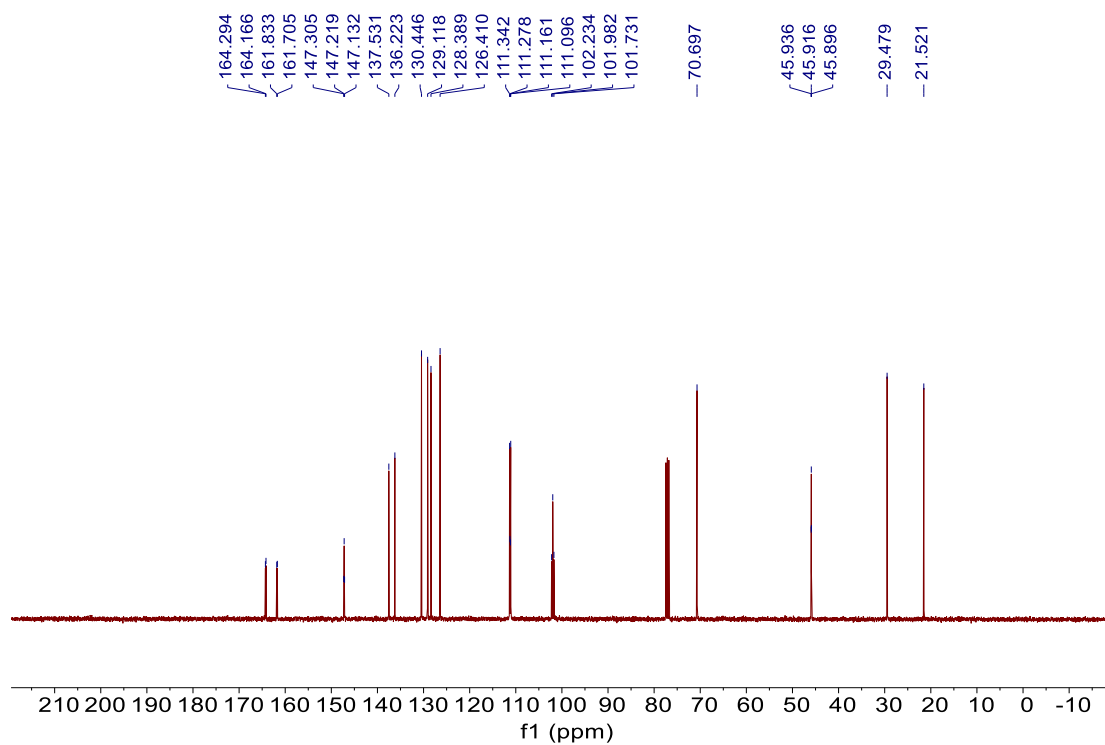
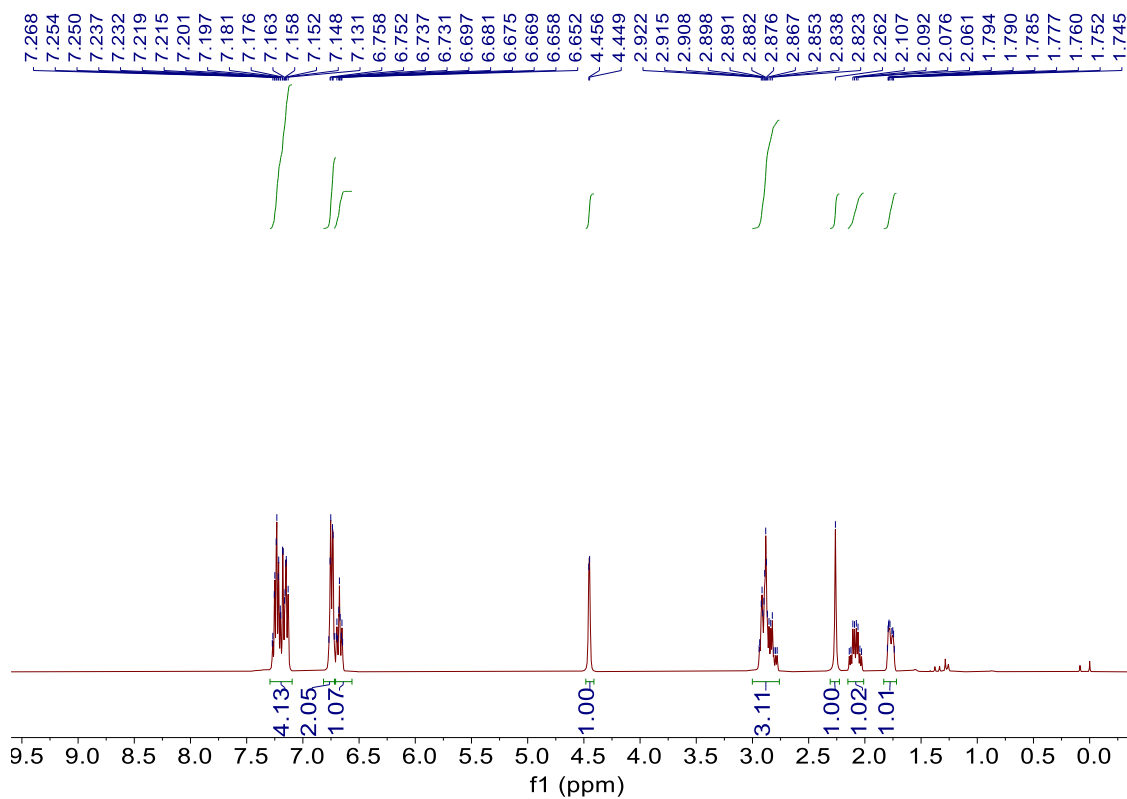
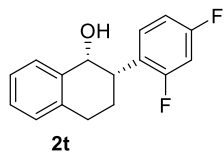


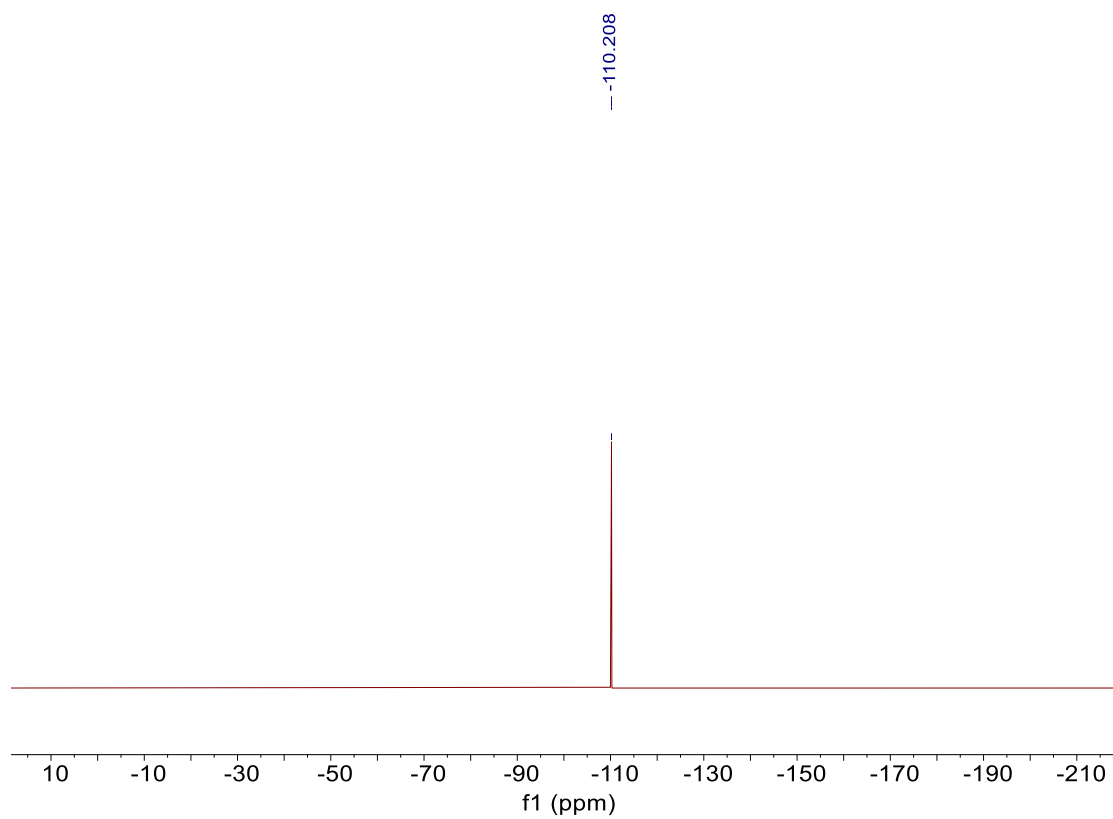
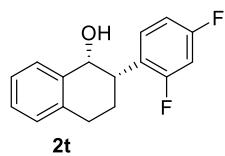


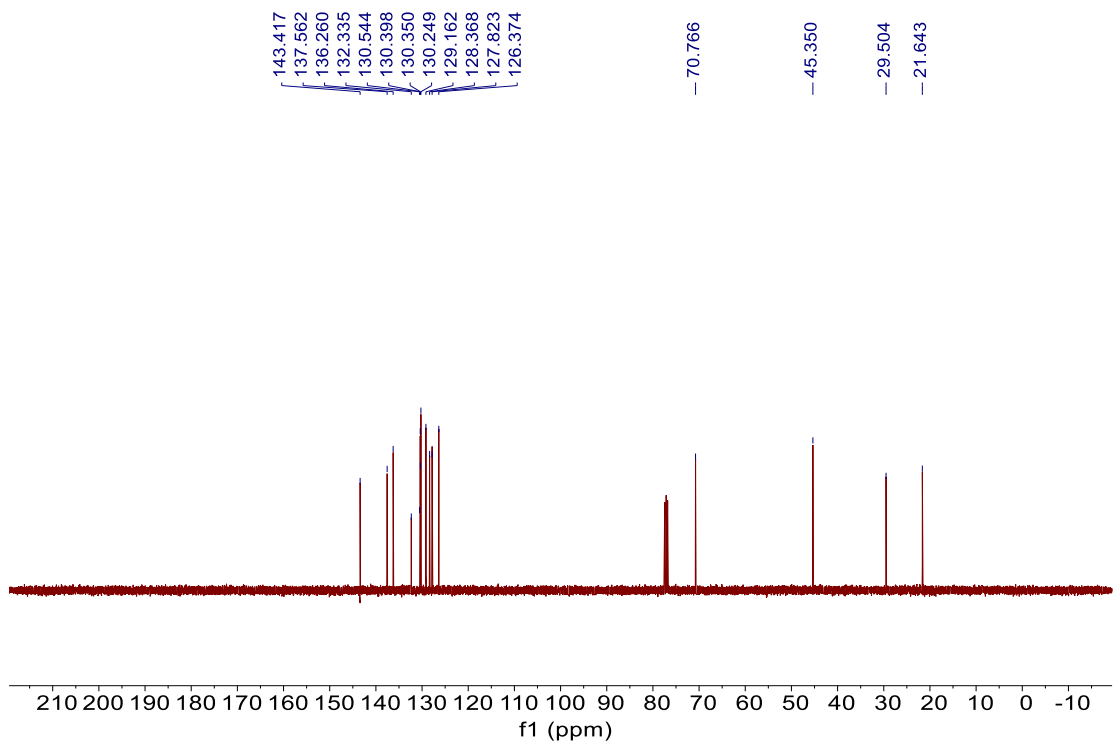
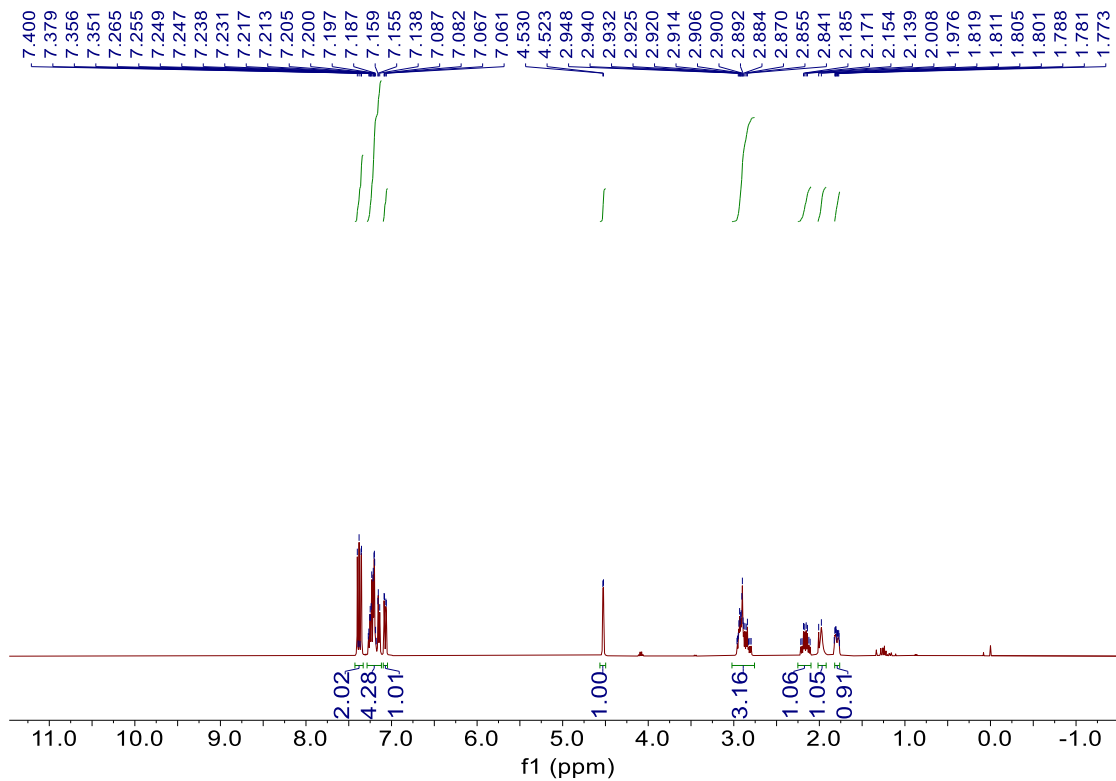
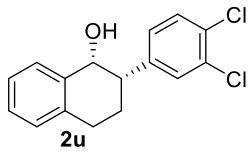


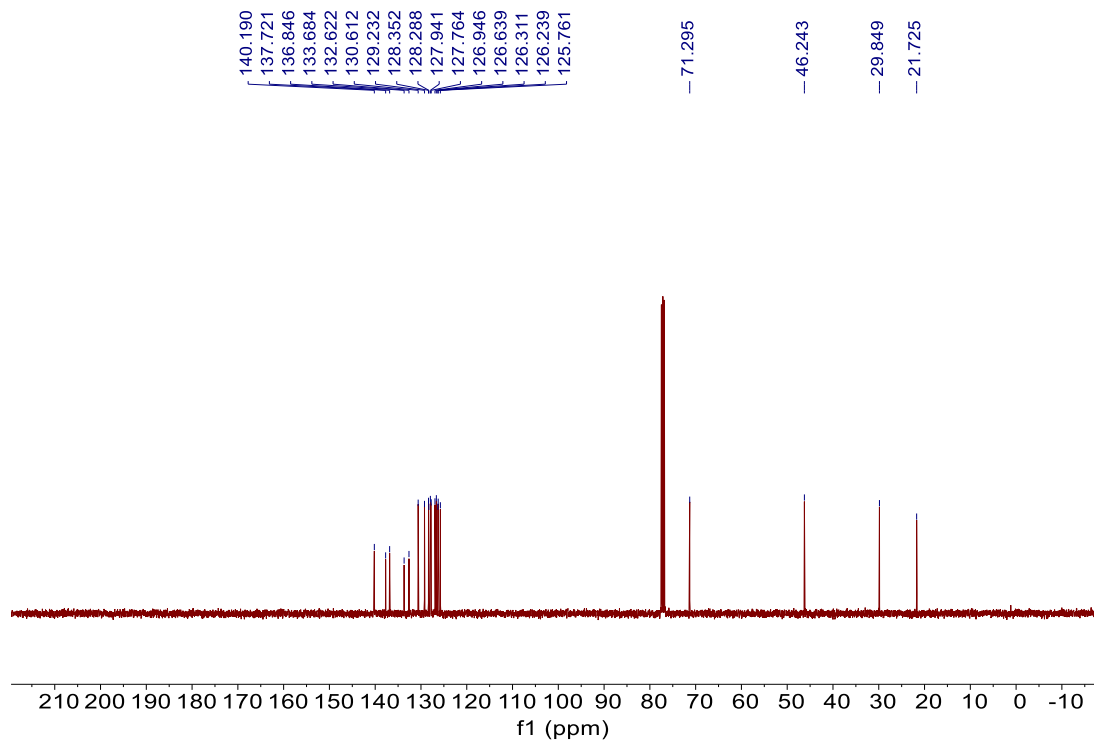
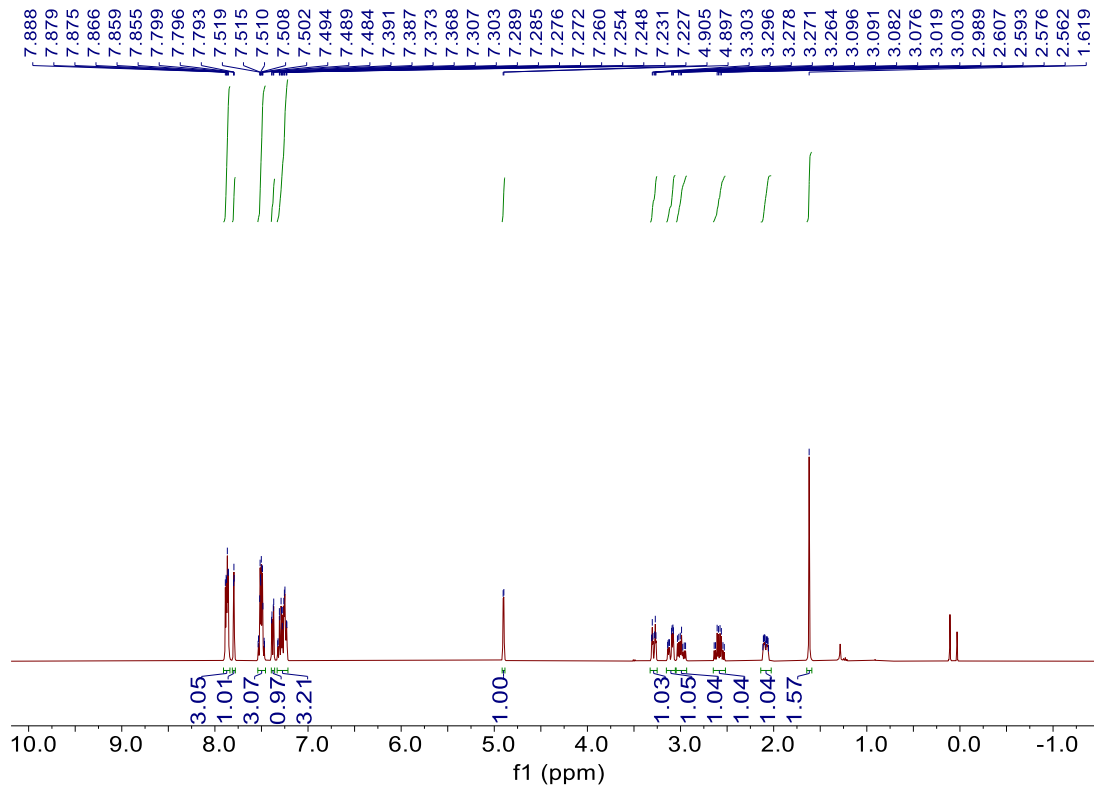
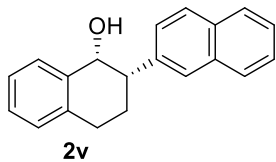


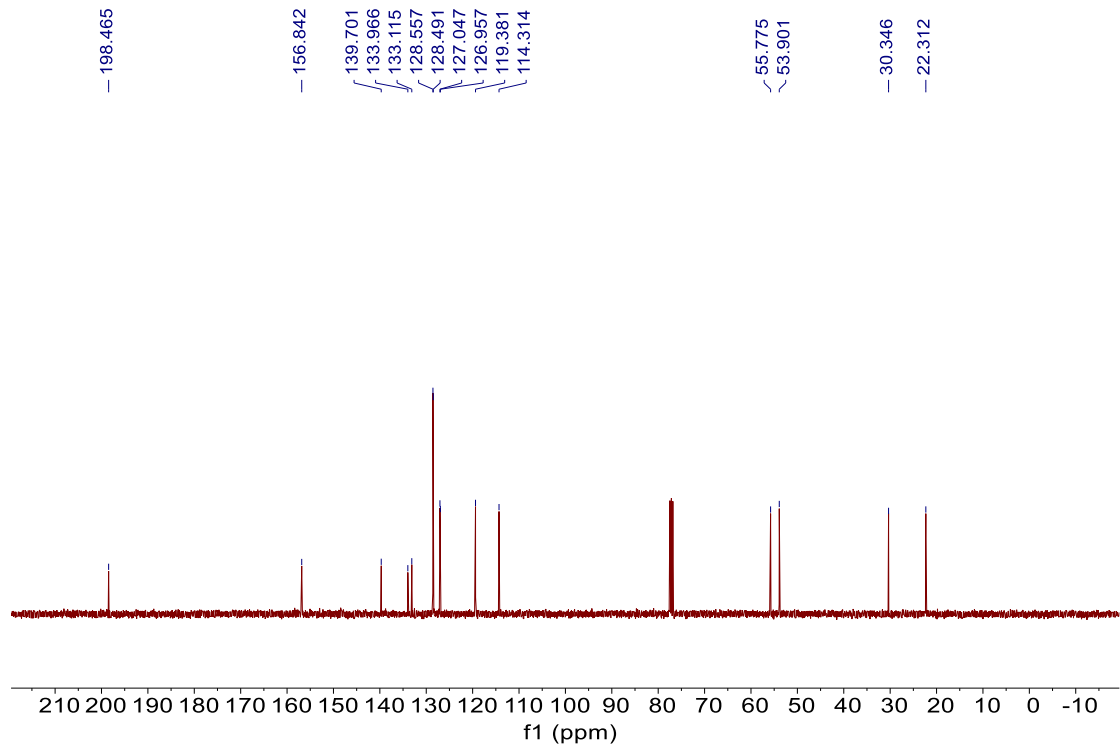
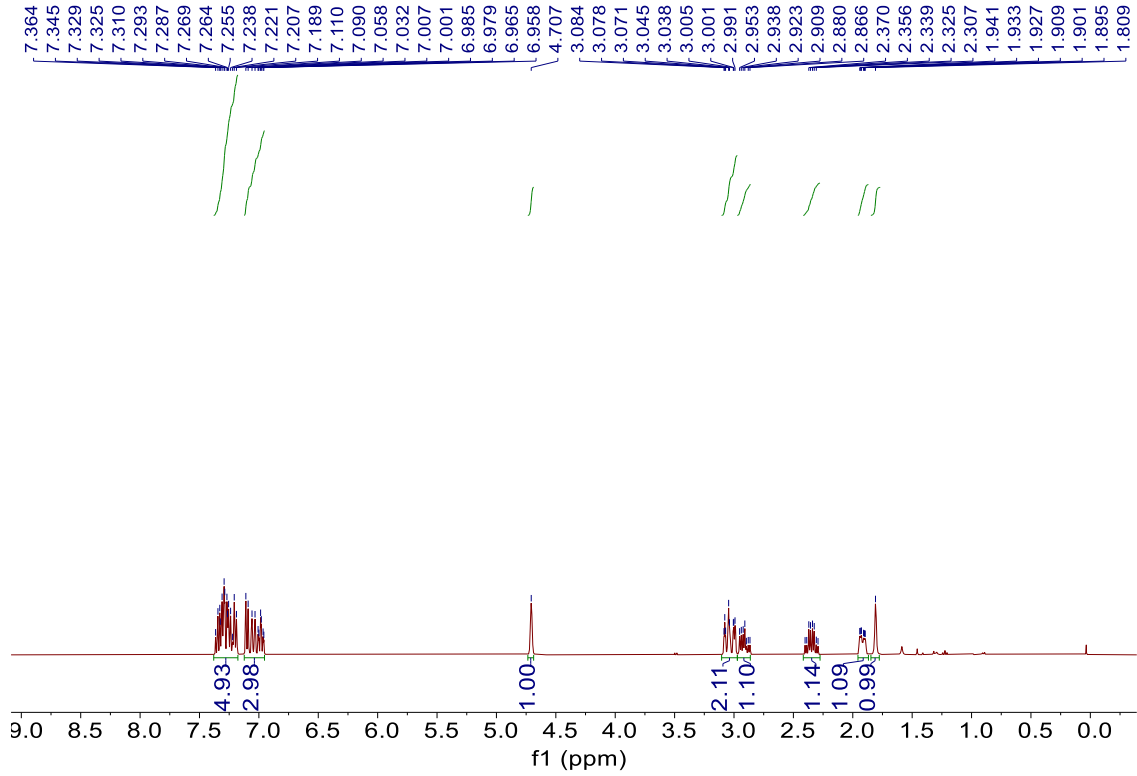
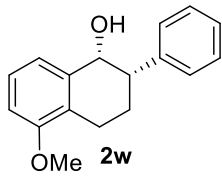


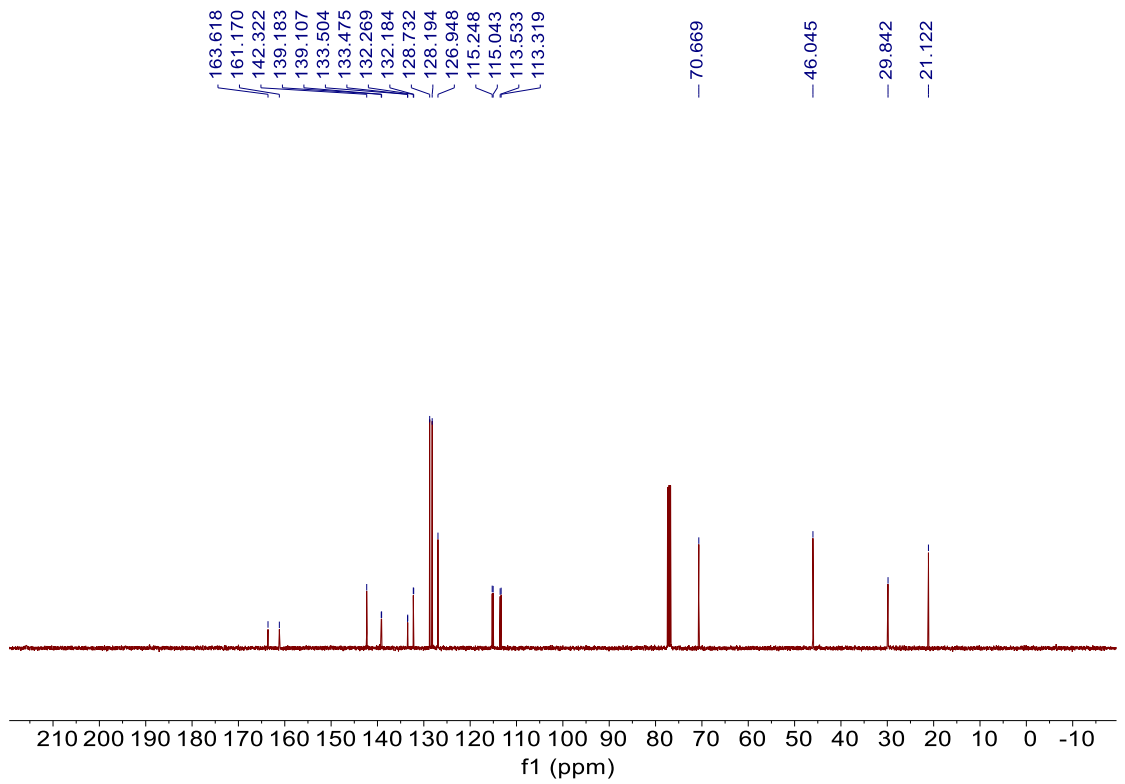
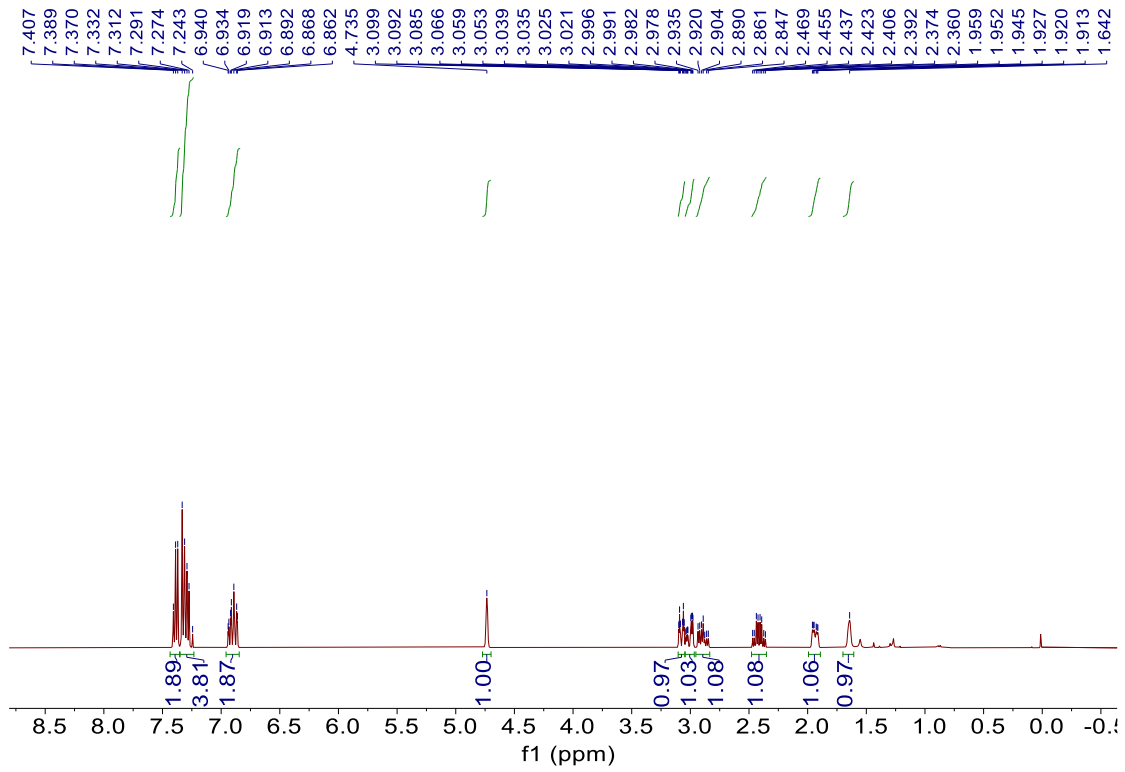
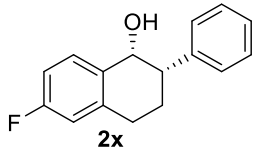


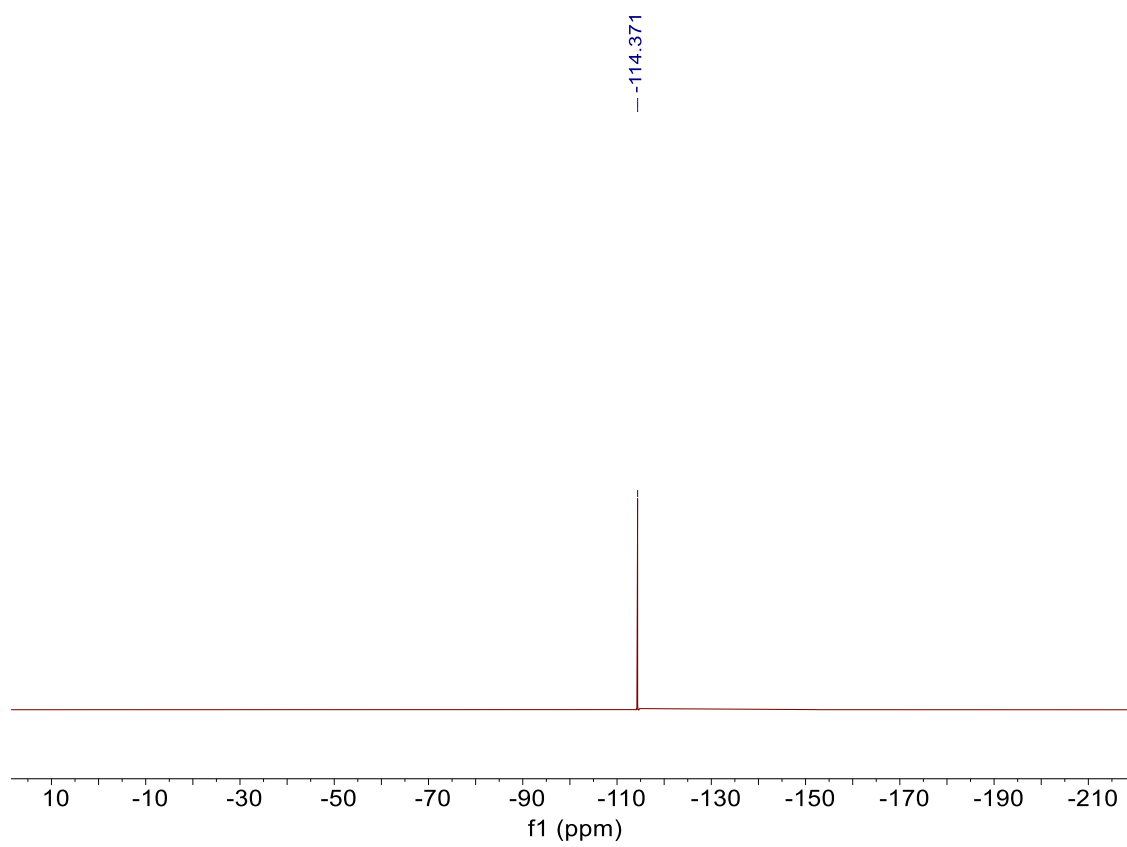
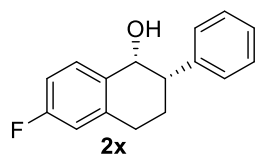


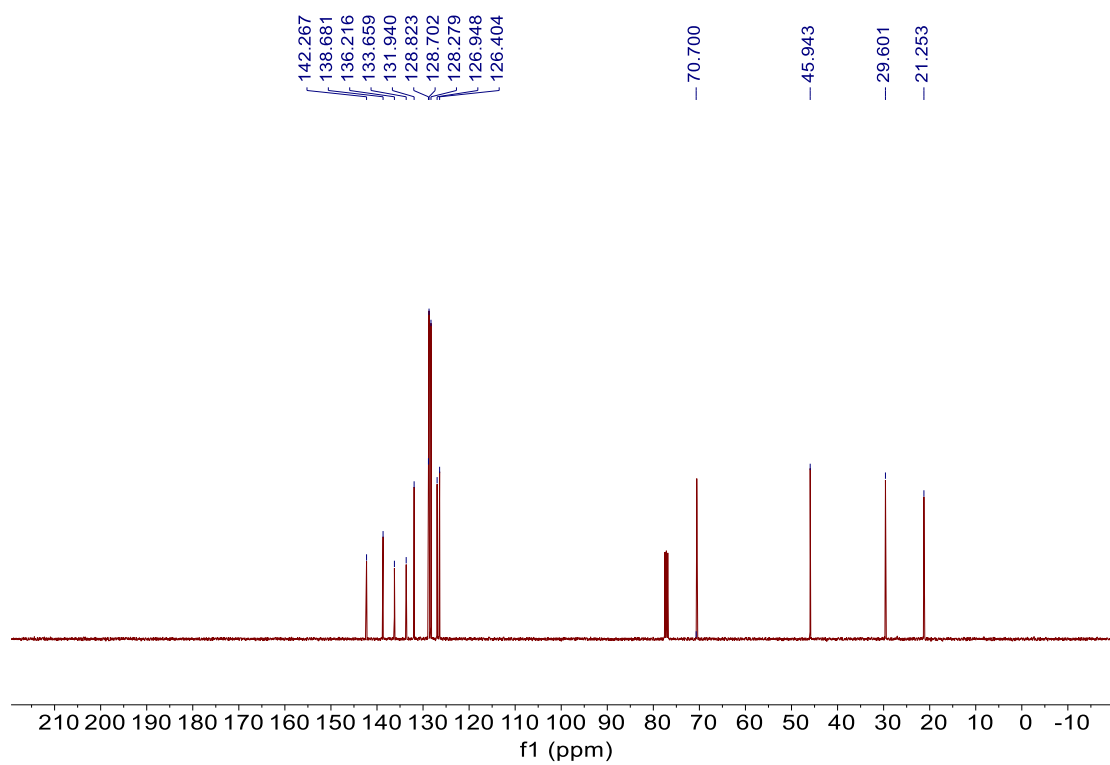
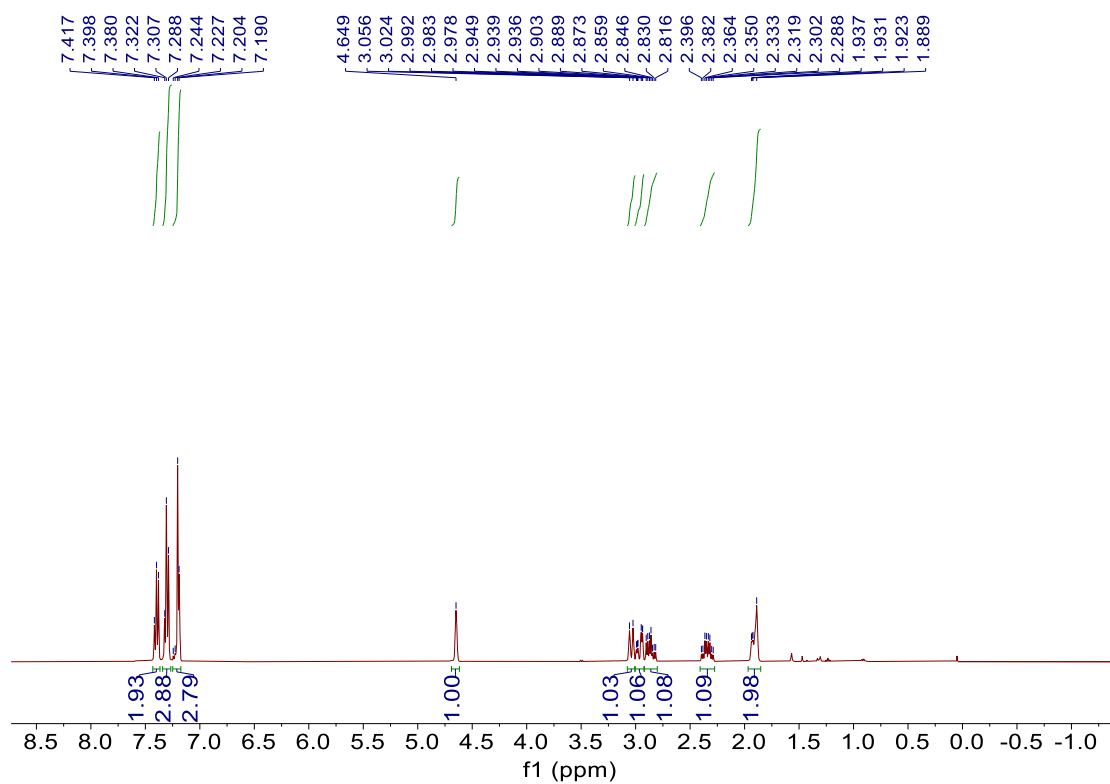
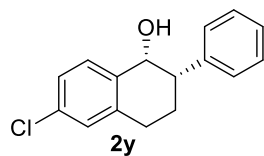


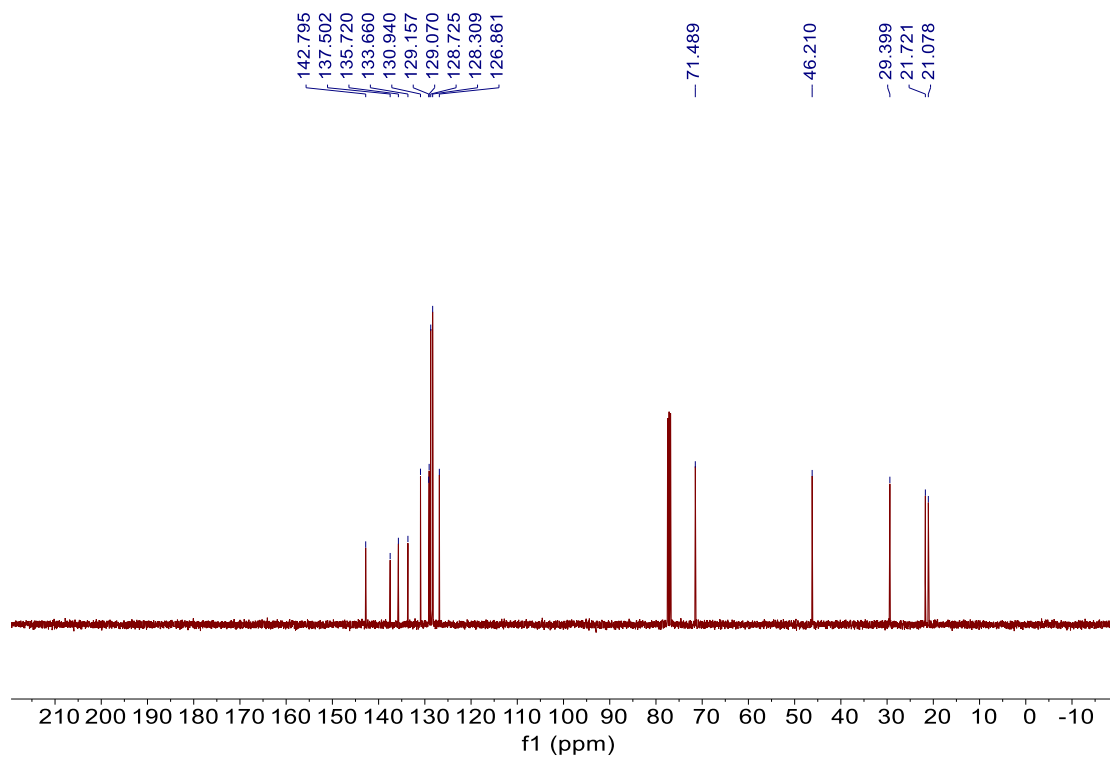
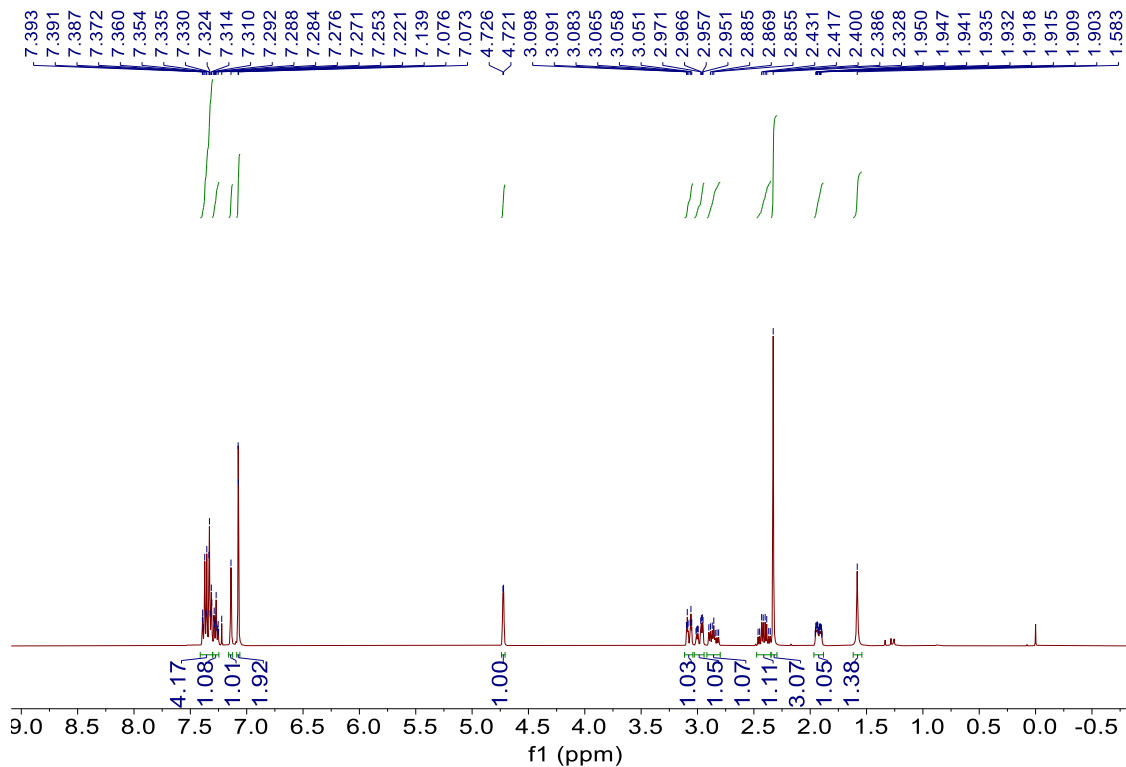
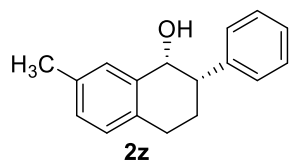


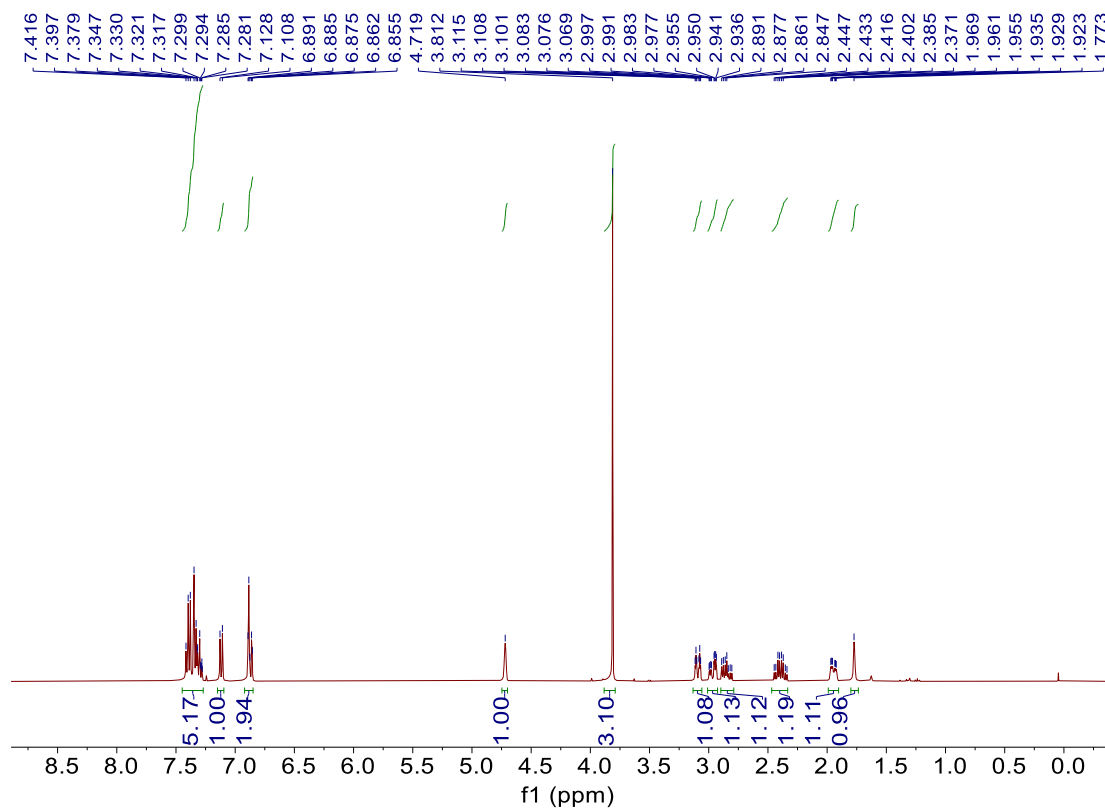
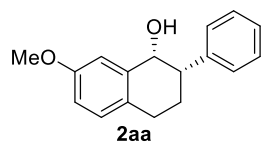




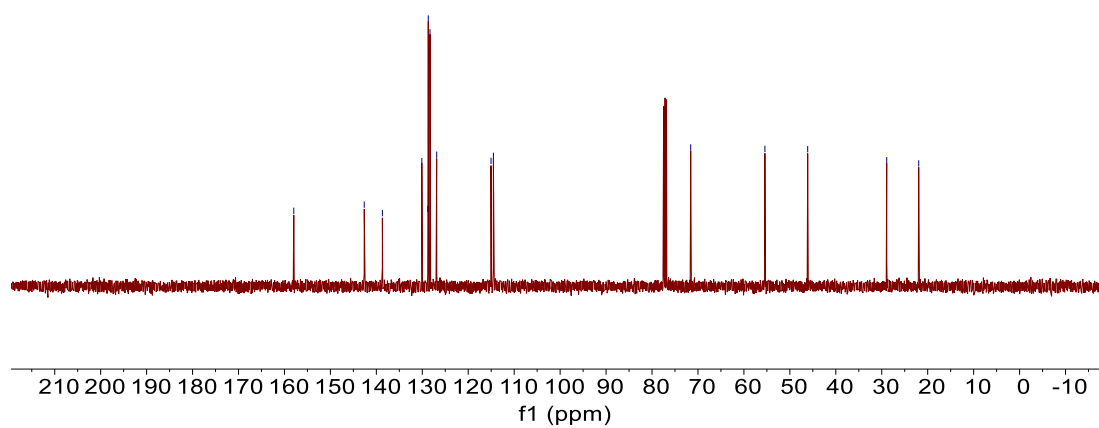


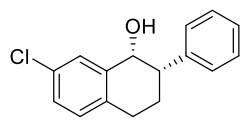




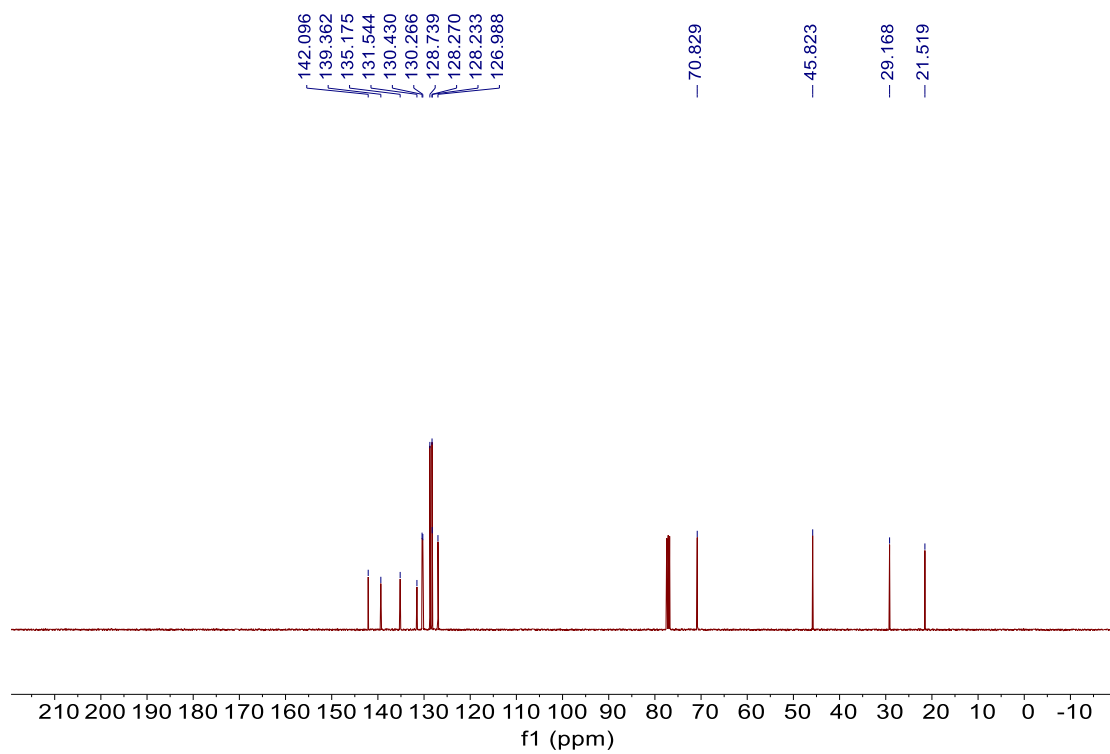
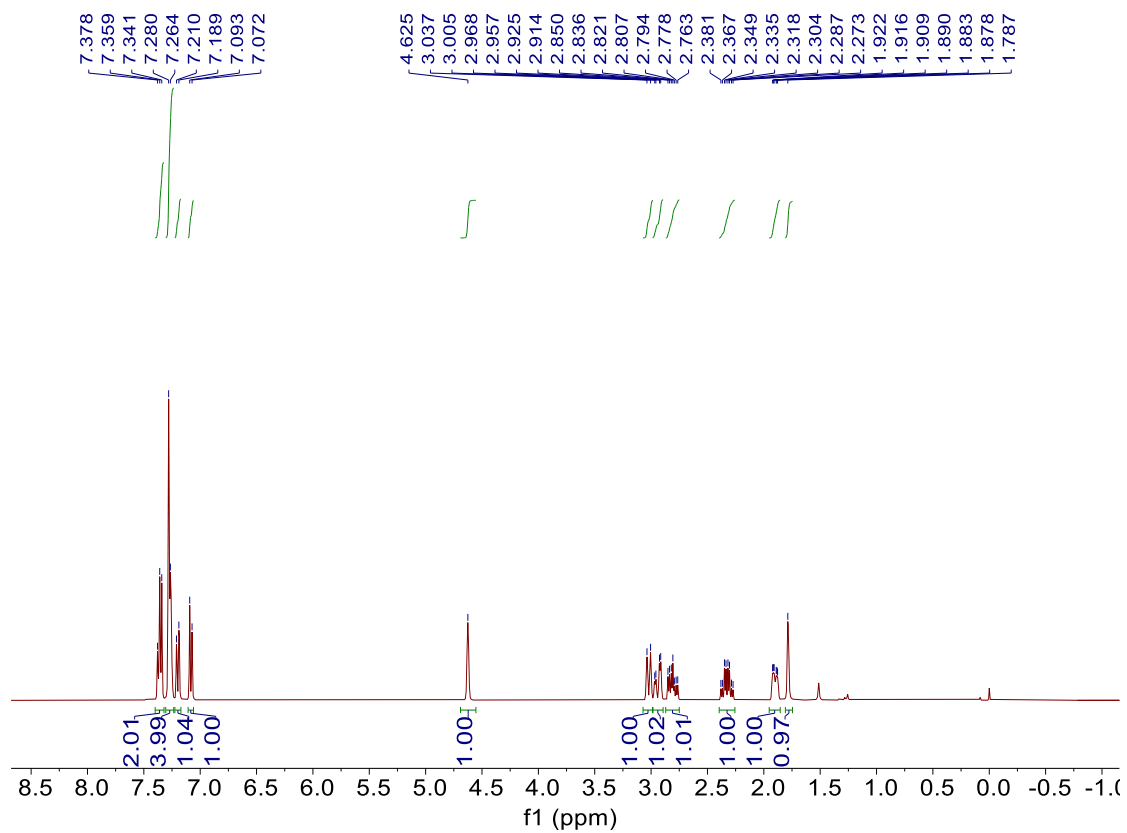


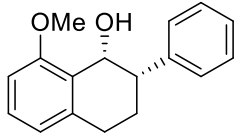
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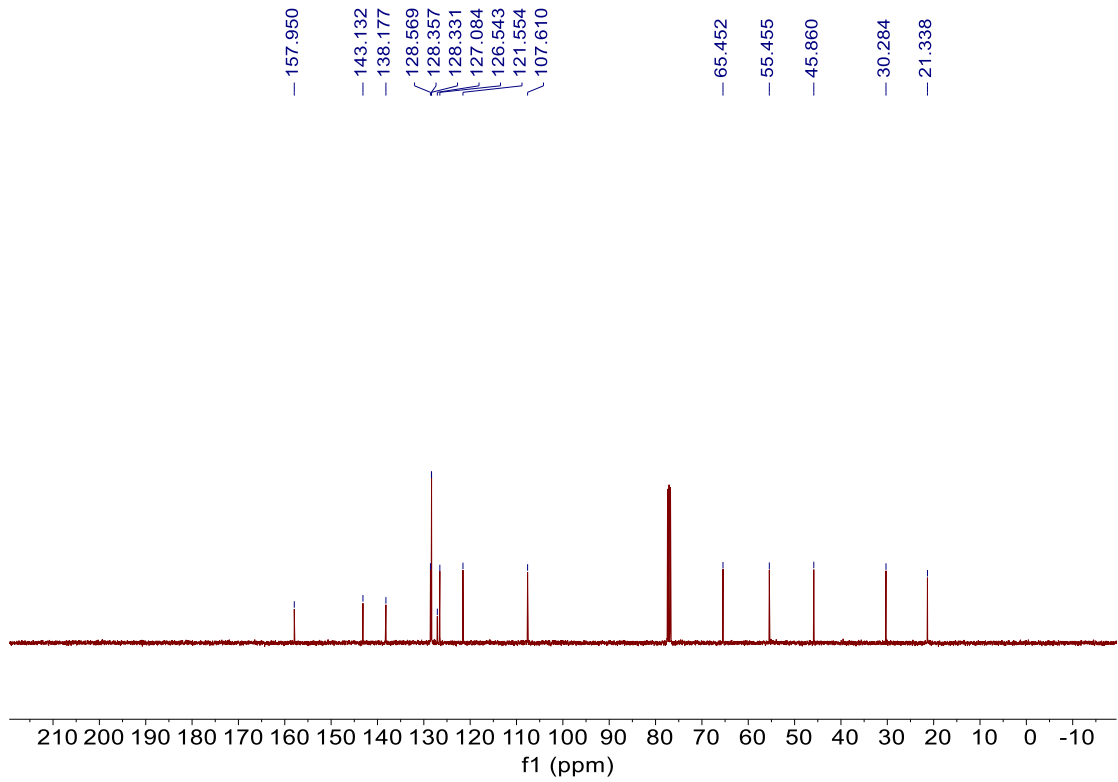
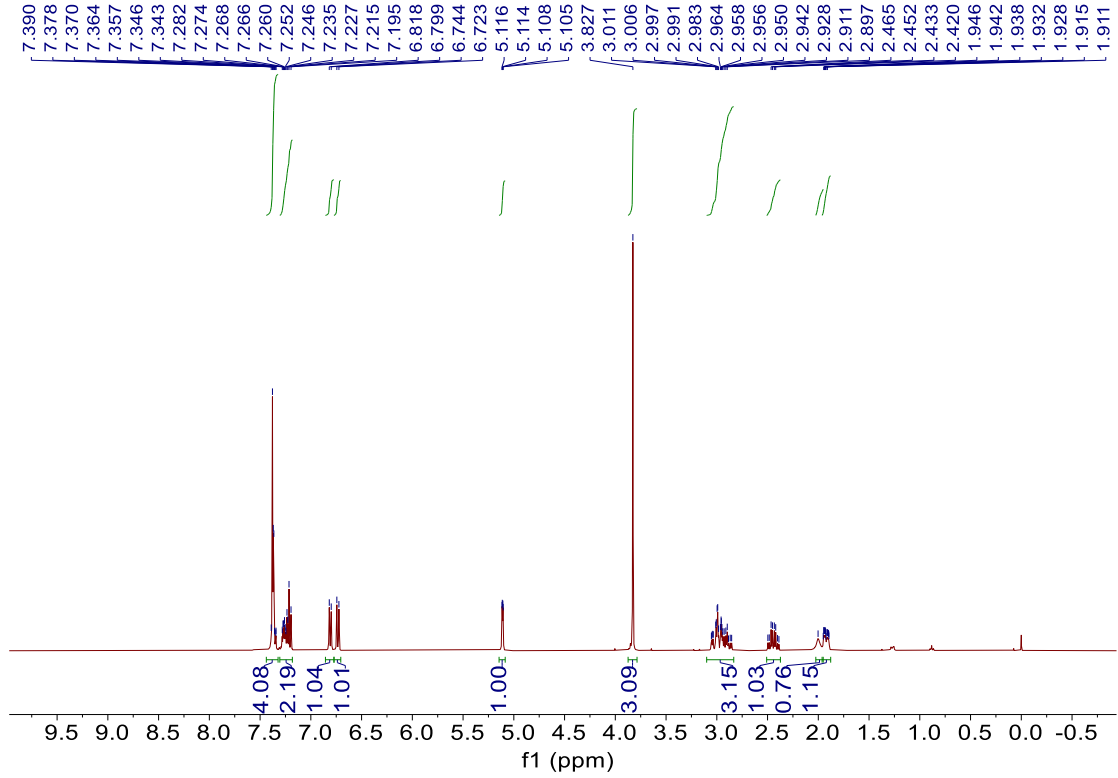


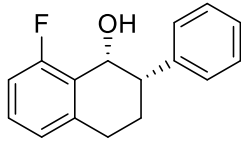
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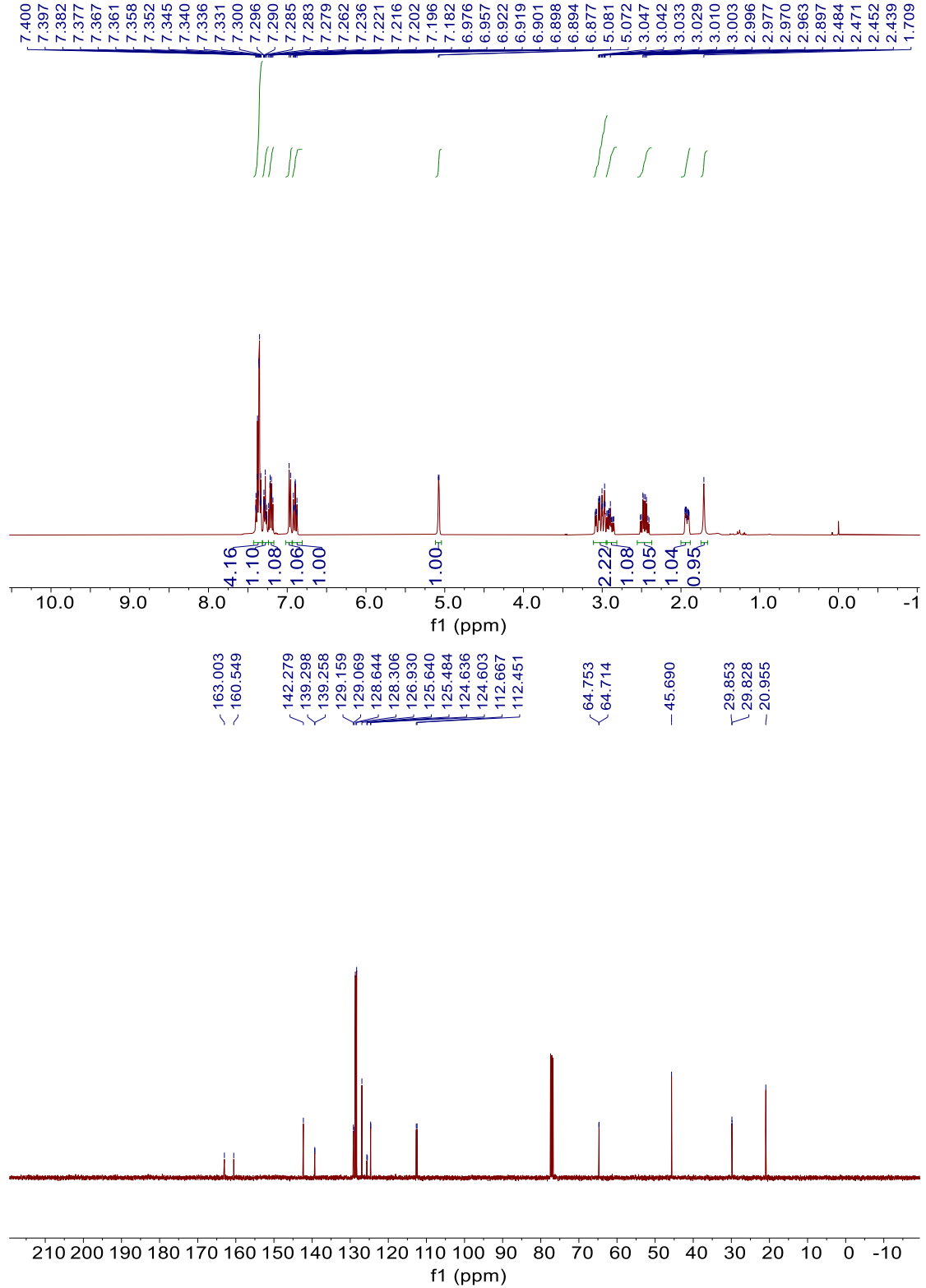


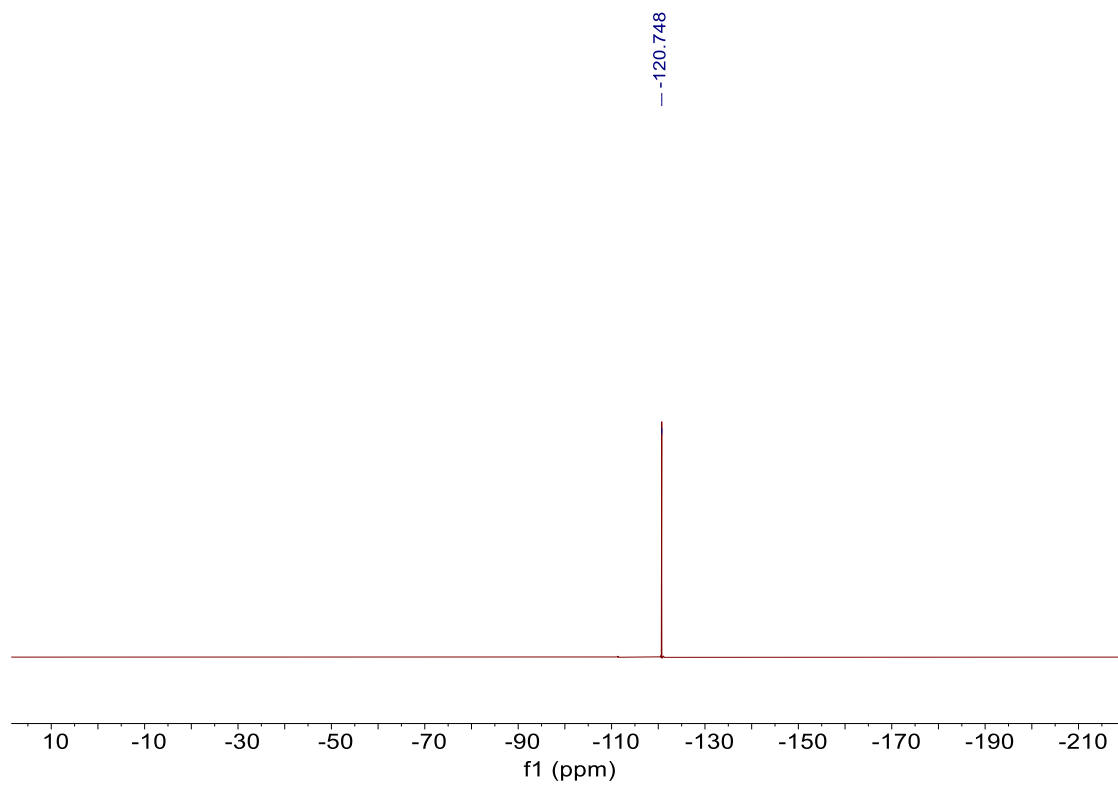
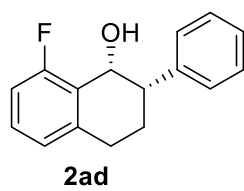
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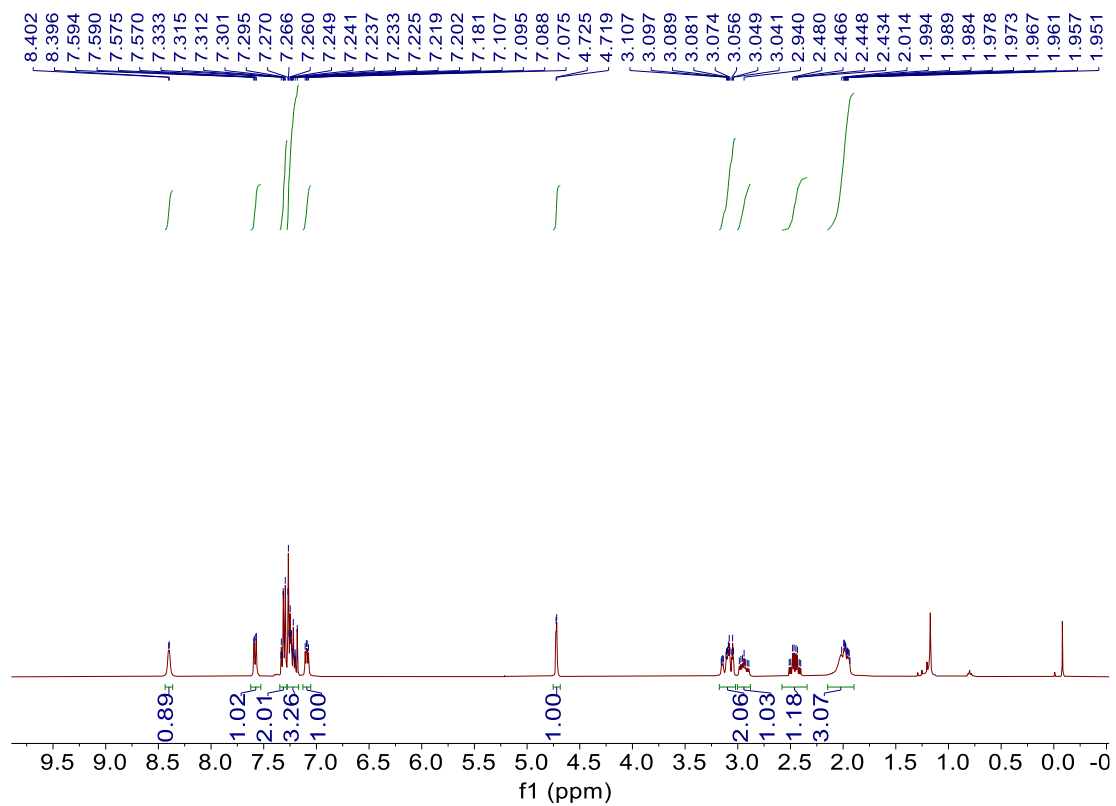
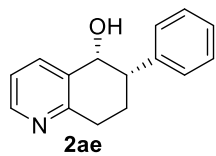


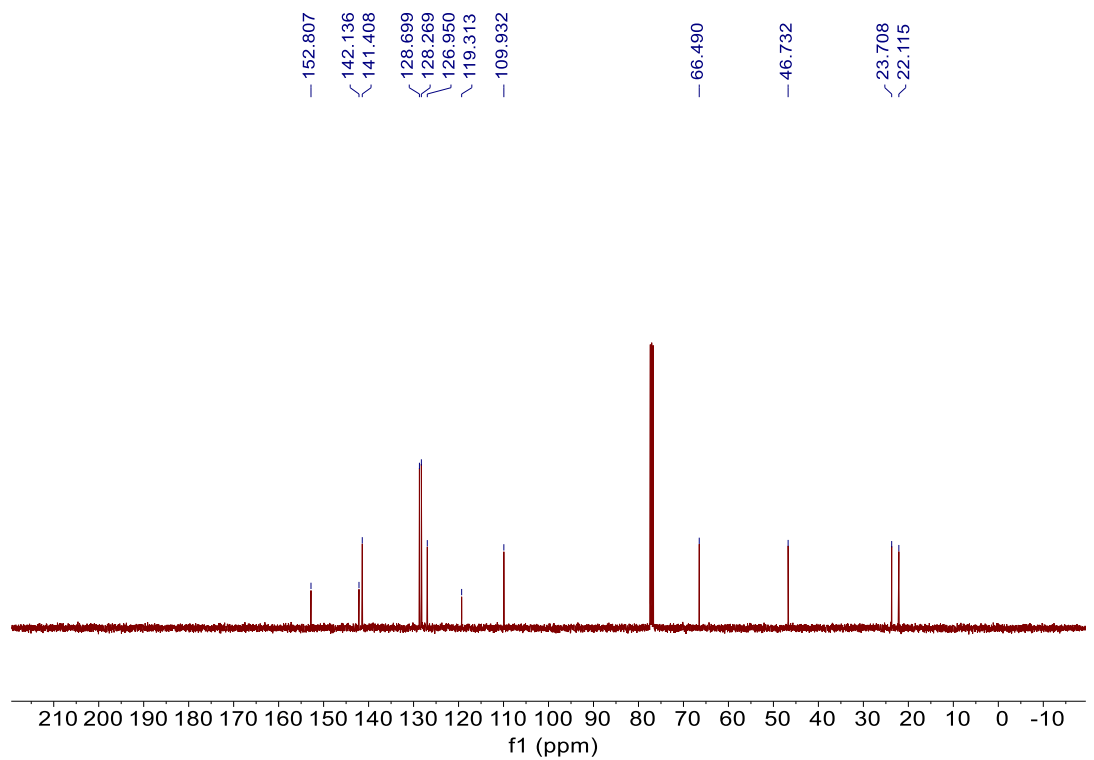
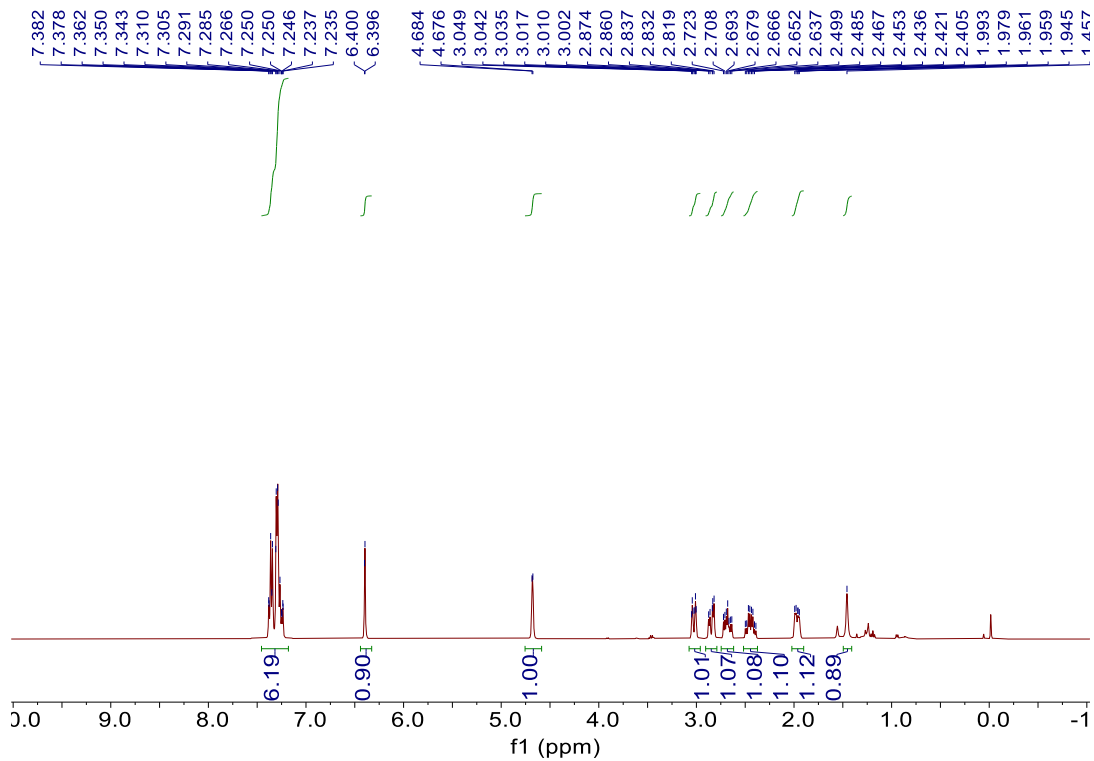
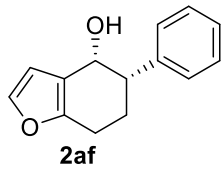


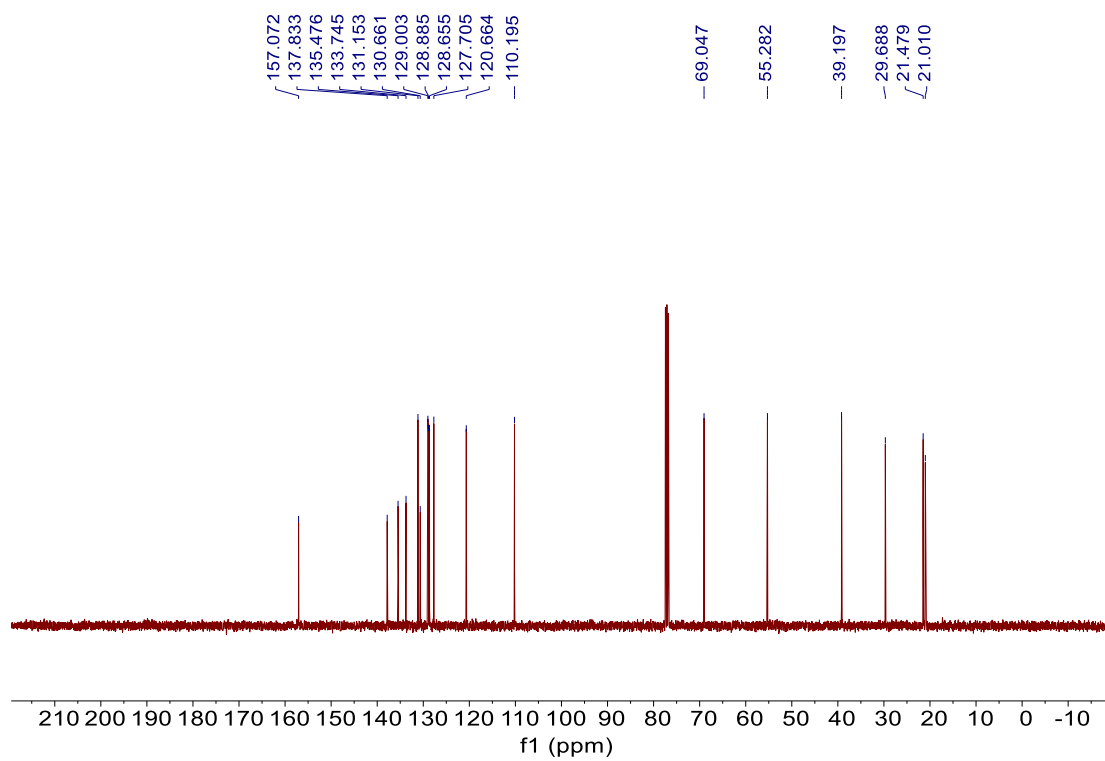
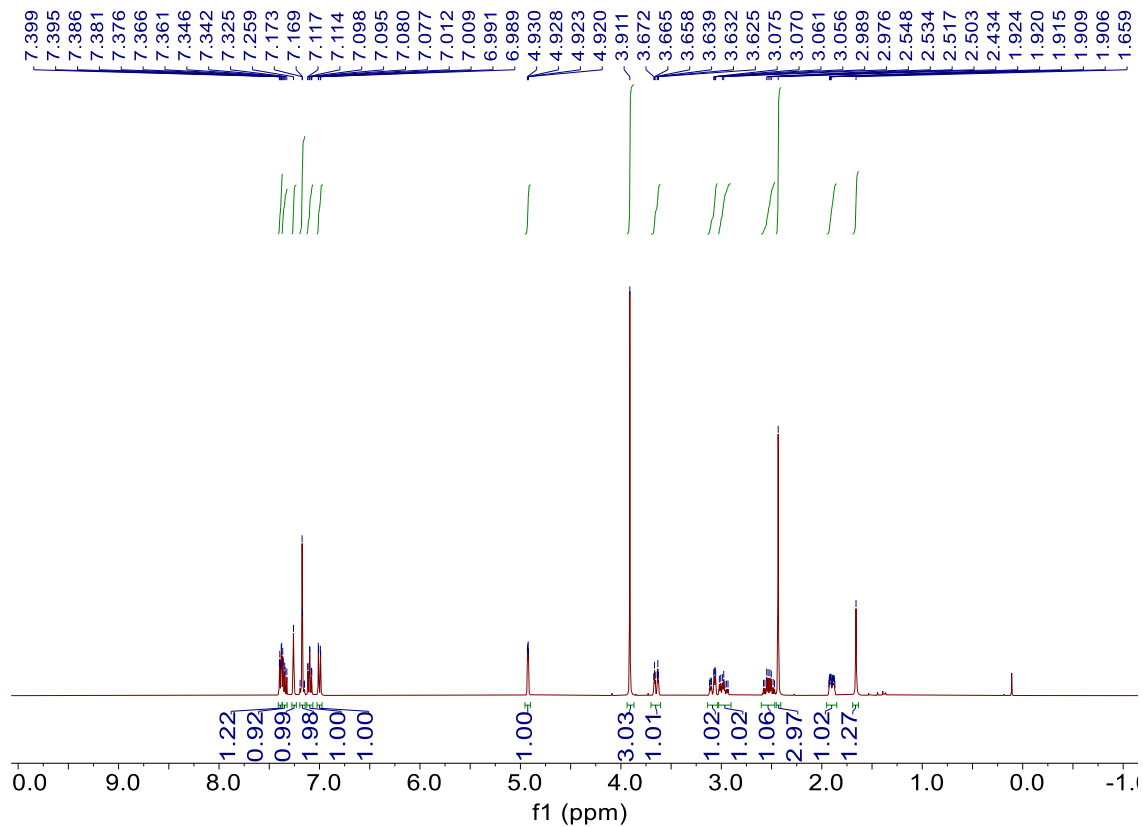
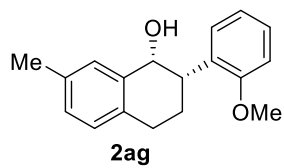
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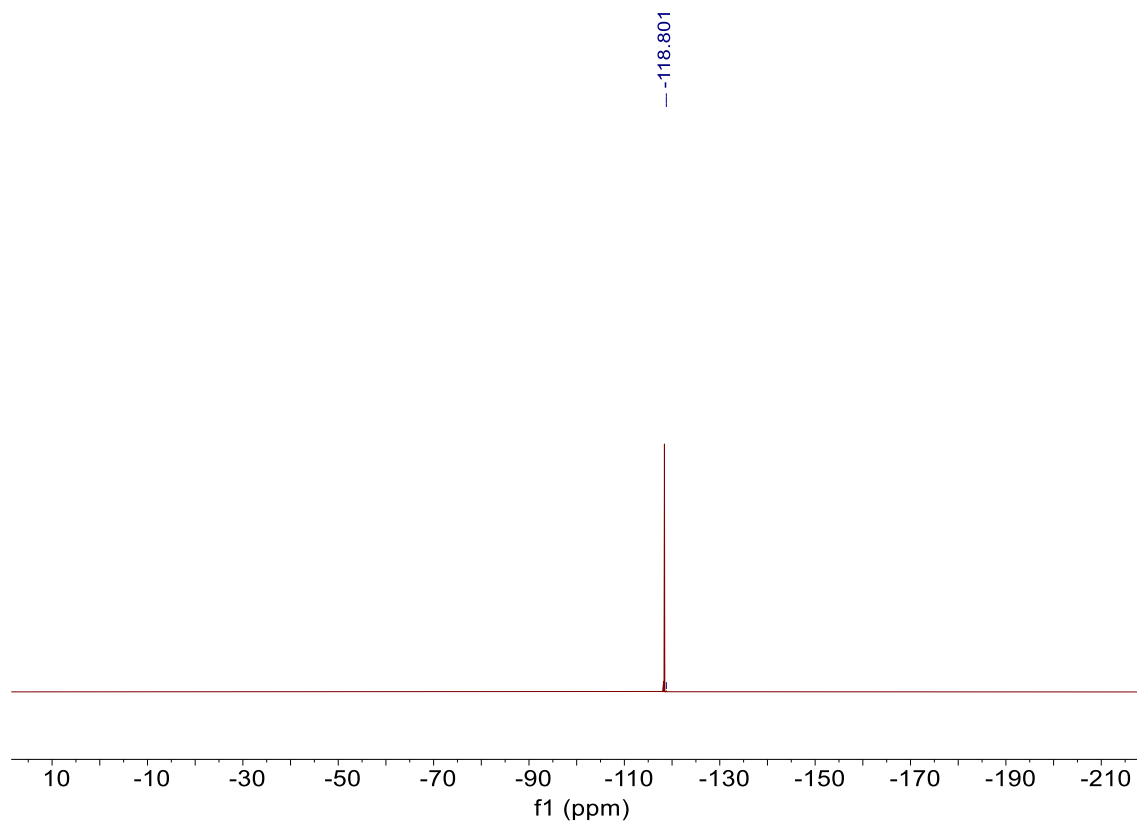
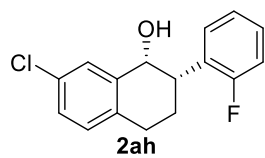


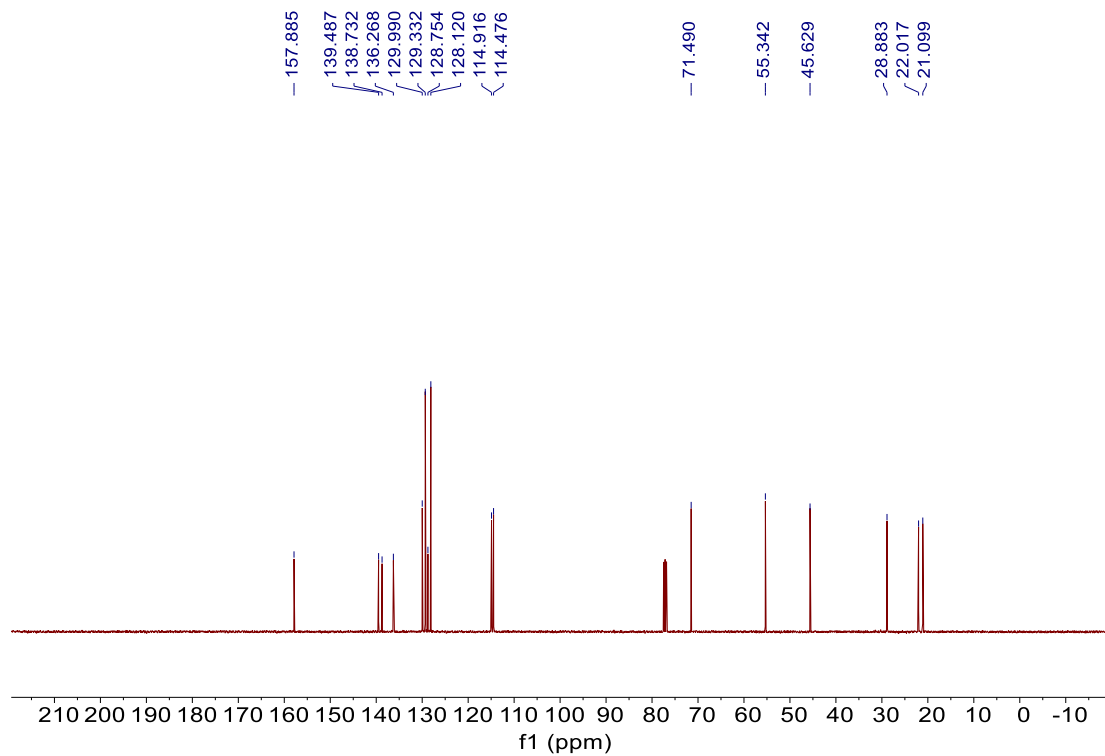
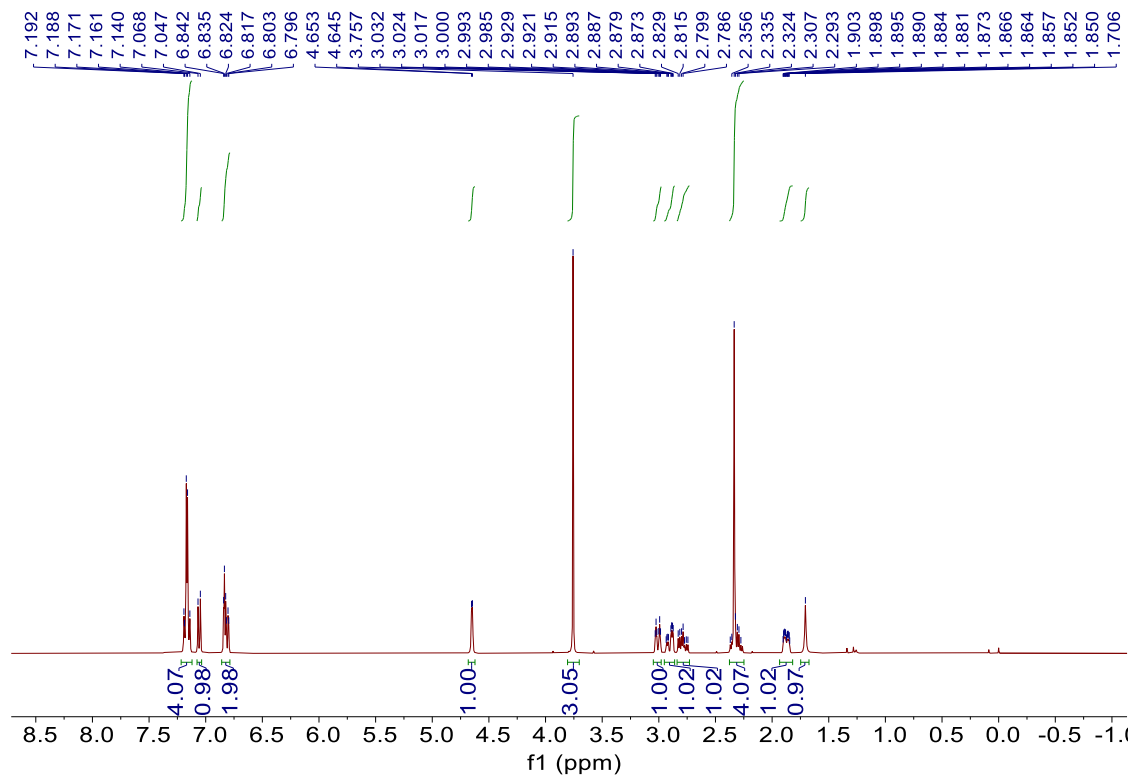
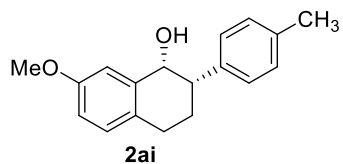


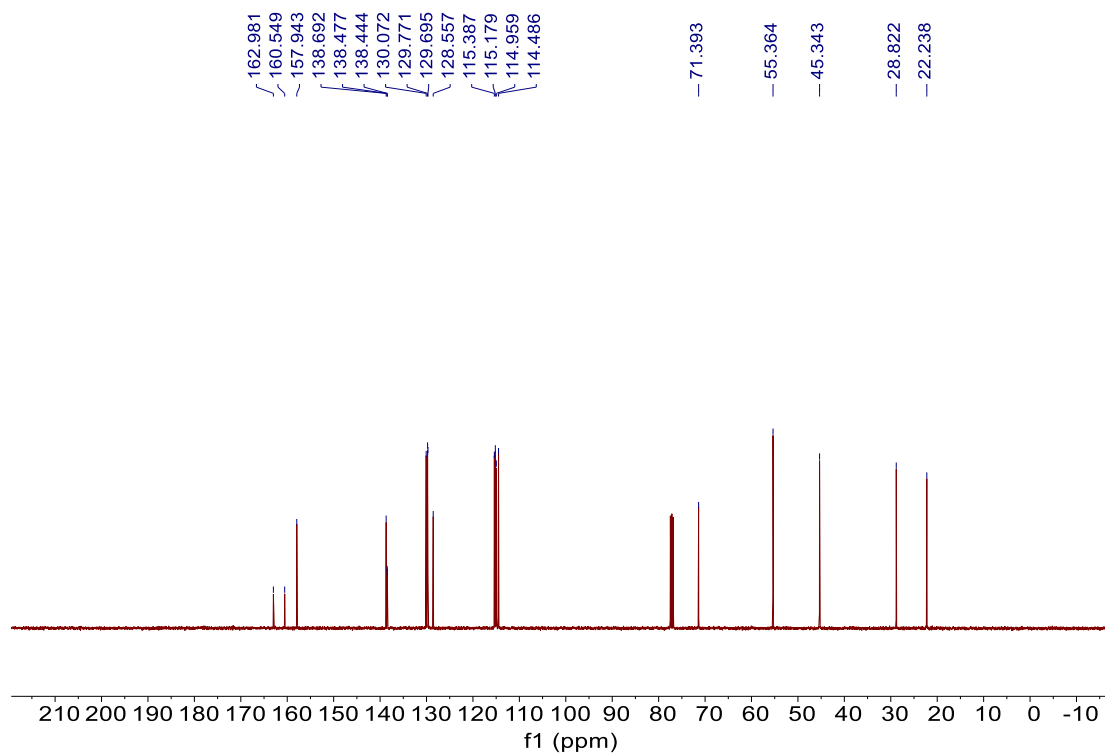
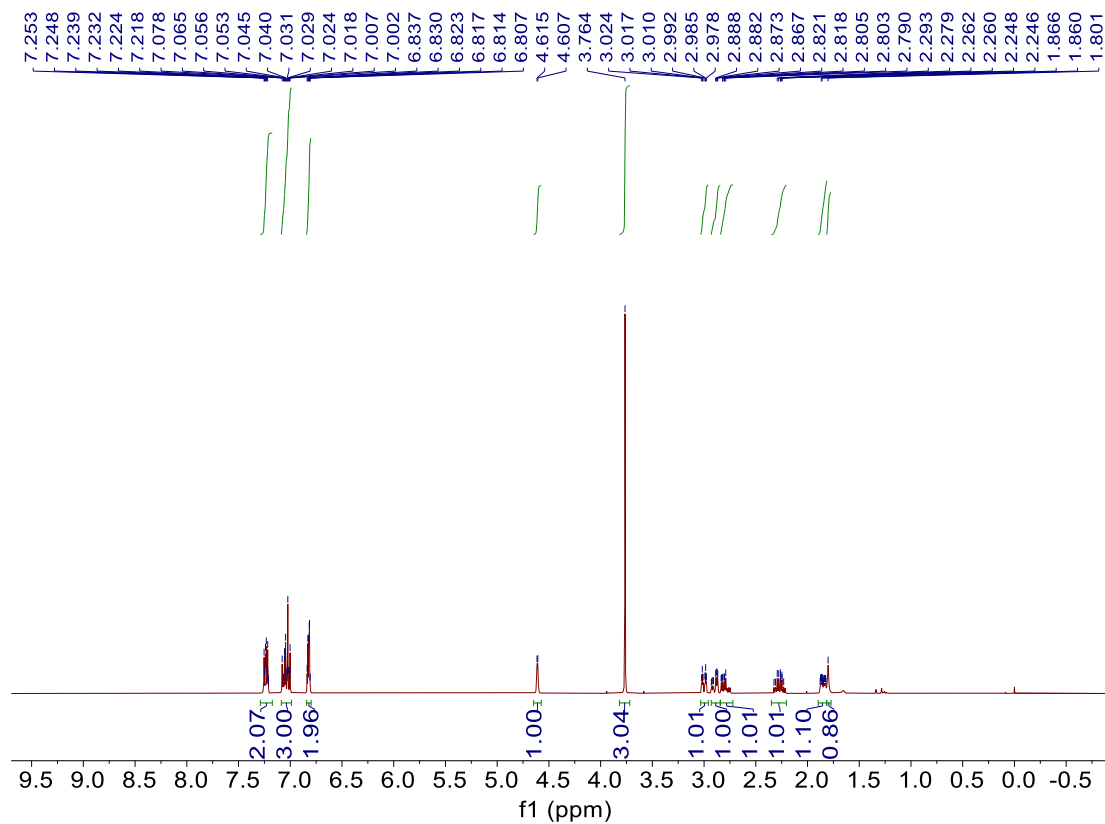
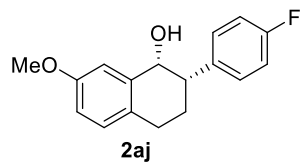


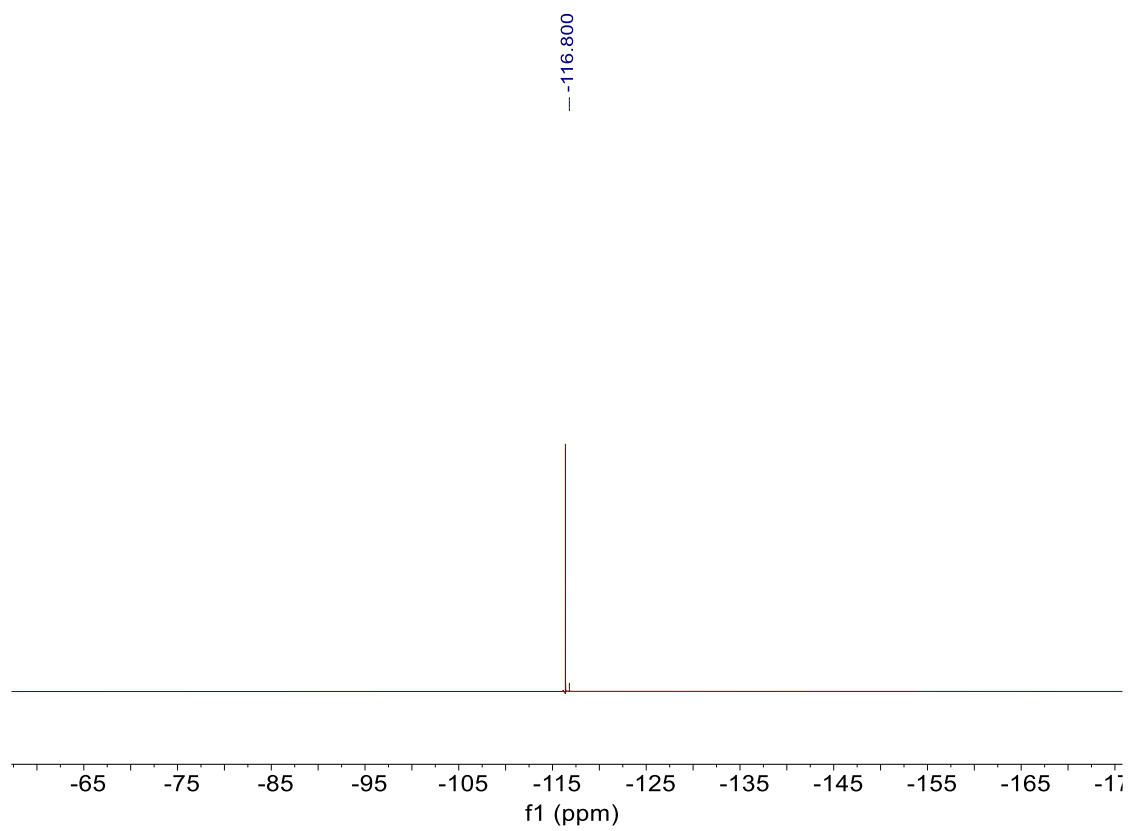
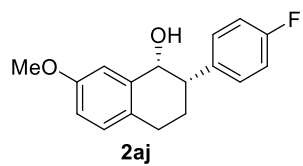


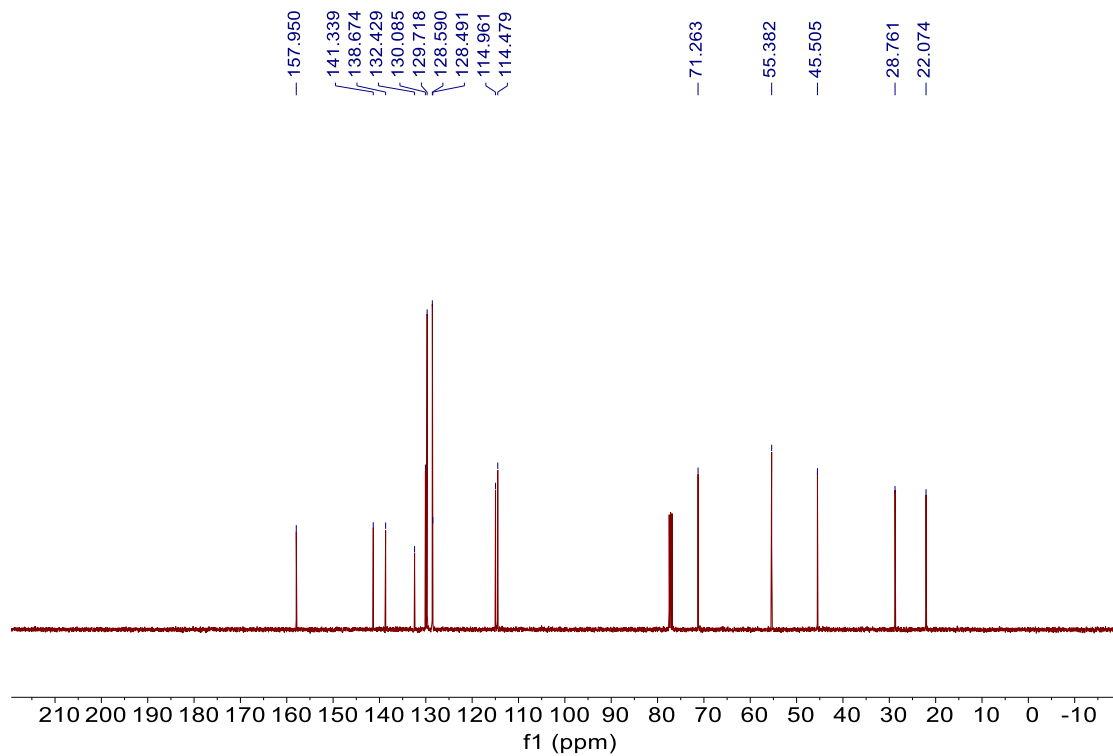
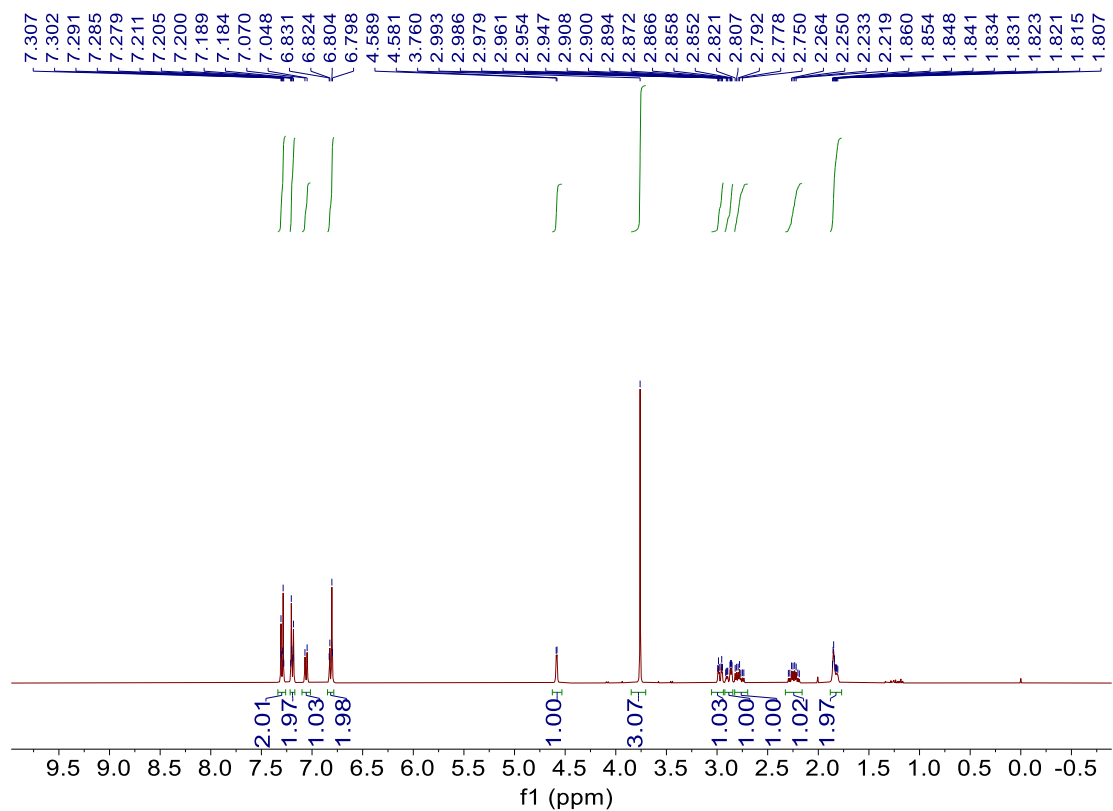
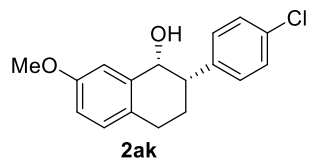


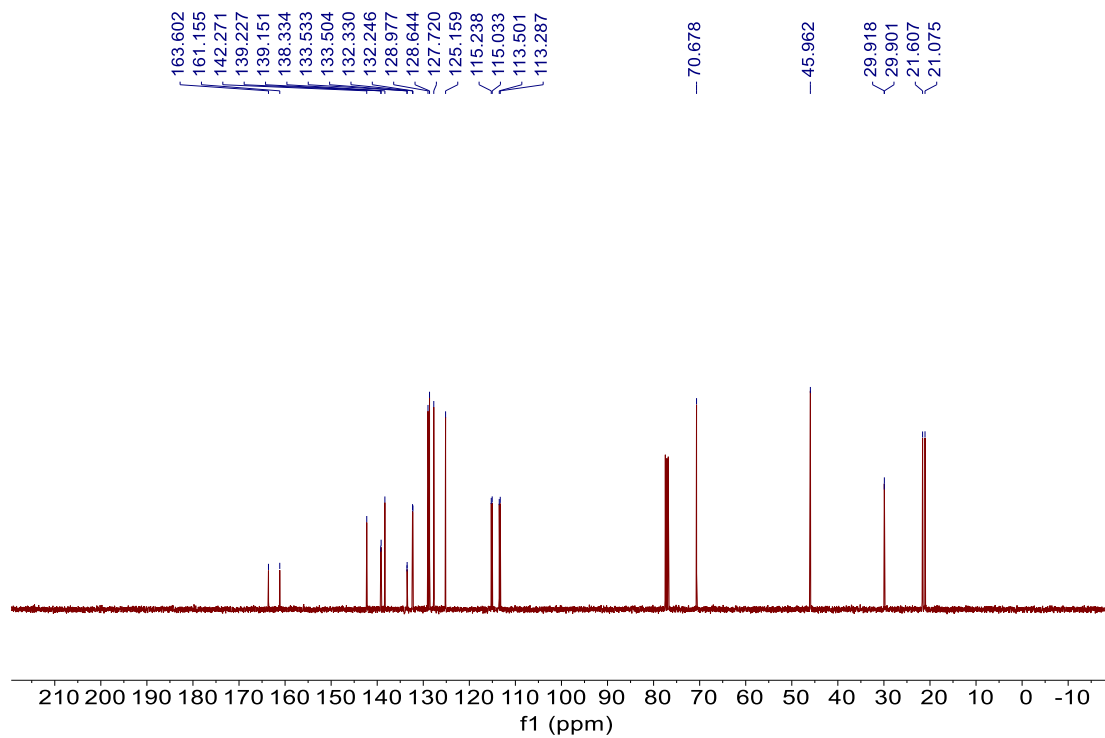
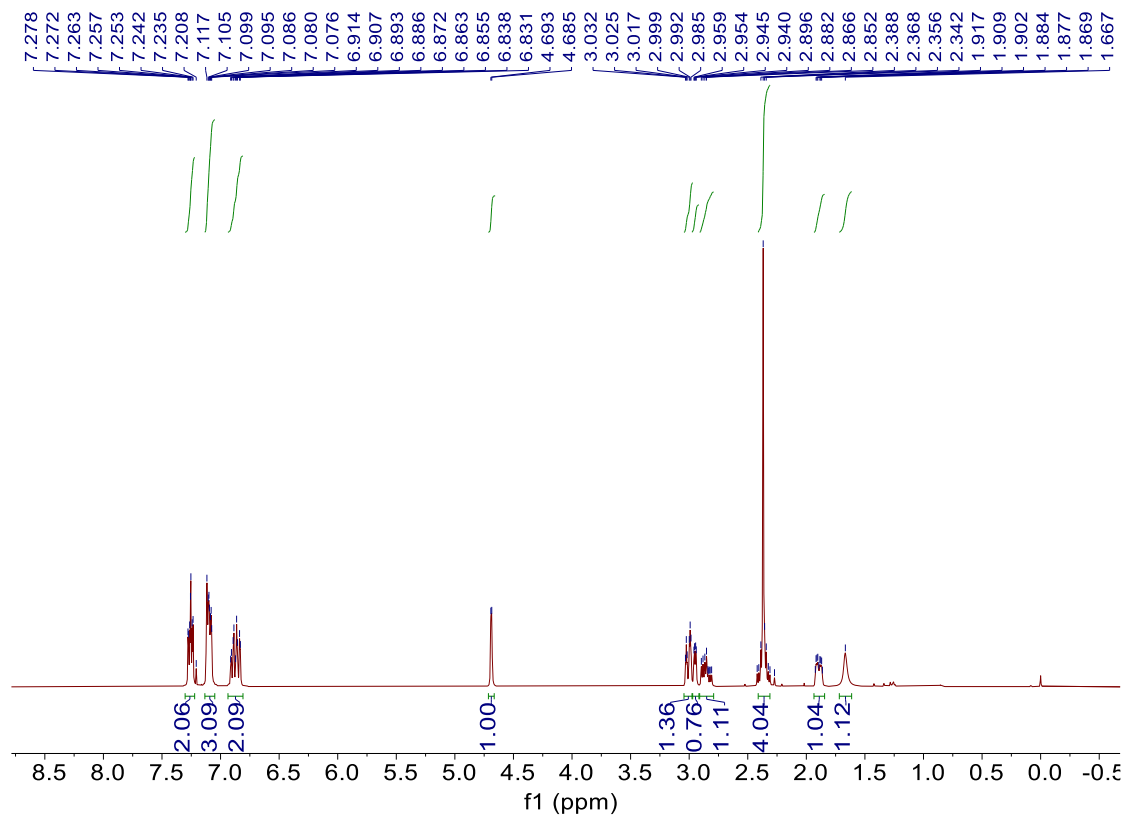
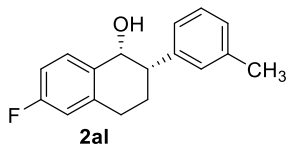


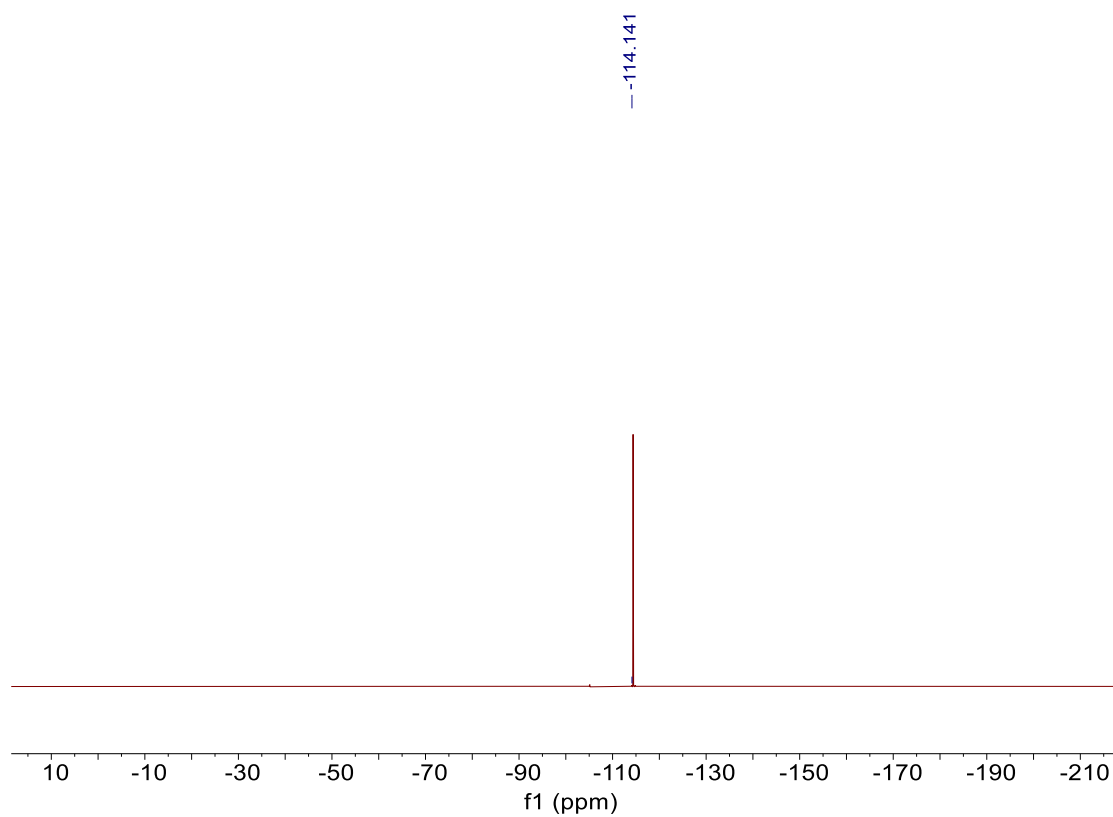
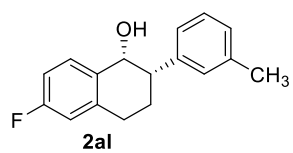


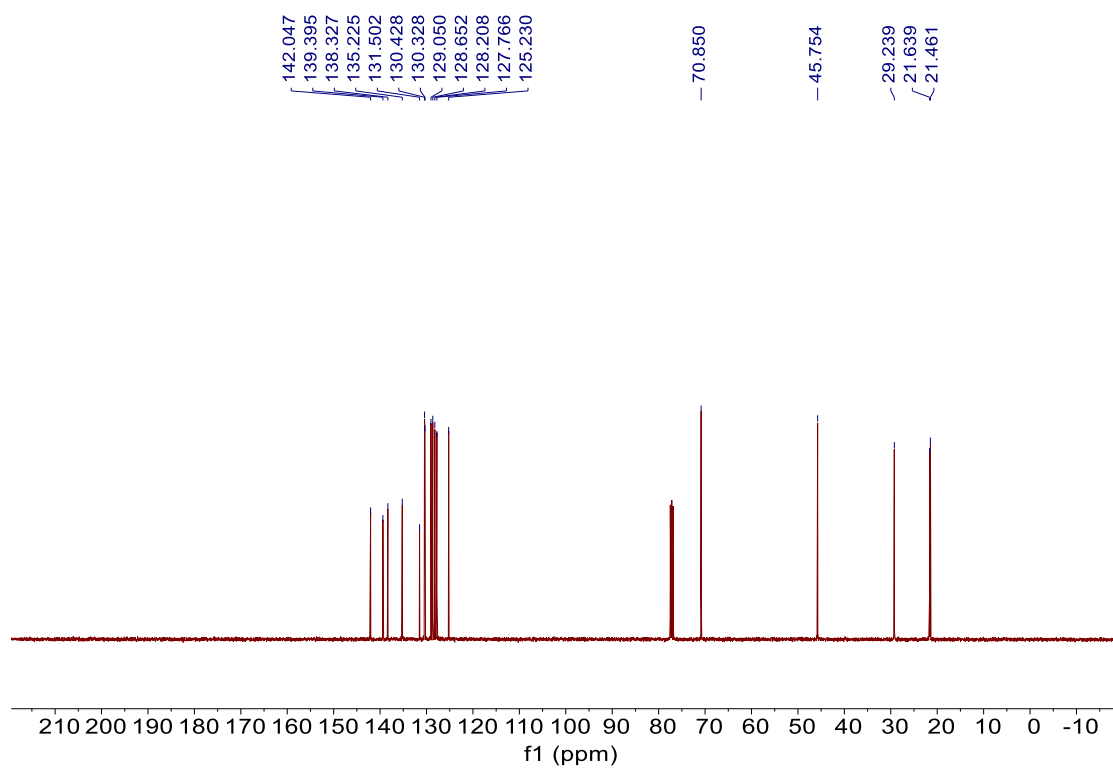
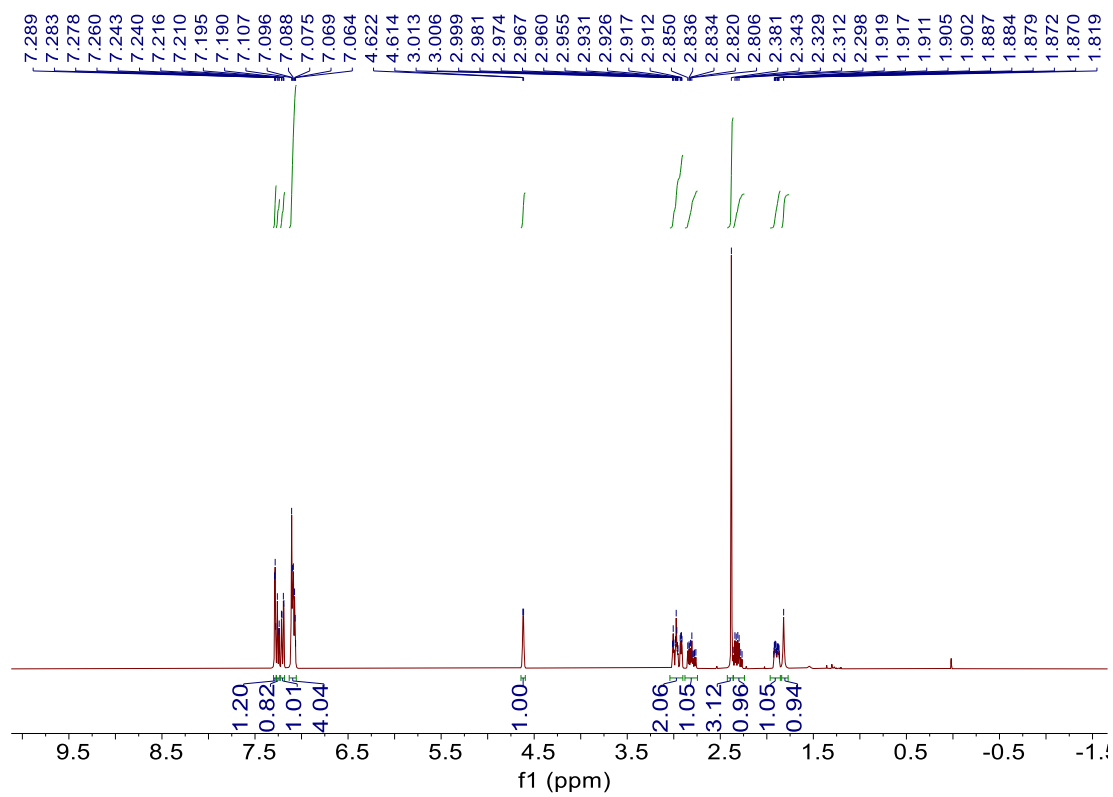
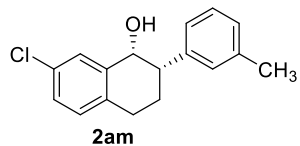


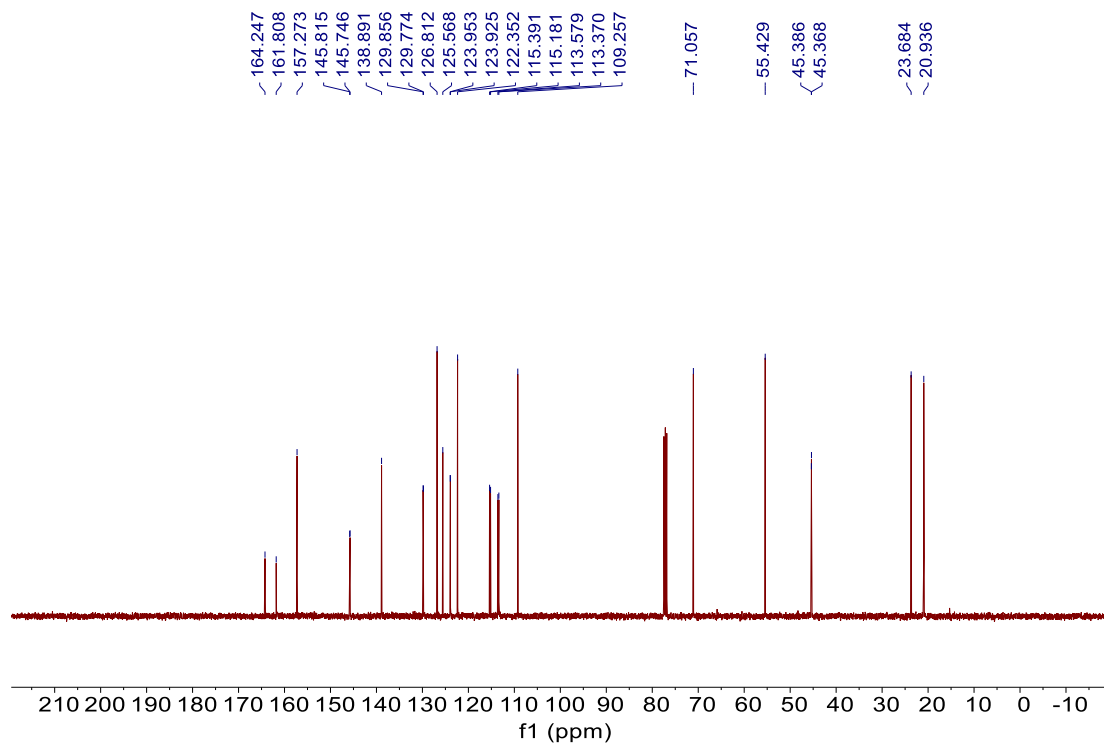
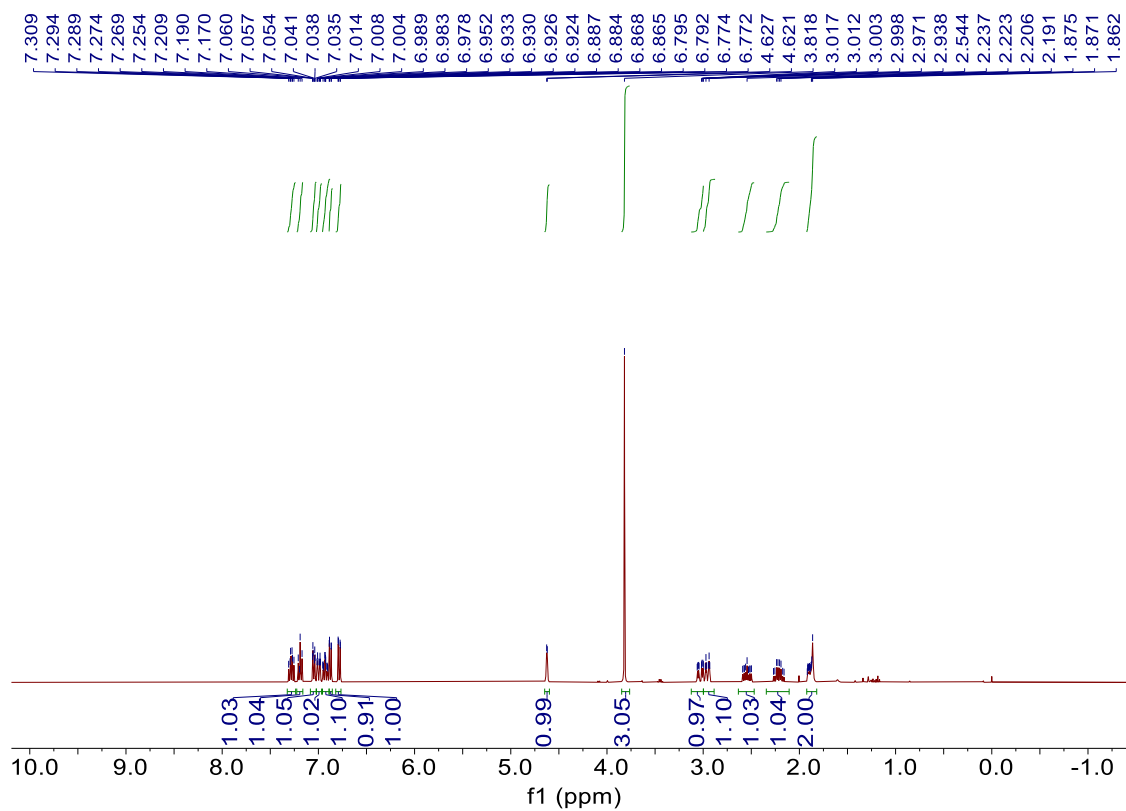
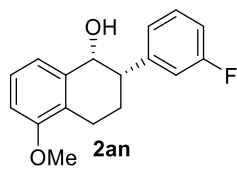


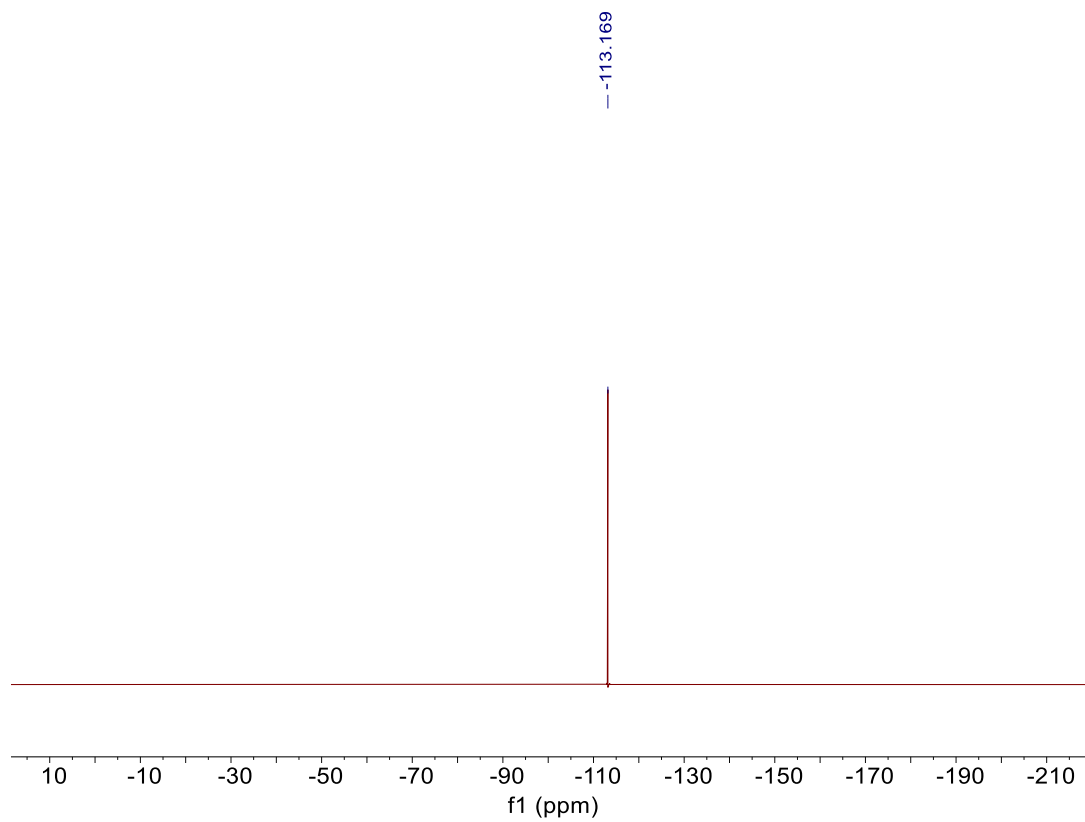
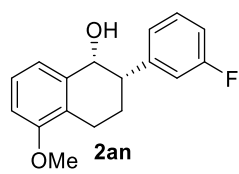


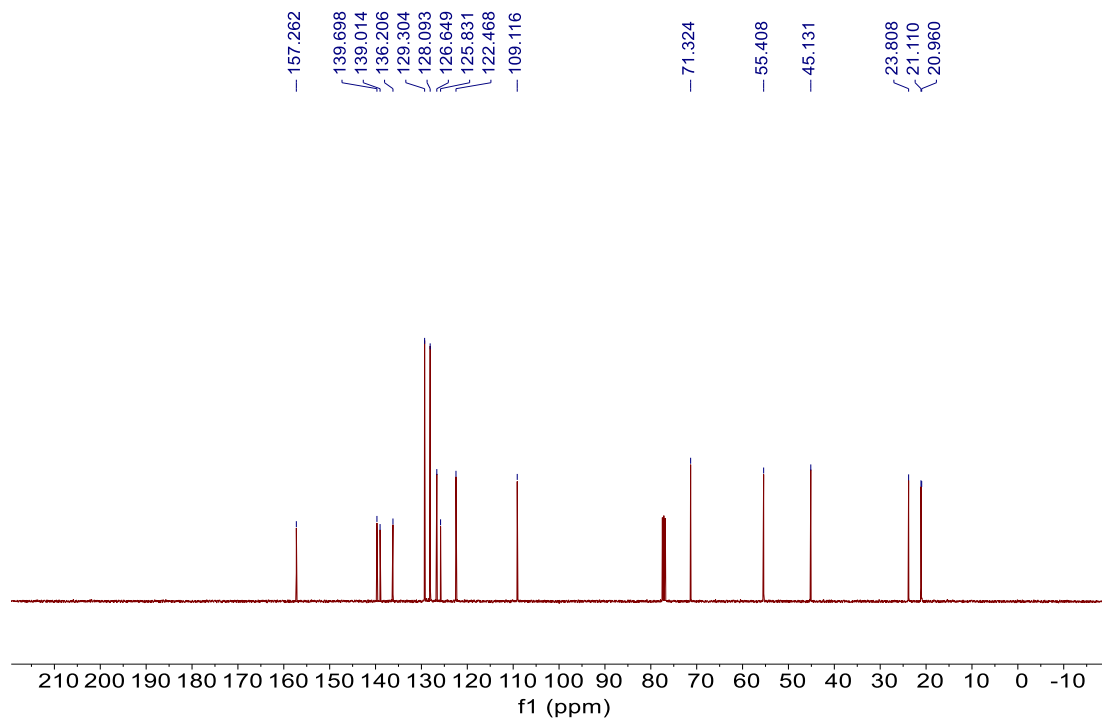
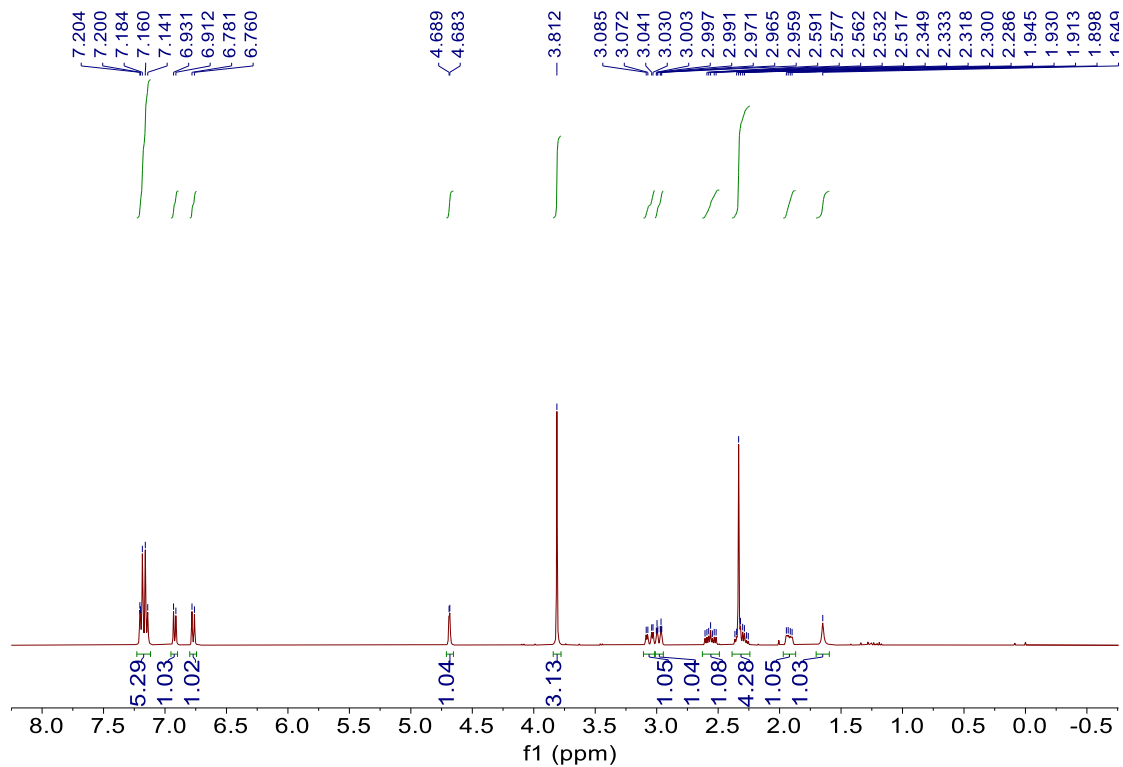
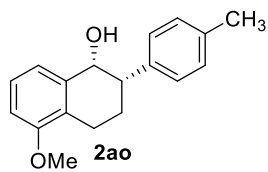


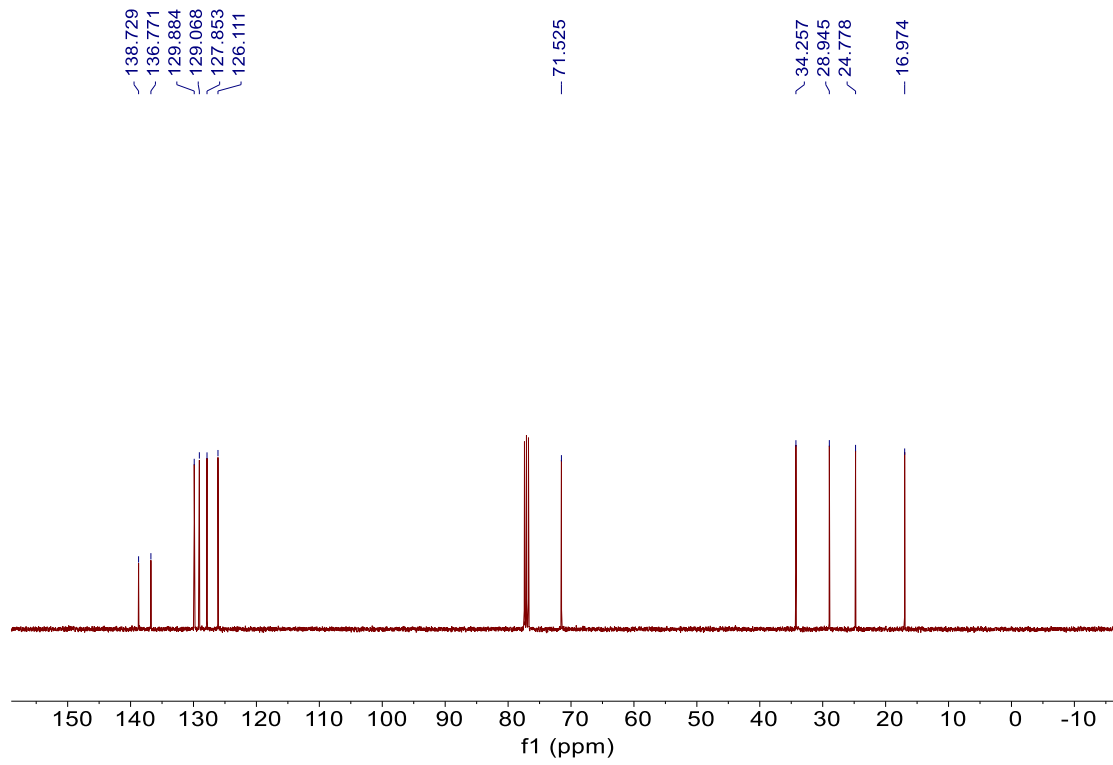
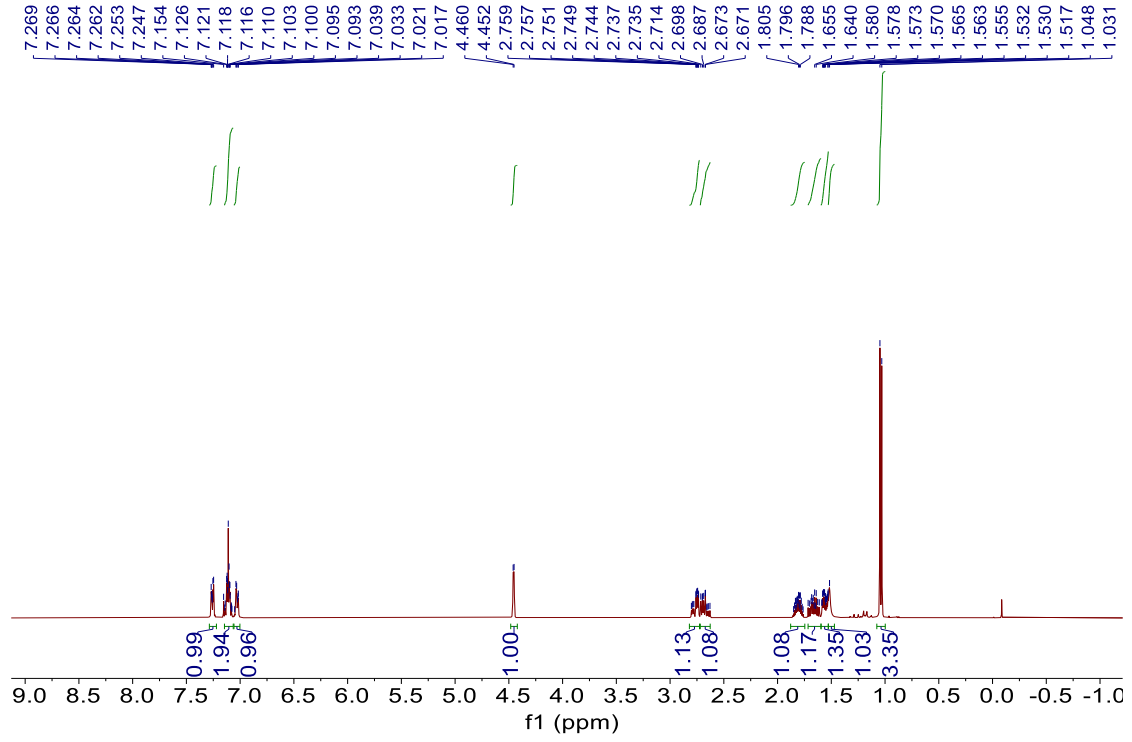
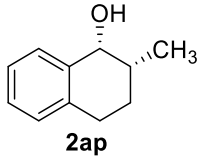


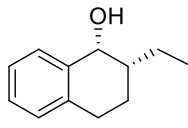




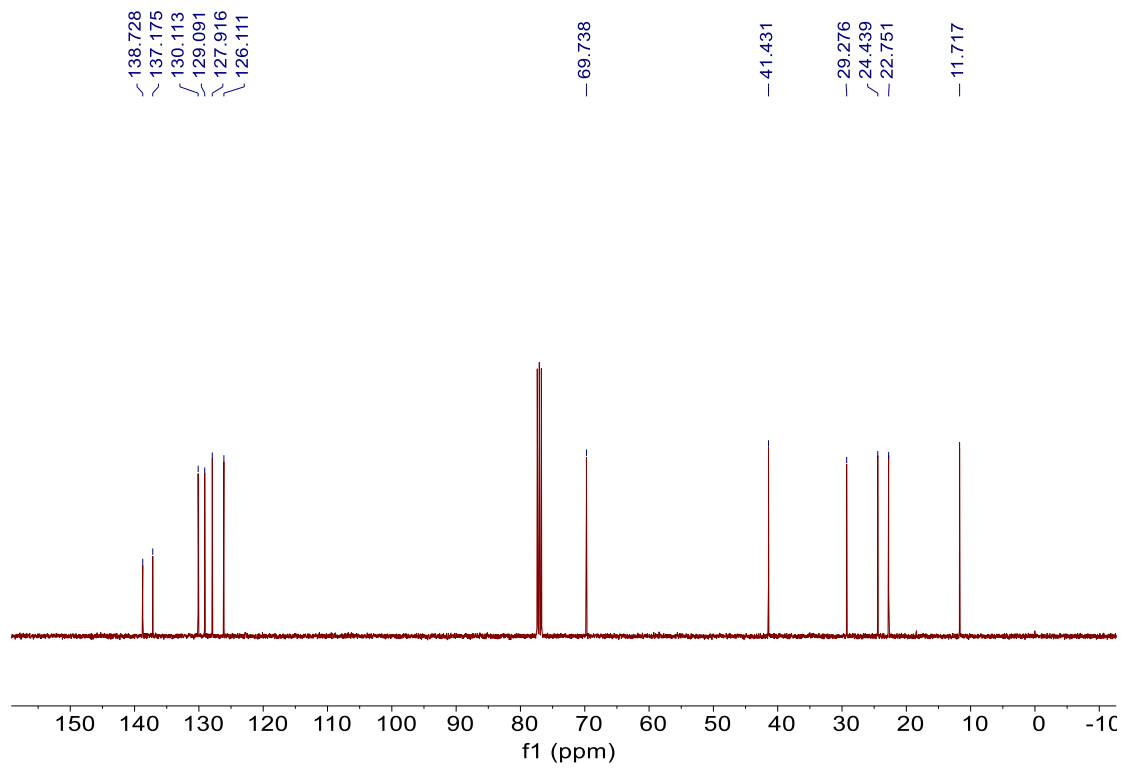
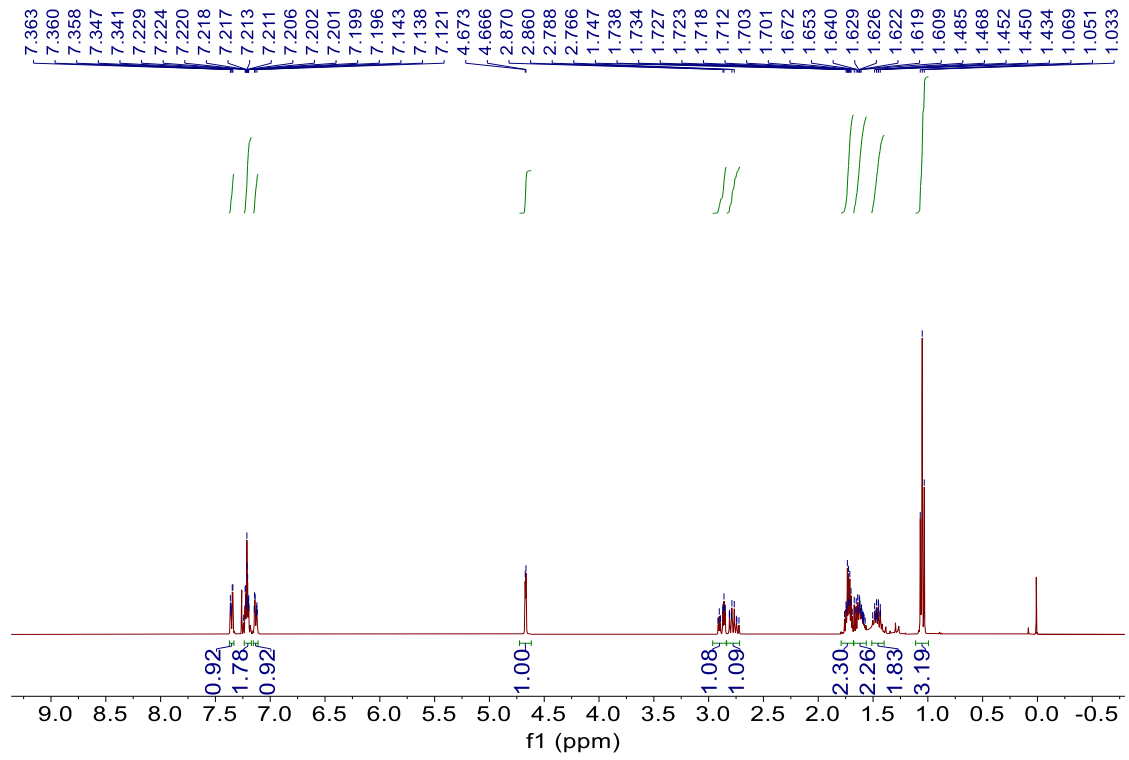


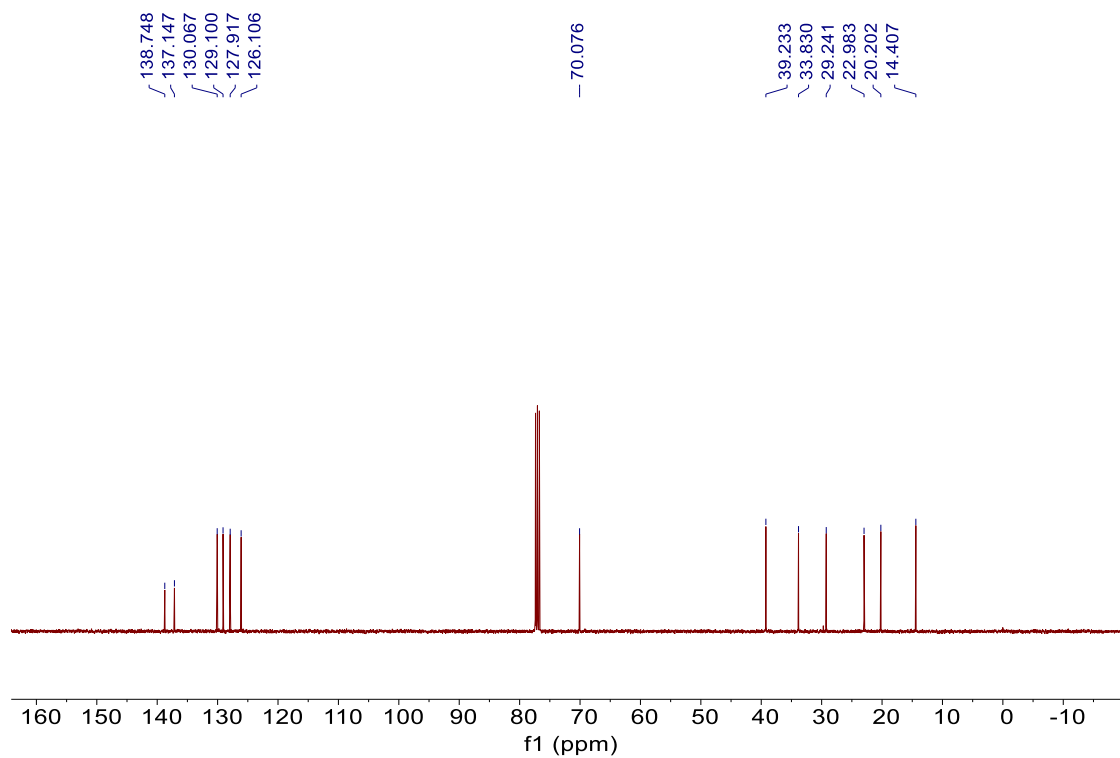
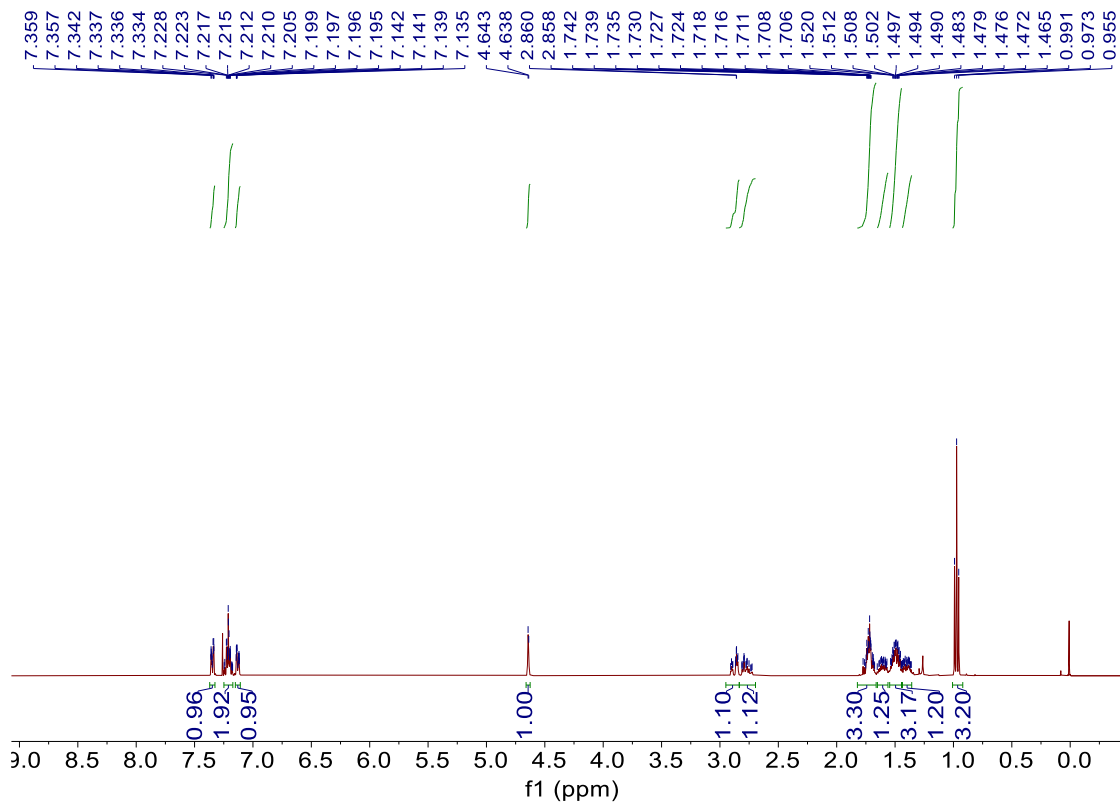
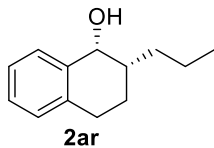


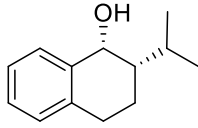




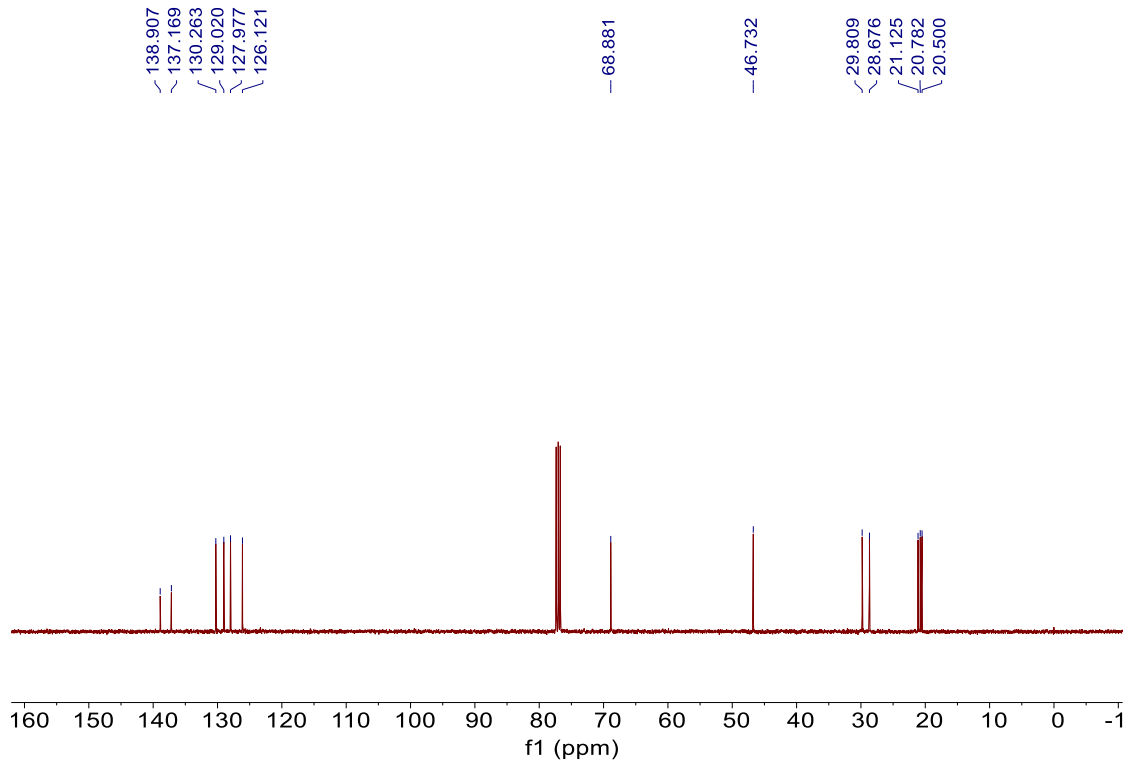
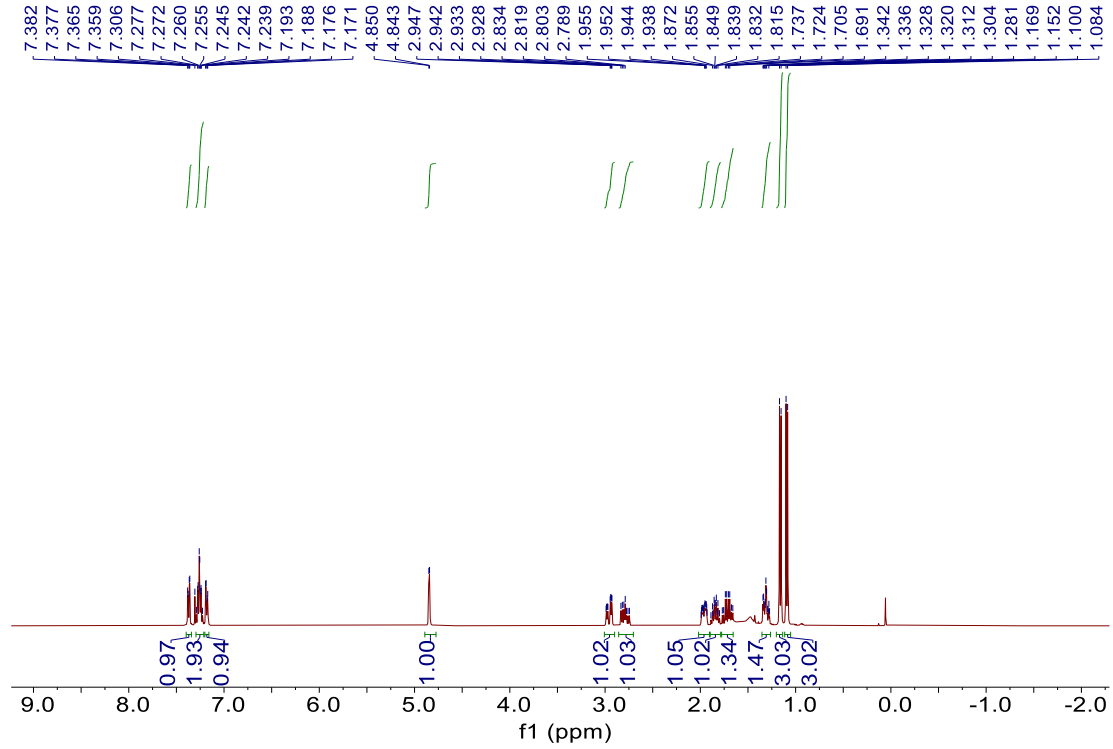
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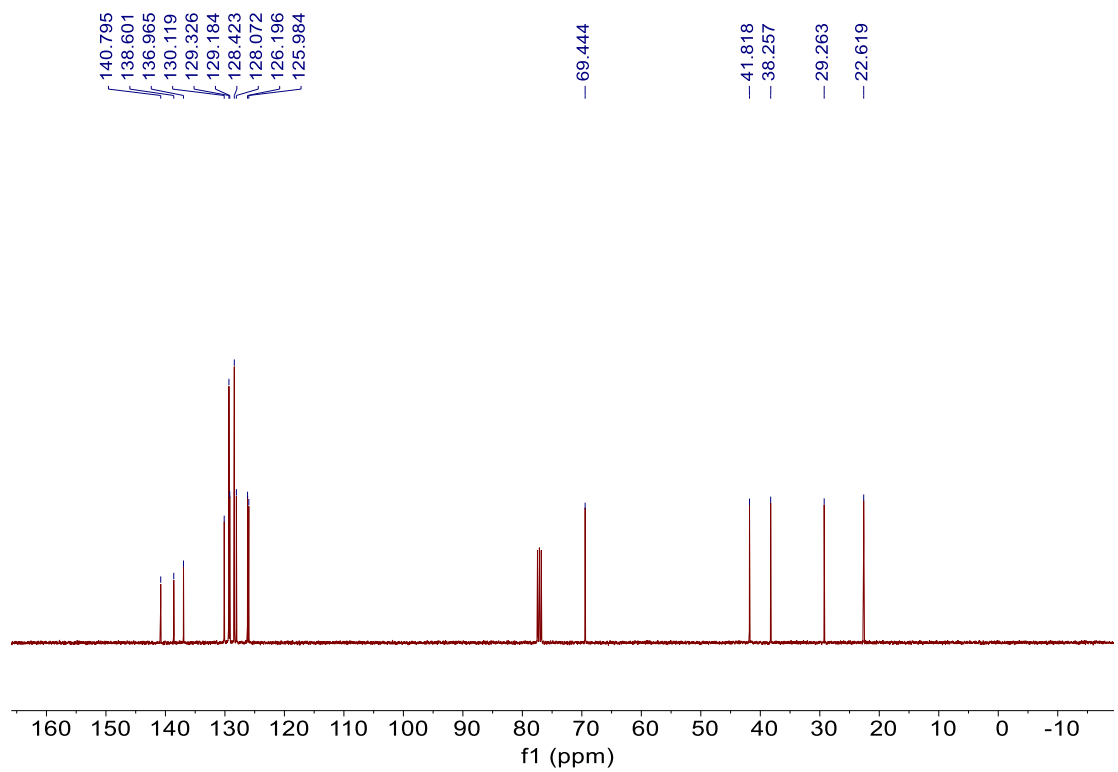
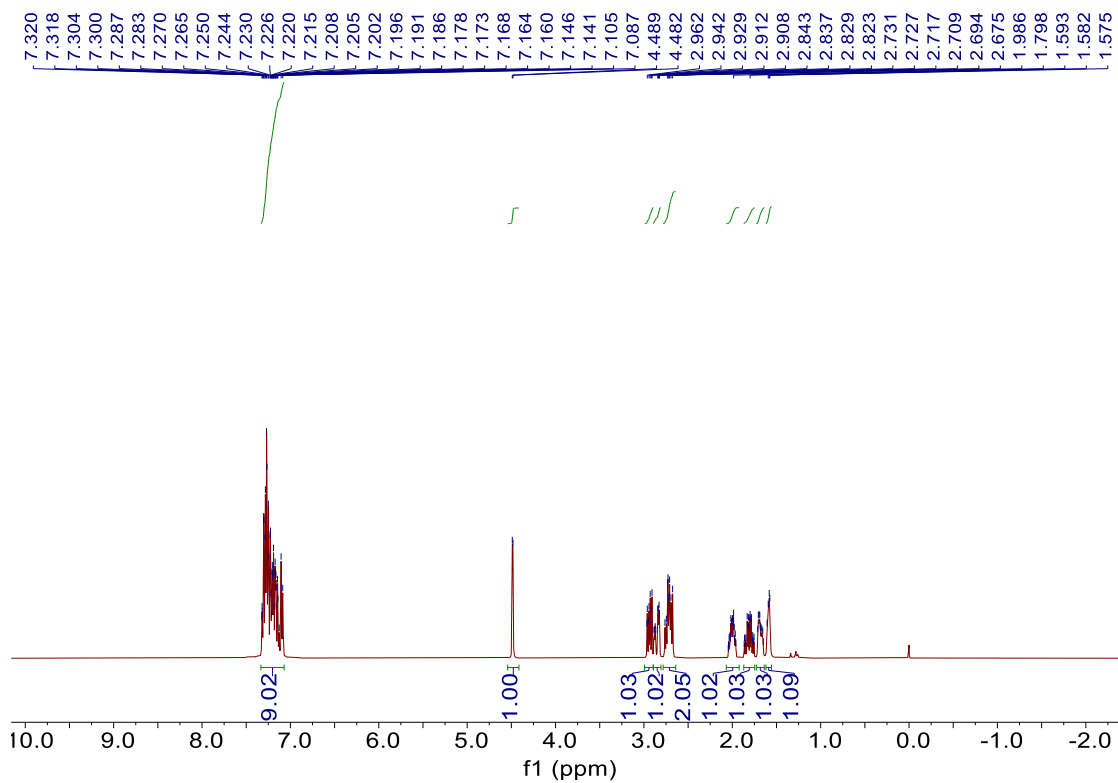
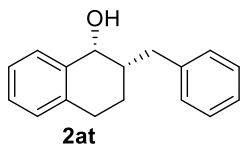


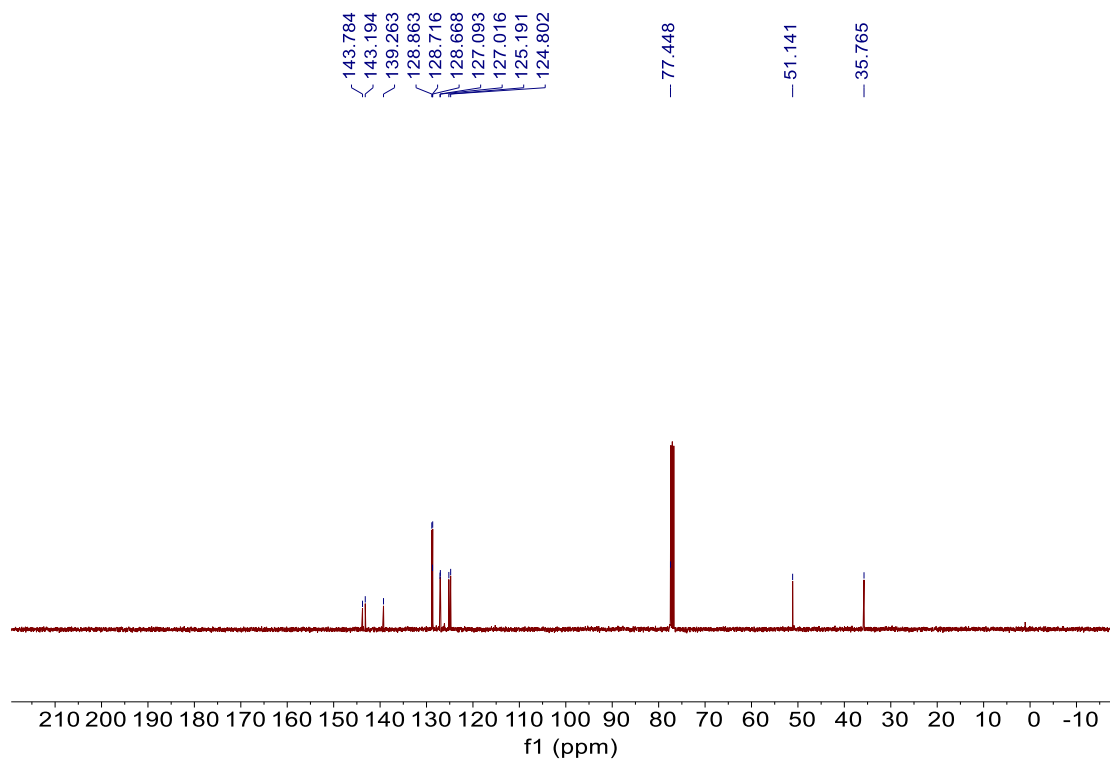
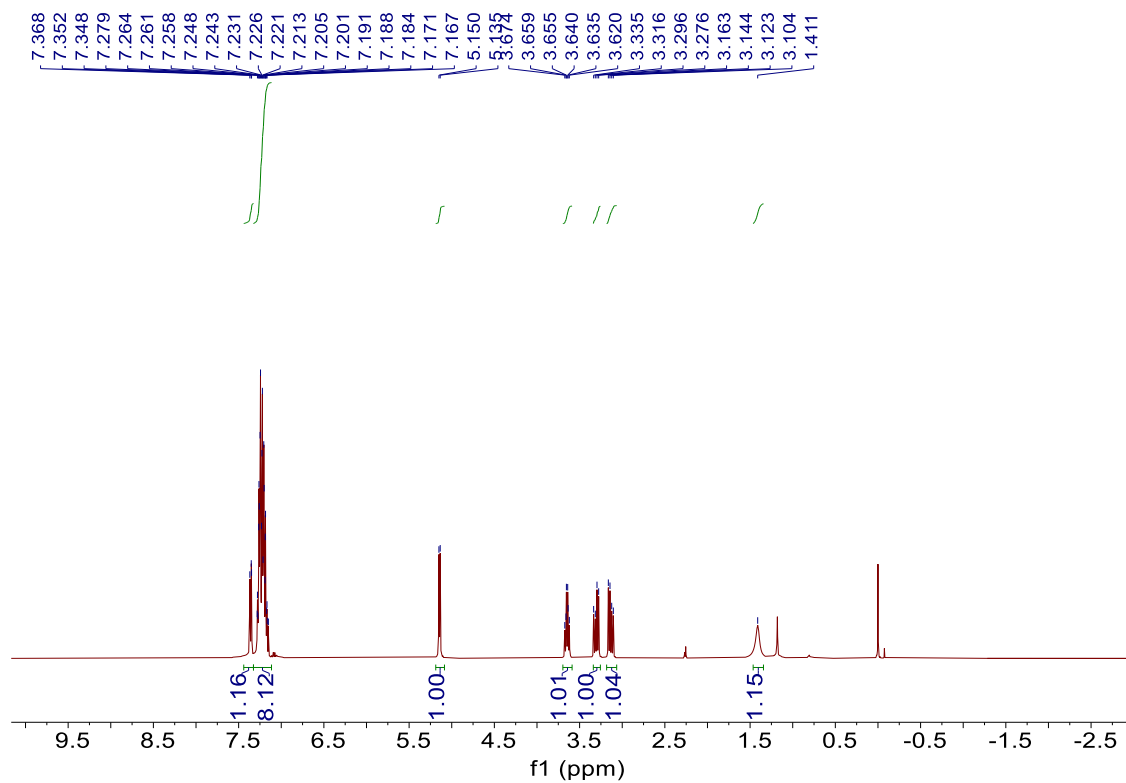
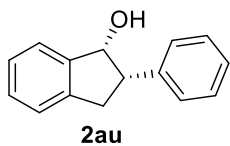


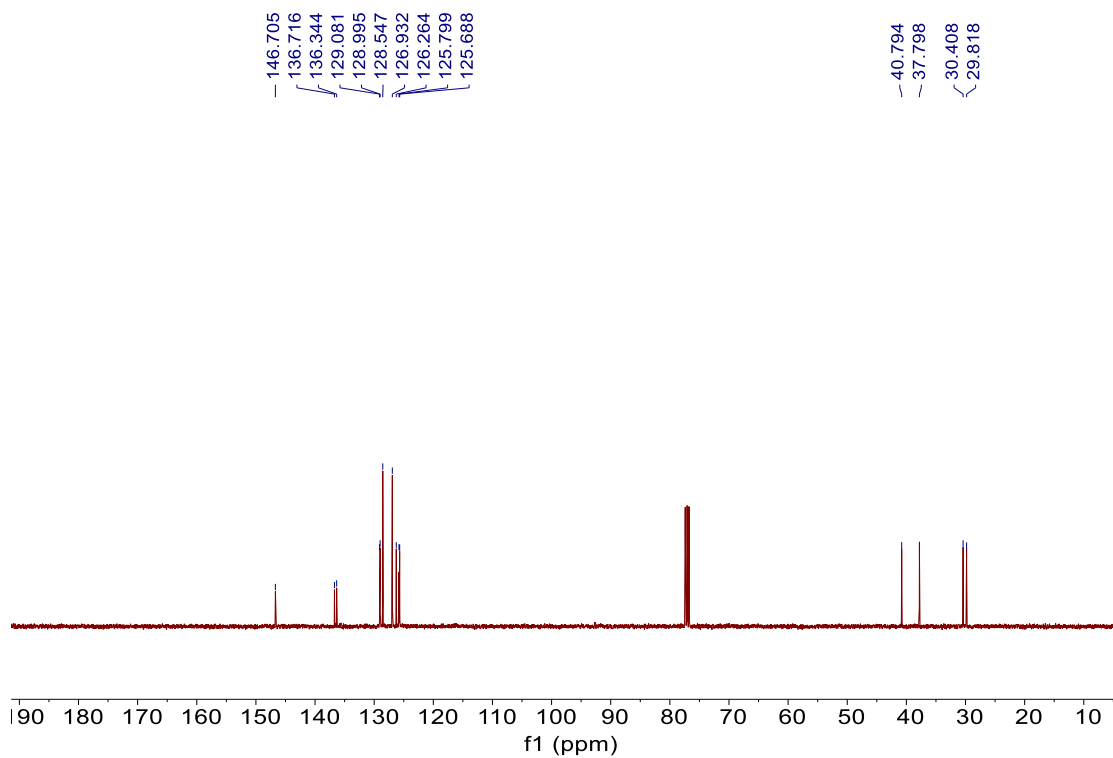
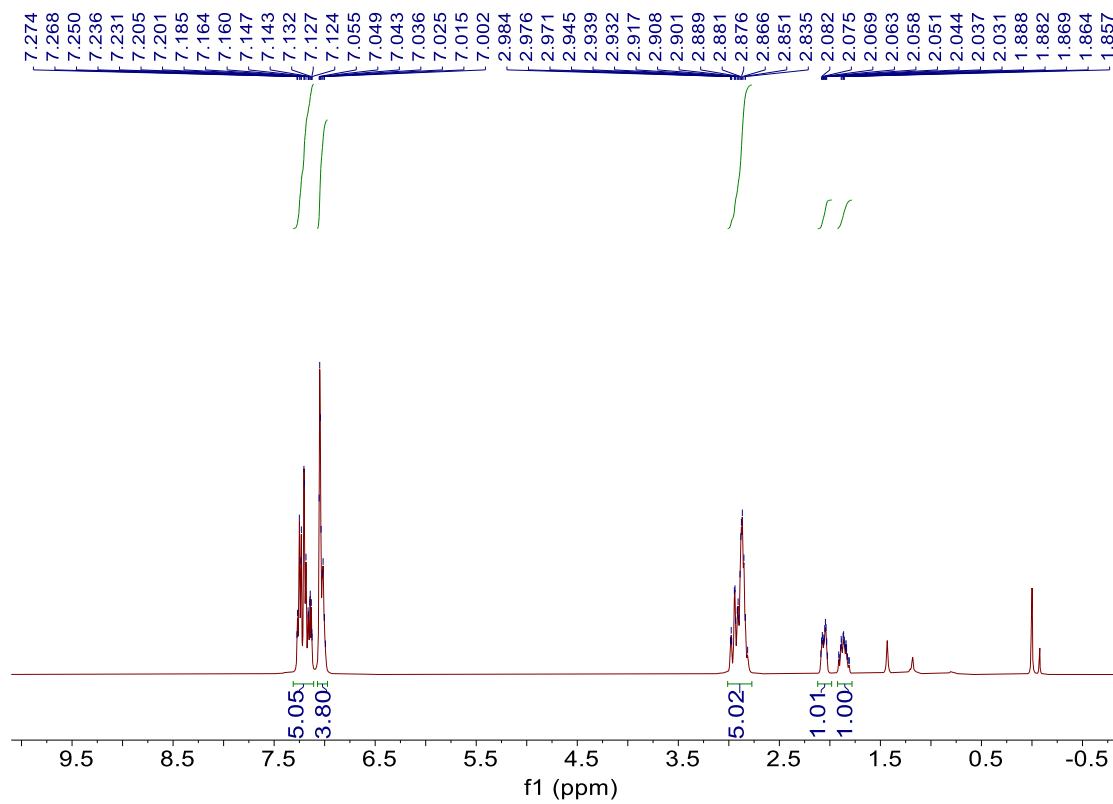
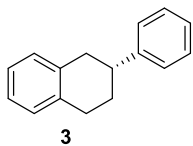


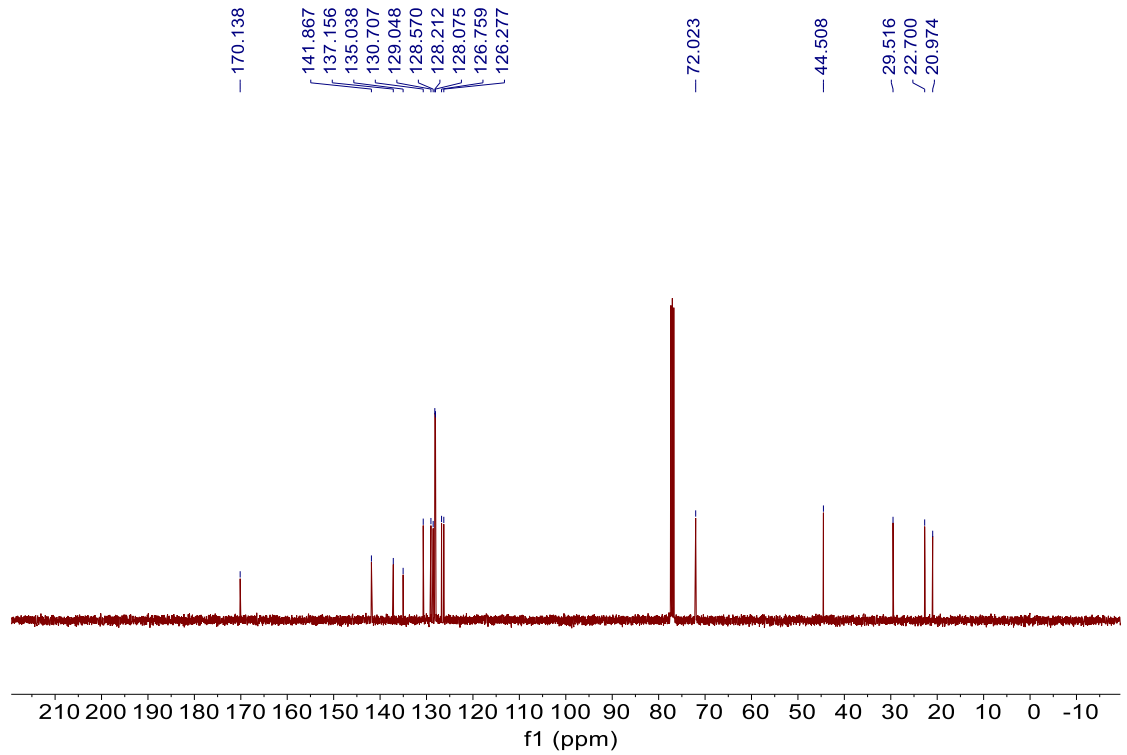
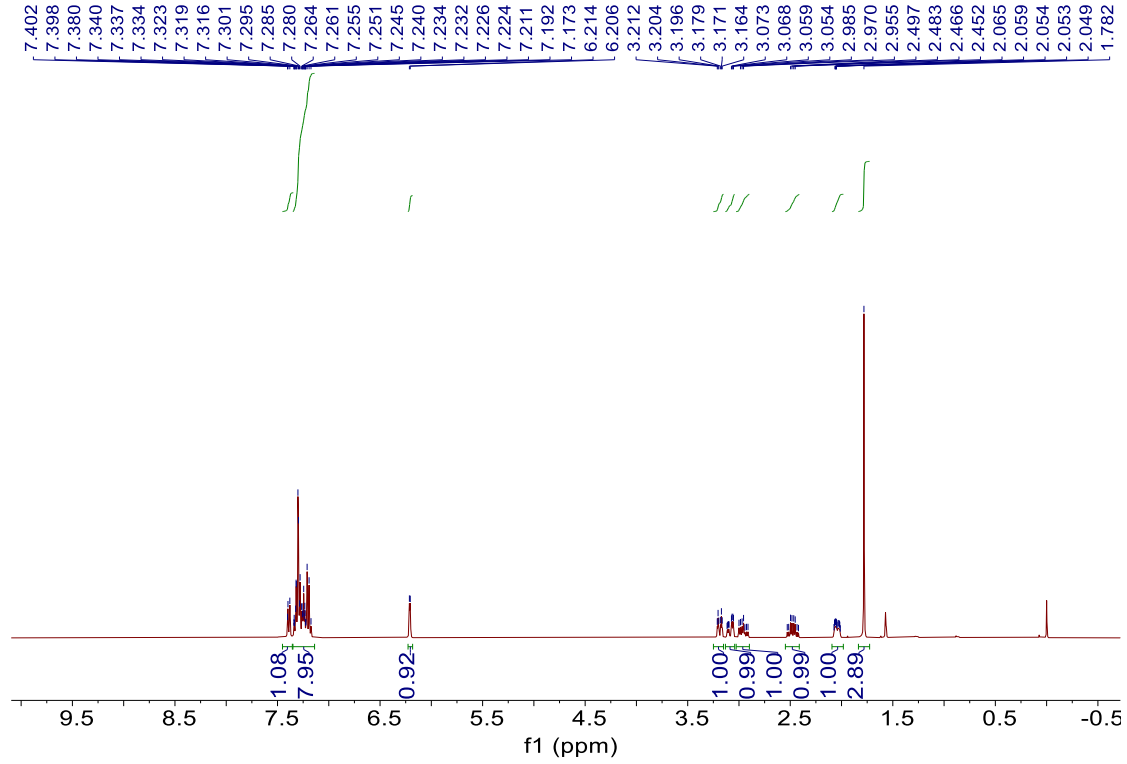
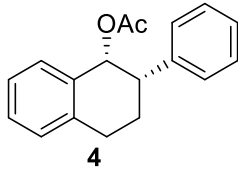
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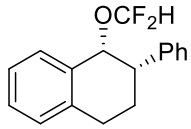




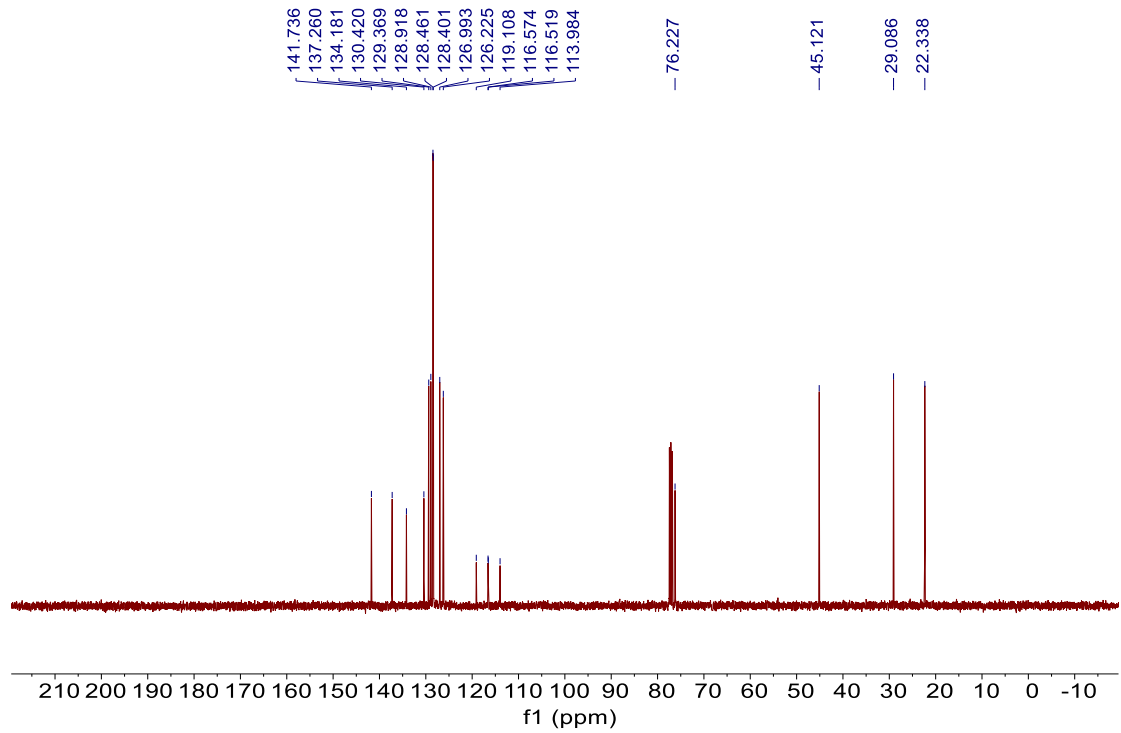
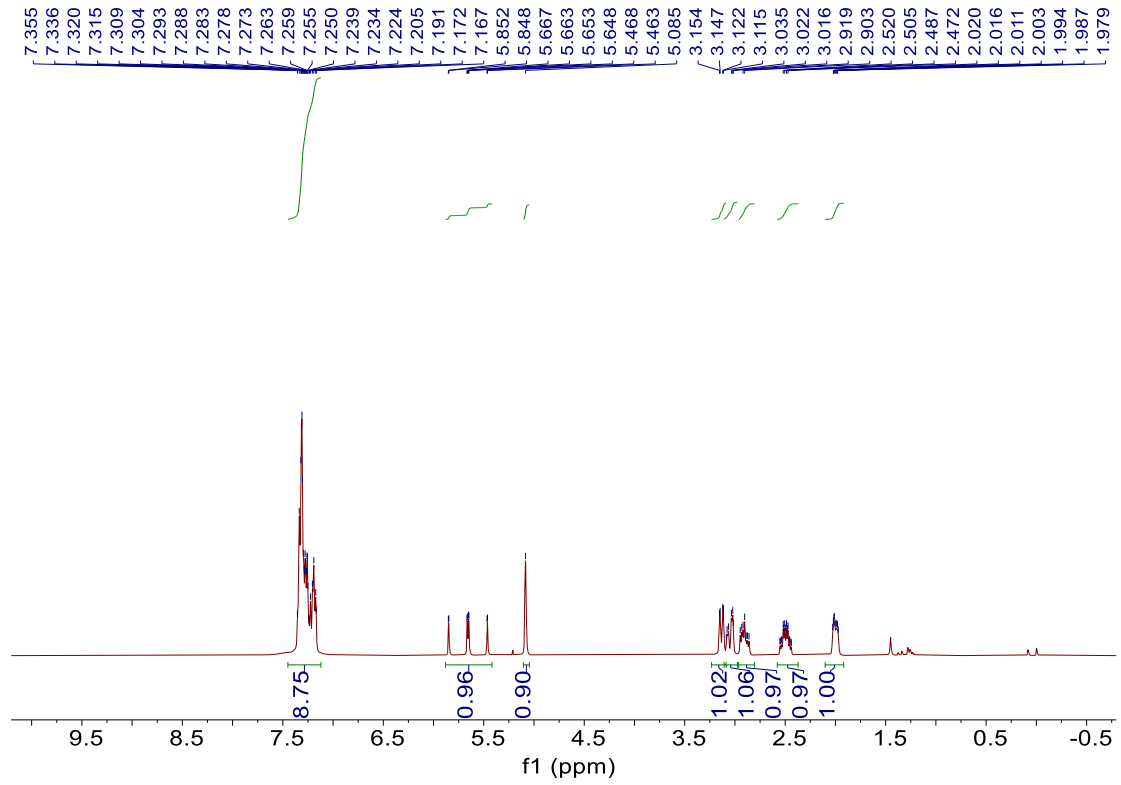


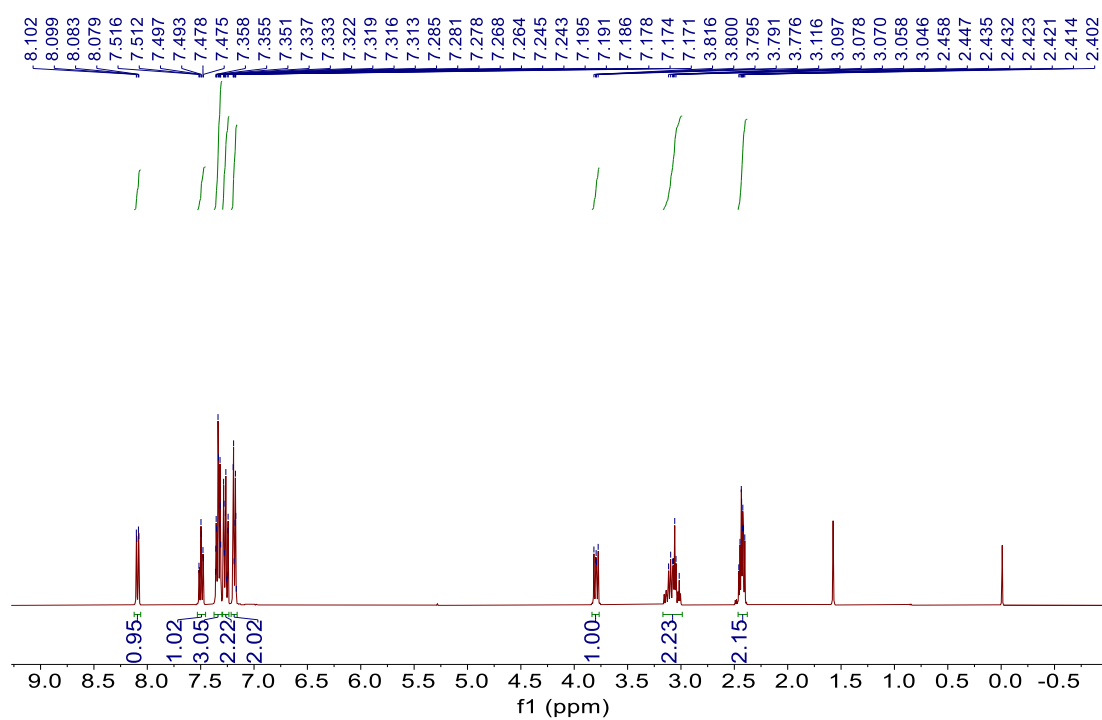
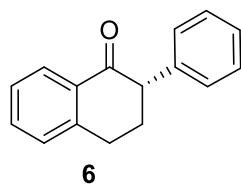
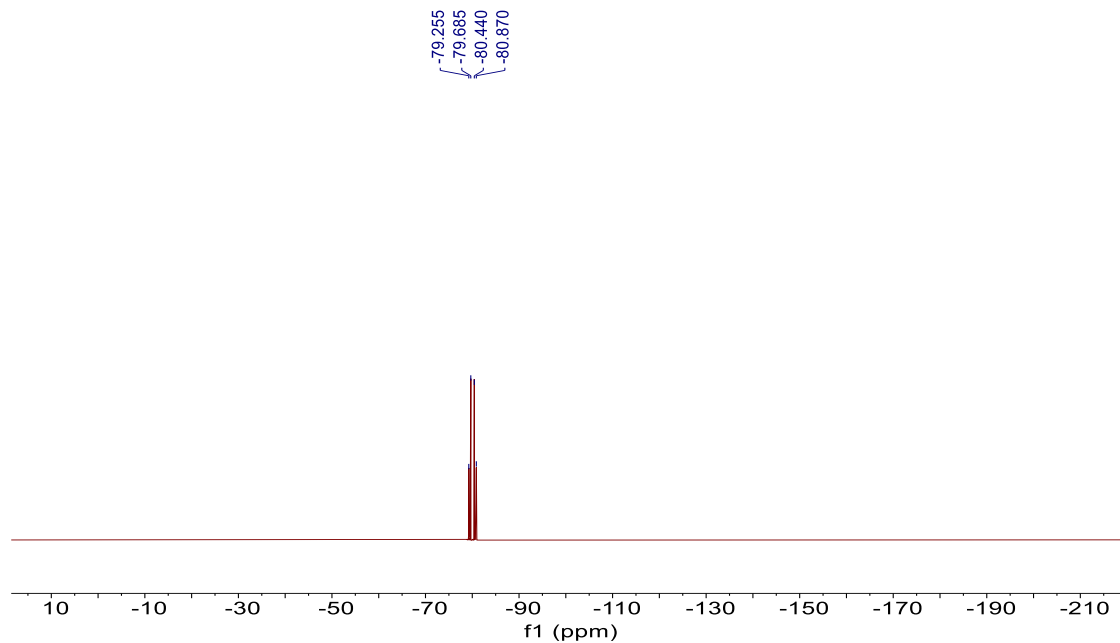
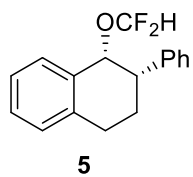


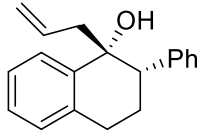




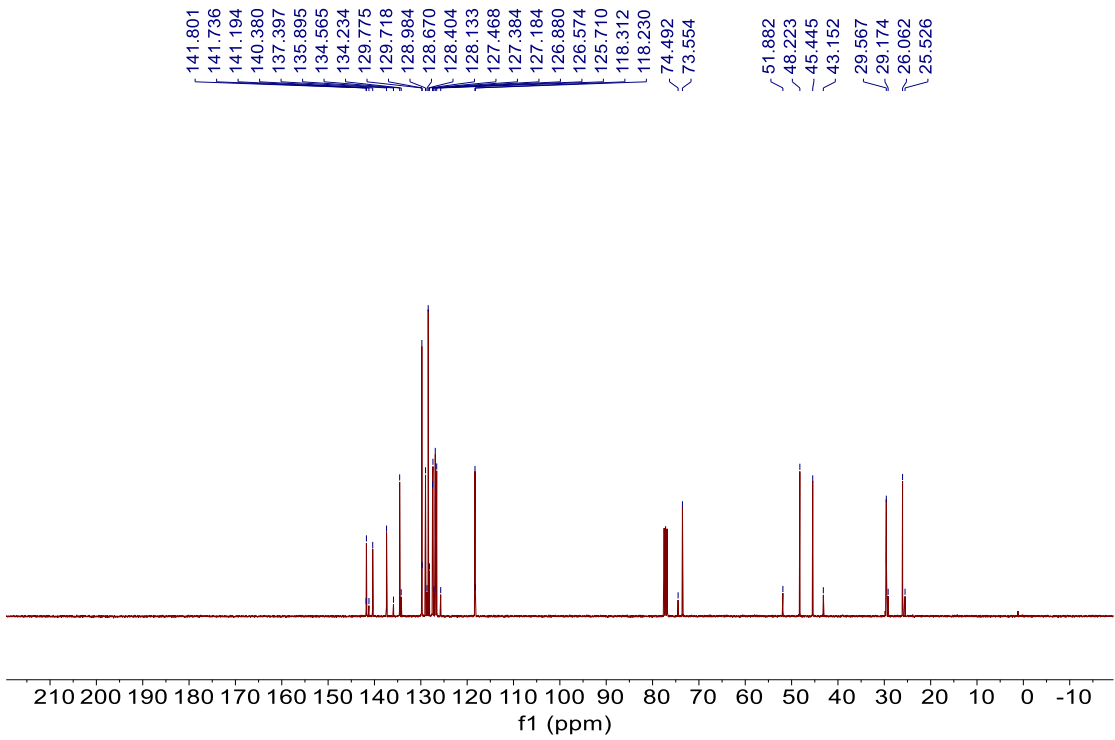
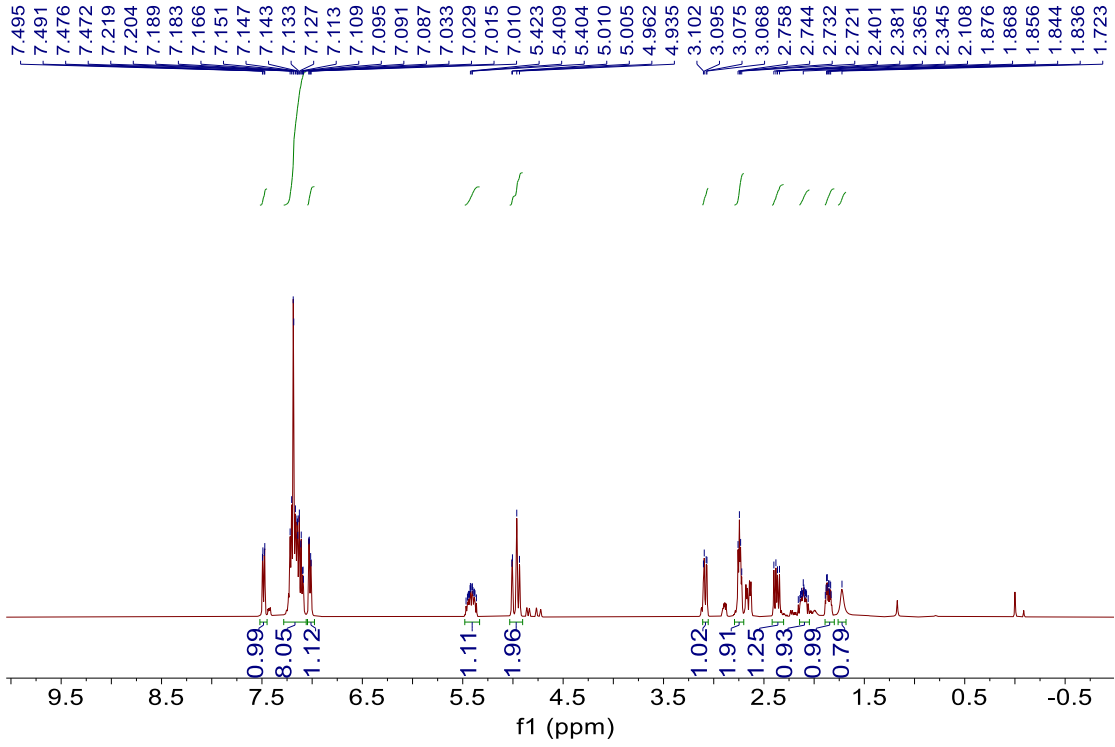
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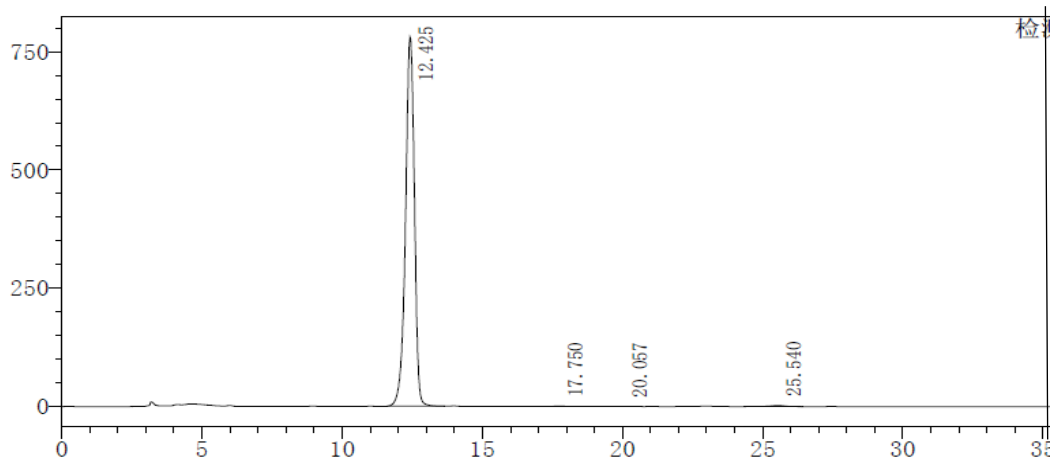
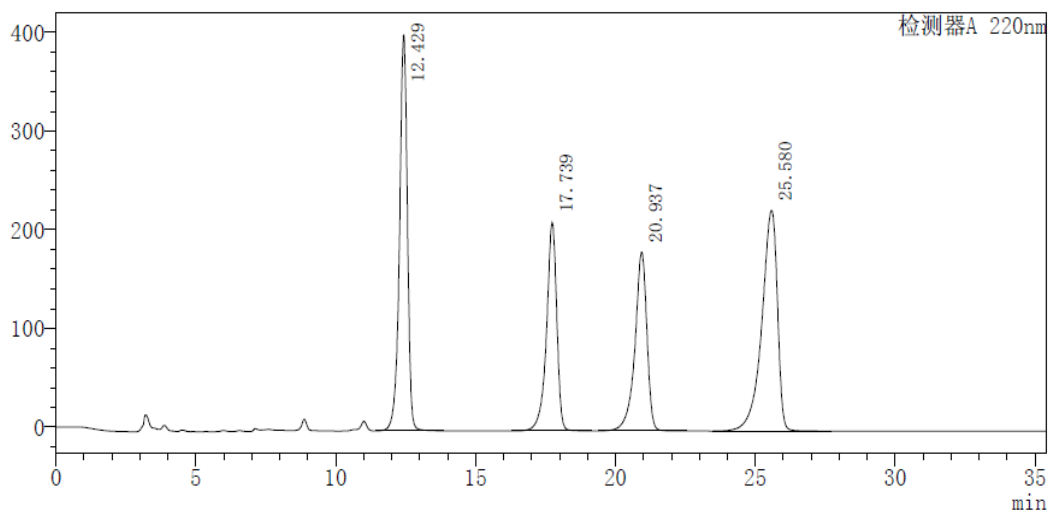
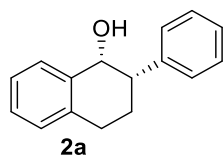




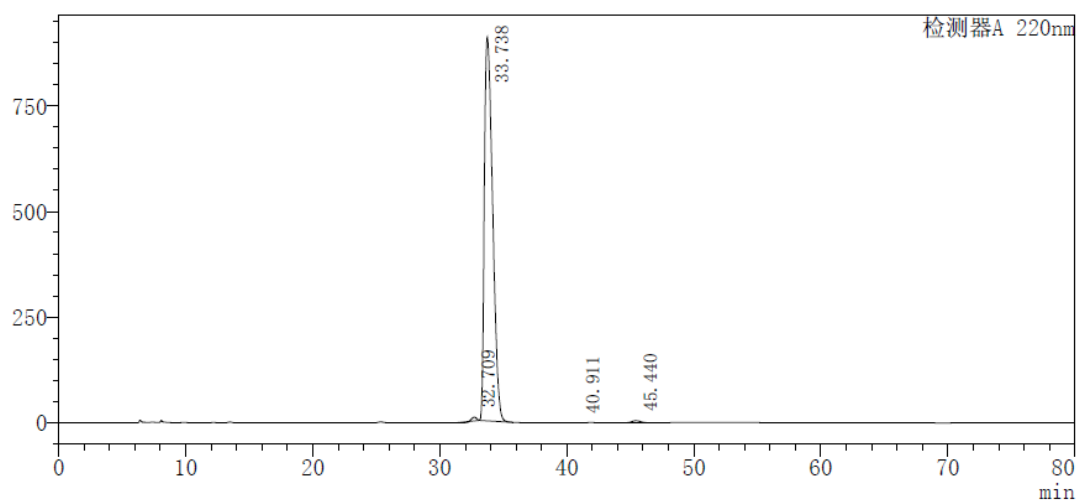
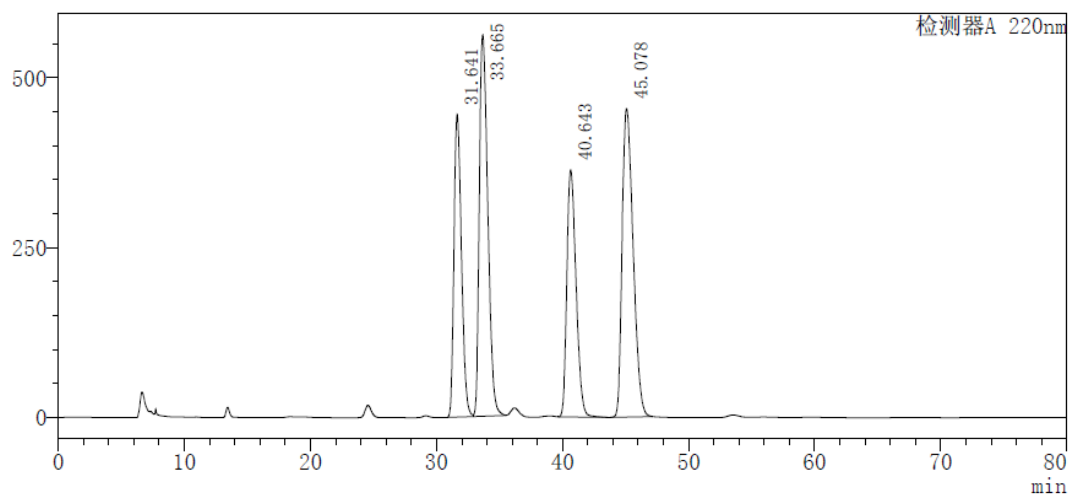
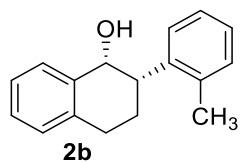
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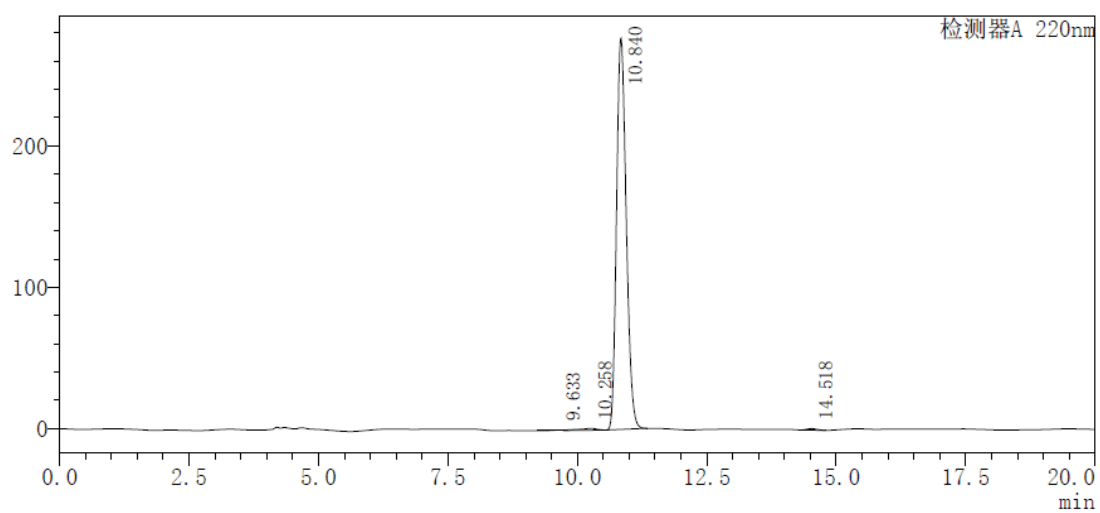
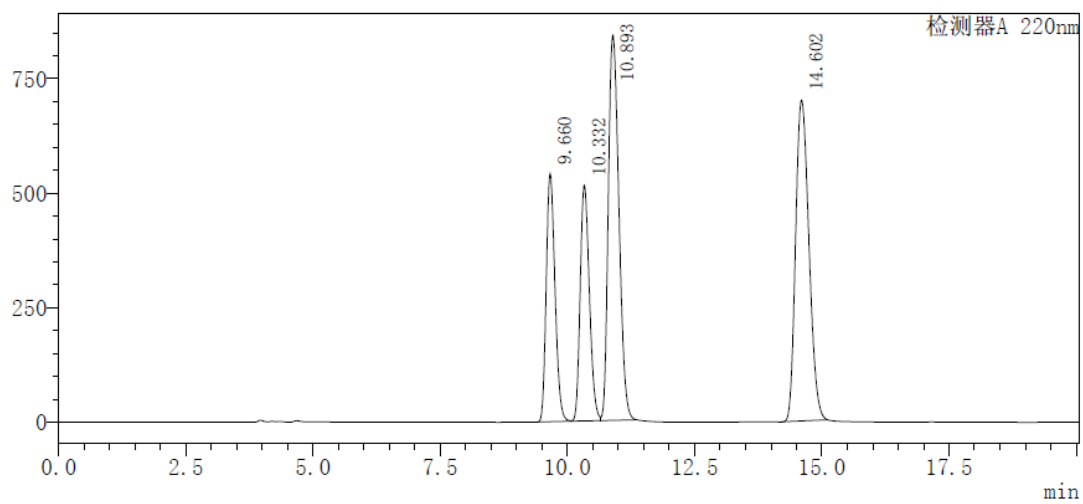
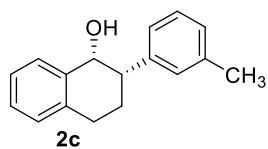
8. HPLC Data



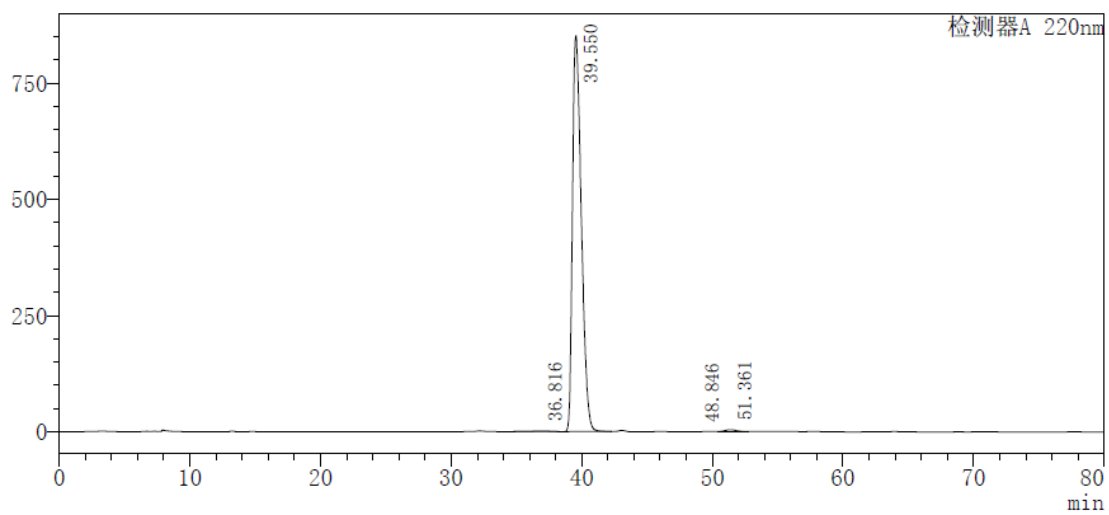
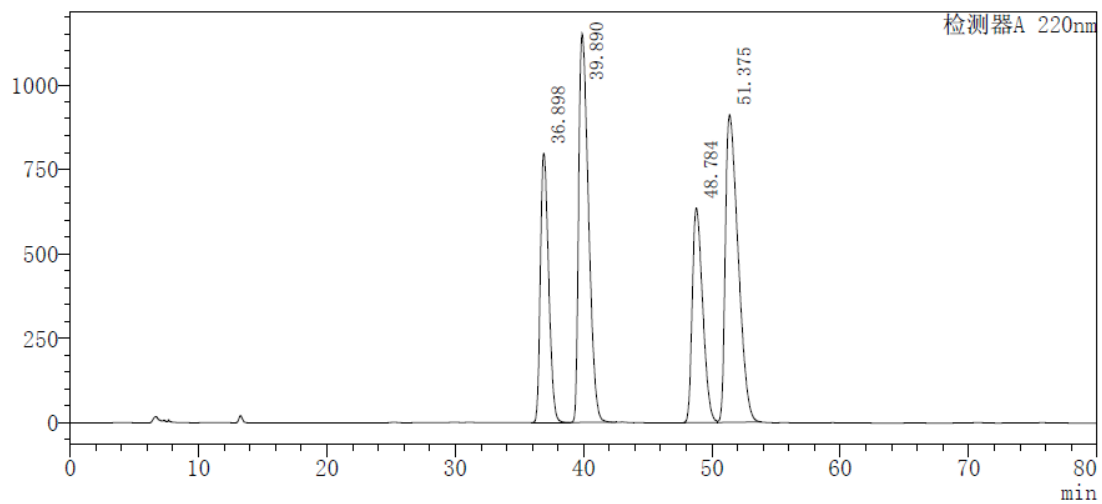
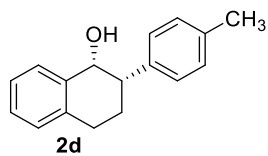
	Retention Time(min)	Relative Area (%)	99.1% ee
Peak 1	12.425	99.426	
Peak 2	17.750	0.157	
Peak 3	20.057	0.007	
Peak 4	25.540	0.410	



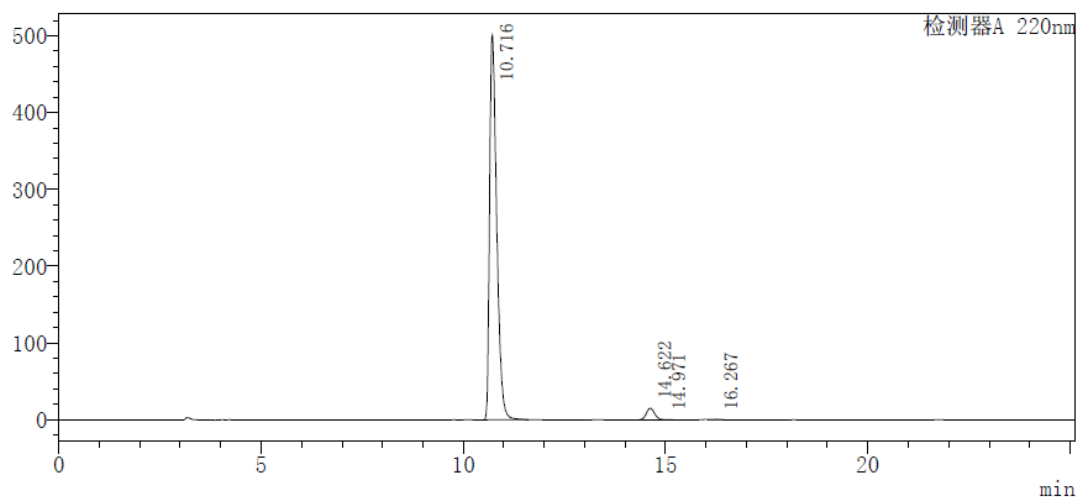
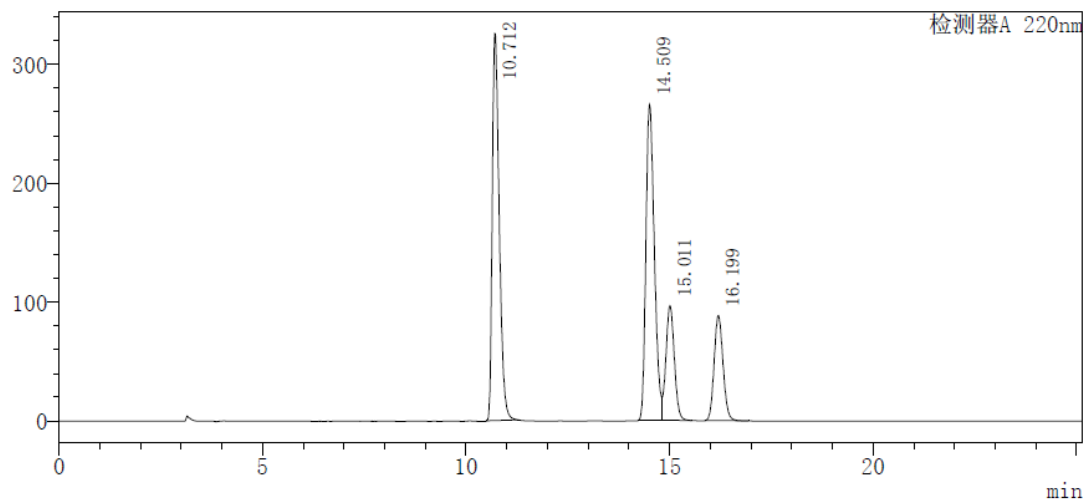
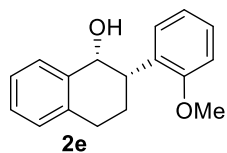
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	32.709	0.456	
Peak 2	33.738	98.966	
Peak 3	40.911	0.014	
Peak 4	45.440	0.565	



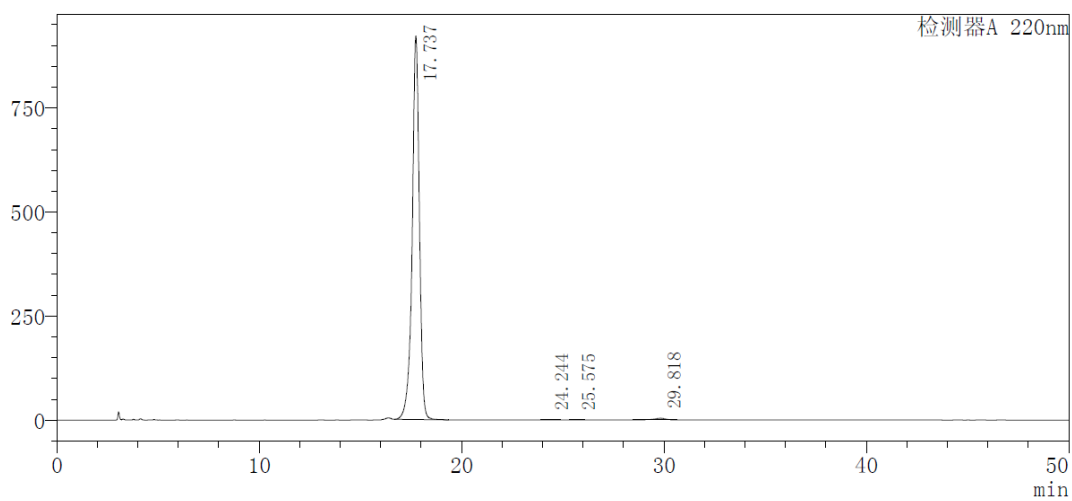
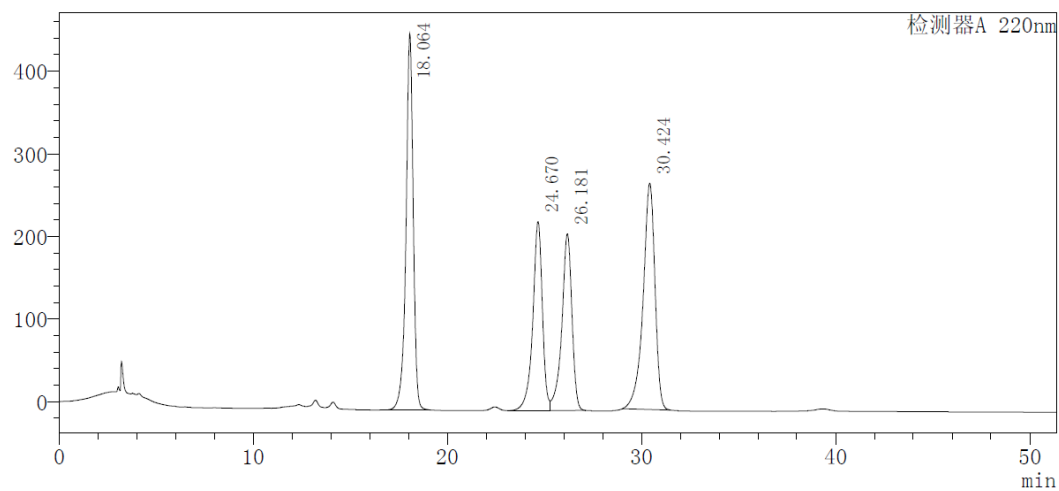
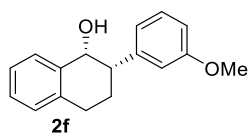
	Retention Time(min)	Relative Area (%)	99.3% ee
Peak 1	9.633	0.142	
Peak 2	10.258	0.842	
Peak 3	10.840	98.662	
Peak 4	14.518	0.354	



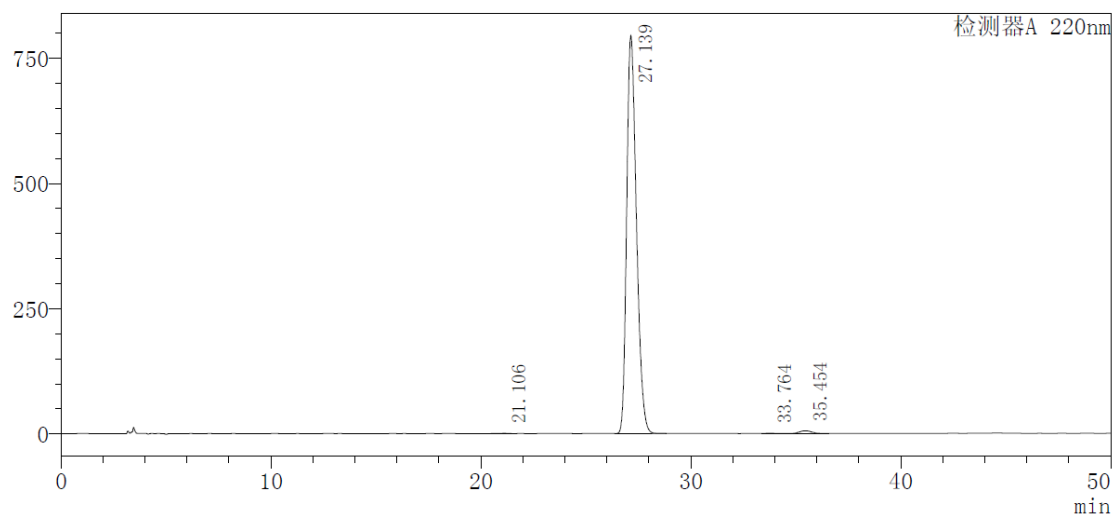
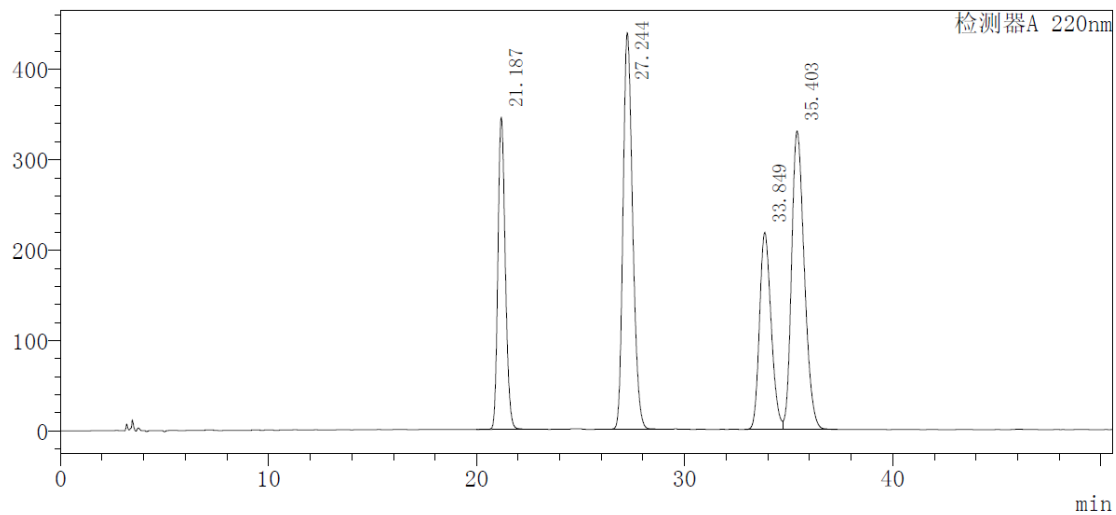
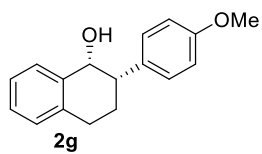
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	36.816	0.272	
Peak 2	39.550	99.264	
Peak 3	48.846	-0.015	
Peak 4	51.361	0.478	



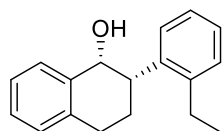
	Retention Time(min)	Relative Area (%)	93% ee
Peak 1	10.716	96.531	
Peak 2	14.622	3.402	
Peak 3	14.971	0.030	
Peak 4	16.267	0.036	



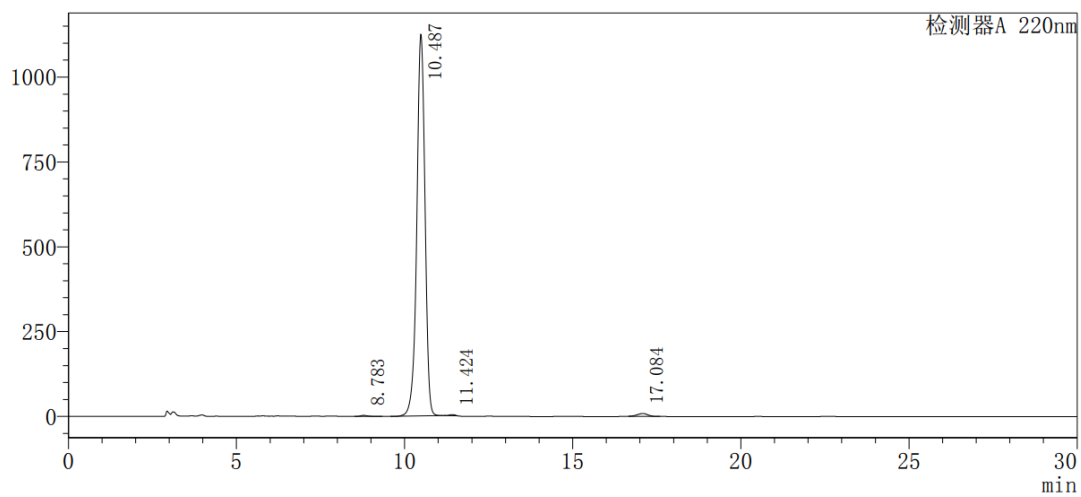
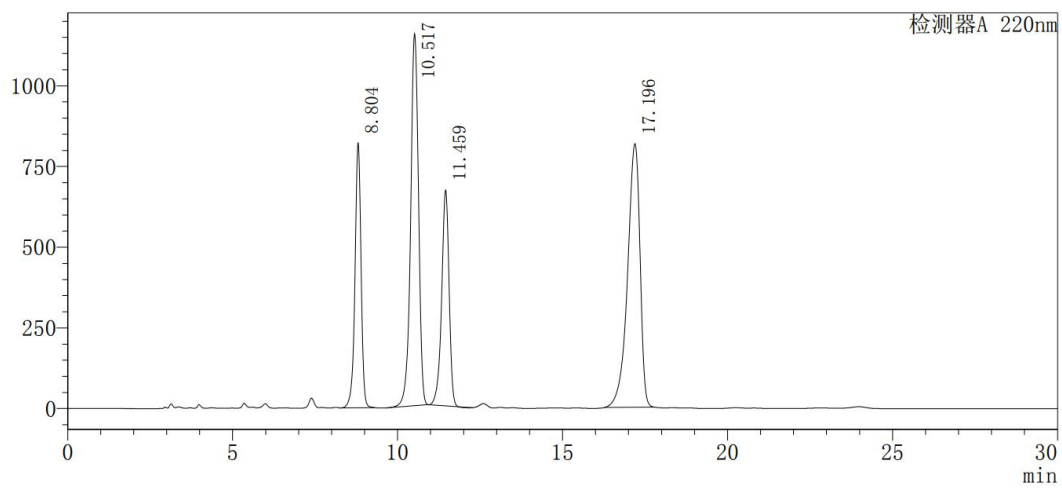
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	17.737	99.244	
Peak 2	24.244	0.082	
Peak 3	25.575	0.007	
Peak 4	29.818	0.667	



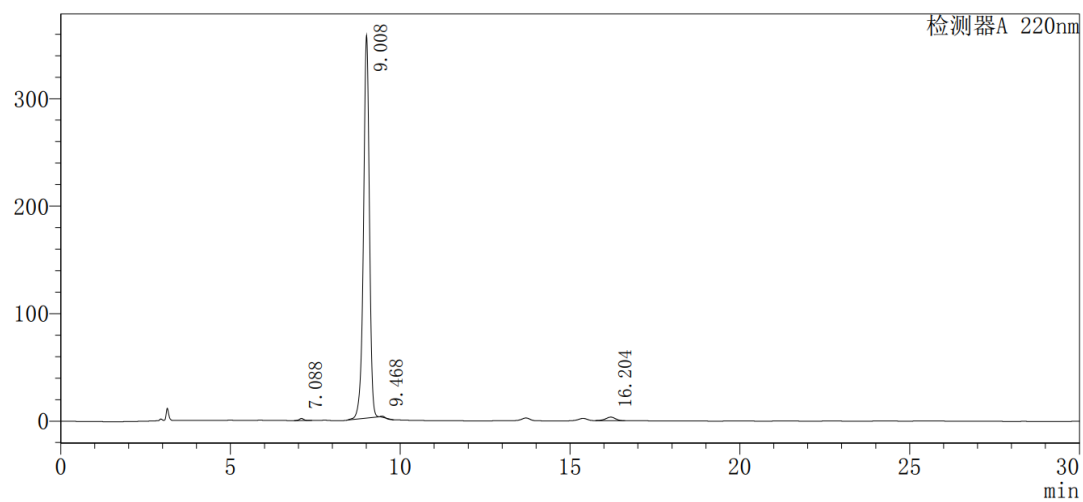
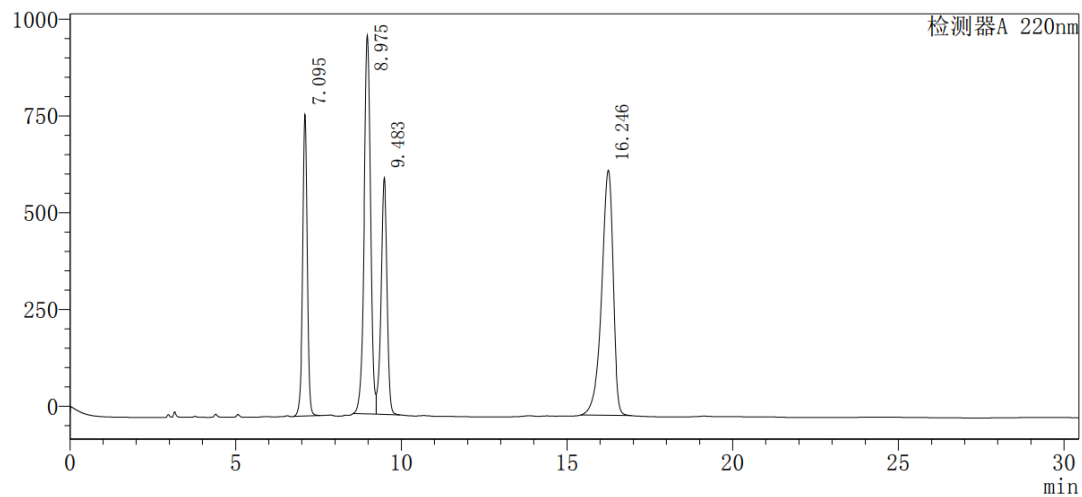
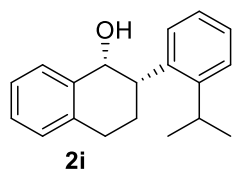
	Retention Time(min)	Relative Area (%)	98% ee
Peak 1	21.106	0.073	
Peak 2	27.139	99.020	
Peak 3	33.764	0.046	
Peak 4	35.454	0.861	



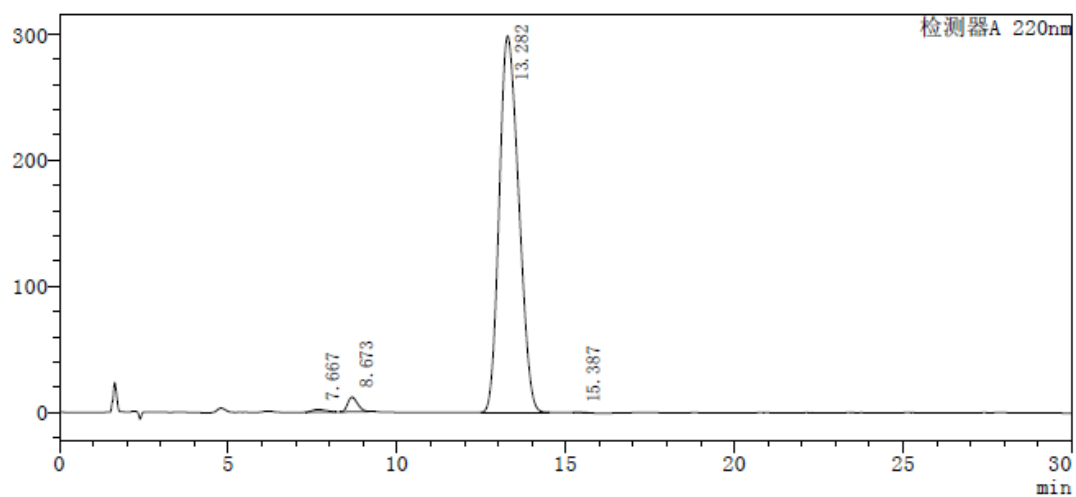
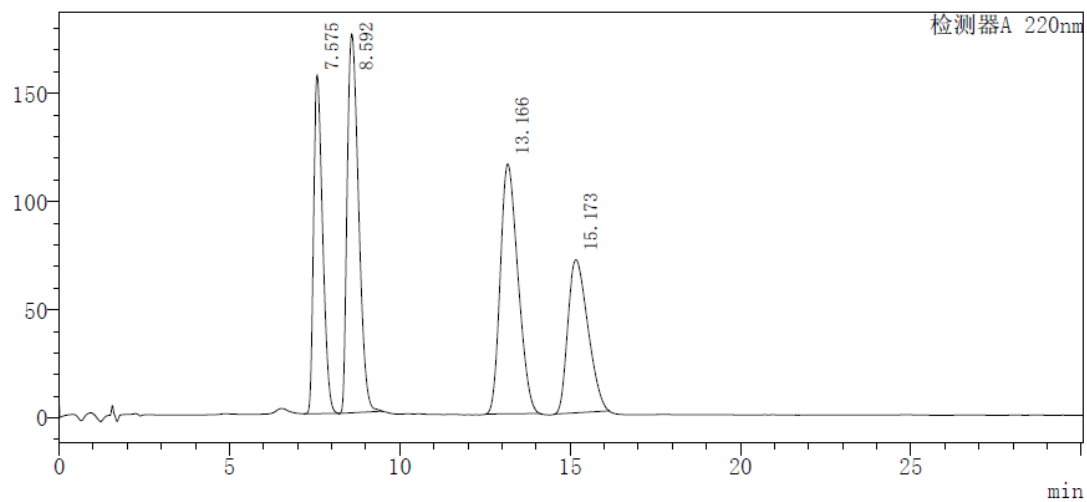
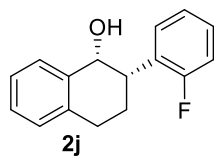
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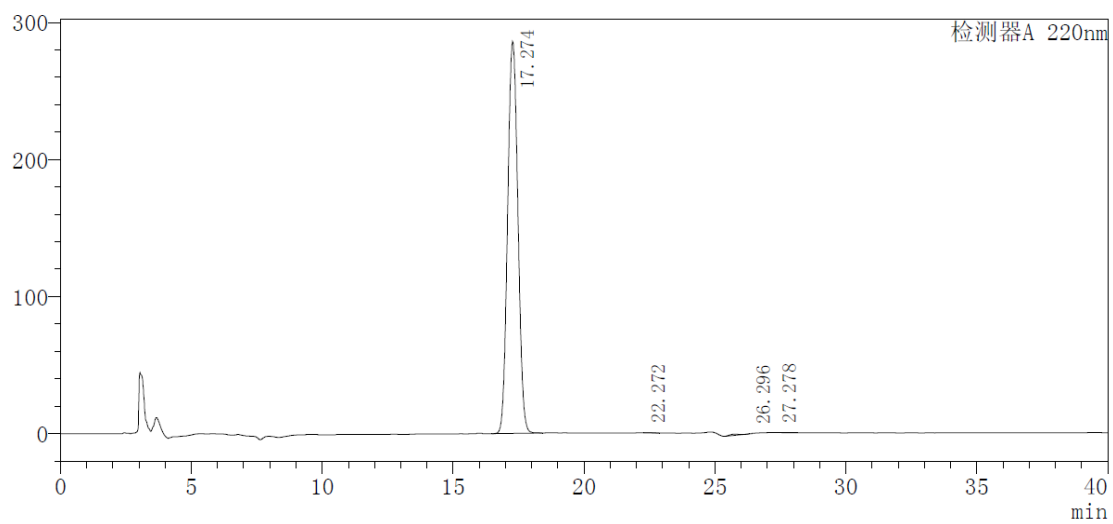
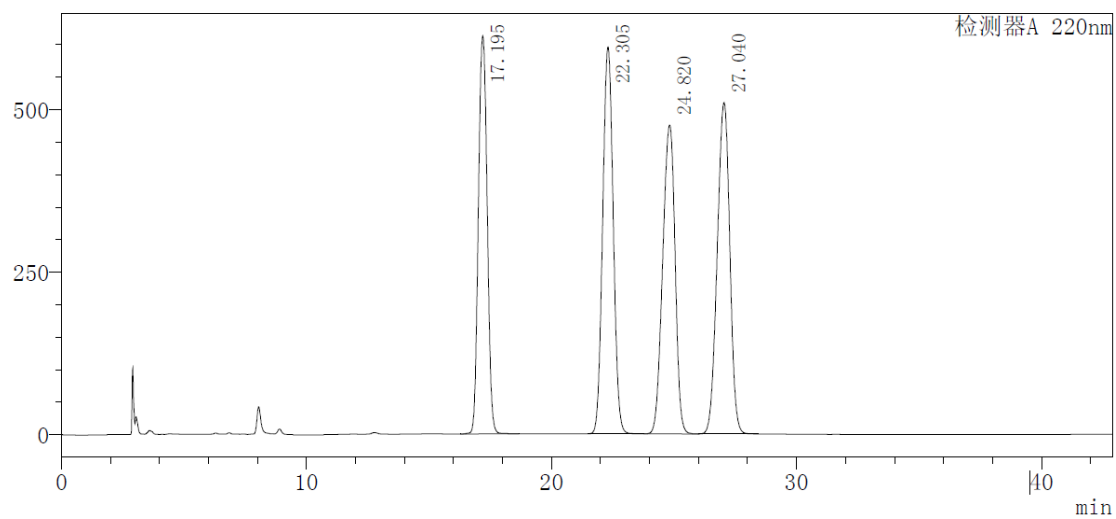
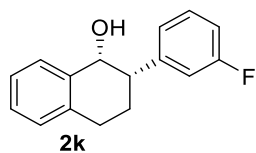
	Retention Time(min)	Relative Area (%)	98% ee
Peak 1	8.783	0.229	
Peak 2	10.487	98.625	
Peak 3	11.424	0.196	
Peak 4	17.084	0.949	



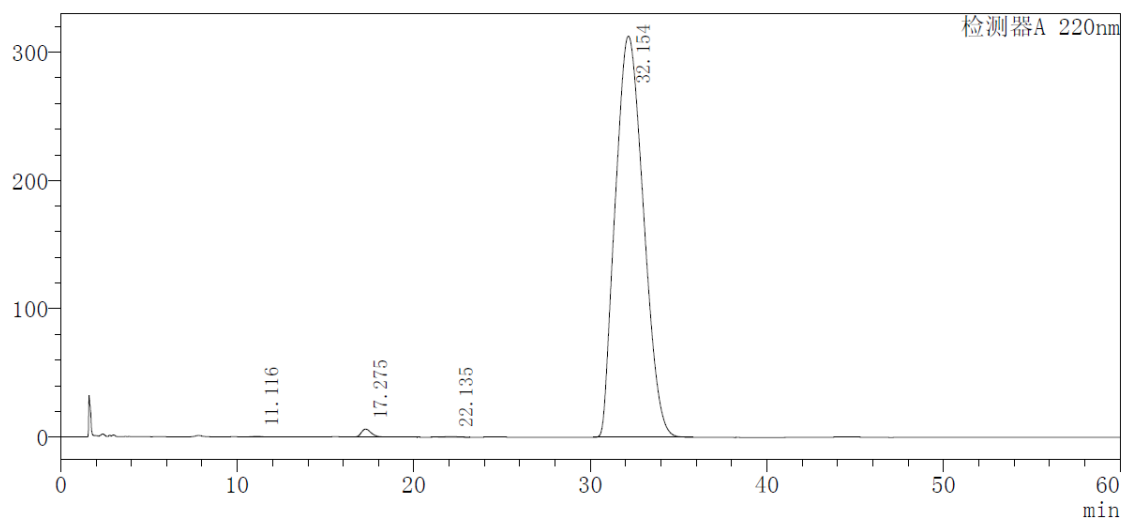
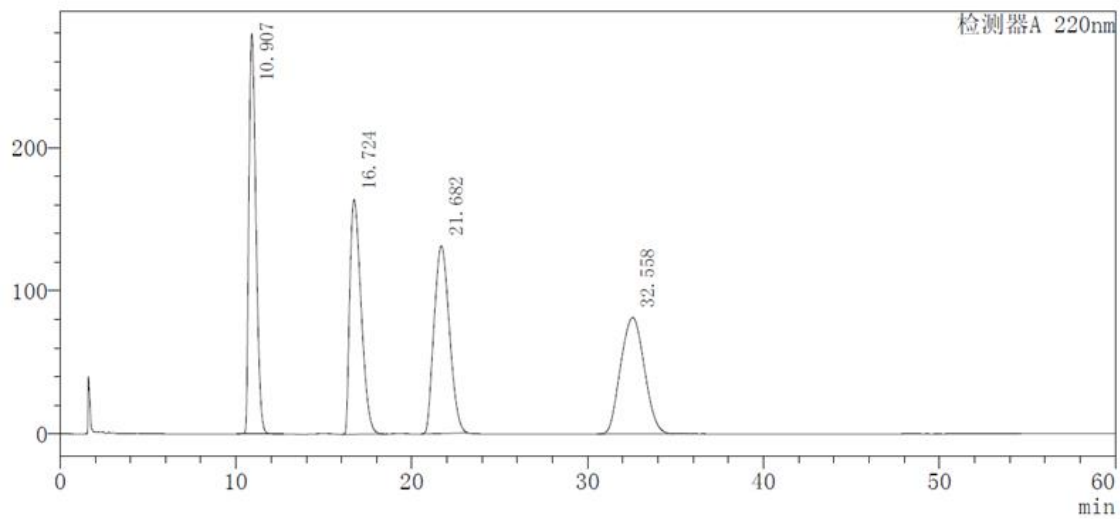
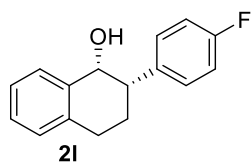
	Retention Time(min)	Relative Area (%)	97% ee
Peak 1	7.088	0.412	
Peak 2	9.008	98.078	
Peak 3	9.468	0.004	
Peak 4	16.204	1.505	



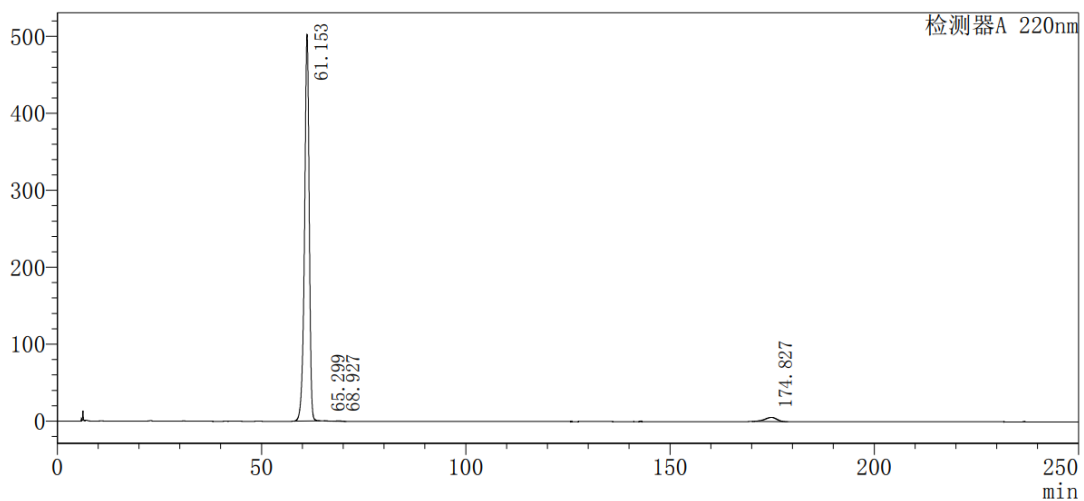
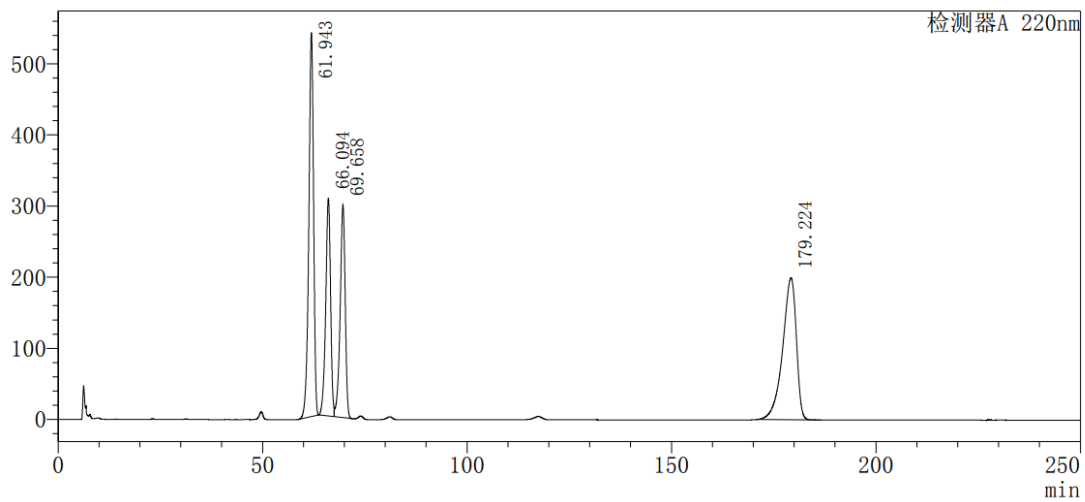
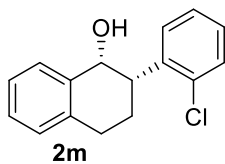
	Retention Time(min)	Relative Area (%)	96% ee
Peak 1	7.667	0.447	
Peak 2	8.673	1.894	
Peak 3	13.282	97.635	
Peak 4	15.387	0.023	



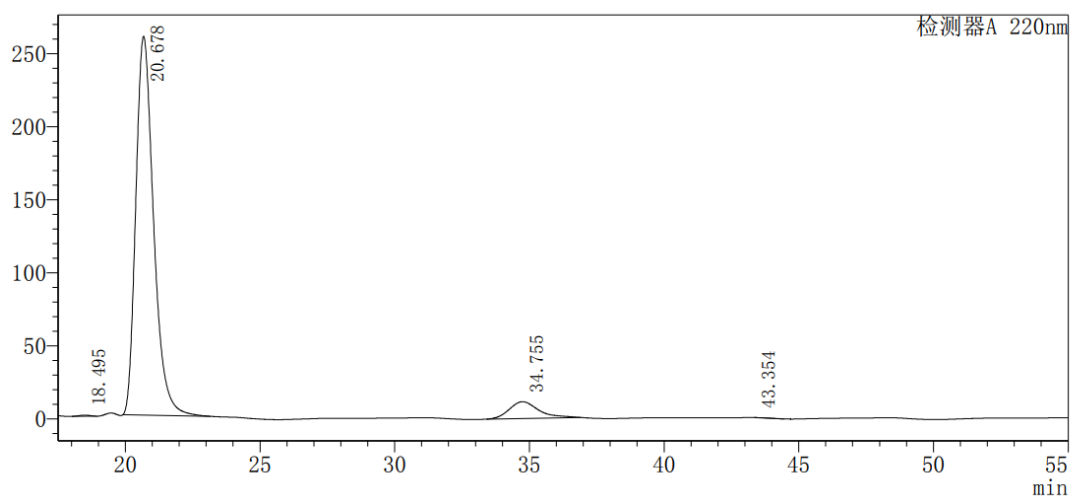
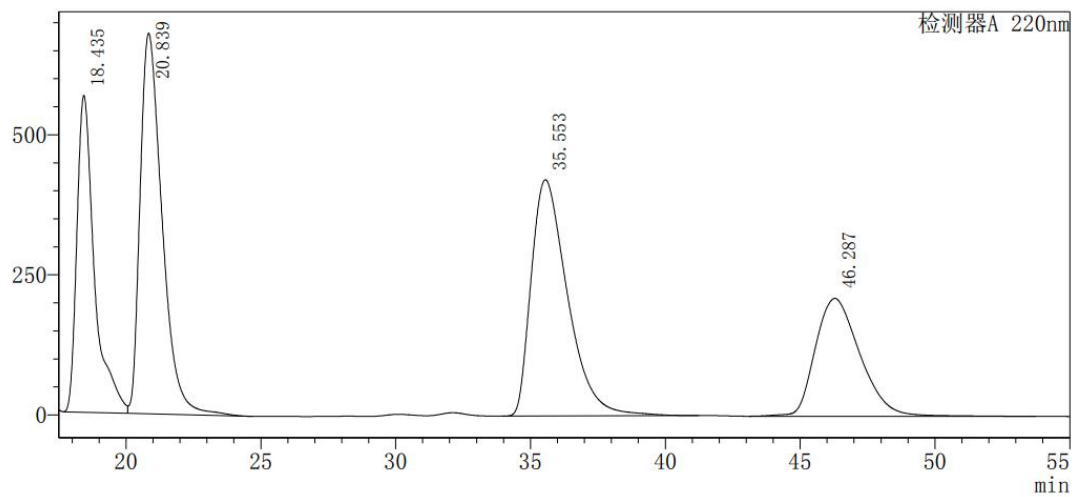
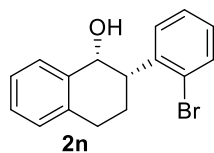
	Retention Time(min)	Relative Area (%)	99.6% ee
Peak 1	17.274	99.718	
Peak 2	22.272	0.009	
Peak 3	26.296	0.213	
Peak 4	27.278	0.060	



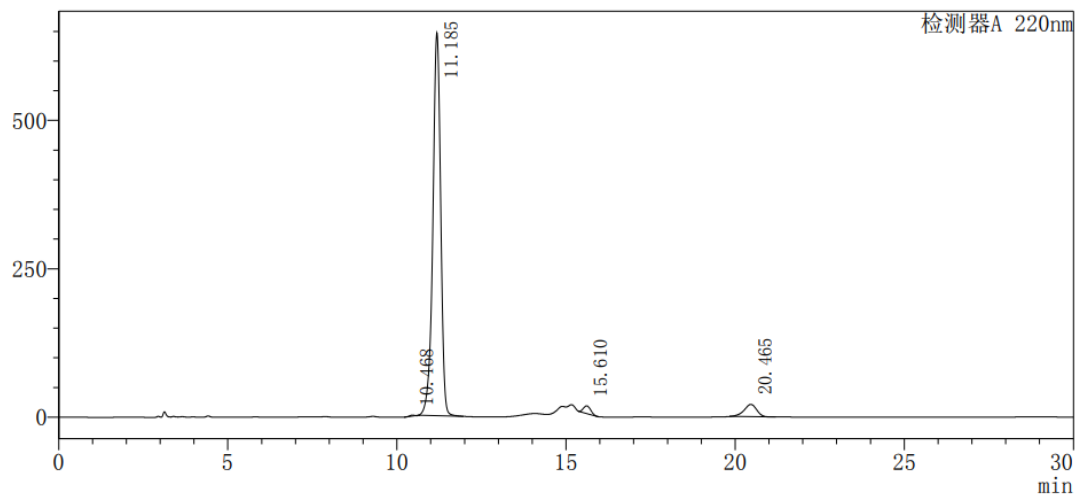
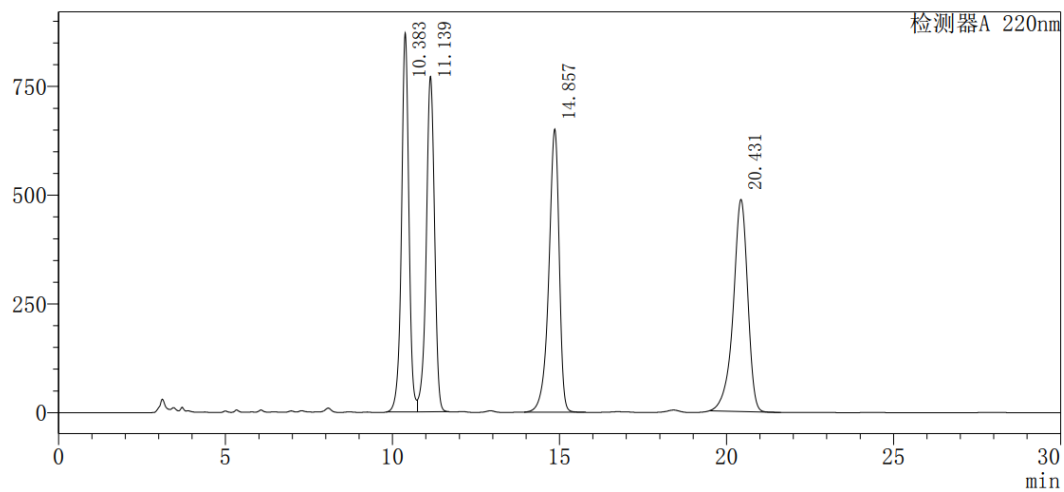
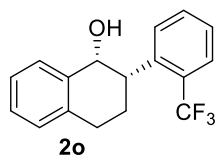
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	11.116	0.040	
Peak 2	17.275	0.685	
Peak 3	22.135	0.055	
Peak 4	32.154	99.220	



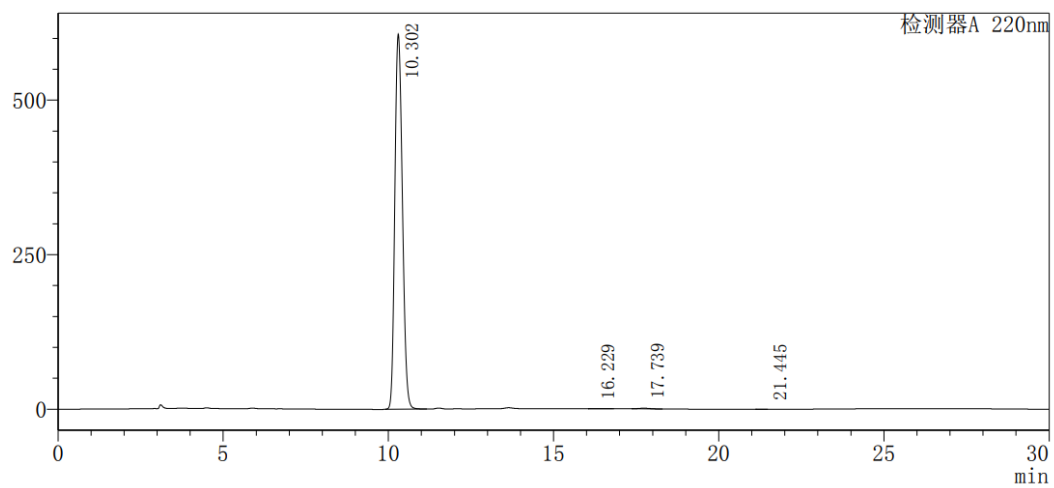
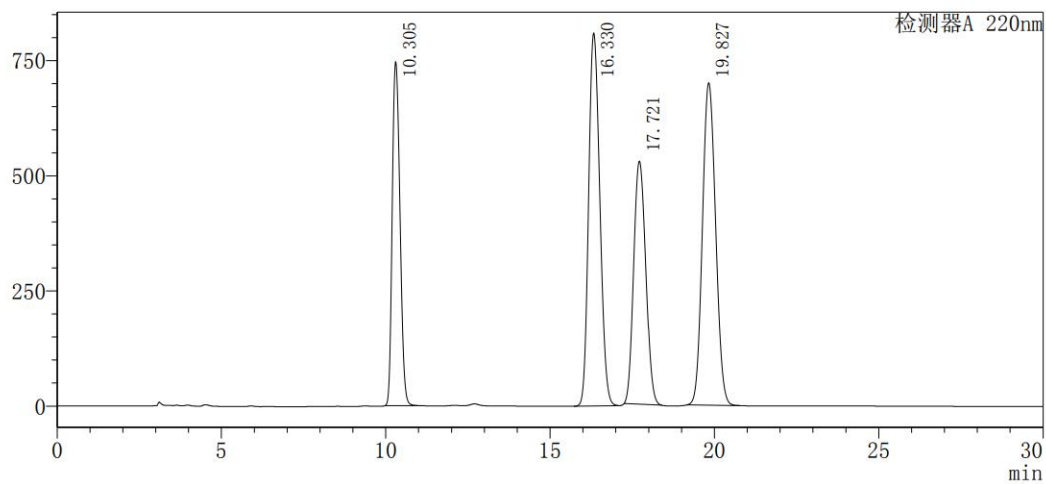
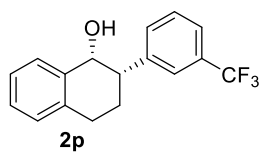
	Retention Time(min)	Relative Area (%)	95% ee
Peak 1	61.153	97.215	
Peak 2	65.299	0.003	
Peak 3	68.927	0.097	
Peak 4	174.827	2.685	



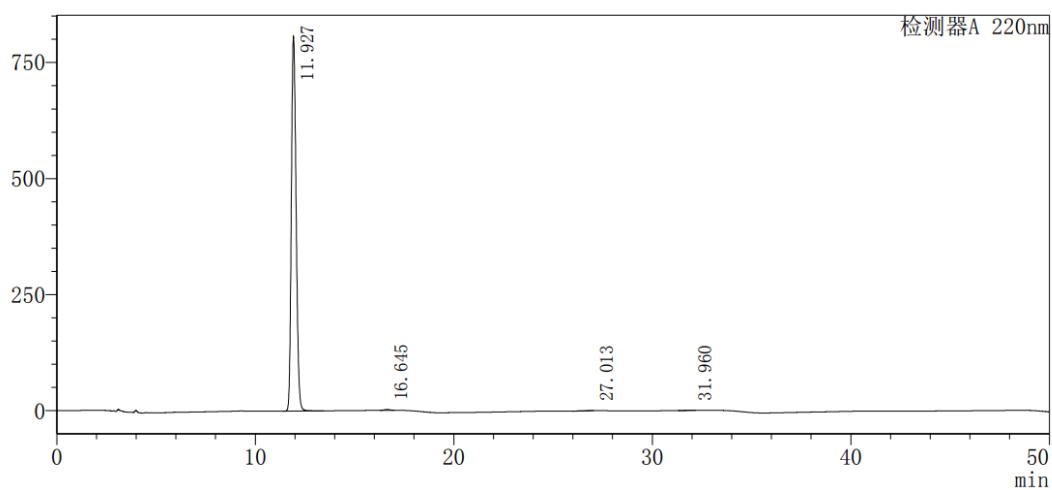
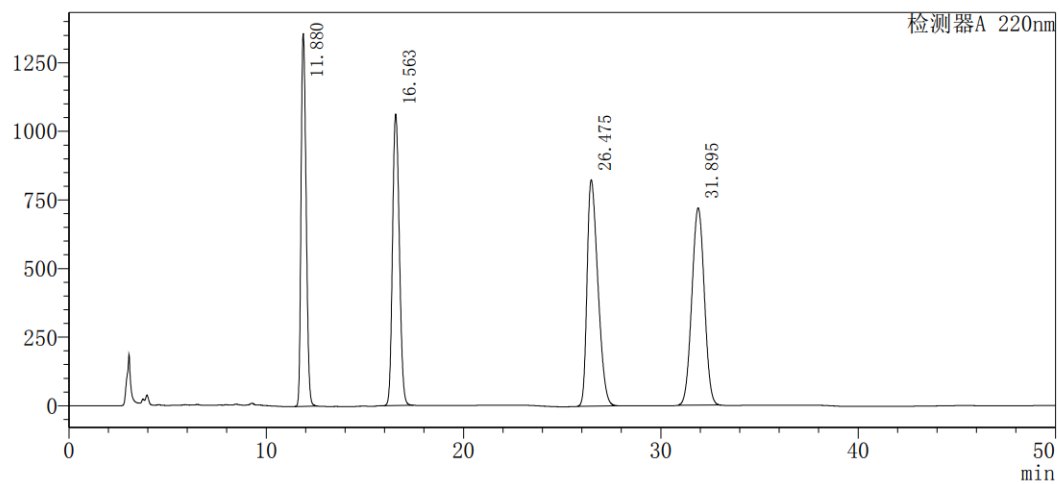
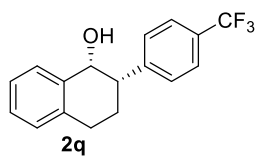
	Retention Time(min)	Relative Area (%)	86% ee
Peak 1	18.495	0.164	
Peak 2	20.678	92.993	
Peak 3	34.755	6.820	
Peak 4	43.354	0.024	



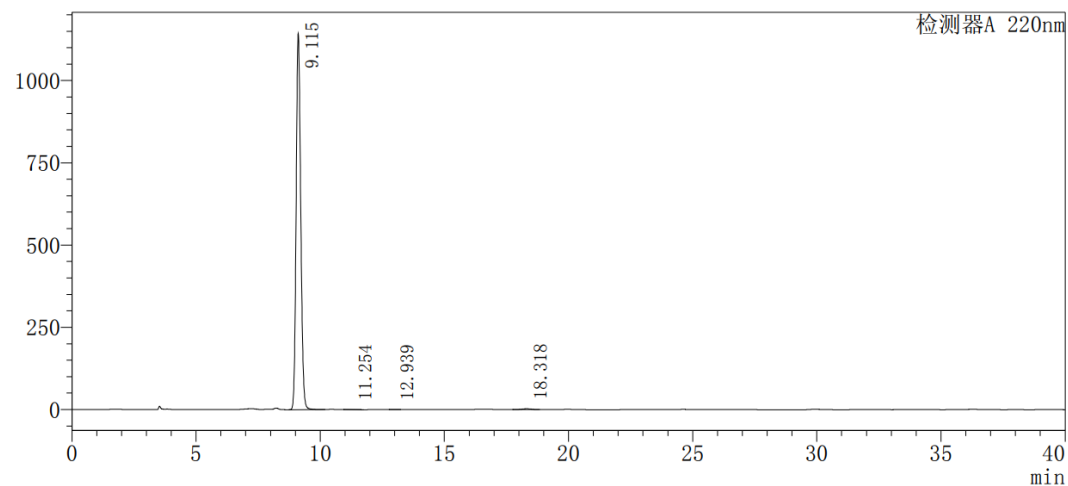
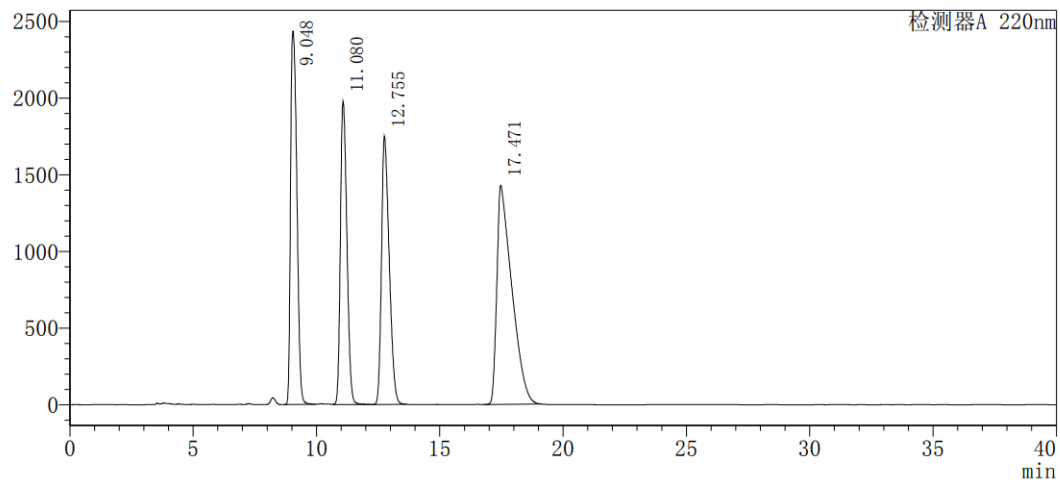
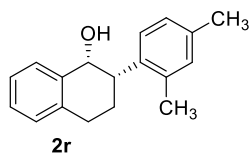
	Retention Time(min)	Relative Area (%)	90% ee
Peak 1	10.468	0.124	
Peak 2	11.185	93.323	
Peak 3	15.610	1.710	
Peak 4	20.465	4.842	



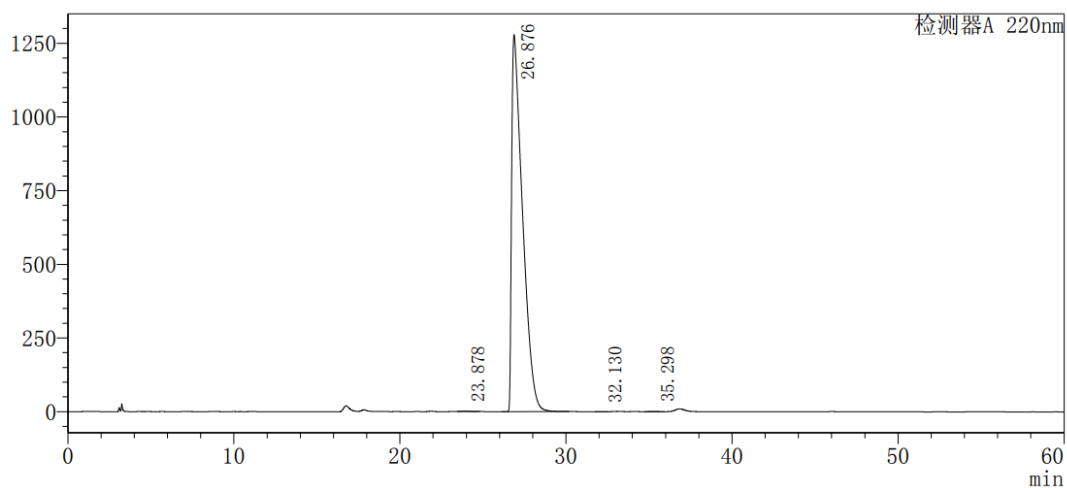
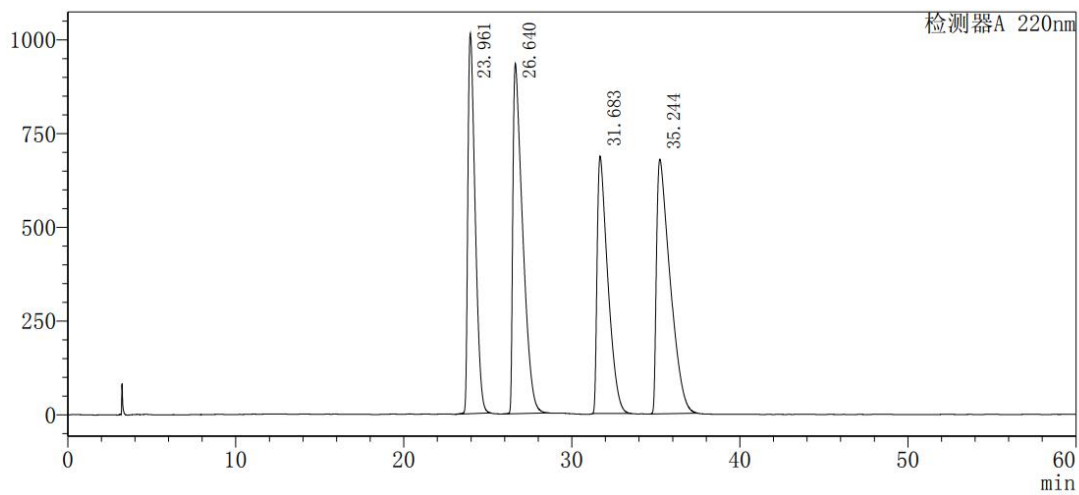
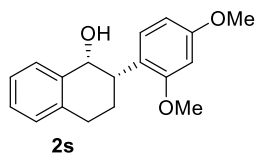
	Retention Time(min)	Relative Area (%)	99.5% ee
Peak 1	10.302	99.728	
Peak 2	16.229	0.014	
Peak 3	17.739	0.256	
Peak 4	21.445	0.002	



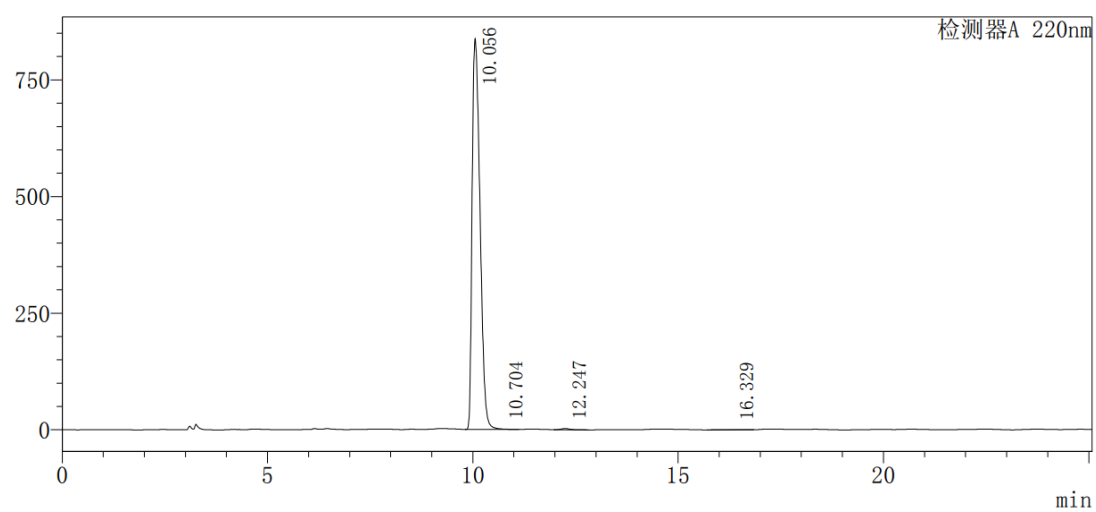
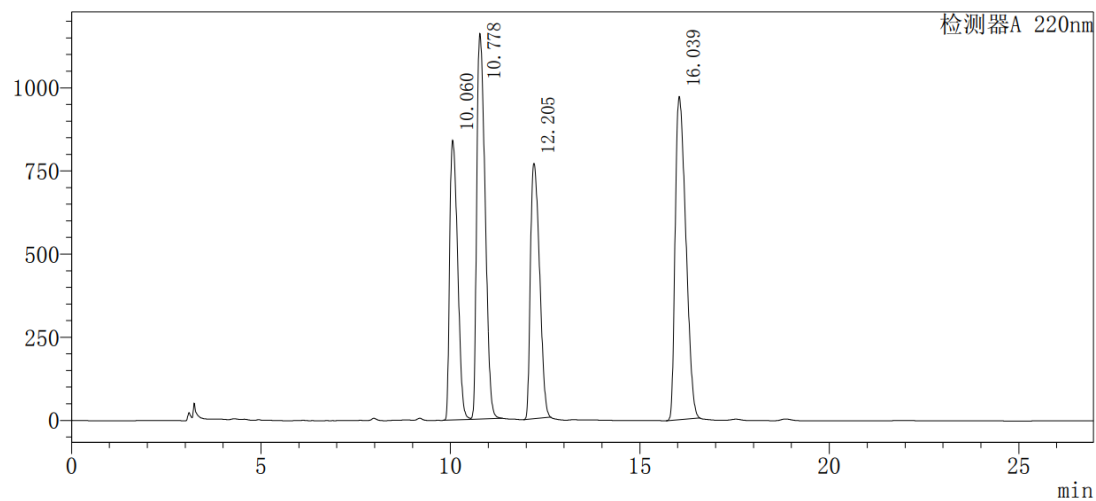
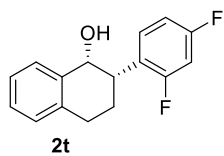
	Retention Time(min)	Relative Area (%)	99.5% ee
Peak 1	11.927	99.703	
Peak 2	16.645	0.260	
Peak 3	27.013	0.011	
Peak 4	31.960	0.025	



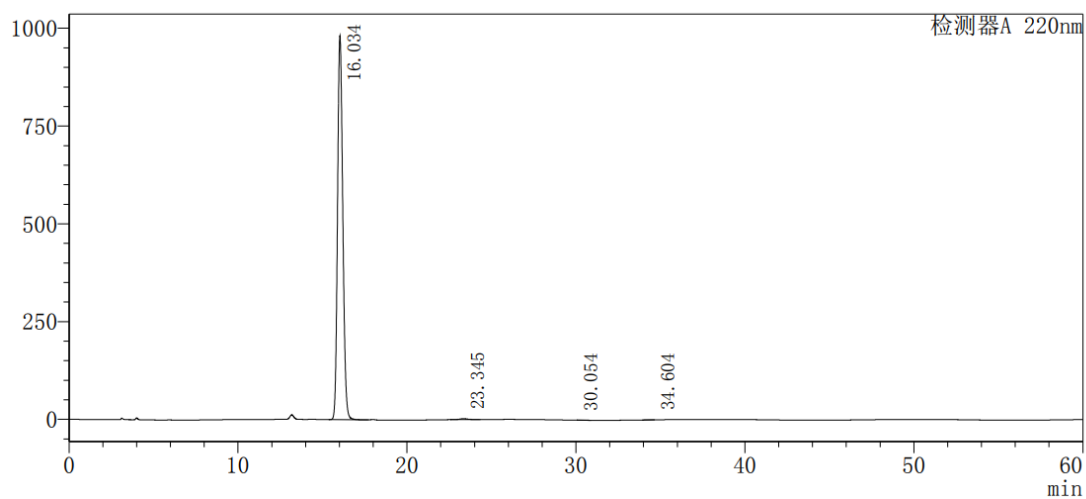
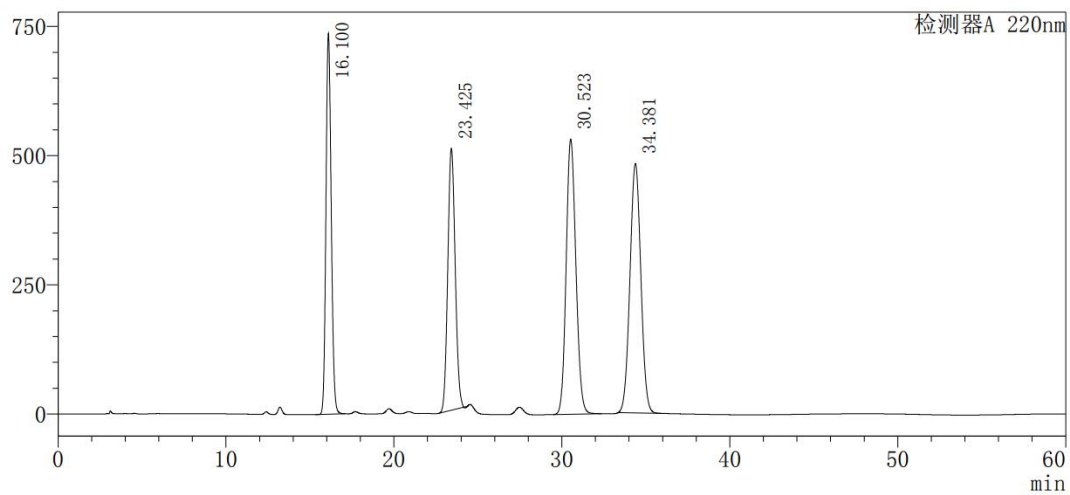
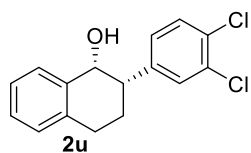
	Retention Time(min)	Relative Area (%)	99.1% ee
Peak 1	9.115	99.518	
Peak 2	11.254	0.020	
Peak 3	12.939	0.022	
Peak 4	18.318	0.440	



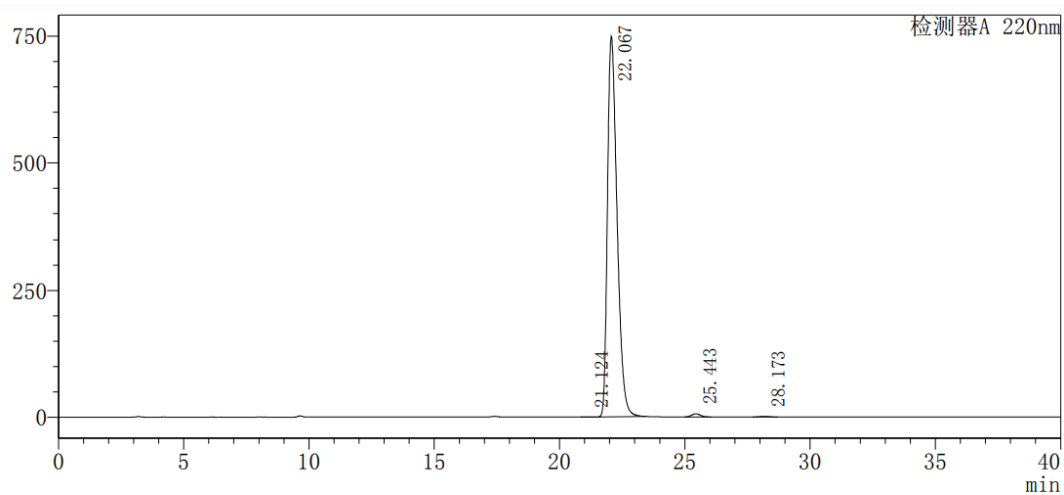
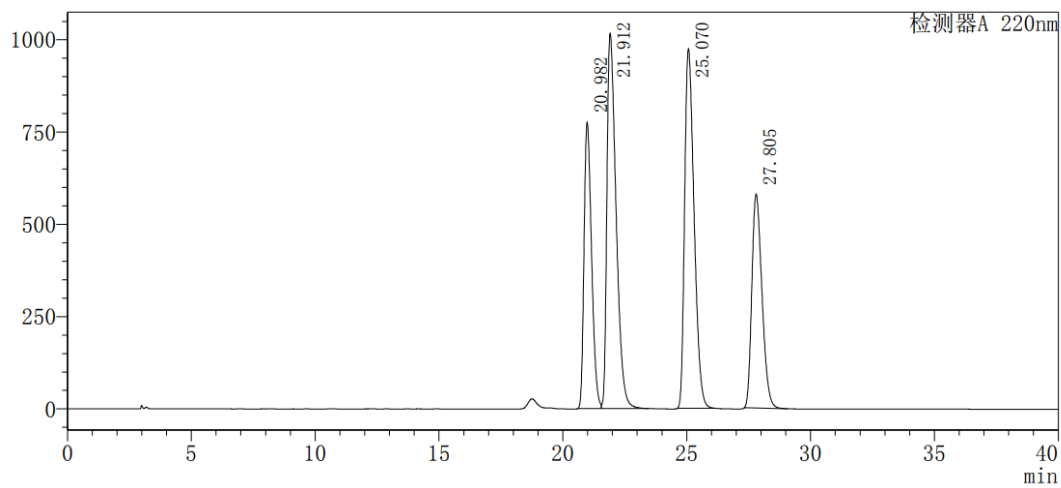
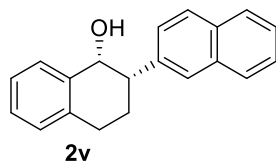
	Retention Time(min)	Relative Area (%)	>99.9% ee
Peak 1	23.878	0.051	
Peak 2	26.876	99.910	
Peak 3	32.130	0.007	
Peak 4	35.298	0.032	



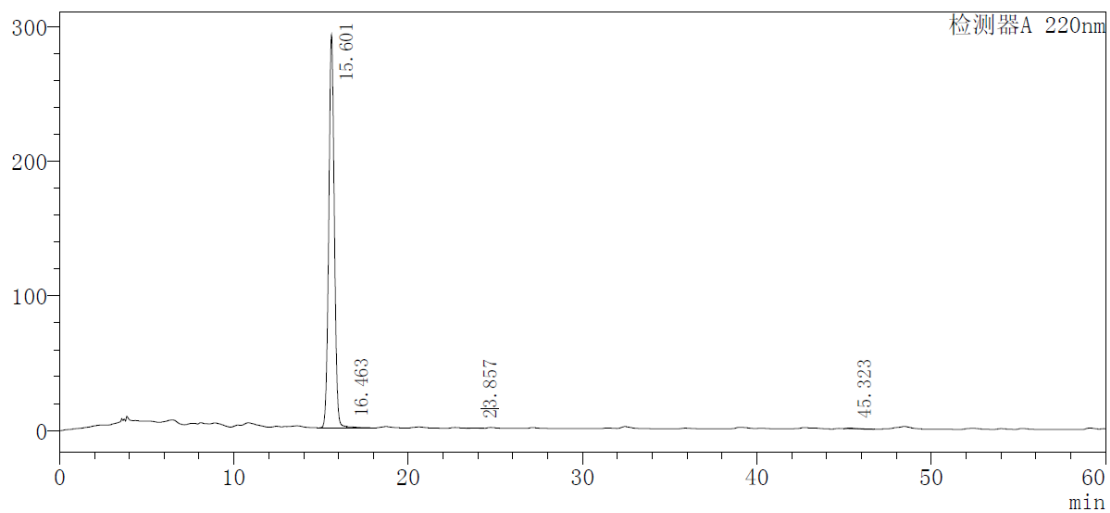
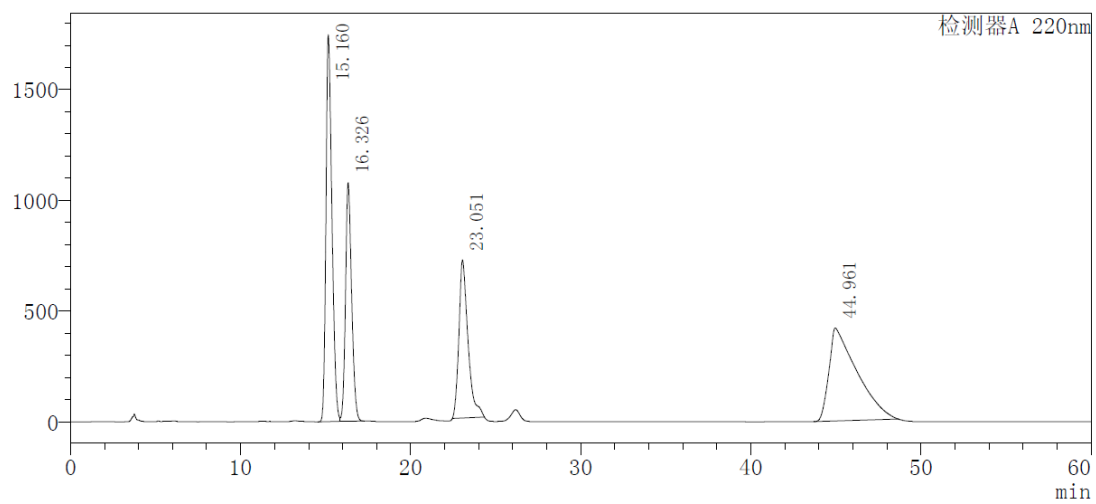
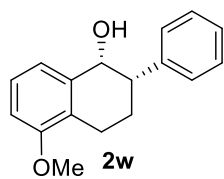
	Retention Time(min)	Relative Area (%)	99.4% ee
Peak 1	10.056	99.395	
Peak 2	10.704	0.091	
Peak 3	12.247	0.337	
Peak 4	16.329	0.177	



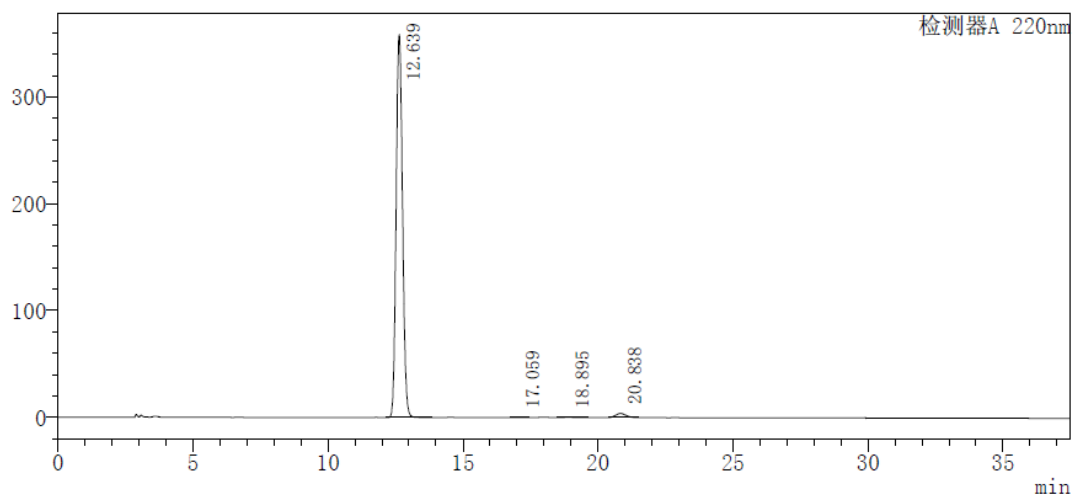
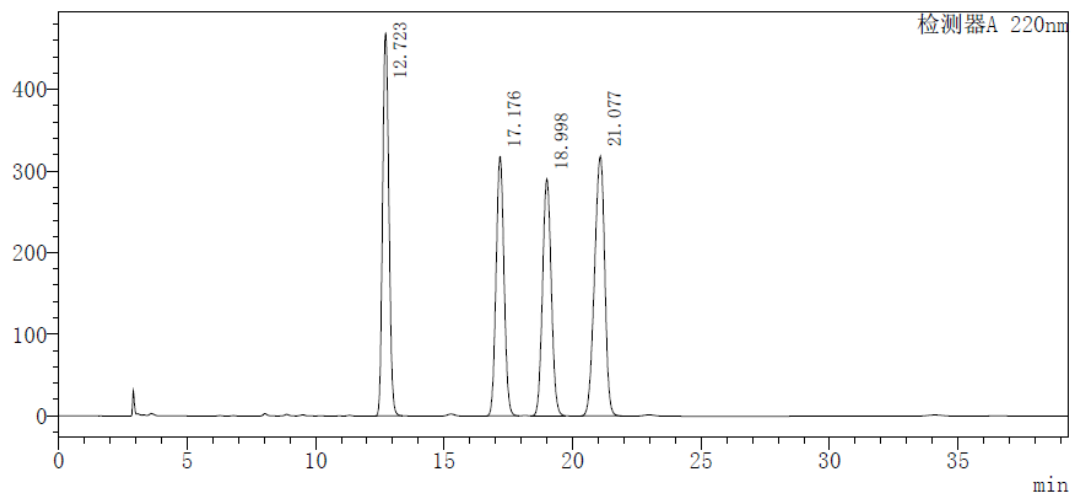
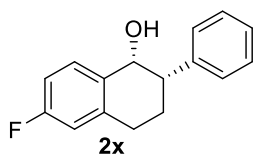
	Retention Time(min)	Relative Area (%)	99.3% ee
Peak 1	16.034	99.656	
Peak 2	23.345	0.334	
Peak 3	30.054	0.003	
Peak 4	34.604	0.007	



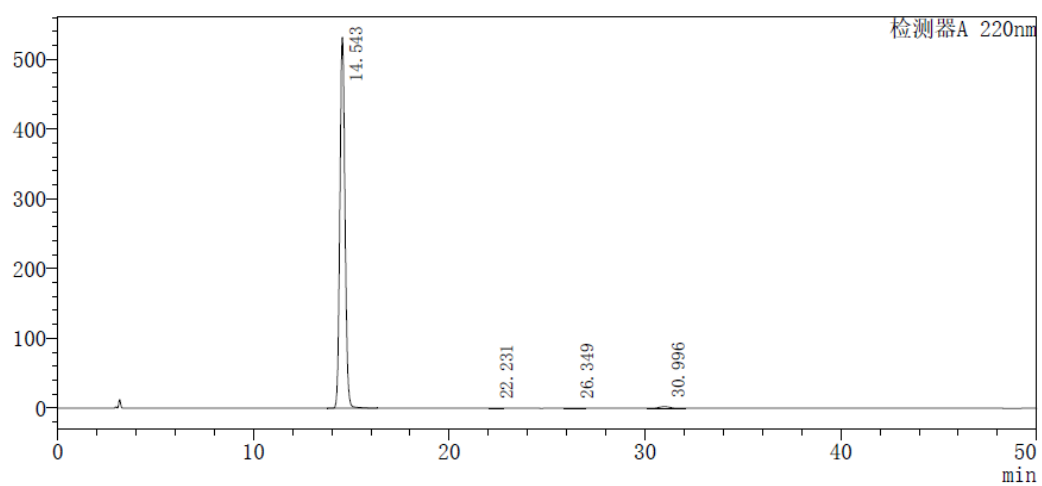
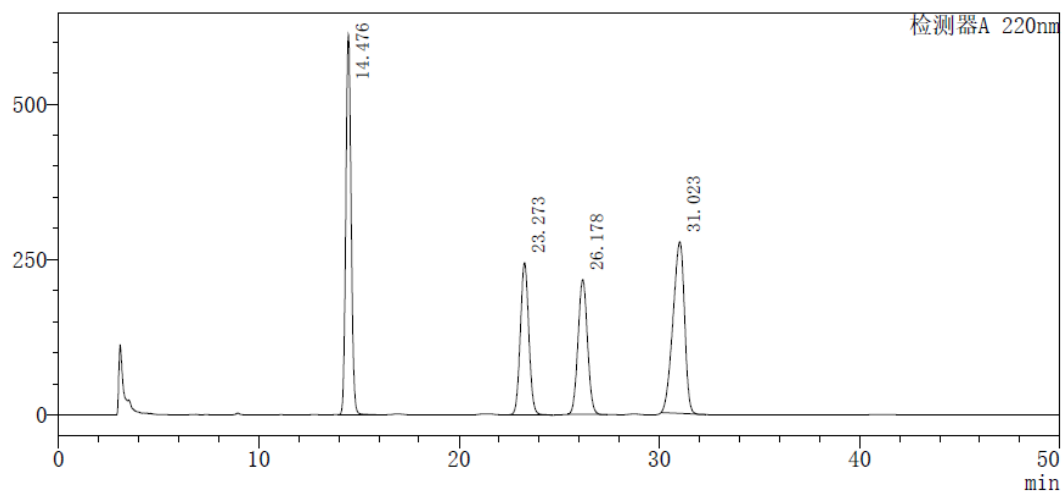
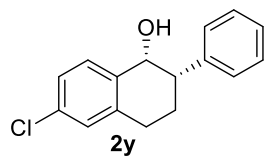
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	21.124	0.029	
Peak 2	22.067	99.043	
Peak 3	25.443	0.758	
Peak 4	28.173	0.170	



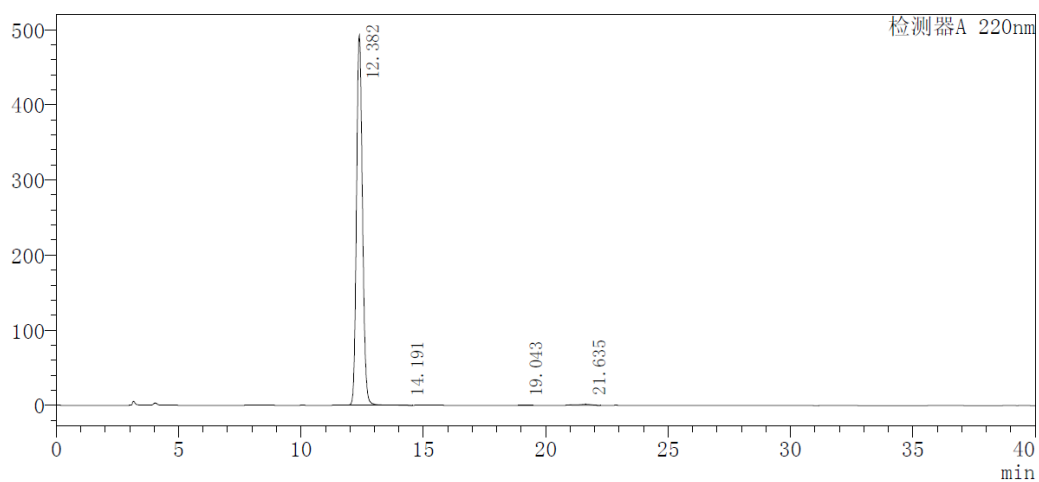
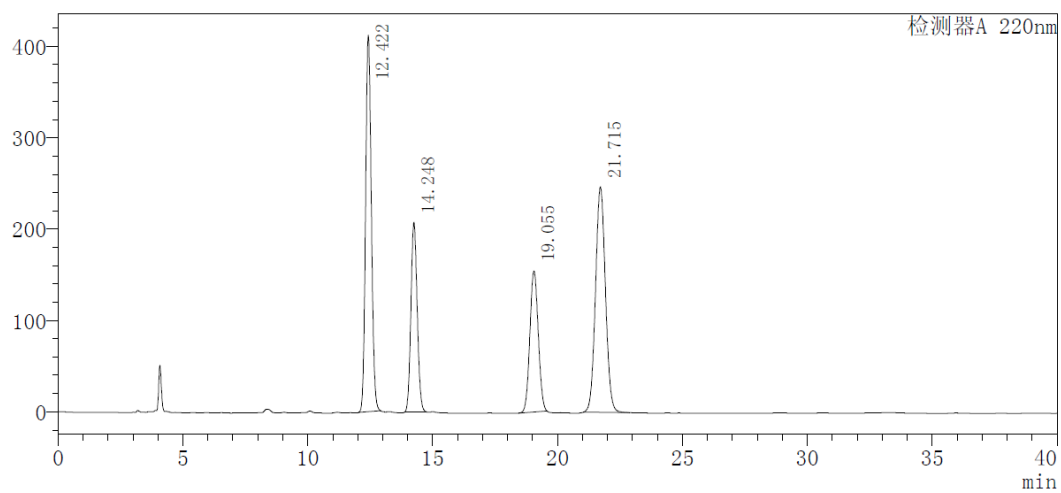
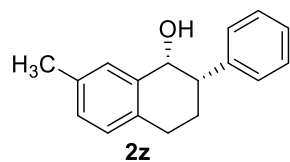
	Retention Time(min)	Relative Area (%)	99.5% ee
Peak 1	15.601	99.195	
Peak 2	16.463	0.523	
Peak 3	23.857	0.054	
Peak 4	45.323	0.228	



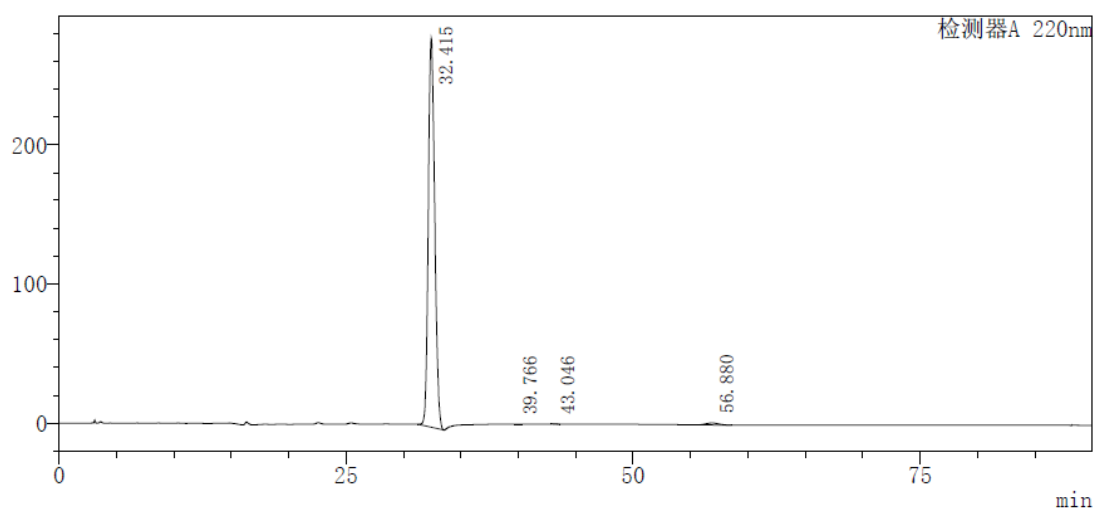
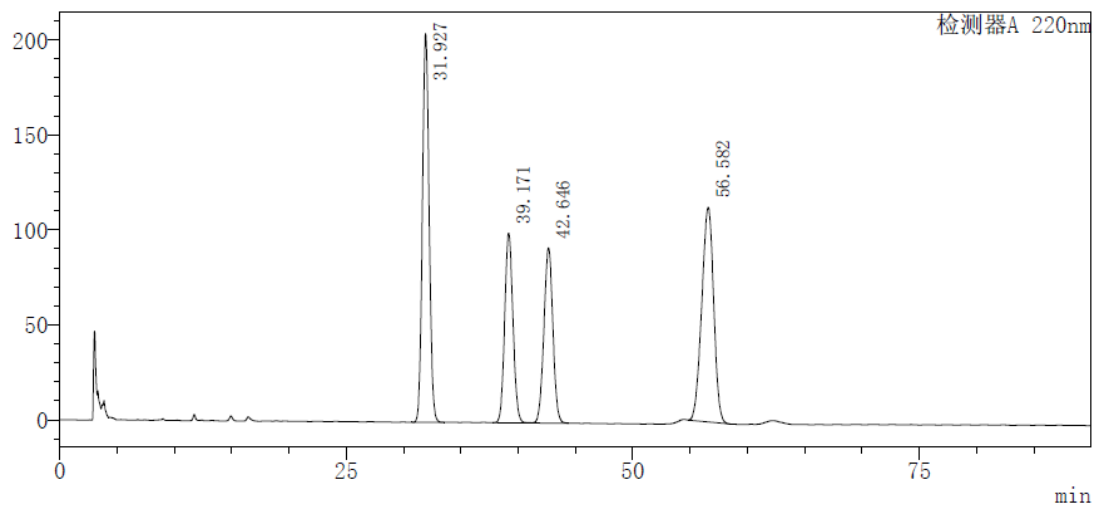
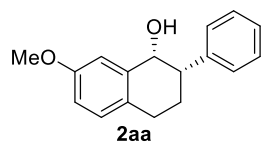
	Retention Time(min)	Relative Area (%)	97% ee
Peak 1	12.639	98.182	
Peak 2	17.059	0.031	
Peak 3	18.895	0.146	
Peak 4	20.838	1.640	



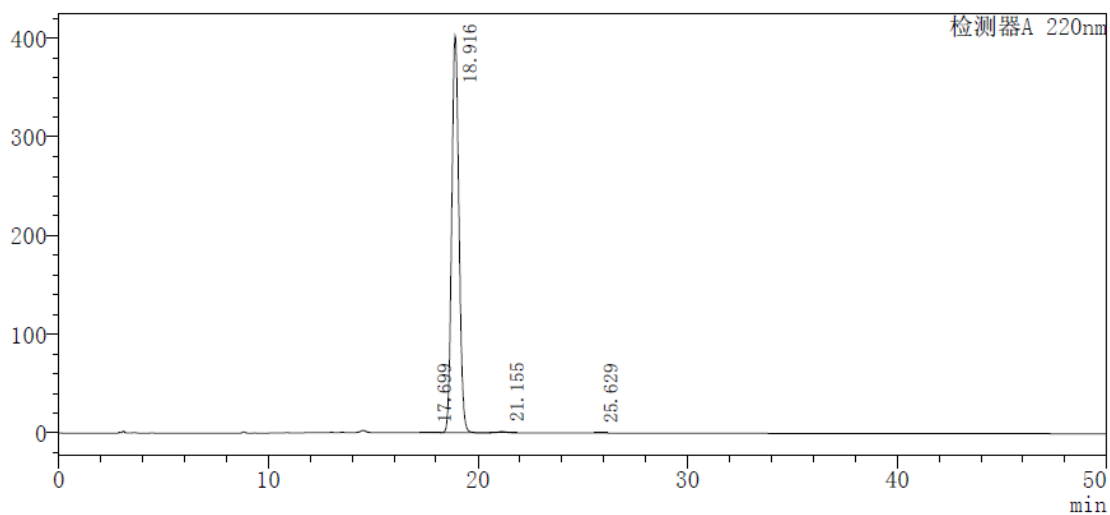
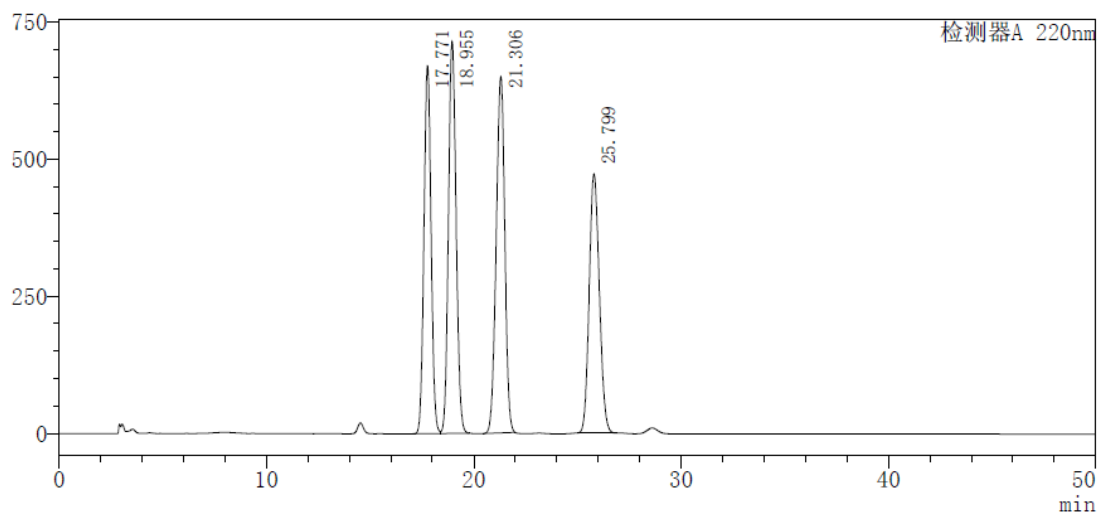
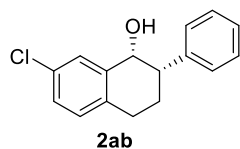
	Retention Time(min)	Relative Area (%)	98% ee
Peak 1	14.543	98.839	
Peak 2	22.231	0.023	
Peak 3	26.349	0.139	
Peak 4	30.996	0.999	



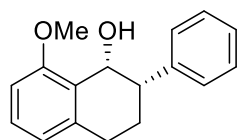
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	12.382	99.448	
Peak 2	14.191	0.038	
Peak 3	19.043	0.009	
Peak 4	21.635	0.505	



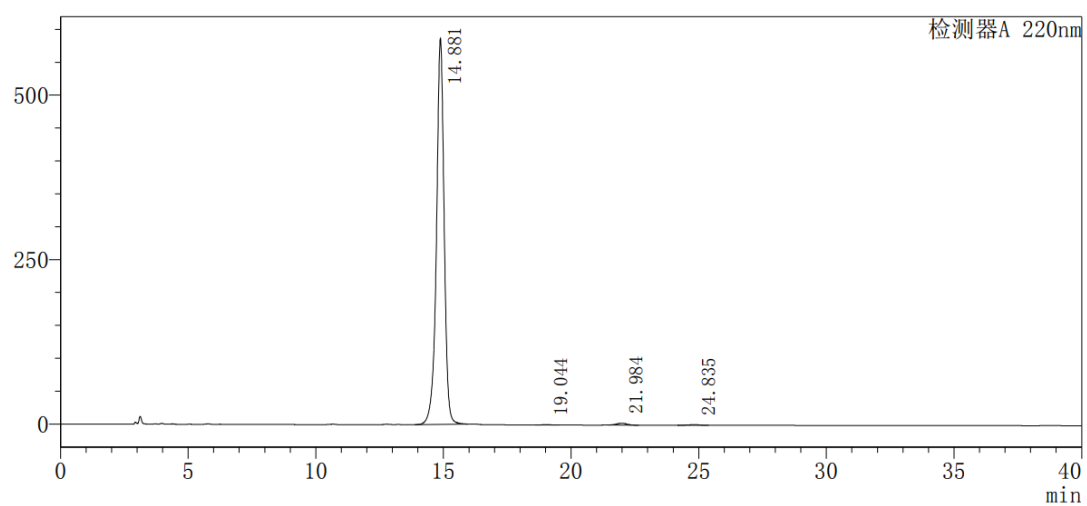
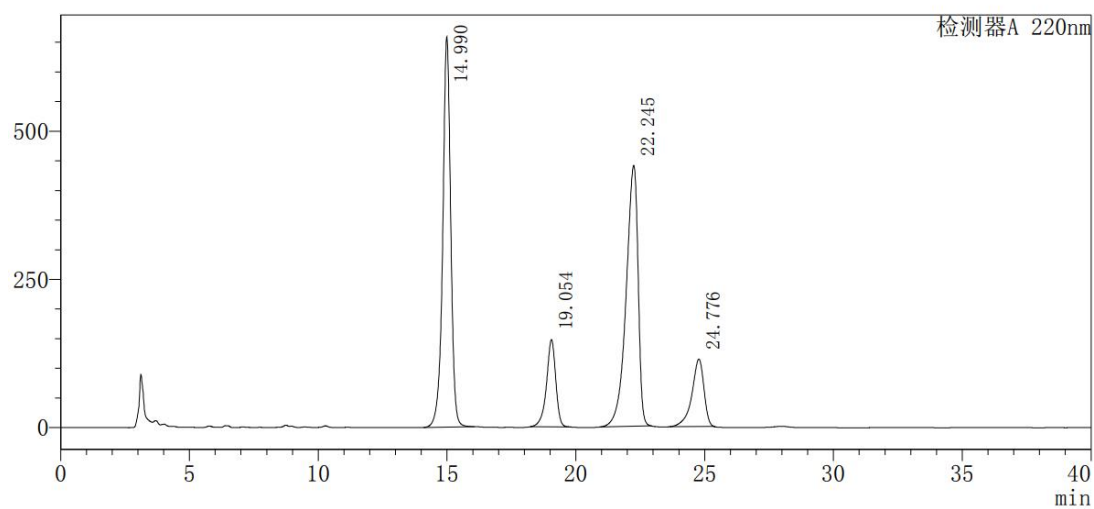
	Retention Time(min)	Relative Area (%)	99.5% ee
Peak 1	32.415	98.999	
Peak 2	39.766	0.002	
Peak 3	43.046	0.004	
Peak 4	56.880	0.995	



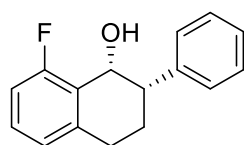
	Retention Time(min)	Relative Area (%)	99.3% ee
Peak 1	17.699	0.012	
Peak 2	18.916	99.654	
Peak 3	21.155	0.331	
Peak 4	25.629	0.003	



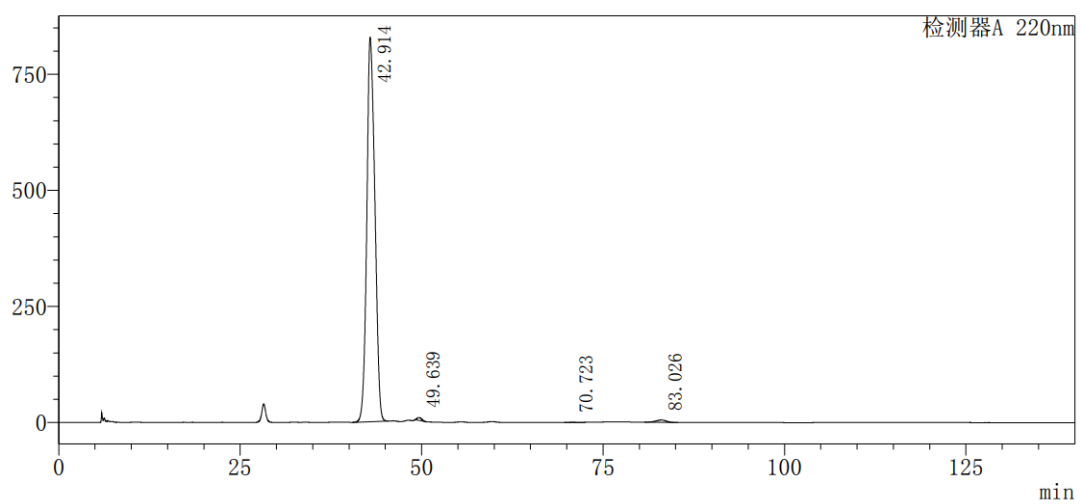
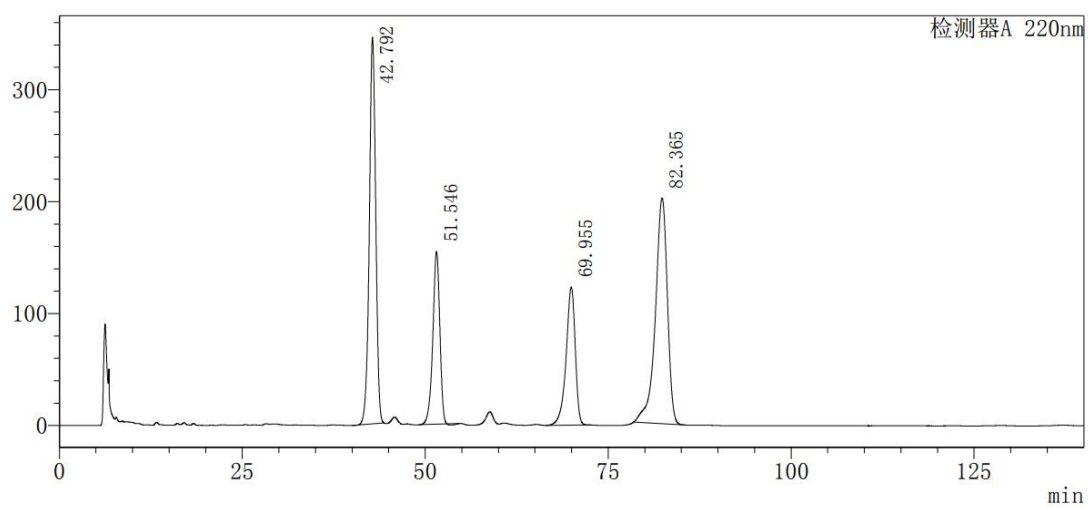
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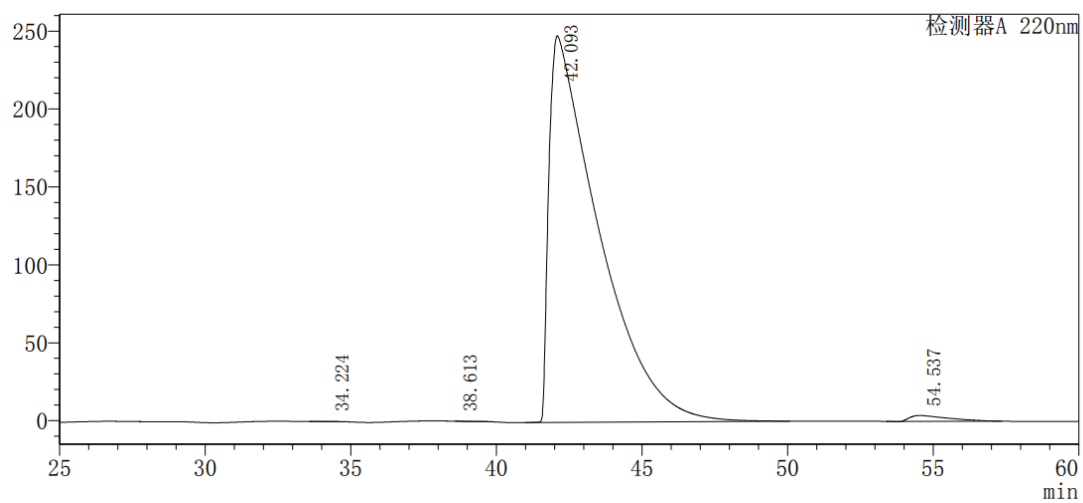
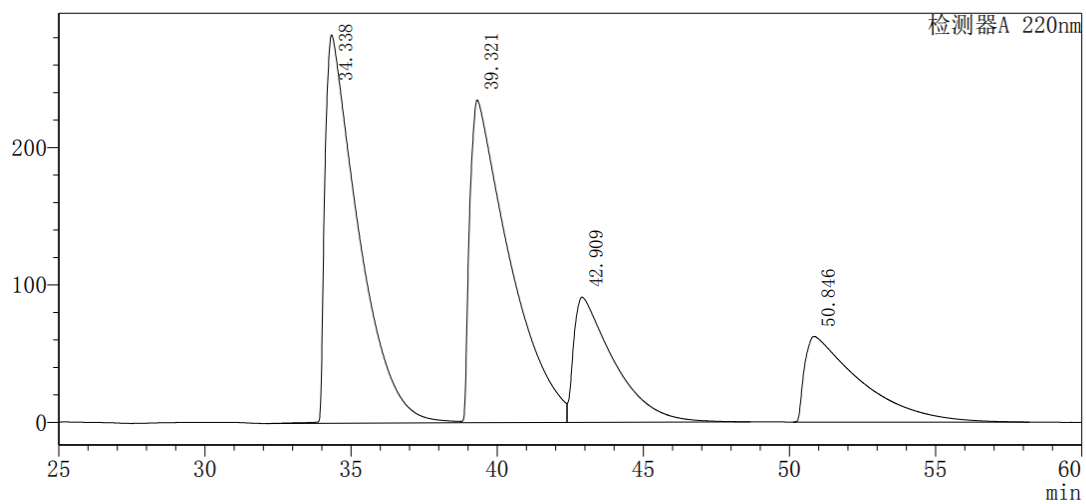
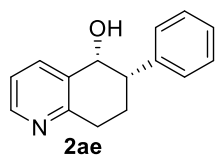
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	14.881	99.003	
Peak 2	19.044	0.108	
Peak 3	21.984	0.663	
Peak 4	24.835	0.225	



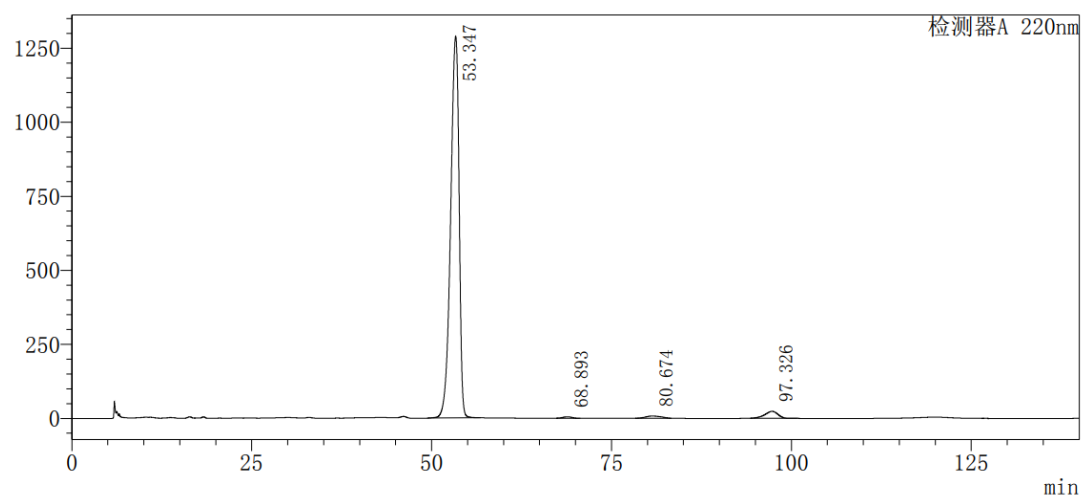
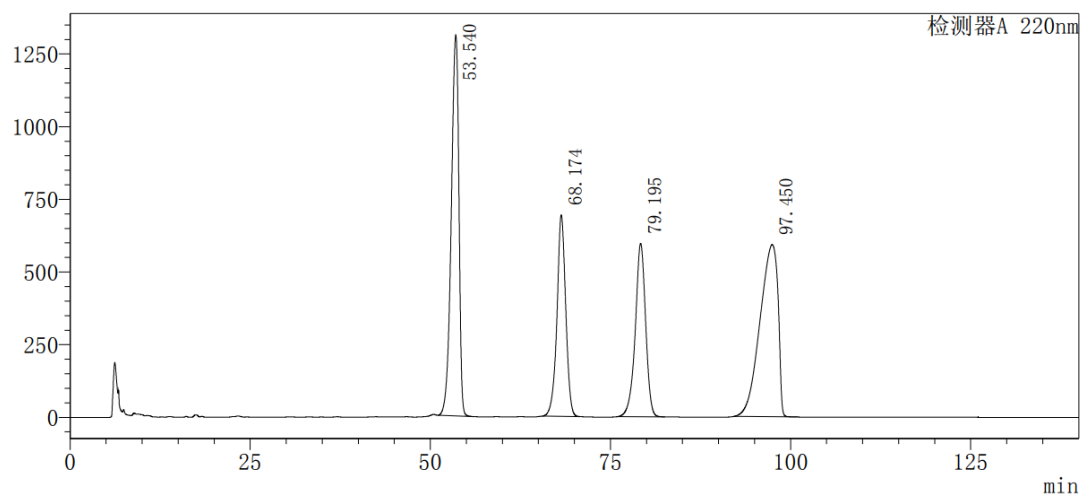
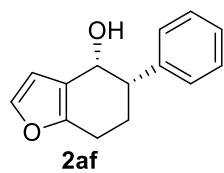
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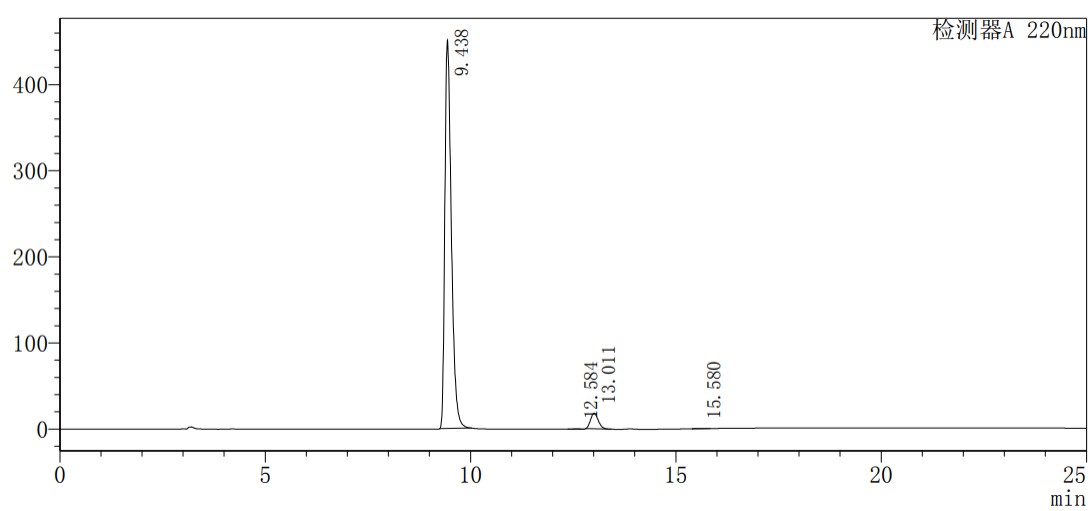
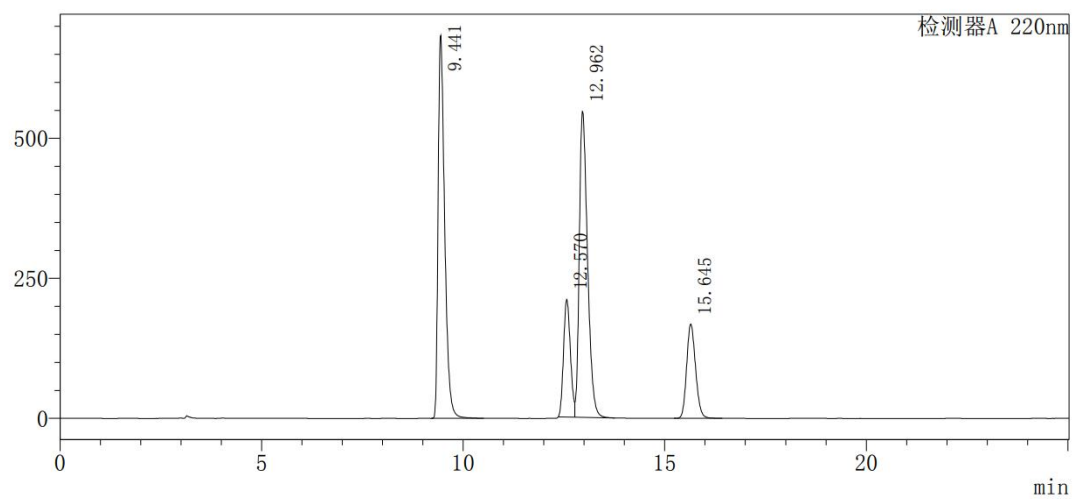
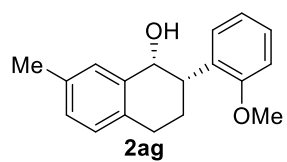
	Retention Time(min)	Relative Area (%)	98% ee
Peak 1	42.914	98.803	
Peak 2	49.639	0.430	
Peak 3	70.723	0.013	
Peak 4	83.026	0.754	



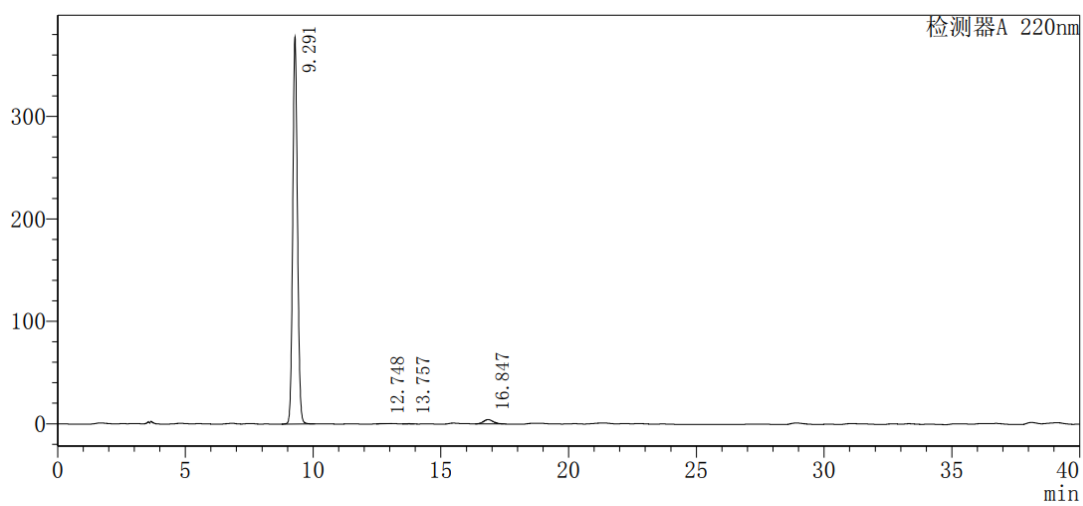
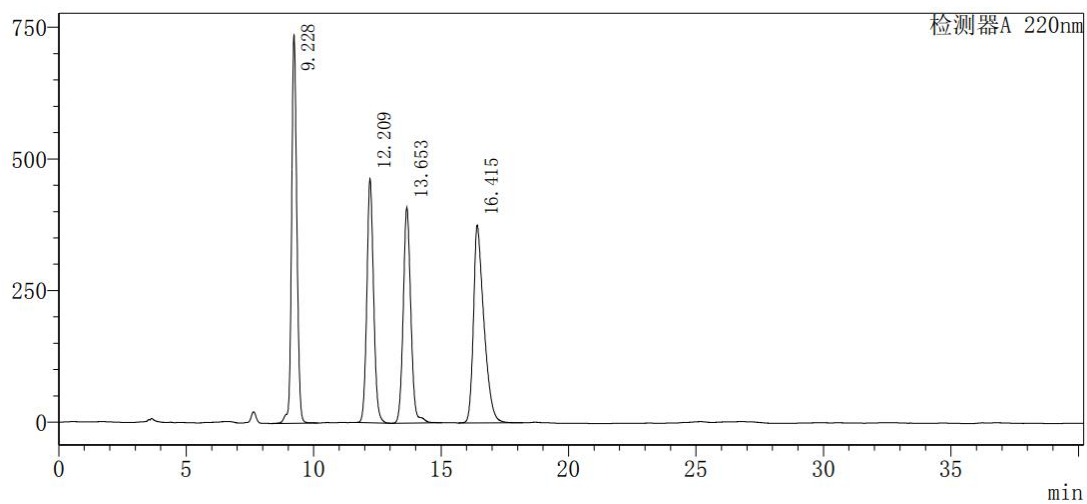
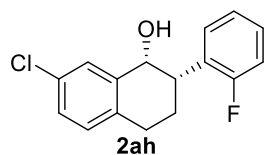
	Retention Time(min)	Relative Area (%)	98% ee
Peak 1	34.224	0.013	
Peak 2	38.613	0.015	
Peak 3	42.093	98.828	
Peak 4	54.537	1.144	



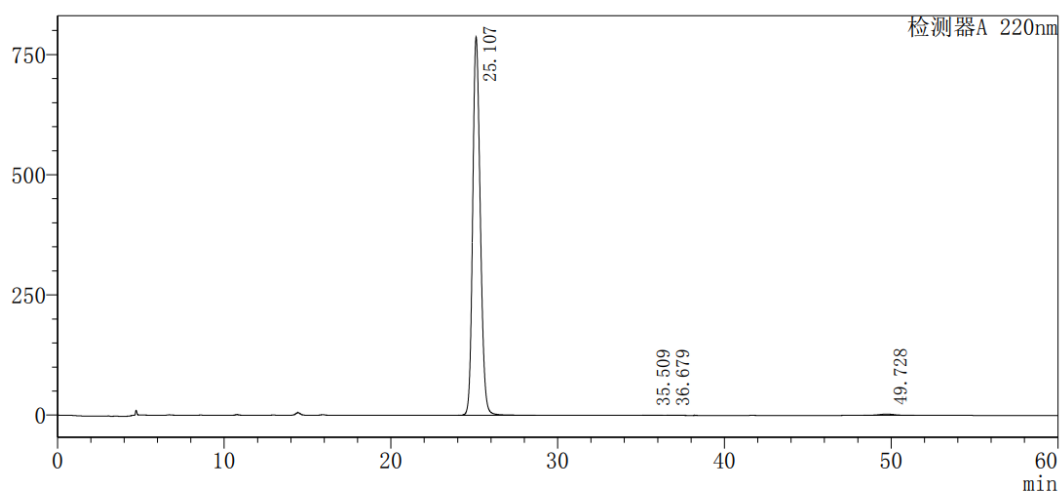
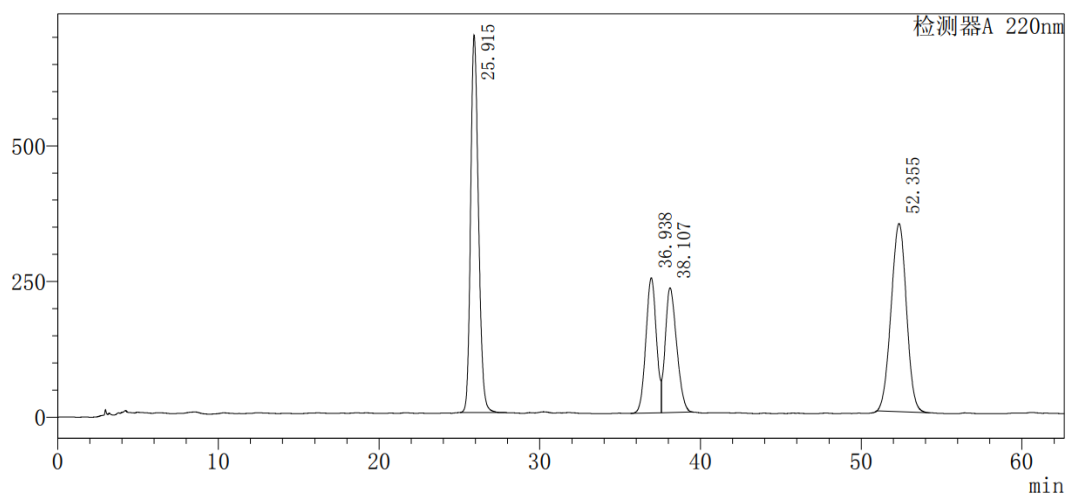
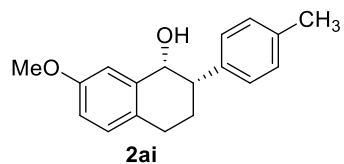
	Retention Time(min)	Relative Area (%)	95% ee
Peak 1	53.347	95.887	
Peak 2	68.893	0.398	
Peak 3	80.674	1.011	
Peak 4	97.326	2.705	



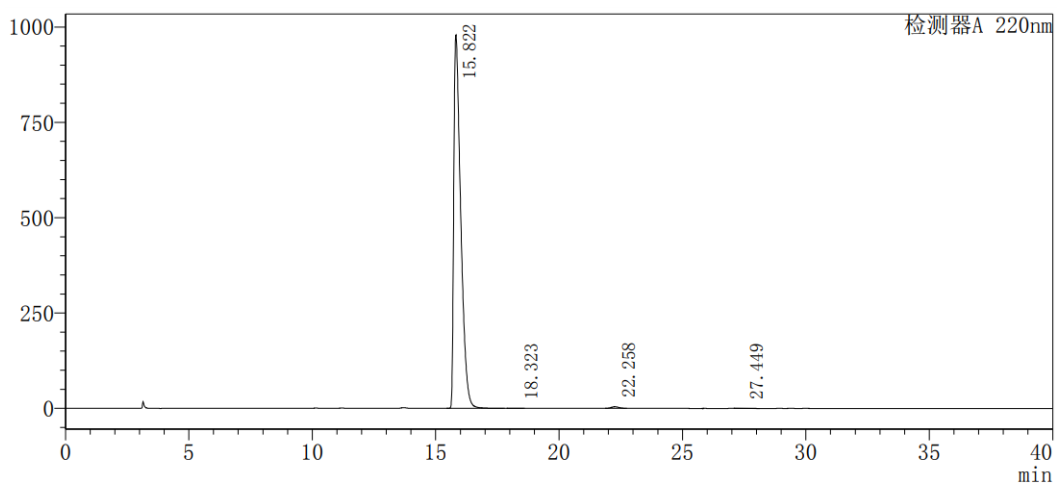
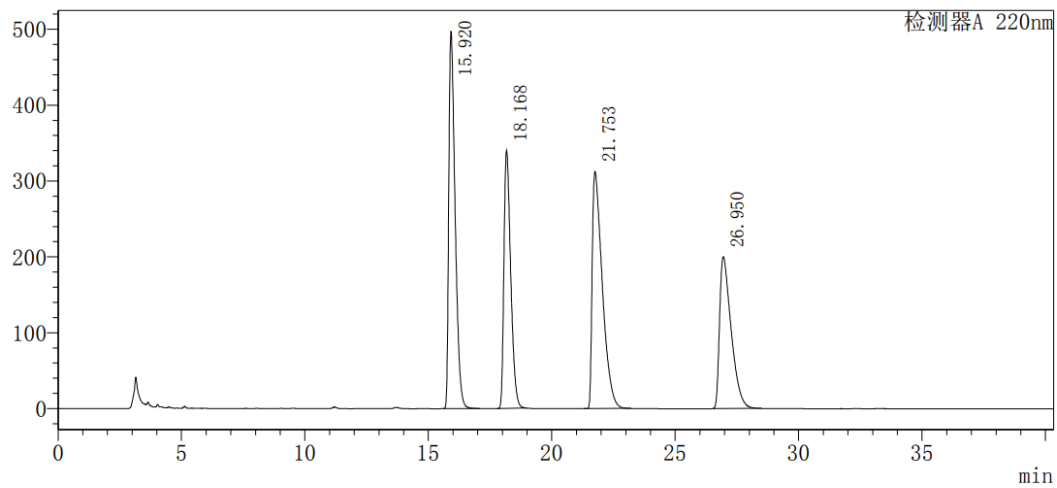
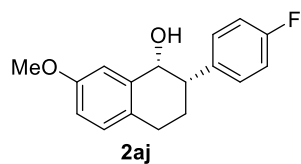
	Retention Time(min)	Relative Area (%)	91% ee
Peak 1	9.438	95.310	
Peak 2	12.584	0.094	
Peak 3	13.011	4.537	
Peak 4	15.580	0.060	



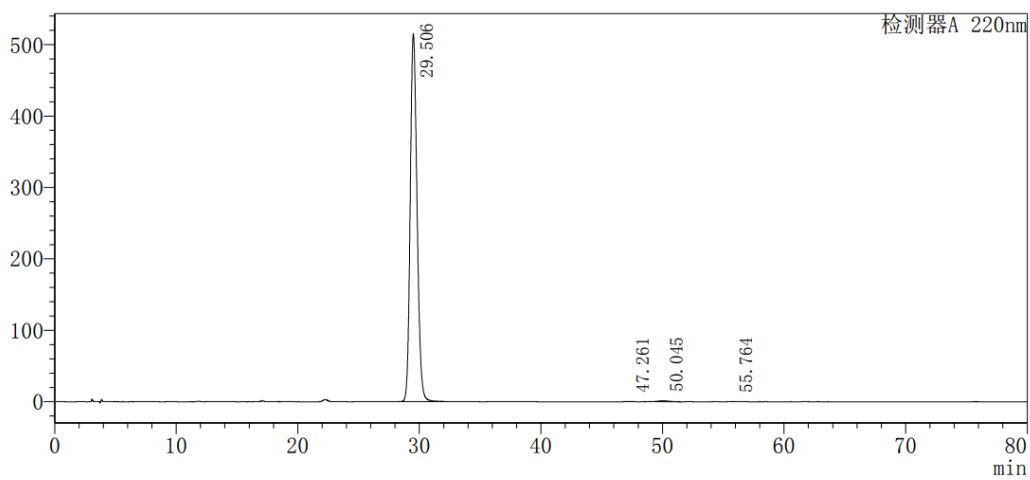
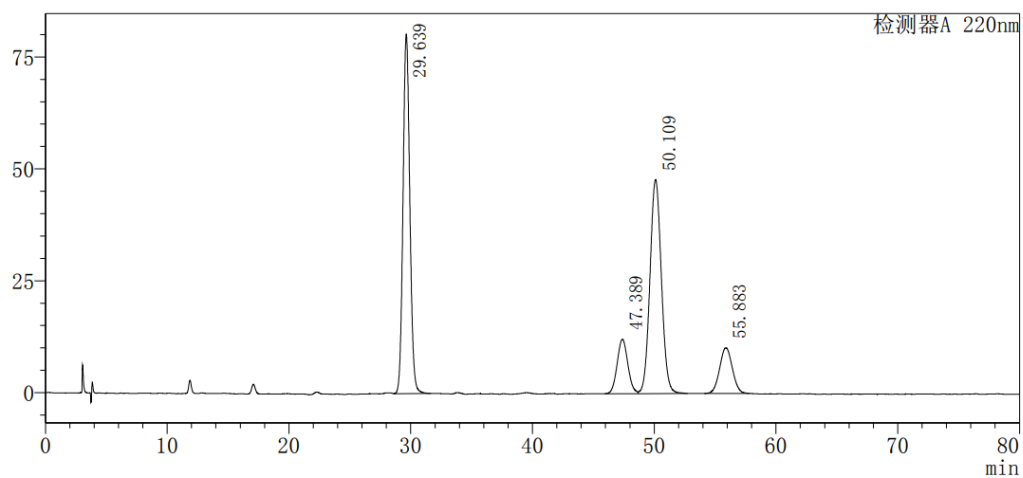
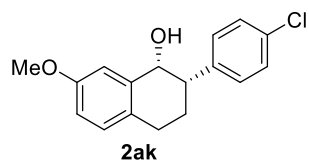
	Retention Time(min)	Relative Area (%)	96% ee
Peak 1	9.291	97.642	
Peak 2	12.748	0.098	
Peak 3	13.757	0.055	
Peak 4	16.847	2.205	



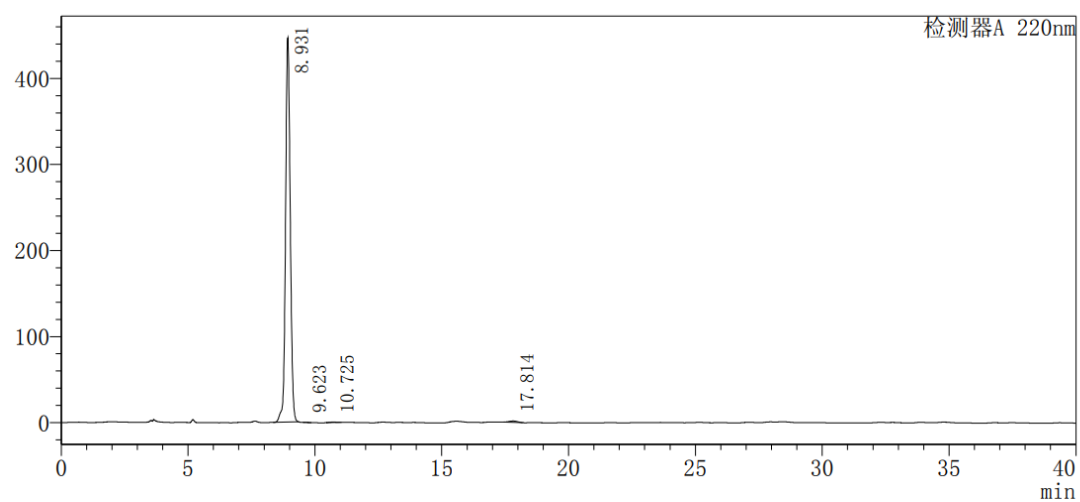
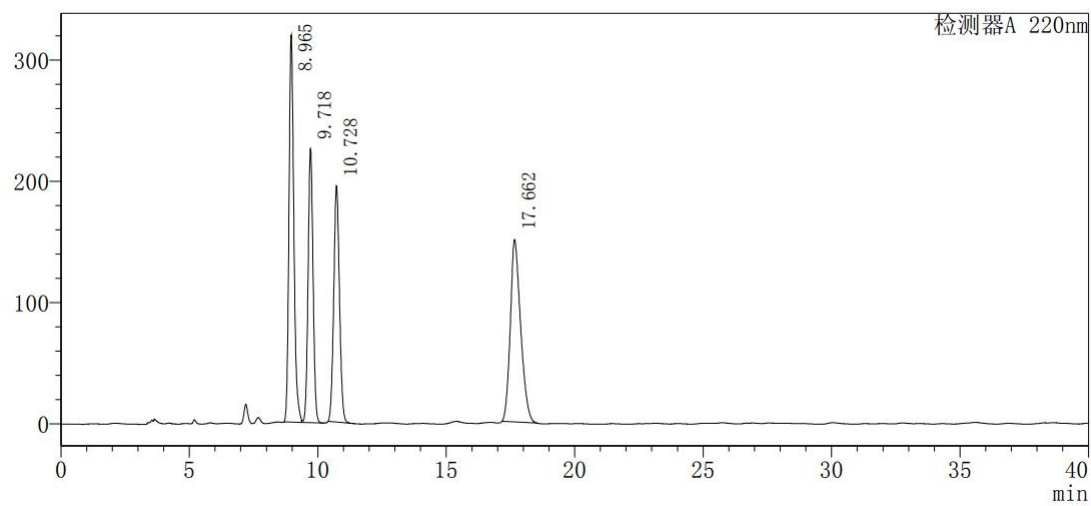
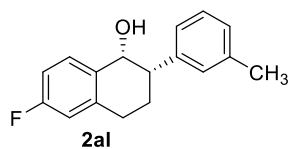
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	25.107	99.340	
Peak 2	35.509	0.021	
Peak 3	36.679	0.001	
Peak 4	49.728	0.639	



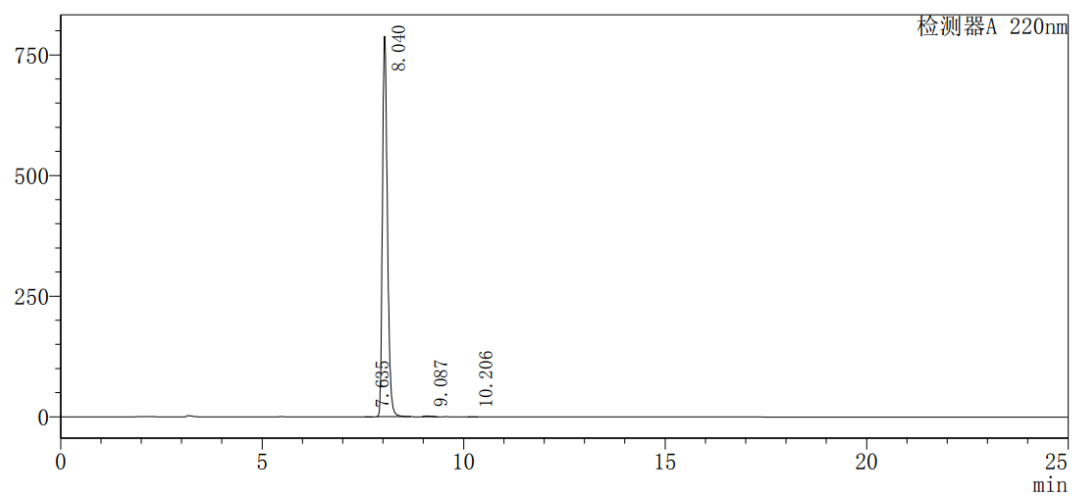
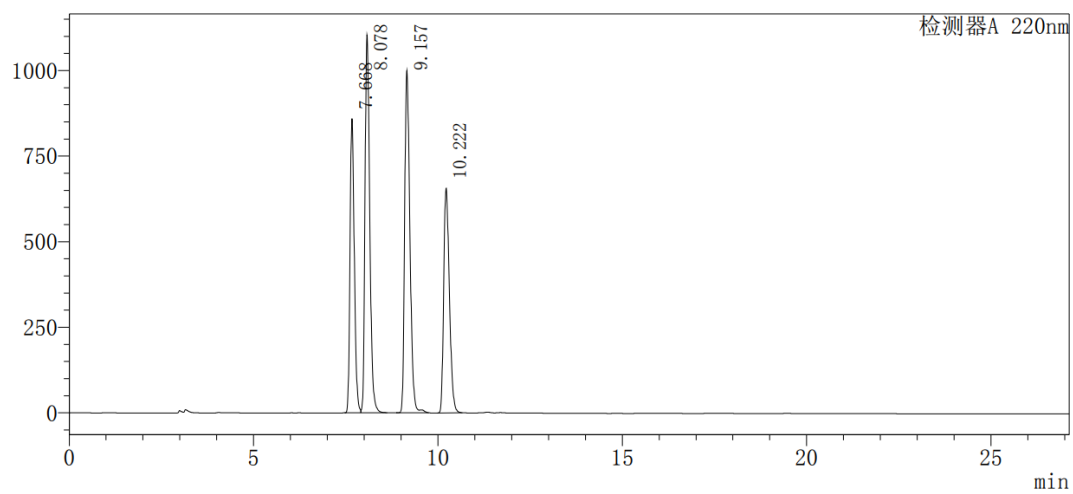
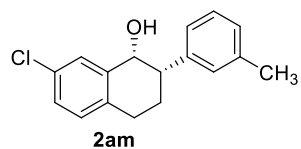
	Retention Time(min)	Relative Area (%)	99.1% ee
Peak 1	15.822	99.496	
Peak 2	18.323	0.027	
Peak 3	22.258	0.457	
Peak 4	27.449	0.020	



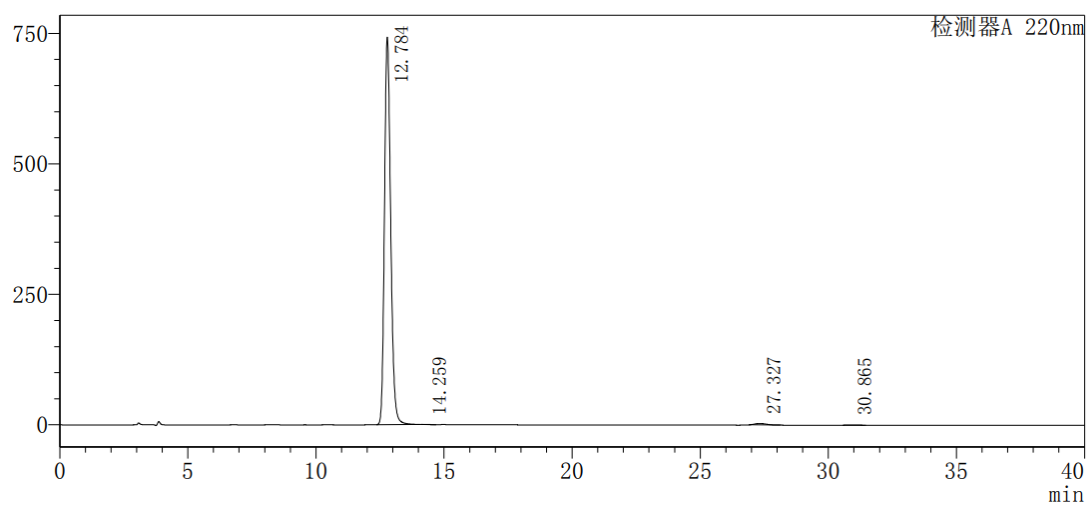
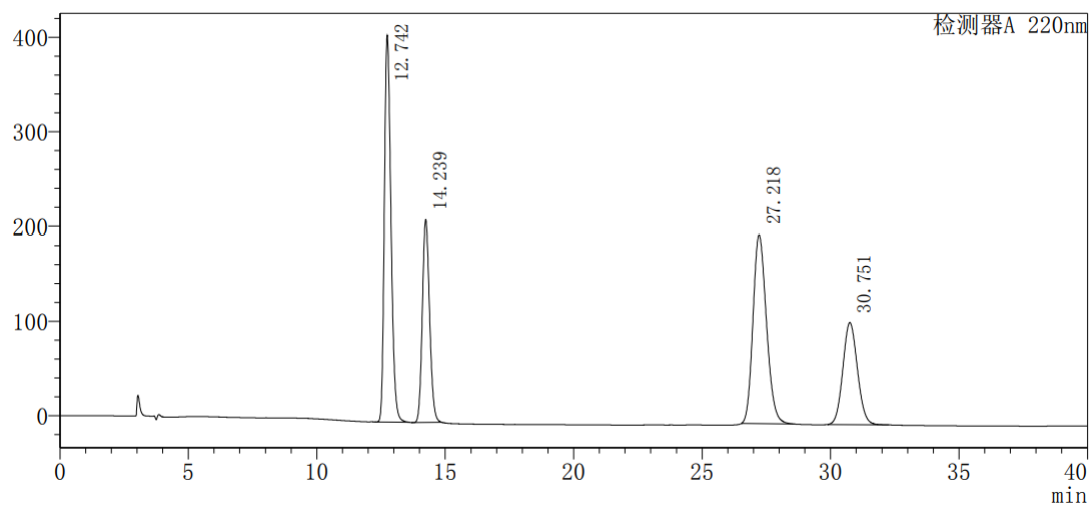
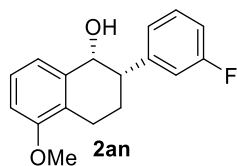
	Retention Time(min)	Relative Area (%)	99.2% ee
Peak 1	29.506	99.575	
Peak 2	47.261	0.003	
Peak 3	50.045	0.421	
Peak 4	55.764	0.001	



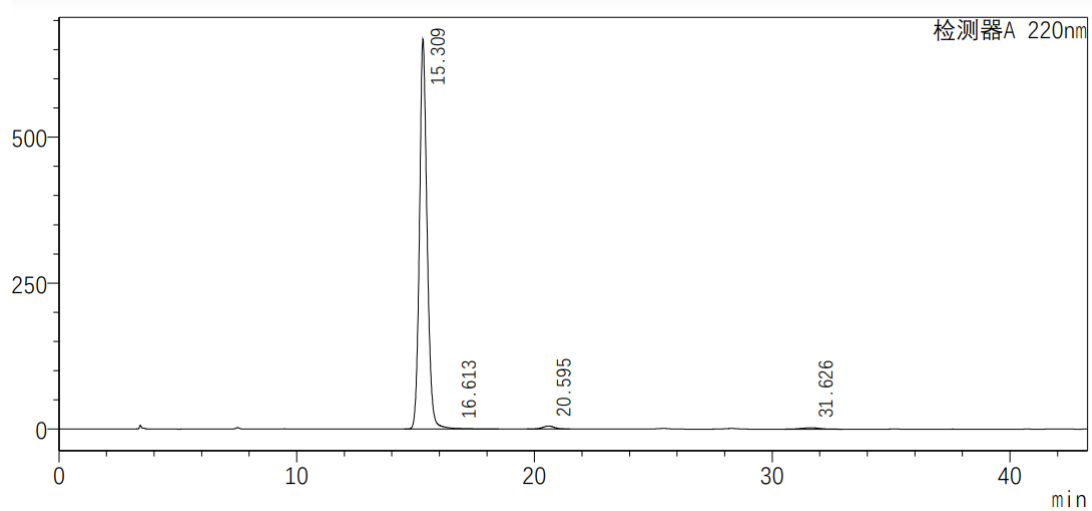
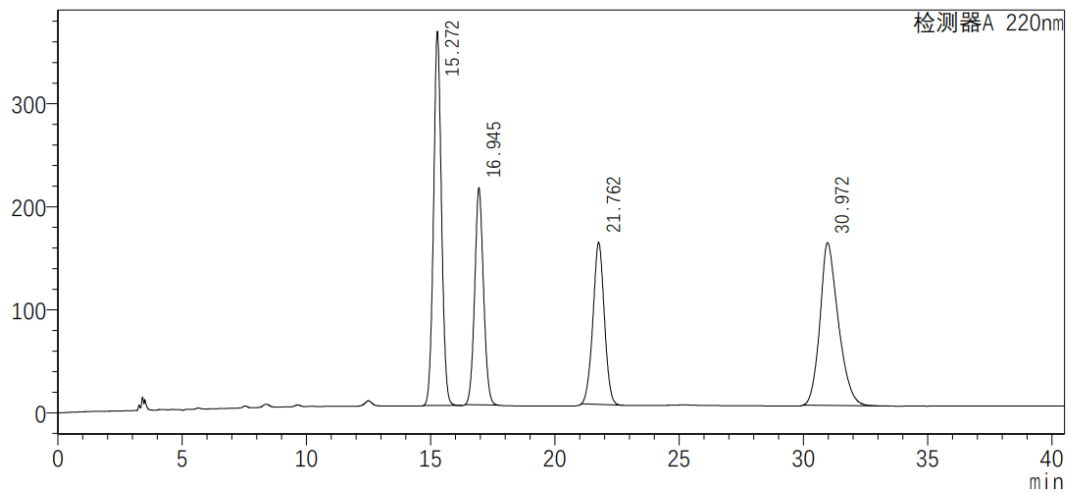
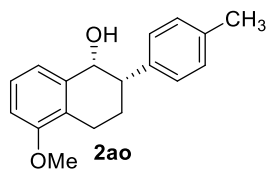
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	8.931	99.218	
Peak 2	9.623	0.031	
Peak 3	10.725	0.148	
Peak 4	17.814	0.602	



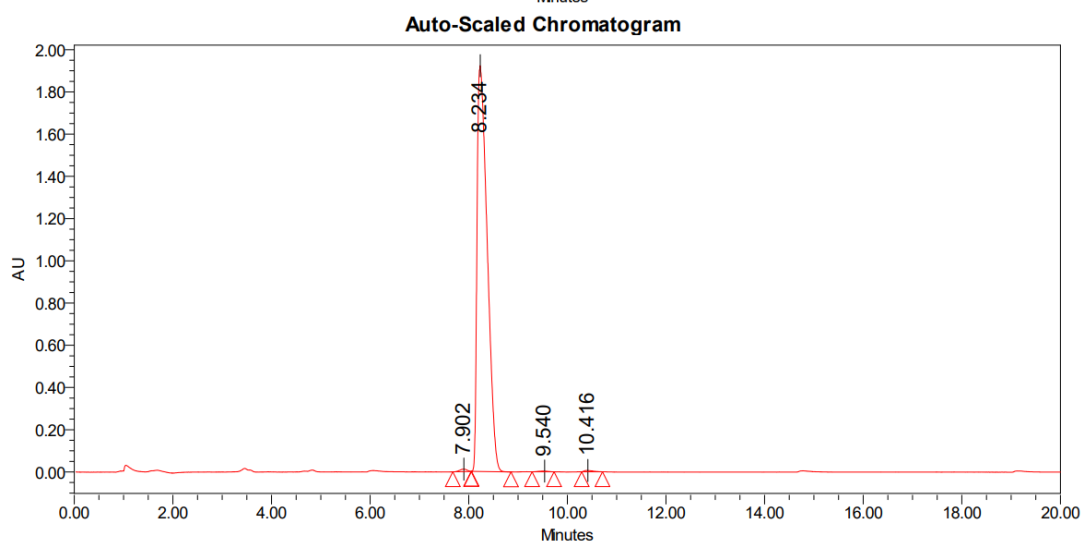
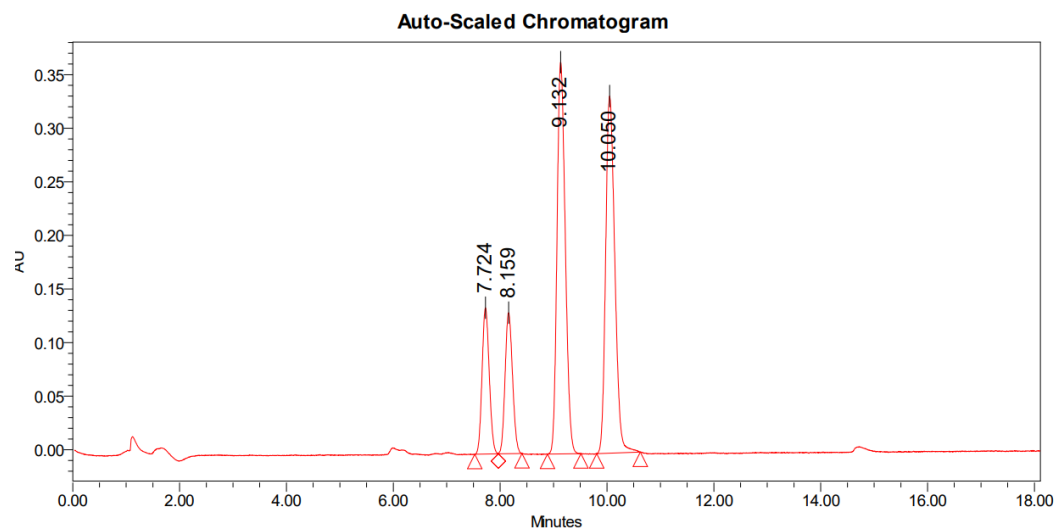
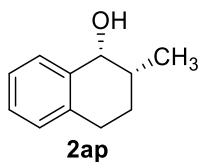
	Retention Time(min)	Relative Area (%)	99.4% ee
Peak 1	7.635	0.004	
Peak 2	8.040	99.692	
Peak 3	9.087	0.296	
Peak 4	10.206	0.009	



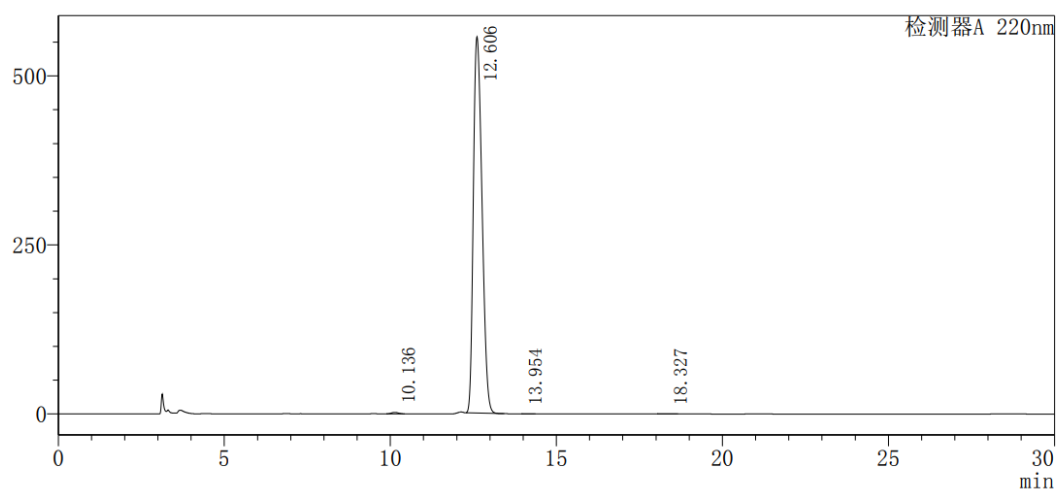
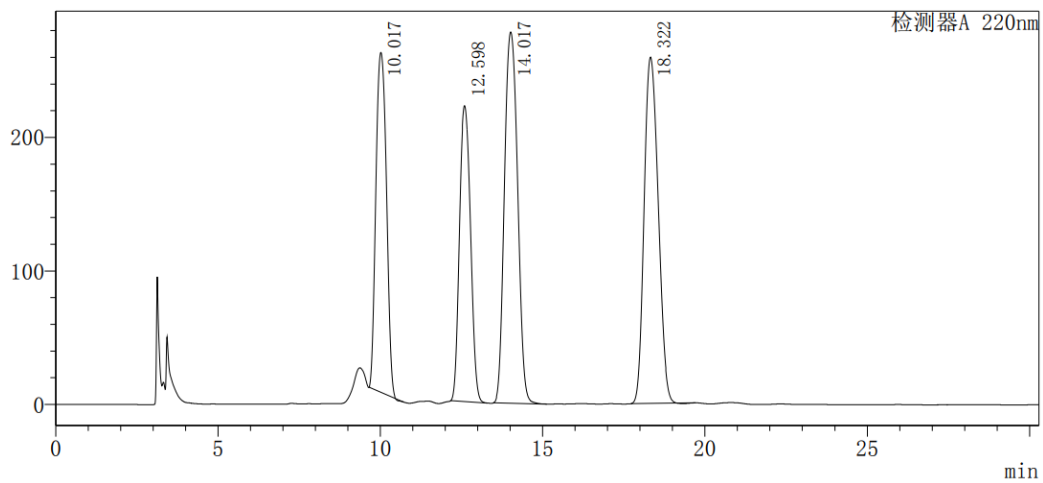
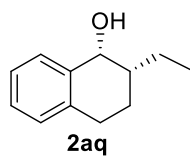
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	12.784	99.264	
Peak 2	14.259	0.026	
Peak 3	27.327	0.668	
Peak 4	30.865	0.042	



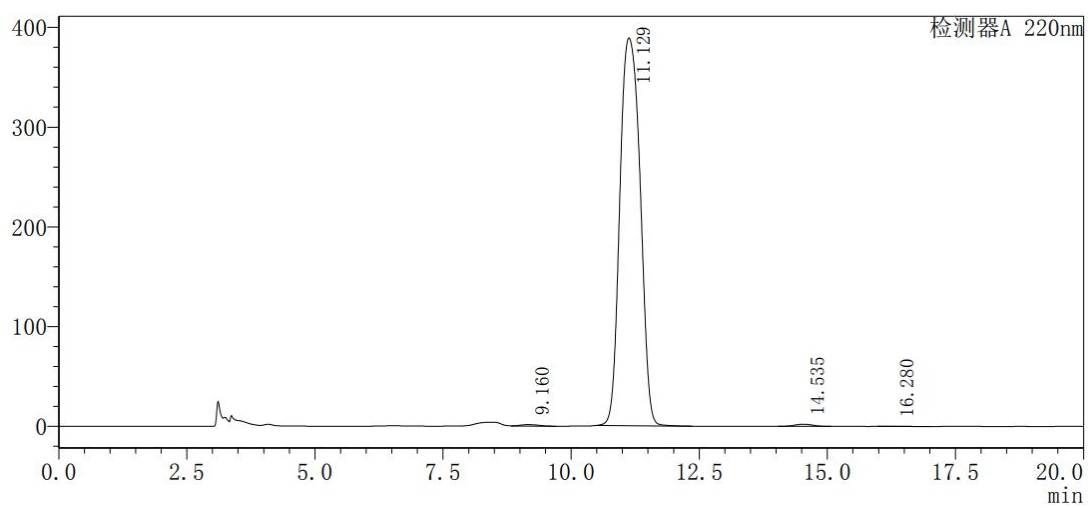
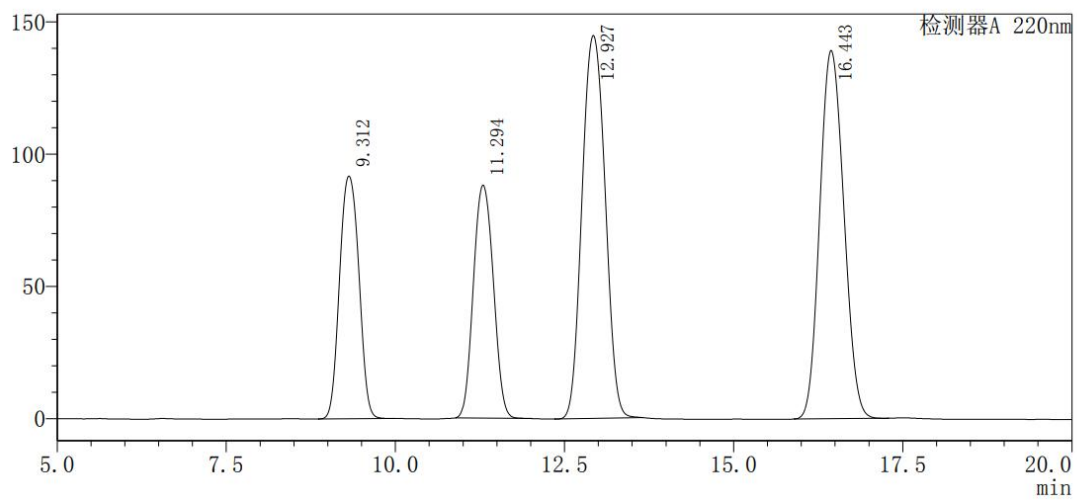
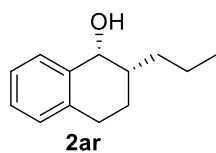
	Retention Time(min)	Relative Area (%)	98% ee
Peak 1	15.309	97.687	
Peak 2	16.613	0.288	
Peak 3	20.595	1.210	
Peak 4	31.626	0.815	



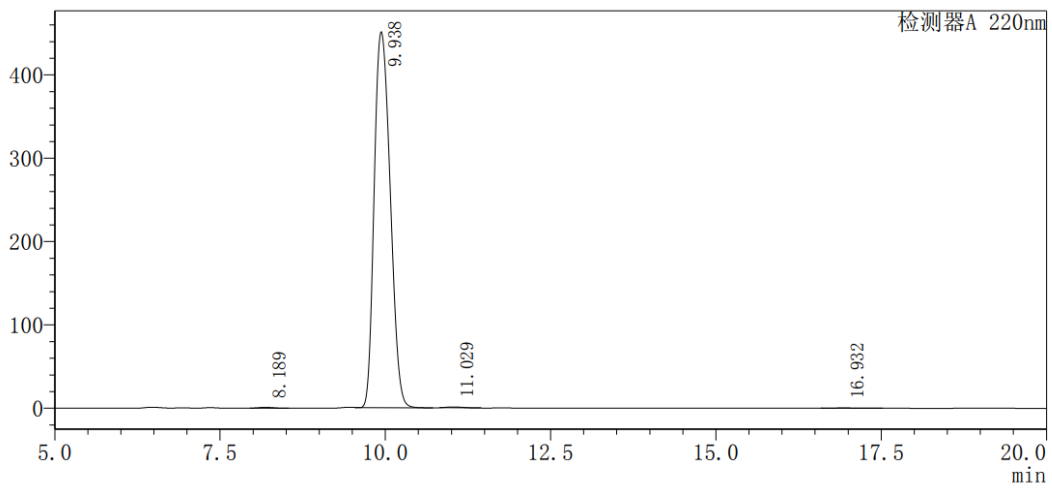
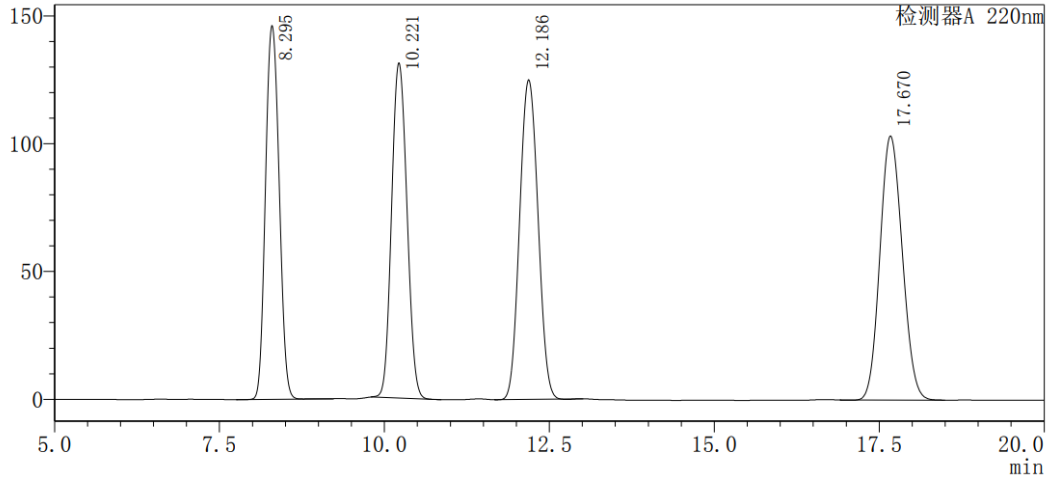
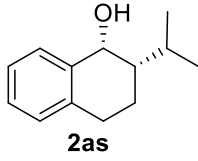
	Retention Time(min)	Relative Area (%)	99.1% ee
Peak 1	7.902	0.442	
Peak 2	8.234	99.089	
Peak 3	9.540	0.173	
Peak 4	10.416	0.296	



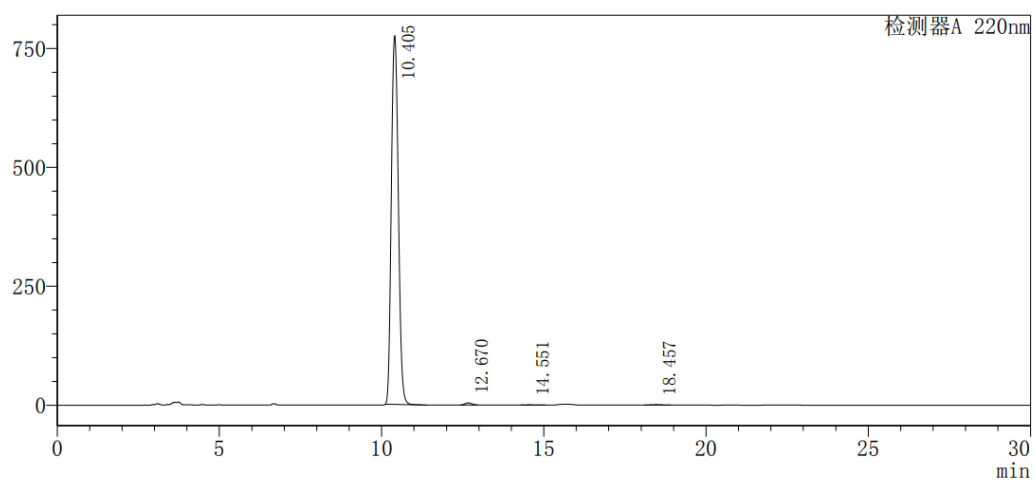
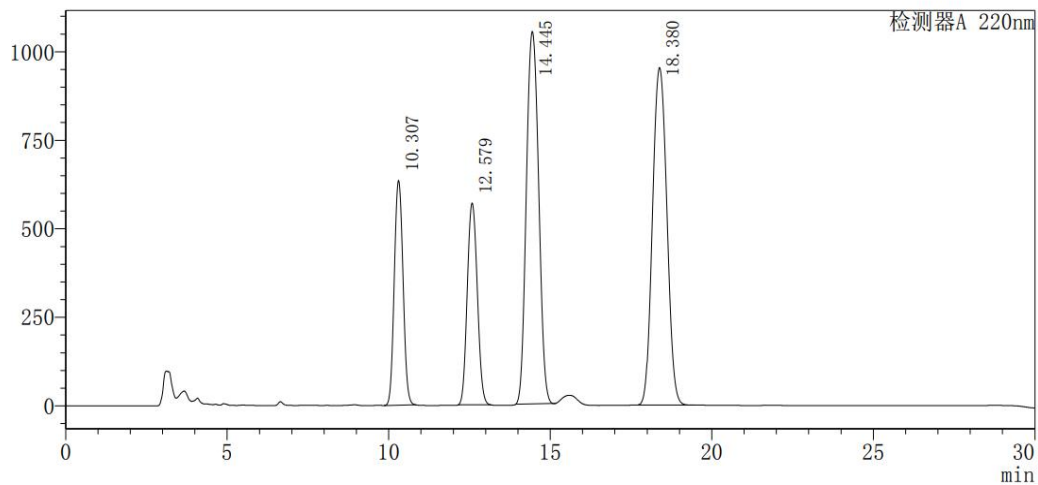
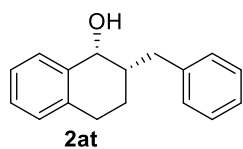
	Retention Time(min)	Relative Area (%)	99.4% ee
Peak 1	10.136	0.304	
Peak 2	12.606	99.674	
Peak 3	13.954	0.003	
Peak 4	18.327	0.018	



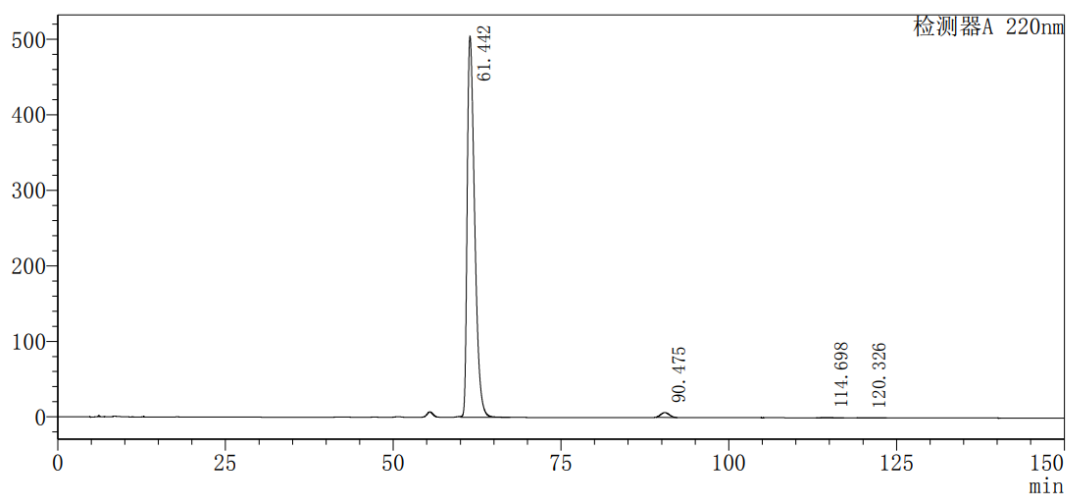
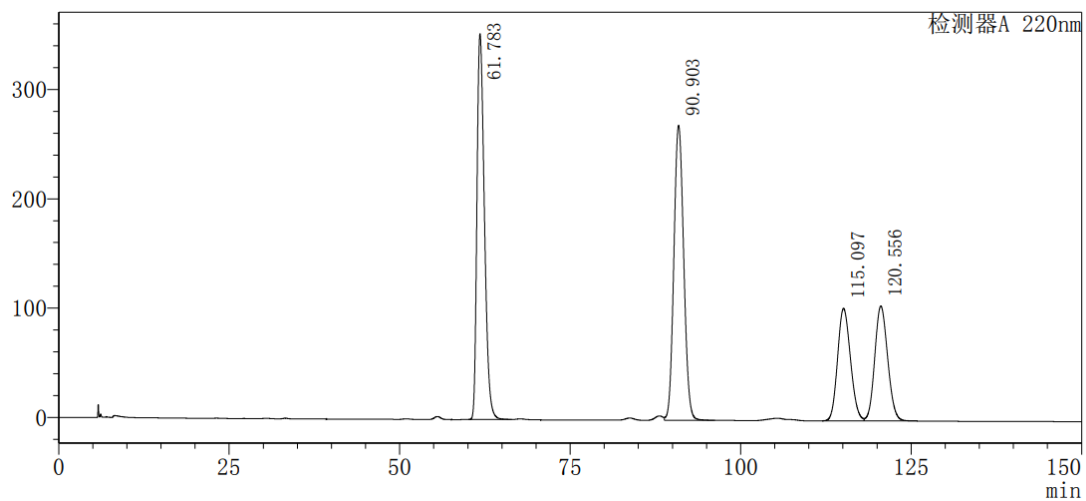
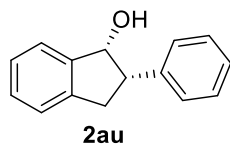
	Retention Time(min)	Relative Area (%)	99.4% ee
Peak 1	9.160	0.301	
Peak 2	11.129	99.168	
Peak 3	14.535	0.495	
Peak 4	16.280	0.036	



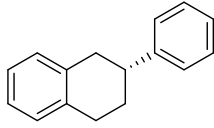
	Retention Time(min)	Relative Area (%)	99.6% ee
Peak 1	8.189	0.186	
Peak 2	9.938	99.490	
Peak 3	11.029	0.239	
Peak 4	16.932	0.085	



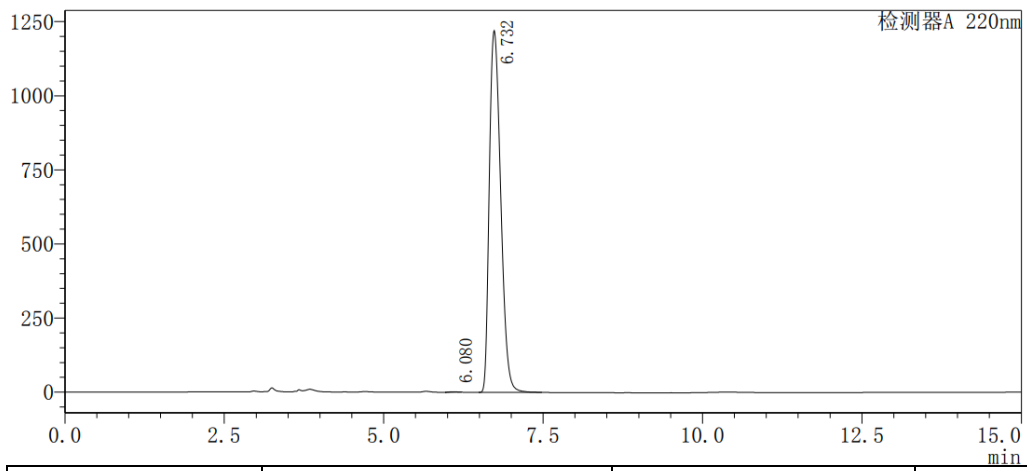
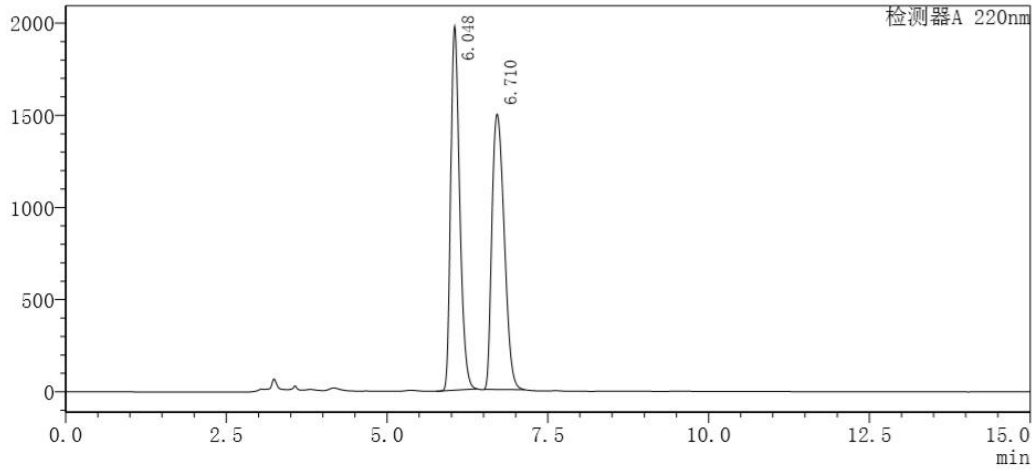
	Retention Time(min)	Relative Area (%)	99% ee
Peak 1	10.405	99.193	
Peak 2	12.670	0.522	
Peak 3	14.551	0.084	
Peak 4	18.457	0.200	



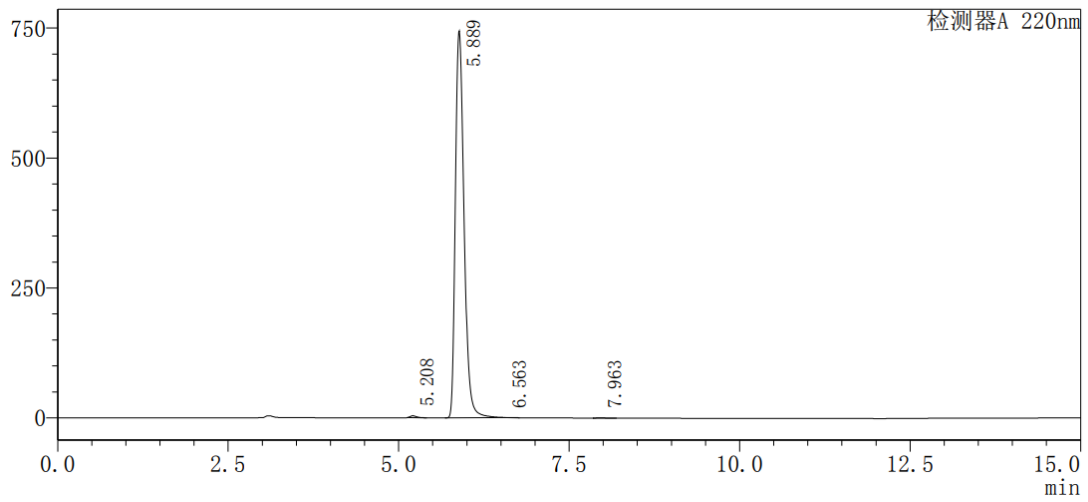
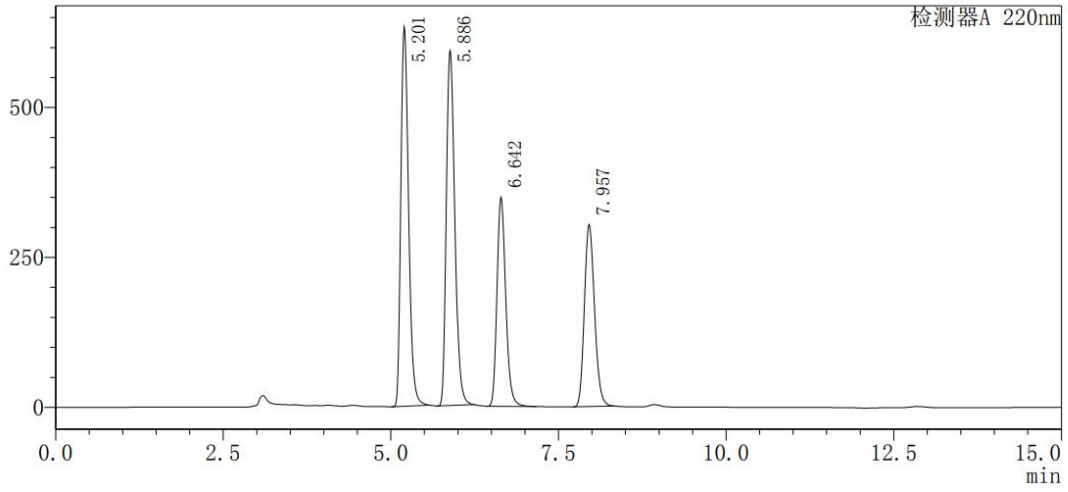
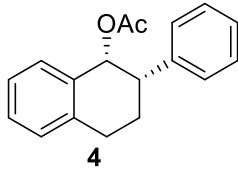
	Retention Time(min)	Relative Area (%)	97% ee
Peak 1	61.442	98.538	
Peak 2	90.475	1.372	
Peak 3	114.698	0.054	
Peak 4	120.326	0.036	



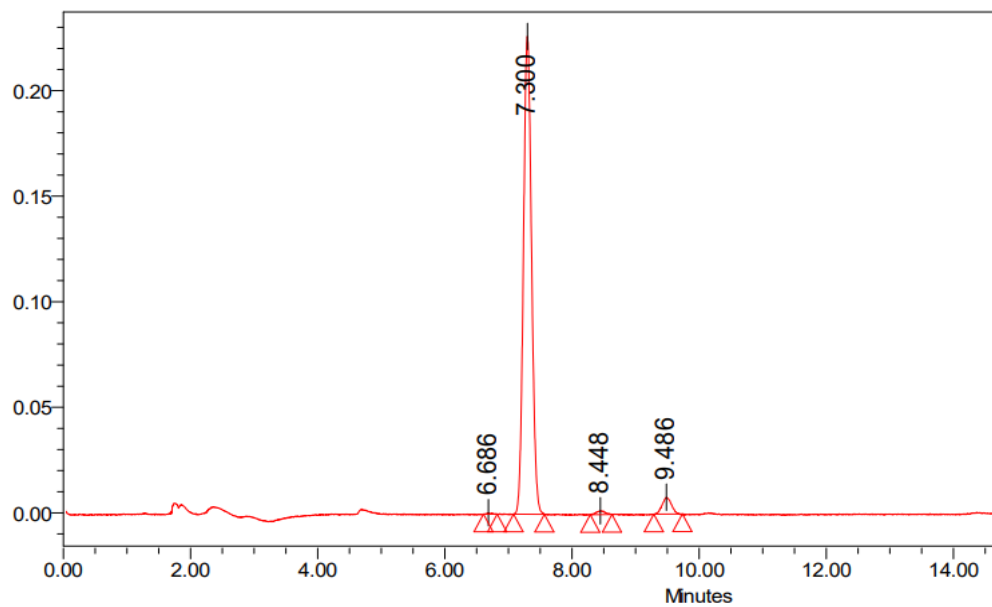
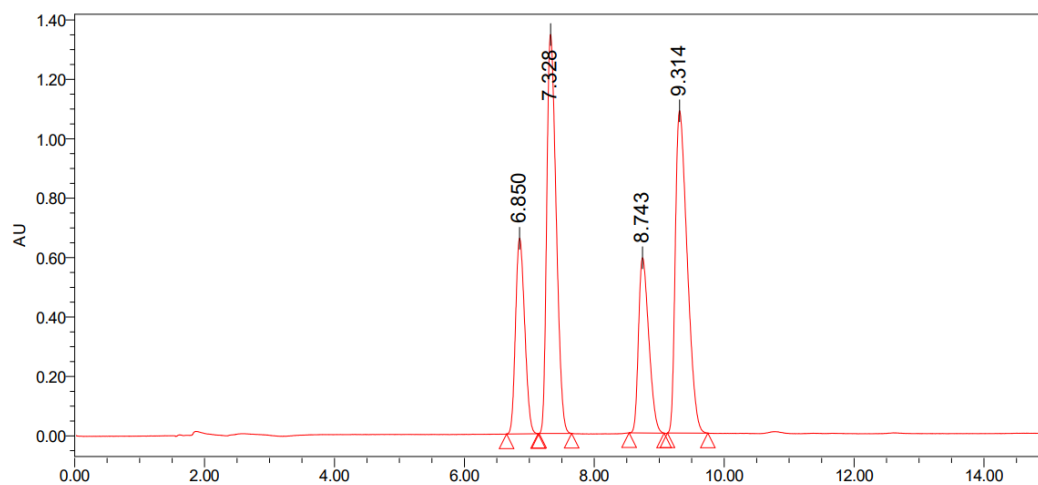
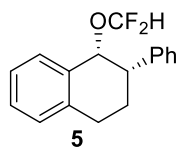
3



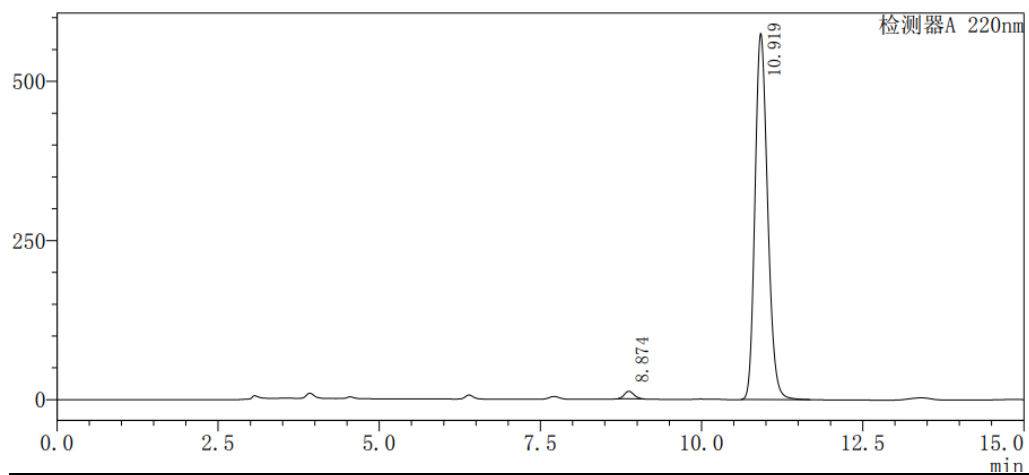
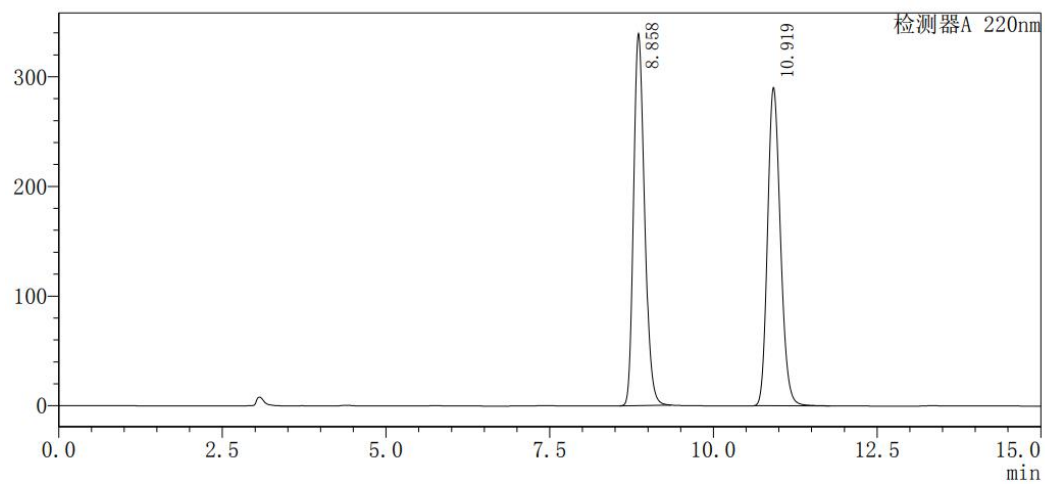
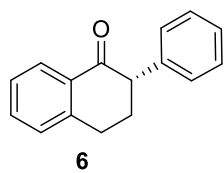
	Retention Time(min)	Relative Area (%)	99.8% ee
Peak 1	6.080	0.083	
Peak 2	6.732	99.917	



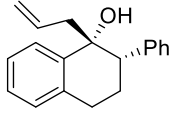
	Retention Time(min)	Relative Area (%)	99.3% ee
Peak 1	5.208	0.374	
Peak 2	5.889	99.588	
Peak 3	6.563	0.010	
Peak 4	7.963	0.028	



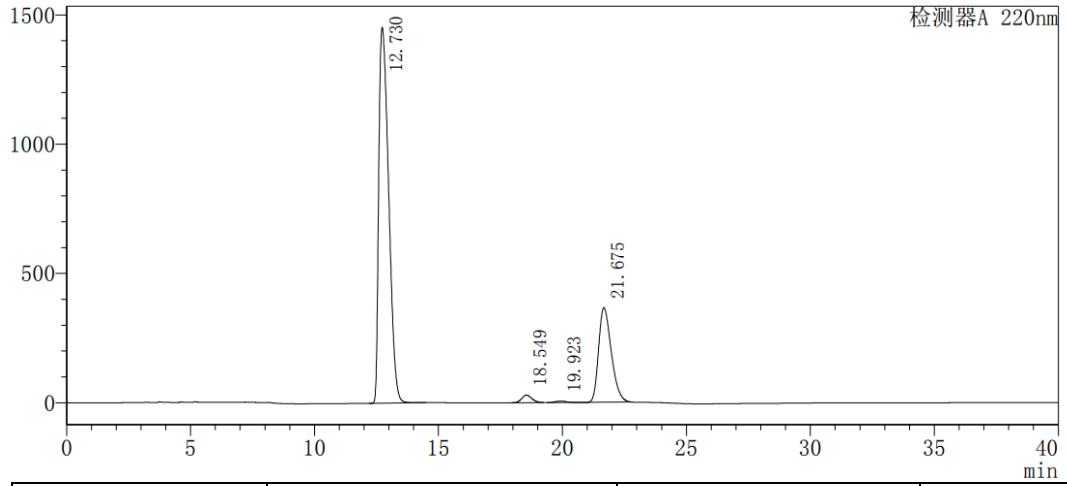
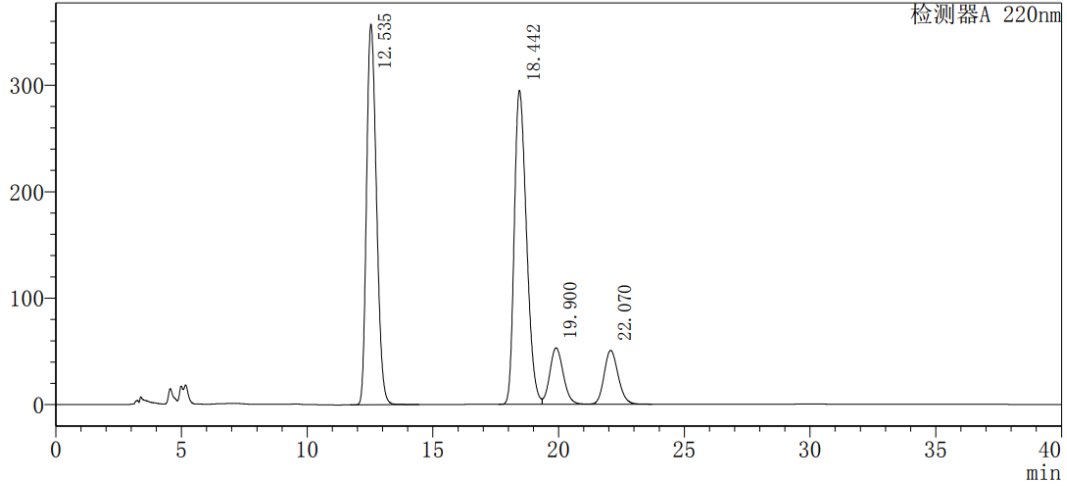
	Retention Time(min)	Relative Area (%)	92% ee
Peak 1	6.686	0.100	
Peak 2	7.300	95.299	
Peak 3	8.448	0.803	
Peak 4	9.486	3.798	



	Retention Time(min)	Relative Area (%)	97% ee
Peak 1	8.874	1.539	
Peak 2	10.919	98.461	



7



	Retention Time(min)	Relative Area (%)	3.2:1dr 96%, 98%ee
Peak 1	12.730	74.295	
Peak 2	18.549	1.505	
Peak 3	19.923	0.259	
Peak 4	21.675	23.942	

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