# Metal-free Electrochemical Anti-Markovnikov Hydration of Aryl Alkenes

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# Supporting Information

## Table of Content

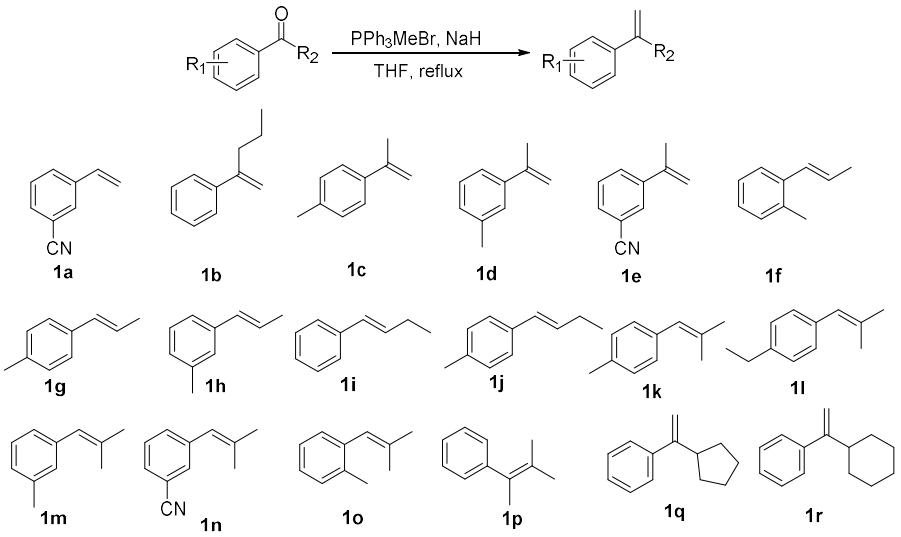
## 1. General Information

All solvents and reagents were obtained from commercial sources and were purified according to standard procedures before use (unless stated otherwise). Column chromatography was performed on silica gel (Qingdao, 300 - 400 mesh) using the indicated eluents. $^{1}H$ and $^{13}C$ NMR data were collected on a Varian Mercury 400 MHz or Agilent Mercury 600 MHz NMR spectrometer at room temperature using chloroform-d or DMSO-d6 as a solvent and TMS as an internal standard, and chemical shift (δ) was expressed in parts per million (ppm). $^{1}H$ and $^{13}C$ NMR spectra were internally referenced to the proton ($^{1}H$) of the internal TMS signal at 0.00 ppm or the solvent residue of DMSO-d6 at 2.50 ppm and the residual carbon nuclei ($^{13}C$) of the solvent at 77.0 or 39.5 ppm, respectively. The following abbreviations were used in expressing the multiplicity: s = singlet, brs = broad singlet, d = doublet, t = triplet, q = quartet, m = multiplet. High resolution mass spectra (HRMS-ESI) were recorded on a Bruker ESI-QTOF mass spectrometer. The course of the reactions was monitored by thin-layer chromatography (TLC).

## 2. Preparation of aryl alkenes

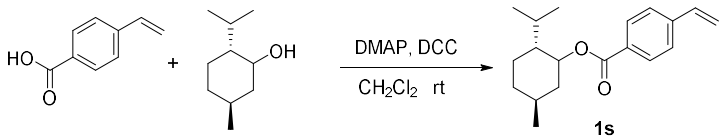
All of aryl alkenes are known compounds. Substrates **1a-1r** were prepared according to the published literature.[1] Other substrate were obtained from commercial sources or prepared according to known procedures as below:

**Method A:** To a solution of $PPh_3MeBr$ (1.2 equiv., 4.8 mmol, 1.7 g) in THF (8 mL) was added NaH (60%, 1.1 equiv., 4.4 mmol, 105.6 mg), the reaction mixture was refluxed for 1 h. Then the corresponding ketones (4 mmol) in THF (2 mL) were added dropwise at 0 °C. The mixture was refluxed overnight. When the starting material was consumed (monitored by TLC), the reaction mixture was diluted by petroleum ether and filtered through a pad of silica gel. The filtrate was concentrated to give a crude product which was purified through flash column chromatography to obtain the desired product.



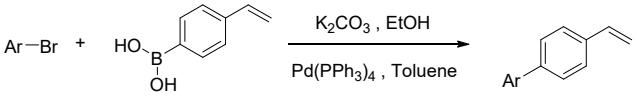

**Method B:** According to known procedures [2], the 4-vinylbenzoic acid (1.2 equiv., 6 mmol, 888.9 mg), DL-Menthol (1.0 equiv., 5 mmol, 781.4 mg), and 4-dimethylaminopyridine (5 mol %, 30.5 mg) were mixed in a flask, 30 mL $CH_2Cl_2$ was added. Then a solution of N, N′-dicyclohexylcarbodiimide (1.2 equiv., 6 mmol, 1237.9 mg) in $CH_2Cl_2$ (10 mL) was added slowly at room temperature. The reaction mixture was maintained at room temperature with stirring for 1-3 h, during which time the reaction mixture became cloudy and a white solid precipitated from the solution. The white solid was removed via vacuum filtration and the filtrate was

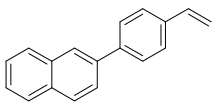
removed under reduced pressure. The residue was purified by flash column chromatography to give **1s**.



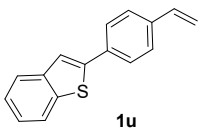

**1s**

**Method C:** According to the published procedures[3], a mixture of aryl bromine (3 mmol), 4-vinylphenylboronic acid (3.03 mmol, 448.3 mg), $K_2CO_3$ solution (2N, 3 mL), toluene (10 mL), ethanol (2.5 mL), $Pd(PPh_3)_4$ (1 mol%, 34.7 mg) were placed in a two-neck glass-reactor equipped with a magnetic stirring bar and reflux condenser. The suspension was heated in an oil bath at 85°C for 12 h. After the reaction was completed (monitored by TLC), the resulting mixture was transferred to a separatory funnel. The mixture was extracted with EtOAc (3×10 mL), and the resulting organic solution was washed with brine and dried over $Na_2SO_4$. The solvent was evaporated under reduced pressure and the resulting residue was purified by silica gel chromatography (5% ethyl acetate in hexanes) provided the desired product **1t** or **1u.**



**1t**



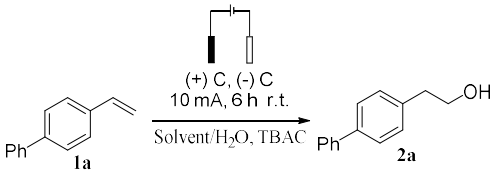

**1u**

## 3. Optimization of the reaction conditions

### 3.1 Electrolysis general information

Electrochemical reactions were performed with ElectraSyn 2.0 package (IKA) using the constant current or constant voltage modes. The reactions were conducted in a 10 mL vial for 6 mL of solvent with a stir bar and a carbon graphite-SK-50 (5.0 × 0.8 × 0.2 cm) working electrode (anode and cathode) with a distance of 0.6 cm between the two electrodes.

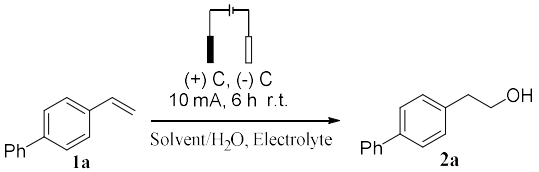
### 3.2 Screening of solvents, amounts of water [a]




| Entry | Solvent | Electrolyte | $H_2O$ | **2a** Yield (%) |
|---|---|---|---|---|
| 1 | TBAC | DMA | 36 μL | 36 |
| 2 | TBAC | DMSO | 36 μL | - |
| 3 | TBAC | DMF | 36 μL | 54 |
| 4 | TBAC | DMF | 108 μL | 49 |
| 5 | TBAC | DMF | 500 μL | 51 |
| 6[b] | TBAC | DMF | 1 mL | 52 |
| 7[c] | TBAC | DMF | 3 mL | 22 |

[a] Conditions: undivided cell, carbon cloth anode and cathode, **1a** (0.2 mmol), TBAC (0.2 mmol), Solvent (6 mL), $H_2O$, CCE = 10 mA, T = 6 h, RT, under air. Yields were isolated yields. CCE = constant current electrolysis. [b] 5 mL DMF was used. [c] 3 mL DMF was used.

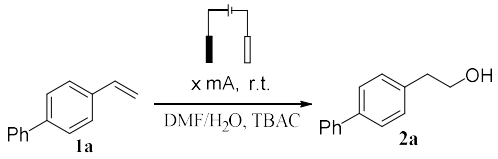
### 3.3 Screening of electrolyte [a]




| Entry | Solvent | Electrolyte | $H_2O$（μL） | **2a** Yield (%) |
|---|---|---|---|---|
| 1 | DMF | $^{n}Bu_4NBr$ | 36 | 22 |
| 2 | DMF | $^{n}Bu_4NI$ | 36 | 13 |
| 3 | DMF | TBAC | 36 | 58 |
| 4 | DMF | $NH_4Cl$ | 36 | - |
| 5 | DMF | $^{n}Bu_4NBF_4$ | 36 | - |
| 6[b] | DMF | $^{n}Bu_4NBF_4$ | 36 | 28 |
| 7 | DMF | $(CH_3)_4NCl$ | 36 | 45 |
| 8 | DMF | $(C_2H_5)_4NCl$ | 36 | 44 |
| 9 | DMF | $(C_3H_7)_4NCl$ | 36 | 41 |
| 10 | DMF | $C_{16}H_{33}(CH_3)_3NCl$ | 36 | 55 |
| 11[c] | DMF | TBAC | 36 | 51 |
| 12[d] | DMF | TBAC | 36 | 54 |
| 13[e] | DMF | TBAC | 36 | 58 |

[a] Conditions: undivided cell, carbon-cloth anode and cathode, **1a** (0.2 mmol), Electrolyte (0.4 mmol), DMF (6 mL), $H_2O$ (36 μL), CCE = 10.0 mA, 6 h, RT, under air. Yields were isolated yields. CCE = constant current electrolysis. [b] 0.2 mmol NaCl was used. [c] 0.1 mmol TBAC was used. [d] 0.2 mmol TBAC was used. [e] 0.6 mmol TBAC was used.

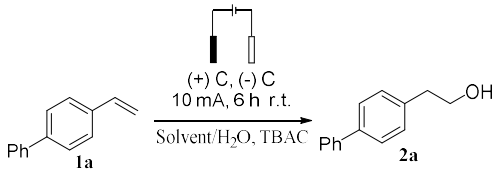
### 3.4 Screening of electrodes, electric current [a]




| Entry | electrode | CCE (x mA) | T (h) | **2a** Yield (%) |
|---|---|---|---|---|
| 1 | (+)C, (-)C | 5 mA | 12 | 34 |
| 2 | (+)C, (-)C | 10 mA | 6 | 58 |
| 3 | (+)C, (-)C | 20 mA | 3 | 50 |
| 4 | (+)C, (-)Pt | 10 mA | 6 | 51 |

[a] Conditions: undivided cell, carbon-cloth anode and cathode, **1a** (0.2 mmol), TBAC, (0.4 mmol) DMF (6 mL), $H_2O$ (36 μL), CCE, T, RT, under air. Yields are based on product isolated by column chromatography. CCE = constant current electrolysis.

### 3.5 Screening of additives [a]

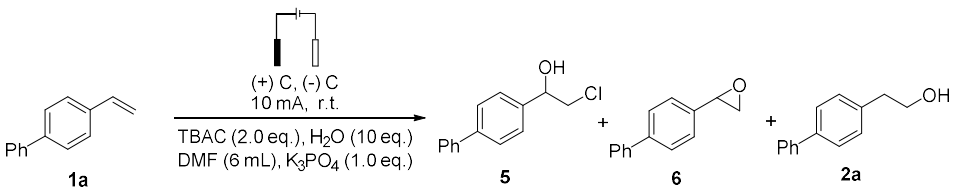



| Entry | Electrolyte | Additives | $H_2O$（μL） | **2a** Yield (%) |
|---|---|---|---|---|
| 1 | TBAC | $Bu_4NHSO_4$ | 36 | 39 |
| 2 | TBAC | $KH_2PO_4$ | 36 | 44 |
| 3 | TBAC | $K_3PO_4$ | 36 | 65 |
| 4 | TBAC | $K_2CO_3$ | 36 | 45 |
| 5 | TBAC | t-BuOK | 36 | 41 |
| 6 | TBAC | KOH | 36 | 63 |
| 7 | TBAC | $Na_3PO_4$ | 36 | 56 |
| 8 | TBAC | NaOH | 36 | 42 |
| 9 | TBAC | AcONa | 36 | 64 |
| 10 | TBAC | $CH_3CH_2ONa$ | 36 | 30 |
| 11 | TBAC | AcOK | 36 | 39 |
| 12 | TBAC | TFA | 36 | - |
| 13 | TBAC | $Et_3N$ | 36 | - |
| 14 | TBAC | $K_2HPO_4$ | 36 | 63 |
| 15 | TBAC | $(PhO)_2P(O)OH$ | 36 | 26 |
| 16 | TBAC | $H_3PO_4$ | 36 | 16 |
| 17 | TBAC | HCl | 36 | 14 |
| 18[b] | TBAC | $K_3PO_4$ | 36 | 45 |
| 19[c] | TBAC | $K_3PO_4$ | 36 | 49 |

[a] Conditions: undivided cell, carbon-cloth anode and cathode, **1a** (0.2 mmol), TBAC (0.4 mmol), DMF (6 mL), $H_2O$ (36 μL), Additives (0.2 mmol), CCE = 10.0 mA, 6h, RT, under air. Yields are based on product isolated by column chromatography. CCE = constant current electrolysis. [b] 0.1 mmol $K_3PO_4$ was used. [c] 0.4 mmol $K_3PO_4$ was used.

## 4. Mechanistic studies

### 4.1 Kinetic experiments




**Reaction procedure:**

A mixture of **1a** (0.2 mmol, 36.1 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg) and TBAC (0.4 mmol, 111.2 mg) were added in a 10 mL vial with a stir bar, then DMF (6 mL), $H_2O$ (36 μL) were added under air atmosphere. The vial was covered with the electrode holder. The electrolysis was carried out at RT using a constant current of 10.0 mA between a carbon graphite anode and carbon graphite cathode (1.4 x 0.8 x 0.2 cm submerged in solution) with stirring. The reactions were stopped respectively at 0.5 h, 1 h, 2 h, 4 h, 6 h. The reaction mixture was diluted with EtOAc. The organic phase was washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. Yields were determined by $^1$H NMR with TTCE as internal standard. The plots of the percentage yield of the product displayed in Figure S2.

| Entry | *t* (h) | Yield **5** (%) | Yield **6** (%) | Yield **2a** (%) | Recoved yield **1a** (%) |
|---|---|---|---|---|---|
| 1 | 0.5 | 6 | 19 | 13 | 52 |
| 2 | 1 | 4 | 18 | 28 | 37 |
| 3 | 2 | 3 | 12 | 49 | 4 |
| 4 | 4 | 2 | 7 | 61 | 1 |
| 5 | 6 | 0 | 0 | 74 | 0 |

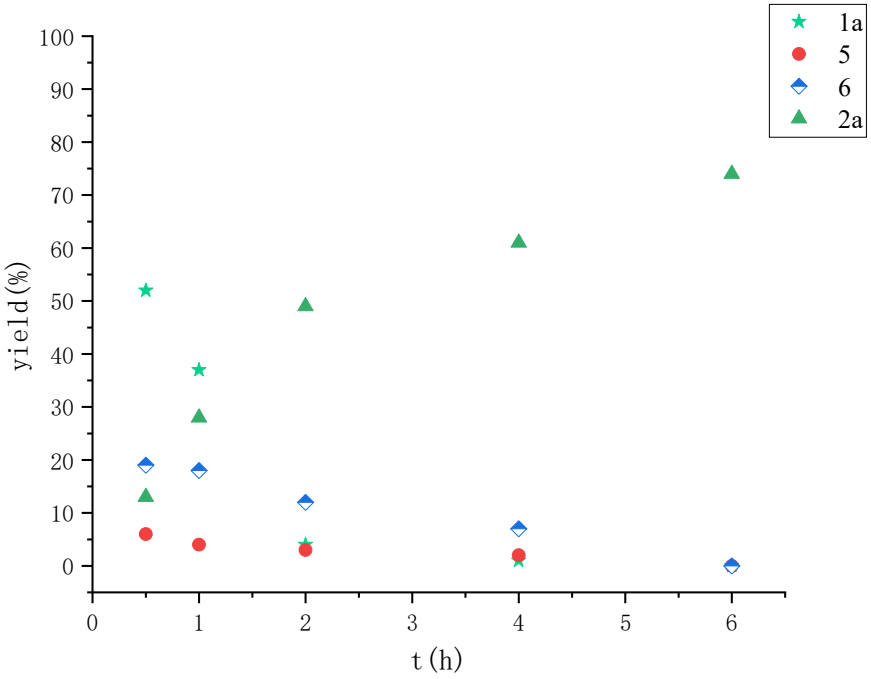
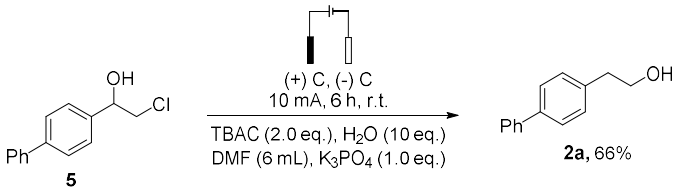
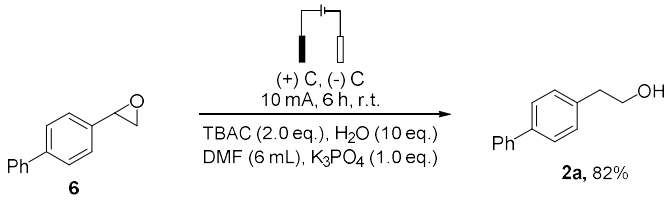



**Figure S2 Results of kinetic experiments**

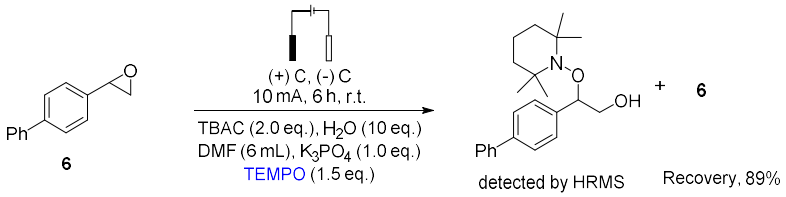
## 4.2 Control experiments

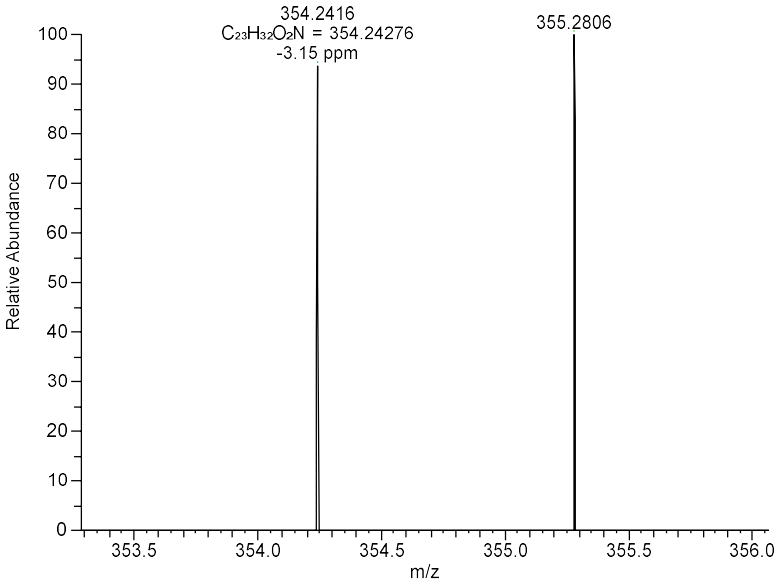



To a 10 mL flask, equipped with a magnetic stir bar and two graphite rods (Φ = 5 mm) as anode and cathode, was added **5** (0.2 mmol, 46.5 mg), TBAC (0.4 mmol, 111.2 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg), DMF (6ml), $H_2O$ (10.0 equiv.). The mixture was stirred at room temperature and reacted at a constant current of 10 mA for 6 h. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (eluent: Petroleum ether/ethyl acetate = 5:1, v/v) to afford. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel to afford **2a** (26.1 mg, 66% yield).



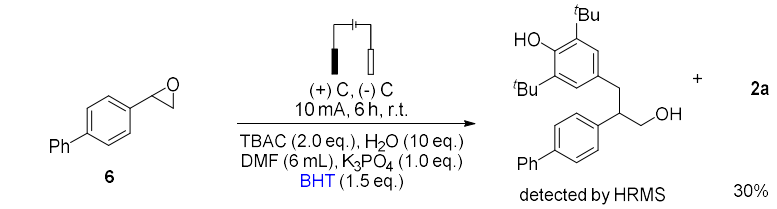

To a 10 mL flask, equipped with a magnetic stir bar and two graphite rods (Φ = 5 mm) as anode and cathode, was added **6** (0.2 mmol, 39.3 mg), TBAC (0.4 mmol, 111.2 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg), DMF (6 mL), $H_2O$ (10.0 equiv.). The mixture was stirred at room temperature and reacted at a constant current of 10 mA for 6 h. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (eluent: Petroleum ether/ethyl acetate = 5:1, v/v) to afford. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel to afford **2a** (32.5 mg, 82% yield).

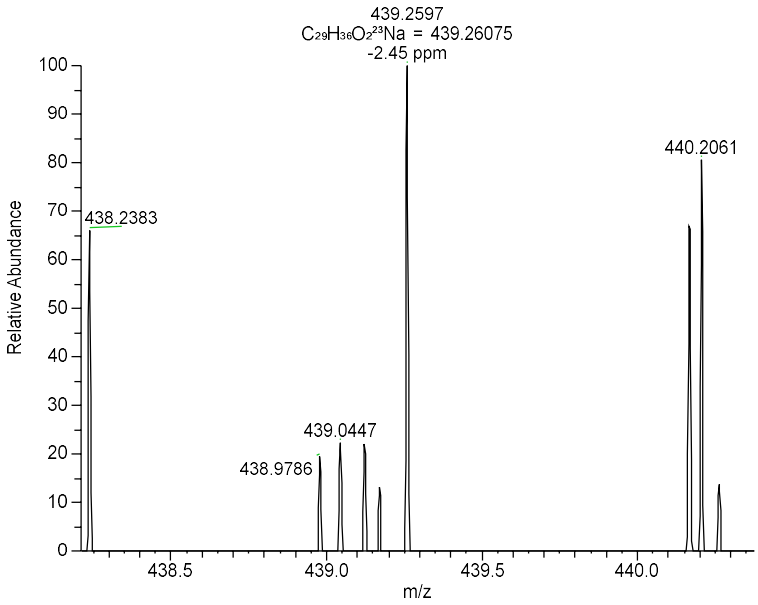



To a 10 mL flask, equipped with a magnetic stir bar and two graphite rods (Φ = 5 mm) as anode and cathode, was added **6** (0.2 mmol, 39.3 mg), TBAC (0.4 mmol, 111.2 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg), DMF (6 mL), $H_2O$ (10.0 equiv.), TEMPO

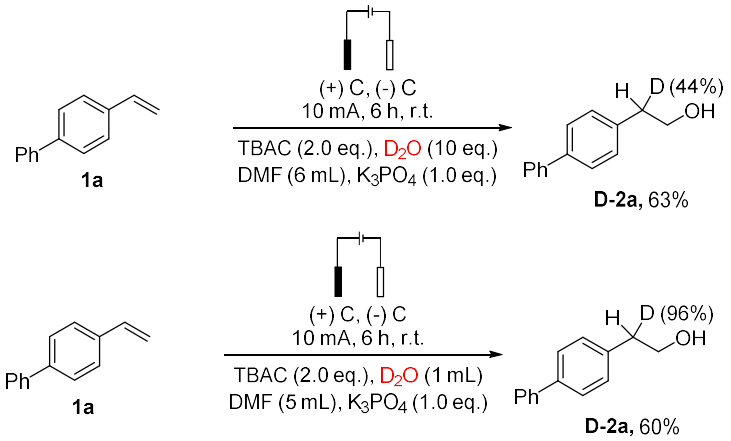
(46.8 mg 1.5 equiv.). The mixture was stirred at room temperature and reacted at a constant current of 10 mA for 6 h. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (eluent: Petroleum ether/ethyl acetate = 5:1, v/v) to afford. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel to recovery **6** (34.9 mg, 89% yield). We further investigated the possible intermediates generated in the reaction process by the use of high resolution mass spectrometry (HRMS) analysis, and the corresponding TEMPO adduct could be clearly detected. **HRMS** (ESI) m/z: $[M + H]^+$ Calcd for $C_{23}H_{32}O_2N$ 354.2428; Found 354.2416.



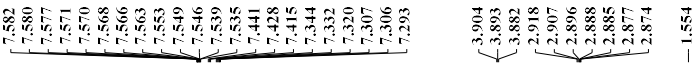




To a 10 mL flask, equipped with a magnetic stir bar and two graphite rods (Φ = 5 mm) as anode and cathode, was added **6** (0.2 mmol, 39.3 mg), TBAC (0.4 mmol, 111.2 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg), DMF (6 mL), $H_2O$ (10.0 equiv.), BHT (66.0 mg 1.5 equiv.). The mixture was stirred at room temperature and reacted at a constant

current of 10 mA for 6 h. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (eluent: Petroleum ether/ethyl acetate = 5:1, v/v) to afford. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel to afford **2a** (11.9 mg, 30% yield). We further investigated the possible intermediates generated in the reaction process by the use of high resolution mass spectrometry (HRMS) analysis, and the corresponding BHT adduct could be clearly detected. **HRMS** (ESI) m/z: [M + Na] $^{+}$ Calcd for $C_{29}H_{36}O_2Na$ 439.2608; Found 439.2597.




To a 10 mL flask, equipped with a magnetic stir bar and two graphite rods (Φ = 5 mm) as anode and cathode, was added **1a** (0.2 mmol, 36.1 mg), TBAC (0.4 mmol, 111.2 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg), DMF (6 or 5 mL), $D_2O$ (36 μL. or 1 mL), the mixture was stirred at room temperature and reacted at a constant current of 10 mA for 6 h. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (eluent: Petroleum ether/ethyl acetate = 5:1, v/v) to afford. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel to afford **D-2a**.

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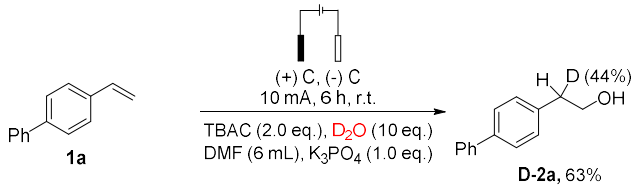


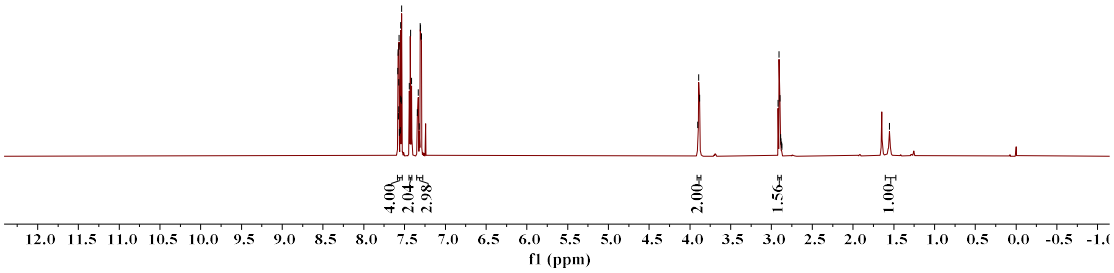


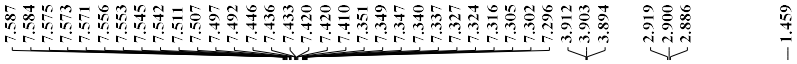


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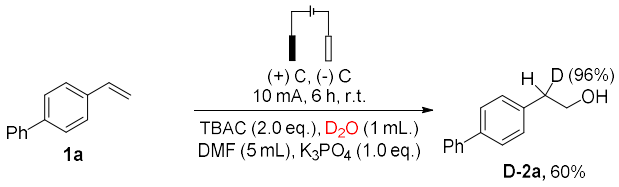
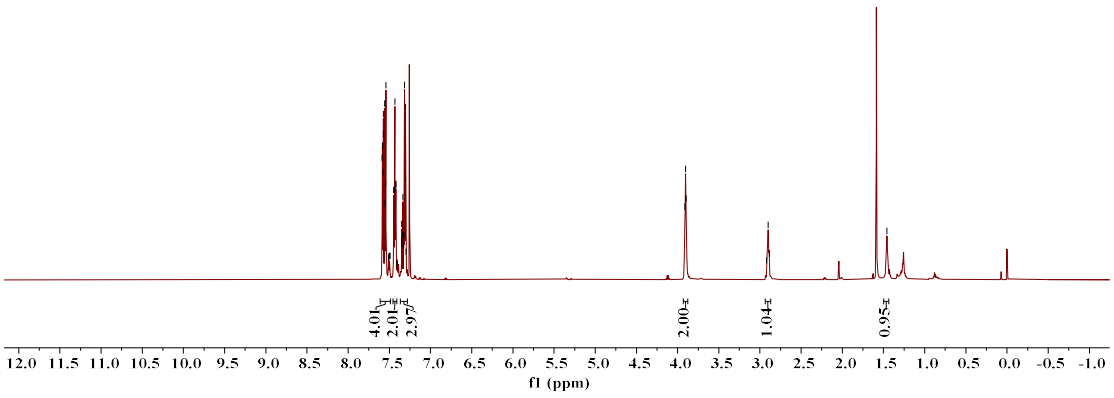


### 4.3. General procedure for cyclic voltammetry (CV)

Cyclic voltammetry was performed with ElectraSyn 2.0 package (IKA). A glassy carbon disc (diameter 3 mm) working electrode, a platinum wire counter electrode and a saturated silver chloride electrode as reference electrode were used at scan rate of 400 mV/s. The experiments were conducted in a 10 mL vial without stirring in $CH_3CN$ (5 mL) with **1a** (0.025 M) and/or TBAC (0.025 M), $K_3PO_4$ (0.025 M), $H_2O$ (36 μL) and $Et_4NBF_4$ (0.025 M) at 25 °C.

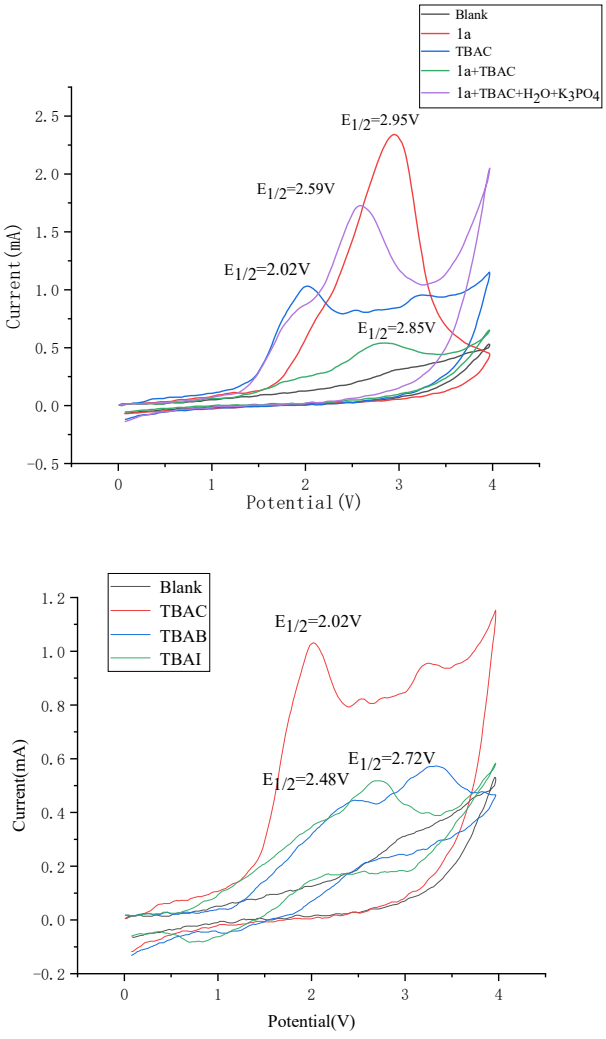
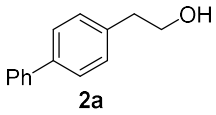



Figure **S2**. Cyclic voltammogram of $Et_4NBF_4$ (0.025 M) in $CH_3CN$

## 5. General procedure for 3-5 and product characterizations

To a 10 mL flask, equipped with a magnetic stir bar and two graphite rods (Φ = 5 mm) as anode and cathode, was added aryl alkenes (0.2 mmol), TBAC (0.4 mmol, 111.2 mg), $K_3PO_4$ (0.2 mmol, 42.5 mg), DMF (6 mL), $H_2O$ (10.0 equiv.), the mixture was stirred at room temperature and reacted at a constant current of 10 mA for 6 h. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel (eluent: Petroleum ether/ethyl acetate = 5:1, v/v) to afford. The reaction mixture was concentrated under reduced pressure and purified by column chromatography on silica gel to afford products.

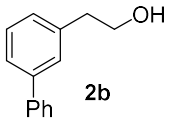
**2-([1,1'-biphenyl]-4-yl) ethan-1-ol** (**2a**)



2a

white solid, 6 h, 25.9 mg, 65% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.60 (dd, *J* = 22.8, 7.8 Hz, 4H), 7.47 (t, *J* = 7.8 Hz, 2H), 7.38 (t, *J* = 7.4 Hz, 1H), 7.33 (d, *J* = 7.7 Hz, 2H), 3.91 (t, *J* = 6.6 Hz, 2H), 2.93 (t, *J* = 6.6 Hz, 2H), 1.87 (s, 1H). The spectral data is consistent with the literature.[4]

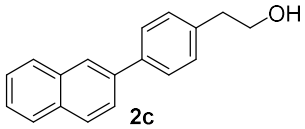
**2-([1,1'-biphenyl]-3-yl) ethan-1-ol** (**2b**)



2b

white solid, 6 h, 20.4 mg, 51% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.37 – 7.32 (m, 2H), 7.28 – 7.25 (m, 3H), 3.90 (t, *J* = 6.6 Hz, 2H), 2.90 (t, *J* = 6.6 Hz, 2H), 1.62 (s, 1H). ppm. The spectral data is consistent with the literature.[5]

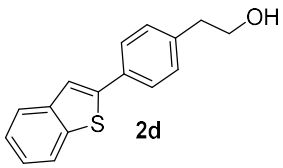
**2-(4-(naphthalen-2-yl) phenyl) ethan-1-ol** (**2c**)



2c

white solid, 6 h, 27.3 mg, 55% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 8.06 (s, 1H), 7.95 – 7.89 (m, 3H), 7.77 (dd, *J* = 8.4, 1.8 Hz, 1H), 7.72–7.71 (m, 2H), 7.55 – 7.51 (m, 2H), 7.40 – 7.38 (m, 2H), 3.96 (t, *J* = 6.6 Hz, 2H), 2.98 (t, *J* = 6.4 Hz, 2H), 1.53 (s, 1H). ppm. **$^{13}$C NMR** (151 MHz, Chloroform-*d*) δ 139.4, 138.3, 137.7, 133.7, 132.6, 129.6, 128.4, 128.2, 127.7, 127.6, 126.3, 125.9, 125.6, 125.5, 63.7, 38.9. ppm. **HRMS** (ESI) m/z: [M + Na] + Calcd for $C_{18}H_{16}ONa$ 271.1086; Found 271.1093.

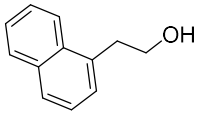
**2-(4-(benzo[b]thiophen-2-yl) phenyl) ethan-1-ol (2d)**



2d

white solid, 6 h, 11.4 mg, 22% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.83 (d, *J* = 7.8 Hz, 1H), 7.77 (d, *J* = 8.8 Hz, 1H), 7.67 (d, *J* = 8.2 Hz, 2H), 7.52 (s, 1H), 7.37 (t, *J* = 7.2 Hz, 1H), 7.32 – 7.30 (m, 3H), 3.91 (t, *J* = 6.6 Hz, 2H), 2.92 (t, *J* = 6.6 Hz, 2H), 1.56 (s, 1H) ppm. **$^{13}$C NMR** (151 MHz, Chloroform-*d*) δ 144.1, 140.7, 139.4, 138.9, 132.7, 129.6, 126.7, 124.5, 124.2, 123.5, 122.3, 119.2, 63.6, 38.9. ppm. **HRMS** (ESI) m/z: [M + H] + Calcd for $C_{16}H_{15}OS$ 255.0839; Found 255.0838.

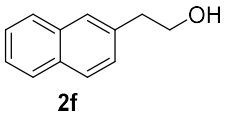
**2-(naphthalen-1-yl) ethan-1-ol (2e)**



2e

Colorless oil, 6 h, 18.4 mg, 53% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 8.05 (d, *J* = 8.4 Hz, 1H), 7.86 (d, *J* = 7.8 Hz, 1H), 7.75 (d, J = 7.2 Hz, 1H), 7.54 – 7.47 (m, 2H), 7.43 – 7.37 (m, 2H), 3.99 (d, *J* = 6.8 Hz, 2H), 3.35 (t, *J* = 6.8 Hz, 2H), 1.64 (s, 1H) ppm. The spectral data is consistent with the literature.[4]

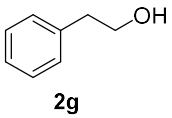
**2-(naphthalen-2-yl) ethan-1-ol (2f)**



2f

Colorless oil, 6 h, 16.8 mg, 49% yield; **$^1$H NMR** (600 MHz, Chloroform-d) δ 7.82 – 7.79 (m, 3H), 7.69 (s, 1H), 7.48 – 7.43 (m, 2H), 7.37 (d, *J* = 1.8 Hz, 1H), 3.95 (t, *J* = 10.4 Hz, 2H), 3.04 (t, *J* = 6.4 Hz, 2H), 1.51 (s, 1H) ppm. The spectral data is consistent with the literature.[6]

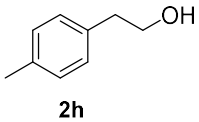
**2-phenylethan-1-ol (2g)**



2g

Colorless oil, 6 h, 8.6 mg, 35% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.37 – 7.35 (m, 2H), 7.29 – 7.26 (m, 3H), 3.86 (t, *J* = 7.8 Hz, 2H), 2.89 (t, *J* = 6.6 Hz, 2H),2.03 (s, 1H) ppm. The spectral data is consistent with the literature.[4]

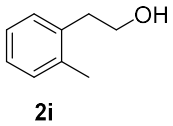
**2-(p-tolyl)ethan-1-ol (2h)**



2h

Colorless oil, 6 h, 10.1 mg, 37% yield;**$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.17-7.14 (s, 4H), 3.87 (t, *J* = 6.6 Hz, 2H), 2.86 (t, *J* = 6.6 Hz, 2H), 2.35 (s, 3H), 1.41 (s, 1H) ppm. The spectral data is consistent with the literature.[4]

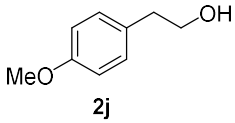
**2-(o-tolyl) ethan-1-ol (2i)**



2i

Colorless oil, 6 h, 10.5 mg, 39% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.21 – 7.17 (m, 4H), 3.87 (t, *J* = 7.0 Hz, 2H), 2.92 (t, *J* = 7.0 Hz, 2H), 2.37 (s, 3H), 1.65 (s, 1H) ppm. The spectral data is consistent with the literature.[4]

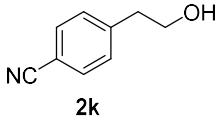
**2-(4-methoxyphenyl) ethan-1-ol (2j)**



2j

Pale yellow oil, 6 h, 8.8 mg, 29% yield;**$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.19-7.16 (m, 2H), 6.90-6.88 (m, 2H), 3.85 (t, *J* = 6.6 Hz, 2H), 3.82 (s, 3H), 2.84 (t, *J* = 6.6 Hz, 2H). 1.66 (s, 1H) ppm.

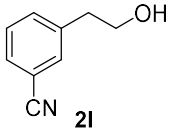
**4-(2-hydroxyethyl) benzonitrile (2k)**



2k

Pale yellow oil, 6 h, 13.6mg, 46% yield; **$^1$H NMR** (600 MHz, Chloroform-d) δ 7.60 (d, J = 8.2 Hz, 2H), 7.36 (d, J = 8.2 Hz, 2H), 3.90 (t, J = 6.4 Hz, 2H), 2.93 (t, J = 6.6 Hz, 2H), 1.74 (s, 1H) ppm. The spectral data is consistent with the literature.[4]

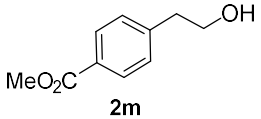
**3-(2-hydroxyethyl) benzonitrile (2l)**



2l

Pale yellow oil, 6 h, 18.5mg, 63% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.59 – 7.52 (m, 2H), 7.53 – 7.48 (m, 1H), 7.43 (t, *J* = 7.8 Hz, 1H), 3.90 (t, *J* = 6.4 Hz, 2H), 2.92 (t, *J* = 6.6 Hz, 2H), 1.76 (s, 1H) ppm. The spectral data is consistent with the literature.[7]

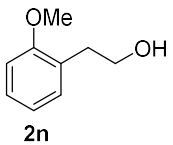
**methyl 4-(2-hydroxyethyl) benzoate (2m)**



2m

Colorless oil, 6 h, 25.6 mg, 71% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.97 (d, *J* = 8.4 Hz, 2H), 7.30 (d, *J* = 8.2 Hz, 2H), 3.90 (s, 3H), 3.87 (t, *J* = 6.6 Hz, 4H), 2.91 (t, *J* = 6.6 Hz, 2H), 1.92 (s, 1H) ppm. The spectral data is consistent with the literature.[8]

**2-(2-methoxyphenyl) ethan-1-ol (2n)**

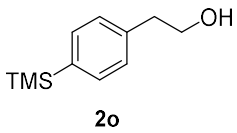


2n

Pale yellow oil, 6 h, 7.2 mg, 24% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.23 (t, *J* = 7.8Hz, 1H), 7.17 (d, *J* = 7.2 Hz, 1H), 6.91 (t, *J* = 7.6 Hz, 1H), 6.88 (d, *J* = 8.2 Hz, 1H), 3.86 – 3.81 (m, 5H), 2.92–2.90 (t, *J* = 6.3 Hz, 2H), 1.81 (s, 1H) ppm. The spectral data is consistent with

the literature.[9]

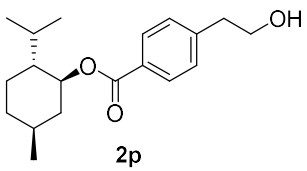
**2-(4-(trimethylsilyl) phenyl) ethan-1-ol (2o)**



2o

Colorless oil, 6 h, 13.3 mg, 34% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.49 – 7.47 (m, 2H), 7.24 – 7.22 (m, 2H), 3.87 (t, *J* = 6.6 Hz, 2H), 2.87 (t, *J* = 6.6 Hz, 2H), 1.64 (s, 1H),0.26 (s, 9H) ppm. The spectral data is consistent with the literature.[10]

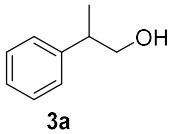
**(1S,2R,5S)-2-isopropyl-5-methylcyclohexyl 4-(2-hydroxyethyl) benzoate (2p)**



2p

white solid, 6 h, 9.1 mg, 15% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.99 (d, *J* = 7.6 Hz, 2H), 7.31 (d, *J* = 6.8 Hz, 2H), 4.94 – 4.90 (m, 1H), 3.89 (t, *J* = 6.6 Hz, 2H), 2.94–2.92 (m, 2H), 2.12 (d, *J* = 11.8 Hz, 1H), 1.98 – 1.93 (m, 1H), 1.74 – 1.72 (m, 2H), 1.66 (s, 1H),1.59 – 1.52 (m, 3H), 1.14 – 1.06 (m, 2H), 0.93 – 0.90 (m, 6H), 0.79 (d, *J* = 7.0 Hz, 3H) ppm. The spectral data is consistent with the literature.[11]

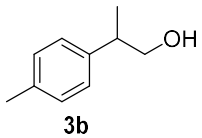
**2-phenylpropan-1-ol (3a)**



3a

Colorless oil, 6 h, 13.3 mg, 49% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.35-7.33 (m, 2H), 7.26 – 7.22 (m, 3H), 3.72 (d, *J* = 6.8 Hz, 2H), 2.98 – 2.94 (m, 1H), 1.58 (s, 1H), 1.28 (d, *J* = 7.2 Hz, 3H) ppm. The spectral data is consistent with the literature.[4]

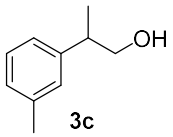
**2-(p-tolyl) propan-1-ol (3b)**



3b

Colorless oil, 6 h, 13.4 mg, 45% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.16-7.13 (m, 4H), 3.68 (d, *J* = 5.6 Hz 2H), 2.94 – 2.90 (m, 1H), 2.33 (s, 3H), 1.58 (s, 1H),1.26 (d, *J* = 6.8 Hz, 3H) ppm. The spectral data is consistent with the literature.[12]

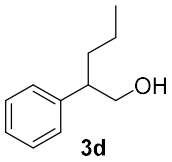
**2-(m-tolyl) propan-1-ol (3c)**



3c

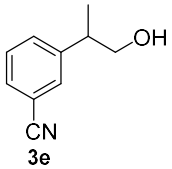
Colorless oil, 6 h, 14.9 mg, 50% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.24 – 7.21 (m, 1H), 7.06 – 7.04 (m, 3H), 3.70 (d, *J* = 7.0 Hz, 2H), 2.93 – 2.90 (m, 1H), 2.36 (s, 3H), 1.60 (s, 1H) ,1.27 (d, *J* = 7.0 Hz, 3H) ppm. The spectral data is consistent with the literature.[13]

**2-phenylpentan-1-ol (3d)**



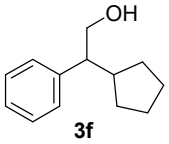

Colorless oil, 6 h,15.1 mg, 46% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.34 – 7.32 (m, 2H), 7.26 – 7.20 (m, 3H), 3.79 – 3.70 (m, 2H), 2.83 – 2.78 (m, 1H), 1.69 – 1.64(m, 1H), 1.59 (s, 1H), 1.57 – 1.54 (m, 1H),1.25– 1.20 (m, 2H), 0.87 (t, *J* = 7.4 Hz, 3H) ppm. The spectral data is consistent with the literature.[14]

**3-(1-hydroxypropan-2-yl) benzonitrile (3e)**



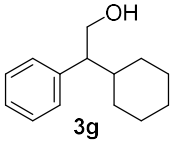

Pale yellow oil, 6 h, 18.3 mg, 57% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.54 – 7.49(m, 3H), 7.45 – 7.42 (m, 1H), 3.72 (t, *J* = 6.2 Hz, 2H), 3.01 – 2.99 (m, 1H), 1.80 (s, 1H), 1.30–1.29 (d, *J* = 7.0 Hz, 3H). ppm. **$^{13}$C NMR** (151 MHz, Chloroform-*d*) δ 145.6, 132.3, 131.2, 130.3, 129.3, 119.0, 112.4, 68.0, 42.0, 17.4. ppm. **HRMS** (ESI) m/z: [M + H] + Calcd for $C_{10}H_{12}ON$ 162.0909; Found 162.0913.

**2-cyclopentyl-2-phenylethan-1-ol (3f)**



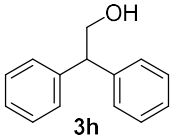

Colorless oil, 6 h, 12.4 mg, 33% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.32(t, *J* = 7.6 Hz, 2H), 7.25 – 7.21 (m, 3H), 3.92 – 3.88 (m, 1H), 3.77 (t, *J* = 10.0 Hz, 1H), 2.58 – 2.54 (m, 1H), 2.10 – 2.02 (m, 1H), 1.94 – 1.89 (m, 1H), 1.71 – 1.68 (m, 1H), 1.59 (s, 1H), 1.54 – 1.49 (m, 1H), 1.45 – 1.39 (m, 2H), 1.29 – 1.23 (m, 2H), 1.02 – 0.98 (m, 1H) ppm. The spectral data is consistent with the literature.[15]

**2-cyclohexyl-2-phenylethan-1-ol (3g)**




Colorless oil, 6 h, 17.3 mg, 42% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.34 – 7.31 (m, 2H), 7.25 –7.23 (t, *J* = 7.4 Hz, 1H), 7.20 – 7.18 (m, 2H), 3.97 – 3.93 (m, 1H), 3.82 (t, *J* = 10.6 Hz, 1H), 2.59 – 2.56 (m, 1H), 1.90 – 1.87 (m, 1H), 1.77 – 1.73(m, 1H), 1.63 – 1.61(m, 1H), 1.60 (s, 1H), 1.43 – 1.39 (m, 1H), 1.29 – 1.22 (m, 2H), 1.14 – 1.09 (m, 3H), 1.06–0.99 (m, 1H), 0.85–0.79 (m, 1H) ppm. The spectral data is consistent with the literature.[15]

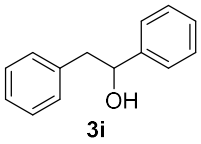
**2,2-diphenylethan-1-ol (3h)**



3h

white solid, 6 h, 14.3 mg, 36% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.35 – 7.31 (m, 4H), 7.28 – 7.22 (m, 6H), 4.23 – 4.21 (m, 1H), 4.19-4.17 (m, 2H), 1.49 (s, 1H) ppm. The spectral data is consistent with the literature.[4]

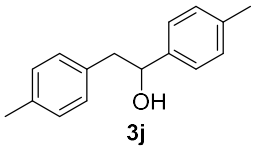
**1,2-diphenylethan-1-ol (3i)**



3i

white solid, 6 h, 12.2 mg, 31% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.37 – 7.34 (m, 4H), 7.32 – 7.27 (m, 3H), 7.25 – 7.19 (m, 3H), 4.91 – 4.89 (m, 1H), 3.04 (dd, *J* = 13.6, 4.8 Hz, 1H), 2.99 (dd, *J* = 13.6, 8.6 Hz, 1H), 1.98 (s, 1H) ppm. The spectral data is consistent with the literature.[16]

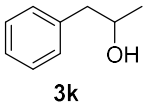
**1,2-di-p-tolylethan-1-ol (3j)**



3j

white solid, 6 h, 14.9 mg, 33% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.26 (d, *J* = 8.0 Hz, 2H), 7.16 (d, *J* = 7.8 Hz, 2H), 7.12-7.09 (m, 4H), 4.85 – 4.81 (m, 1H), 2.99 (dd, *J* = 13.8, 4.6 Hz, 1H), 2.92 (dd, *J* = 13.8, 8.8 Hz, 1H), 2.35 (s, 3H), 2.32 (s, 3H), 1.93 (s, 1H) ppm. The spectral data is consistent with the literature.[17]

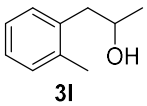
**1-phenylpropan-2-ol (3k)**



3k

Colorless oil, 6 h, 15.7 mg, 58% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.33 – 7.30 (m, 2H), 7.25 – 7.20 (m, 3H), 4.05 – 3.99 (m, 1H), 2.80-2.77 (m, 1H), 2.67-2.71 m, 1H), 1.65 (s, 1H), 1.25 (d, *J* = 6.2 Hz, 3H) ppm. The spectral data is consistent with the literature.[15]

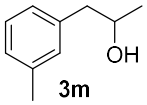
**1-(o-tolyl) propan-2-ol (3l)**



3l

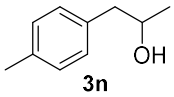
Colorless oil, 6 h,13.1 mg, 44% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.18 – 7.14(m, 4H), 4.05 – 4.02 (m, 1H), 2.80 (dd, *J* = 13.6, 5.0 Hz, 1H), 2.73 (dd, *J* = 13.6, 8.0 Hz, 1H), 2.33 (s, 3H), 1.63 (s, 1H), 1.27 (d, *J* = 6.2 Hz, 3H) ppm. The spectral data is consistent with the literature.[18]

**1-(m-tolyl) propan-2-ol (3m)**



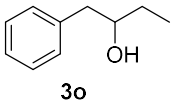

Colorless oil, 6 h, 15.7 mg, 52% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.20 (t, *J* = 7.6 Hz, 1H), 7.06 – 7.00 (m, 3H), 4.04 – 4.00(m, 1H), 2.77 – 2.74(m, 1H), 2.66– 2.63 (m, 1H), 2.34 (s, 3H), 1.63 (s, 1H), 1.25 (d, *J* = 6.2 Hz, 3H) ppm. The spectral data is consistent with the literature.[15]

**1-(p-tolyl) propan-2-ol (3n)**



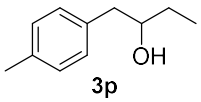

Colorless oil, 6 h, 12.6 mg, 42% yield;**$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.13 – 7.09 (m, 4H), 4.02 – 3.97 (m, 1H), 2.76 (dd, *J* = 13.6, 4.8 Hz, 1H), 2.64 (dd, *J* = 13.6, 8.0 Hz, 1H), 2.33 (s, 3H), 1.61 (s, 1H), 1.24 (d, *J* = 6.2 Hz, 3H) ppm. The spectral data is consistent with the literature.[19]

**1-phenylbutan-2-ol (3o)**



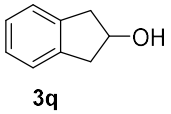

Colorless oil, 6 h, 15.6 mg, 52% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.33 – 7.30 (m, 2H), 7.26 – 7.21 (m, 3H), 3.77 – 3.74 (m, 1H), 2.84 (dd, *J* = 13.6, 4.4 Hz, 1H), 2.65 (dd, *J* = 13.6, 8.2 Hz, 1H), 1.64 (s, 1H), 1.57 – 1.50 (m, 2H), 1.00 (t, *J* = 7.5 Hz, 3H) ppm. The spectral data is consistent with the literature.[20]

**1-(p-tolyl) butan-2-ol (3p)**



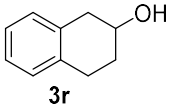

Colorless oil, 6 h, 13.6 mg, 41% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.13 – 7.10 (m, 4H), 3.74 – 3.70(m, 1H), 2.80 (dd, *J* = 13.6, 4.4 Hz, 1H), 2.60 (dd, *J* = 13.6, 8.4 Hz, 1H), 2.33 (s, 3H), 1.64 (s, 1H), 1.55 – 1.49 (m, 3H), 0.99 (t, *J* = 7.4 Hz, 3H) ppm. The spectral data is consistent with the literature.[21]

**2,3-dihydro-1H-inden-2-ol (3q)**




white solid, 6 h, 9.8 mg, 37% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.26 – 7.24 (m, 2H), 7.19 – 7.17 (m, 2H), 4.72 – 4.69 (m, 1H), 3.22 (dd, *J* = 16.4, 5.9 Hz, 2H), 2.92 (dd, *J* = 16.4, 3.2 Hz, 2H),1.70 (s, 1H) ppm. The spectral data is consistent with the literature.[15]

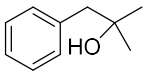
**1,2,3,4-tetrahydronaphthalen-2-ol (3r)**



3r

white solid, 6 h, 15.2 mg, 51% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.13 – 7.07 (m, 4H), 4.18 – 4.14 (m, 1H), 3.09 (dd, *J* = 16.0, 4.8 Hz, 1H), 2.98– 2.93 (m, 1H), 2.87 – 2.82 (m, 1H), 2.79 – 2.75 (m, 1H), 2.08 – 2.05 (m, 1H), 1.85 – 1.79 (m, 1H). 1.73 (s, 1H) ppm. The spectral data is consistent with the literature.[15]

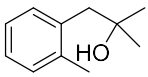
**2-methyl-1-phenylpropan-2-ol (4a)**



4a

Colorless oil, 6 h, 24.7 mg, 82% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.33-7.21 (m, 5H), 2.77 (s, 2H), 1.64 (s, 1H), 1.23 (s, 6H) ppm. The spectral data is consistent with the literature.[18]

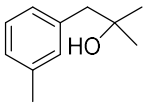
**2-methyl-1-(o-tolyl) propan-2-ol (4b)**



4b

Colorless oil, 6 h, 19.6 mg, 60% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.23 – 7.22 (m, 2H), 7.21 – 7.16 (m, 2H), 2.86 (s, 2H), 2.39 (s, 3H), 1.65 (s, 1H), 1.29 (s, 6H) ppm. **$^{13}$C NMR** (151 MHz, Chloroform-*d*) δ 137.5, 136.1, 131.4, 130.7, 126.6, 125.6, 71.8, 45.5, 29.5, 20.4. ppm. **HRMS** (ESI) m/z: [M + H] + Calcd for $C_{11}H_{17}O$ 165.1272; Found 165.1274.

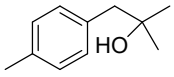
**2-methyl-1-(m-tolyl) propan-2-ol (4c)**



4c

Colorless oil, 6 h, 23.1 mg, 70% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.20 (t, *J* = 7.6 Hz, 1H), 7.07 (d, *J* = 7.6 Hz, 1H), 7.03 – 7.00 (m, 2H), 2.73 (s, 2H), 2.34 (s, 3H), 1.68 (s, 1H), 1.23 (s, 6H). ppm. **$^{13}$C NMR** (151 MHz, Chloroform-*d*) δ 137.8, 137.6, 131.3, 128.1, 127.5, 127.3, 49.7, 29.2, 21.4. ppm. **HRMS** (ESI) m/z: [M + H] + Calcd for $C_{11}H_{17}O$ 165.1274; Found 165.1274.

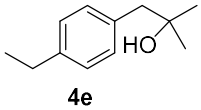
**2-methyl-1-(p-tolyl) propan-2-ol (4d)**



4d

Colorless oil, 6 h, 20.1 mg, 61% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.11 (q, *J* = 8.0 Hz, 4H), 2.73 (s, 2H), 2.34 (s, 3H), 1.61 (s, 1H), 1.22 (s, 6H) ppm. The spectral data is consistent with the literature.[22]

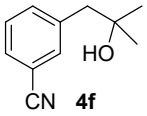
**1-(4-ethylphenyl)-2-methylpropan-2-ol (4e)**



4e

Colorless oil, 6 h, 24.2 mg, 68% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.16 – 7.13 (m, 4H), 2.74 (s, 2H), 2.64 (q, *J* = 7.6 Hz, 2H), 1.44 (s, 1H), 1.26 – 1.23 (m, 9H) ppm. The spectral data is consistent with the literature.[23]

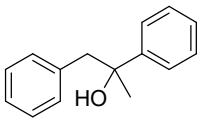
**3-(2-hydroxy-2-methylpropyl) benzonitrile (4f)**



4f

Pale yellow oil, 6 h,24.2mg, 69% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.56 – 7.55 (m, 2H), 7.50 – 7.49 (m, 1H), 7.44 – 7.41 (m, 1H), 2.81 (s, 2H), 1.76 (s, 1H), 1.25 (s, 6H). ppm. **$^{13}$C NMR** (151 MHz, Chloroform-*d*) δ 139.5, 135.0, 133.9, 130.2, 128.8, 119.0, 112.1, 70.7, 49.1, 29.4. ppm. **HRMS** (ESI) m/z: [M + H] + Calcd for $C_{11}H_{14}ON$ 176.1075; Found 176.1070.

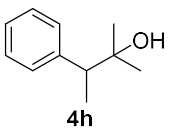
**1,2-diphenylpropan-2-ol (4g)**



4g

white solid, 6 h, 20.8 mg, 49% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.41 – 7.39 (m, 2H), 7.37 – 7.31 (m, 2H), 7.24 – 7.20 (m, 4H), 7.04 – 6.95 (m, 2H), 3.13 (d, *J* = 13.2 Hz, 1H), 3.03 (d, *J* = 13.2 Hz, 1H), 1.88 (s, 1H), 1.57 (s, 3H) ppm. The spectral data is consistent with the literature.[24]

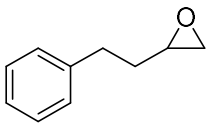
**2-methyl-3-phenylbutan-2-ol (4h)**



4h

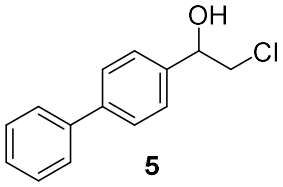
Colorless oil, 6 h, 4.6 mg, 14% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.31 (t, *J* = 7.6 Hz, 2H), 7.26 – 7.23 (m, 3H), 2.81 (q, *J* = 7.2 Hz, 1H), 1.59 (s, 1H), 1.35 (d, *J* = 7.2 Hz, 3H), 1.18 (s, 6H) ppm. The spectral data is consistent with the literature.[25]

**2-phenethyloxirane (4i')**



Colorless oil, 6 h, 13.8 mg, 46% yield; **$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.34 – 7.31 (m, 2H), 7.25 – 7.22 (m, 3H), 3.00 – 2.97 (m, 1H), 2.88 – 2.83 (m, 1H), 2.81 – 2.76 (m, 2H), 2.50 (dd, *J* = 4.9, 2.8 Hz, 1H), 1.94 – 1.84 (m, 2H) ppm. The spectral data is consistent with the literature.[26]

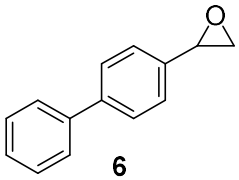
**1-([1,1'-biphenyl]-4-yl)-2-chloroethan-1-ol (5)**



5

**$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.65 – 7.61 (m, 4H), 7.50-7.46 (m, 4H), 7.41 – 7.38 (m, 1H), 4.96 (dd, *J* = 8.6, 3.4 Hz, 1H), 3.82 (dd, *J* = 11.2, 3.4 Hz, 1H), 3.73 (dd, *J* = 11.2, 8.8 Hz, 1H), 2.72 (d, *J* = 3.2 Hz, 1H) ppm. The spectral data is consistent with the literature.[27]

**2-([1,1'-biphenyl]-4-yl)oxirane (6)**



6

**$^1$H NMR** (600 MHz, Chloroform-*d*) δ 7.63 – 7.61 (m, 4H), 7.49 – 7.46 (m, 2H), 7.40 – 7.37 (m, 3H), 3.95 (dd, *J* = 4.2, 2.6 Hz, 1H), 3.22 (dd, *J* = 5.4, 4.2 Hz, 1H), 2.89 (dd, *J* = 5.6, 2.6 Hz, 1H) ppm. The spectral data is consistent with the literature.[27]

## 6. References


[1] B. Yang, Z. Lu, *Chem. Commun*. **2017**, *53*, 12634-12637.

[2] F. Lian, F-X. Luo, M. Wang, K. Xu, C.-C. Zeng, *Chin. J. Chem*. **2023**, *41*, 1583-1588.

[3] M. Majchrzak, G. Wilkowski, M. Kubicki, *J. Org. Chem.* **2017**,*29*, 4291-4299.

[4] C. Huang, W. Ma, X.-L. Zheng, M.-H. Xu, X.-T. Qi, *J. Am. Chem. Soc.***2022**, *144*, 1389-1395.

[5] W. Pendergast, J.- V. Johnson, S.- H. Dickerson, I.- K. Dev, D.- S. Duch, R. Ferone, W.- R. Hall, J. Humphreys, J.- M. Kelly, D.- C. Wilson, *J. Med*. *Chem*. **1993** *36*, 2279- 2291.

[6] S. -N. Kessler, H. -A. Wegner, *Org. Lett.* **2010**, *12*, 4062-4065.

[7] B.- C. Lee, J.- Y. Paik, D.- Y. Chi, K.- H. Lee, Y.- S. Choe, *Bioconjugate Chem*. **2004**, *15*, 104-111.

[8] C. Chen, G. Nagy, A. -V. Waiker, K. Maurer, A. McShea, K.- D. Moeller, *J. Am. Chem. Soc.***2006**, *128*, 16020-16021.

[9] N.- N.- H. Ton, B.- K. Mai, T.- V. Nguyen, *J. Org. Chem*. **2021**, *86*, 9117-9133.

[10] A. Graml, B. Konig, *Chem. Photo. Chem*. **2021**, *5*, 362-368.

[11] X. -C. Lin, Y. -M. Wang, X. Chen, P. -Y. You, K. -M. Mo, G. -H. Ning, D. Li, *Angew. Chem. Int. Ed*. **2023**, *62*, e202306497.

[12] S. M. A. Hakim Siddiki, A.- S. Touchy, M. A.- R. Jamil, T. Toyao, Ken-ichi. Shimizu, *ACS Catal.* **2018**, *8*, 3091-3103.

[13] H.-Q. Geng, T. Meyer, R. Franke, X.-F. Wu, *Chem. Sci.* **2021**,*12*, 14937-14943.

[14] Y. Zhang, B. Han, S. -L. Zhu, *Angew. Chem. Int. Ed.* **2019**, *58*, 13860-13864.

[15] X. Hu, G.-T. Zhang, F.-X. Bu, A.-W. Lei, *ACS Catal.***2017**, *7*, 1432-1437.

[16] S.- V. Ley, C. Mitchell, D. Pears, C. Ramarao, J.-Q. Yu, W- Z. Zhou, *Org Lett.* **2003,** *5*, 4665-4668.

[17] D.-K. Nielsen, A.-G. Doyle, *Angew. Chem. Int. Ed*. **2011**, *50*. 6056-6059.

[18] Y-. Zhao, D.- J. Weix, *J. Am. Chem. Soc.* **2014**, *136*, 48-51.

[19] X.- Y. Du, Y.- L. Zhang, D.- J. Peng, Z. Huang, *Angew. Chem. Int. Ed.* **2016**, *55*,

6671-6675.

[20] T. Mahdi, D.- W. Stephan, *Angew. Chem. Int. Ed.* **2015**, *54*, 8511-8514.

[21] M. Parasram, B.- J. Shields, O. Ahmad, T. Knauber, A.- G. Doyle, *ACS Catal*. **2020**, *10*, 5821-5827.

[23] S.- C. Richter, M. Oestreich, *J. Org. Chem*, **2021**, *14*, 2103-2106.

[24] C.- C. Li, X.-J. Dai, H.- N. Wang, D.- H. Zhu, J. Gao, C.- J. Li, *Org. Lett.* **2018**, *20*, 3801-3805.

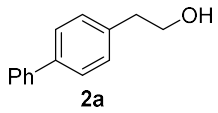
[25] J. Harnedy, H.- A. Maashi, Albara A. M. A. El Gehani, M. Burns, L.- C. Morrill, *Org. Lett.* **2023**, *25*, 1486-1490.

[26] J. M. Mitchell and N. S. Finney, *J. Am. Chem. Soc.*, **2001**, *123*, 862-869.

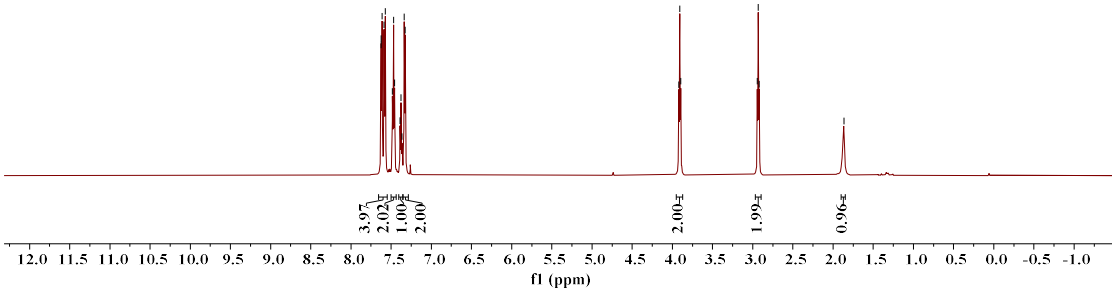
[27] Y. Yuki, T. Touge, H. Nara, K. Matsumura, M. Fujiwhara, Y. Kayaki, T. Ikariya, *Adv. Synth. Catal.,* **2017**, *360*, 568-574.

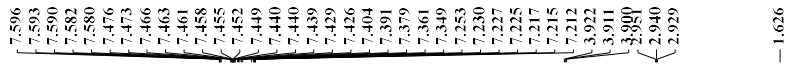
## 7. $^{1}$H NMR and $^{13}$C NMR Spectra of compounds


| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH494-3 1.fid |
| Origin | Bruker BioSpin GmbH & Co. KG |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2025-03-08T23:06:53 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

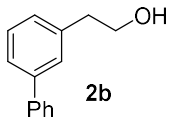



**2a**

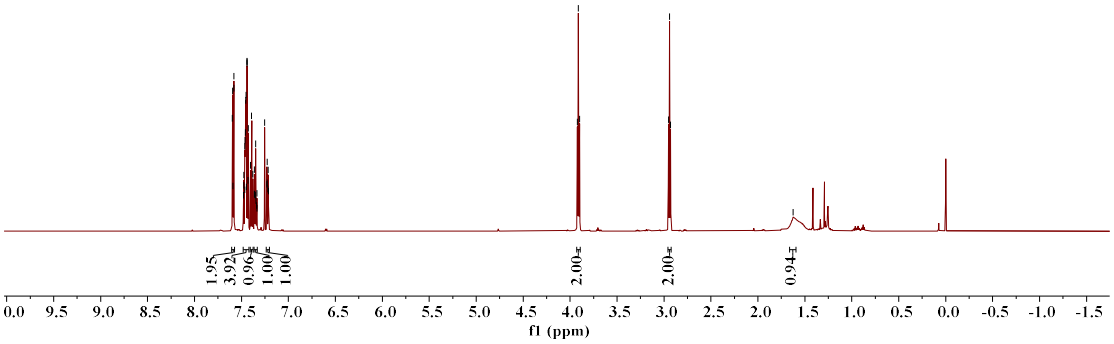


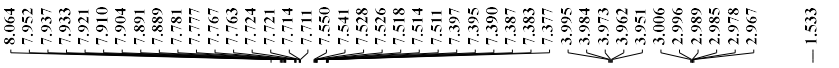



| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH289-1-1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-07-19T11:48:50 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

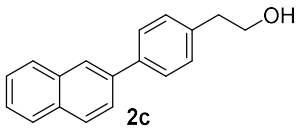



**2b**

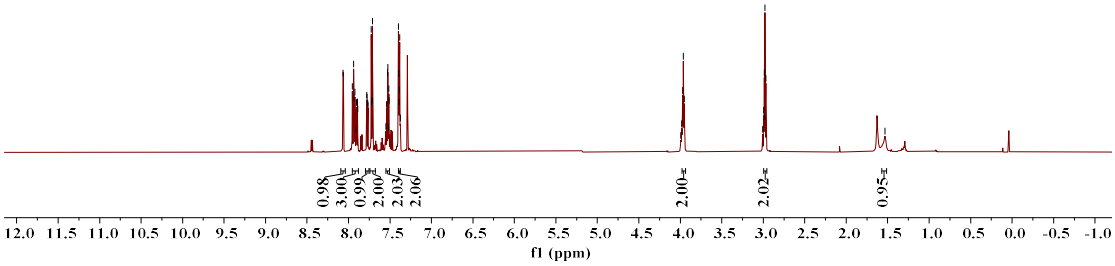





| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH489-1.1.fid |
| Origin | Bruker BioSpin GmbH & Co. KG |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2025-03-04T21:50:39 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

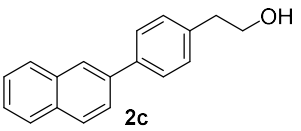



2c

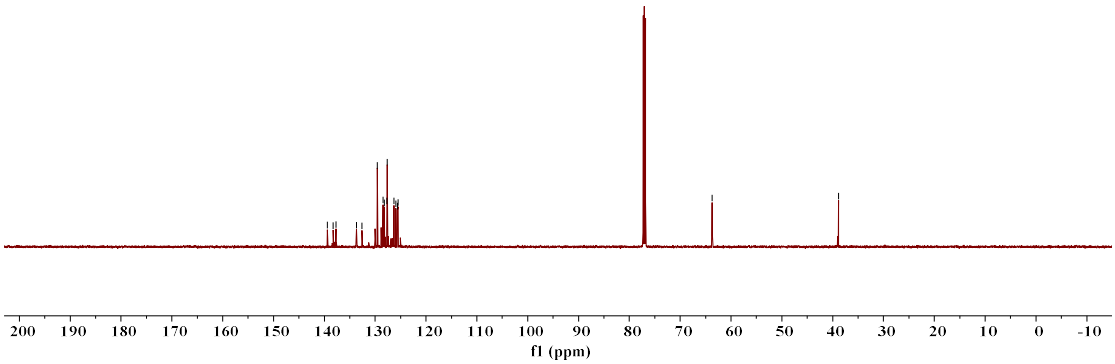


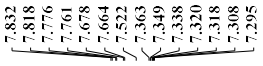


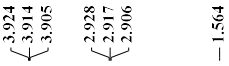
| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH489-1.2.fid |
| Origin | Bruker BioSpin GmbH & Co. KG |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 512 |
| Acquisition Date | 2025-03-04T22:10:20 |
| Spectrometer Frequency | 151 MHz |
| Nucleus | 13C |




2c





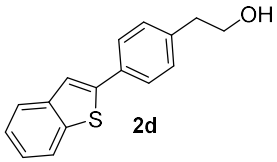



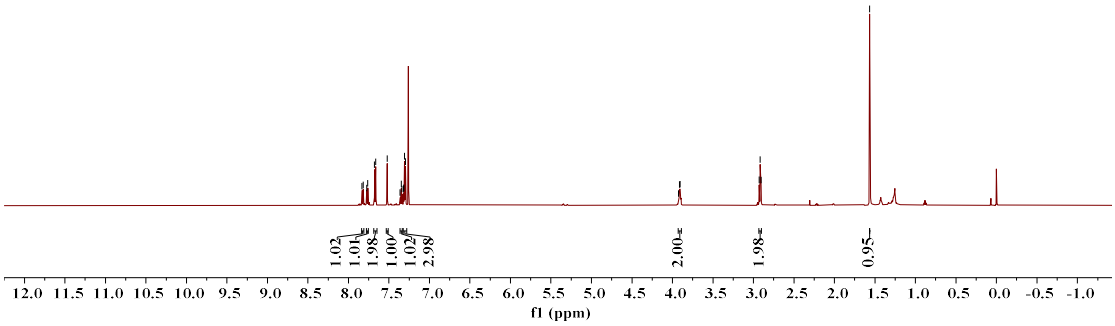


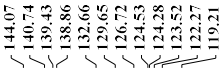





| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH489-2-1.fid |
| Origin | Bruker BioSpin GmbH & Co. KG |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2025-03-04T22:55:54 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

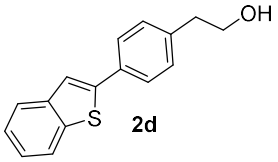


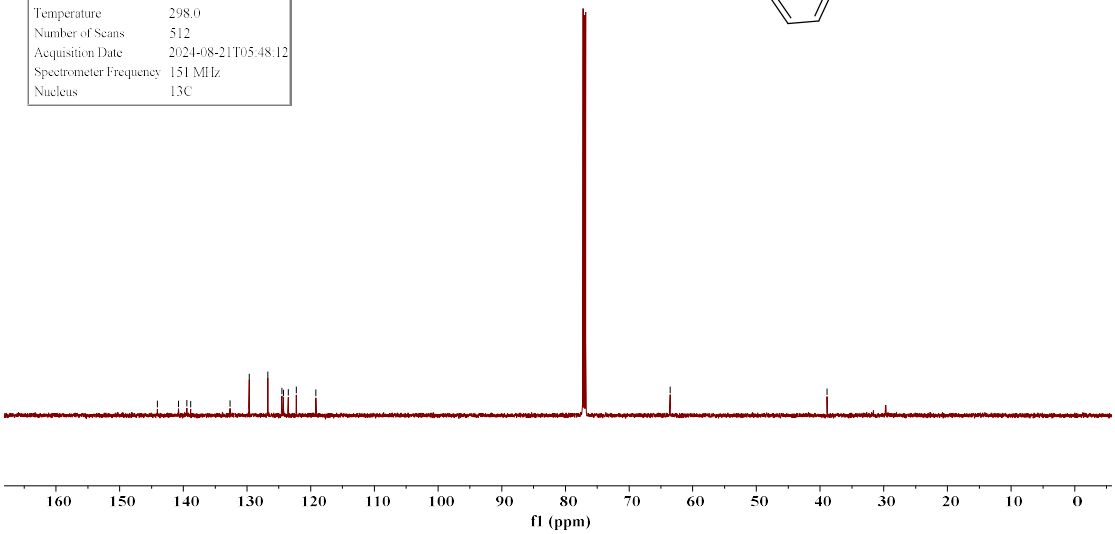



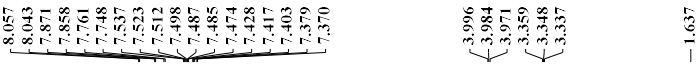





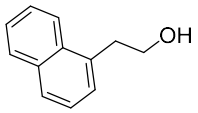

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH294-2-1.2.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 512 |
| Acquisition Date | 2024-08-21T05:48:12 |
| Spectrometer Frequency | 151 MHz |
| Nucleus | 13C |



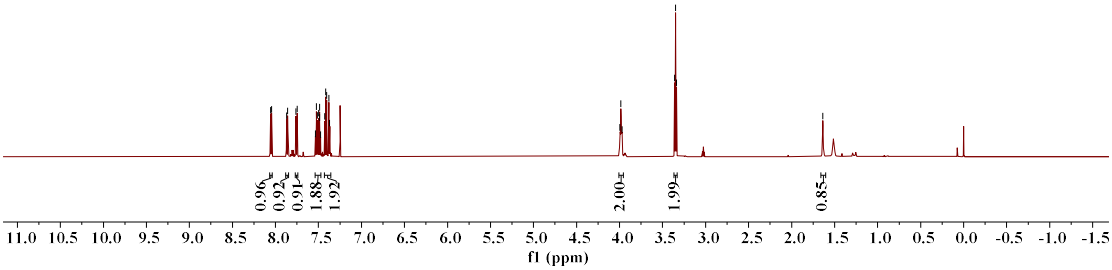



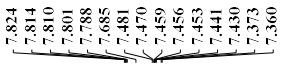


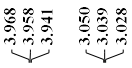

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH299-2-1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-07-25T19:48:38 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |



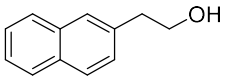

**2e**



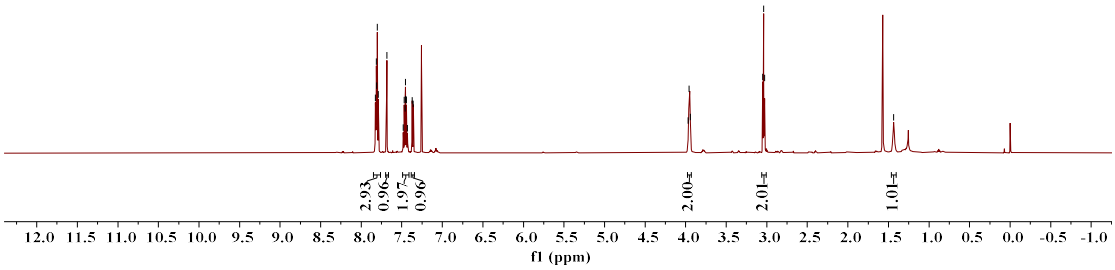


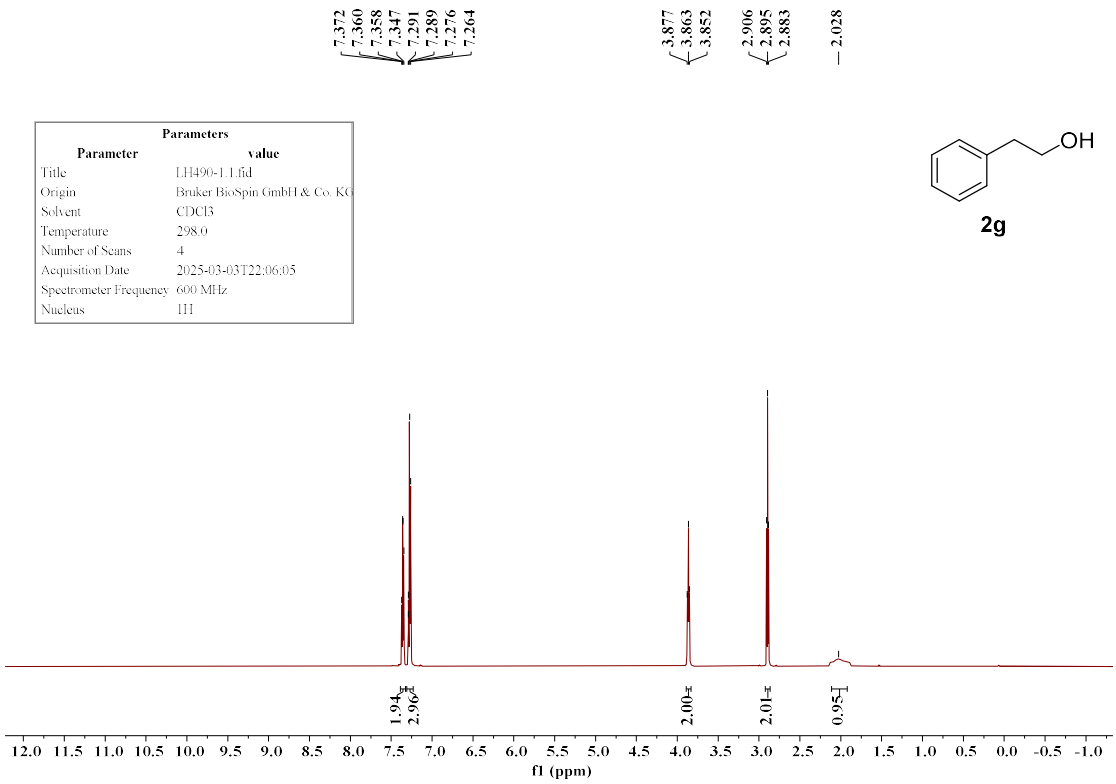



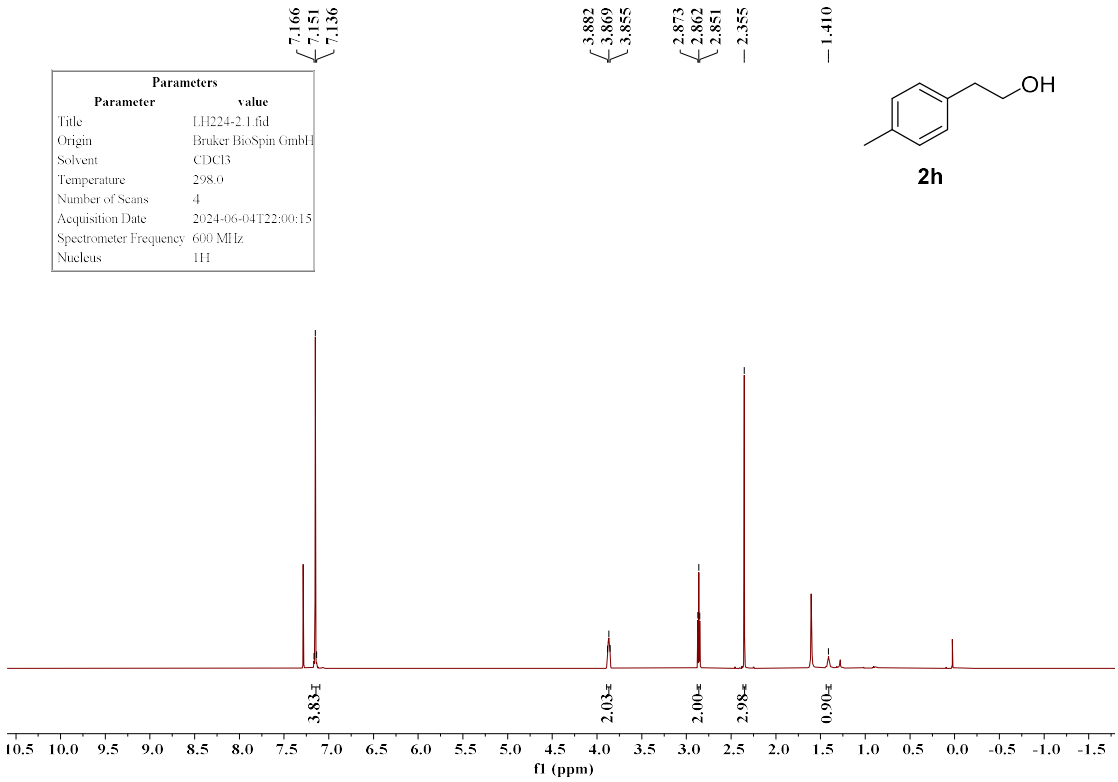

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH490-3.1.fid |
| Origin | Bruker BioSpin GmbH & Co. KG |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2025-03-03T22:12:56 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

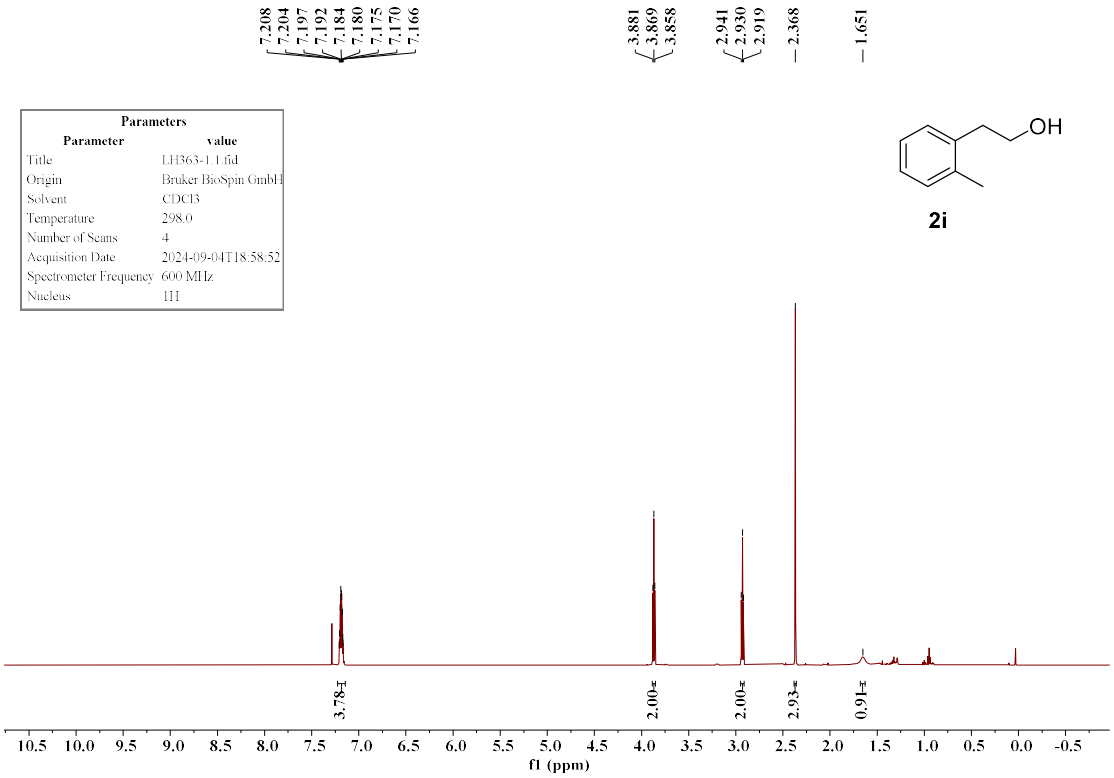


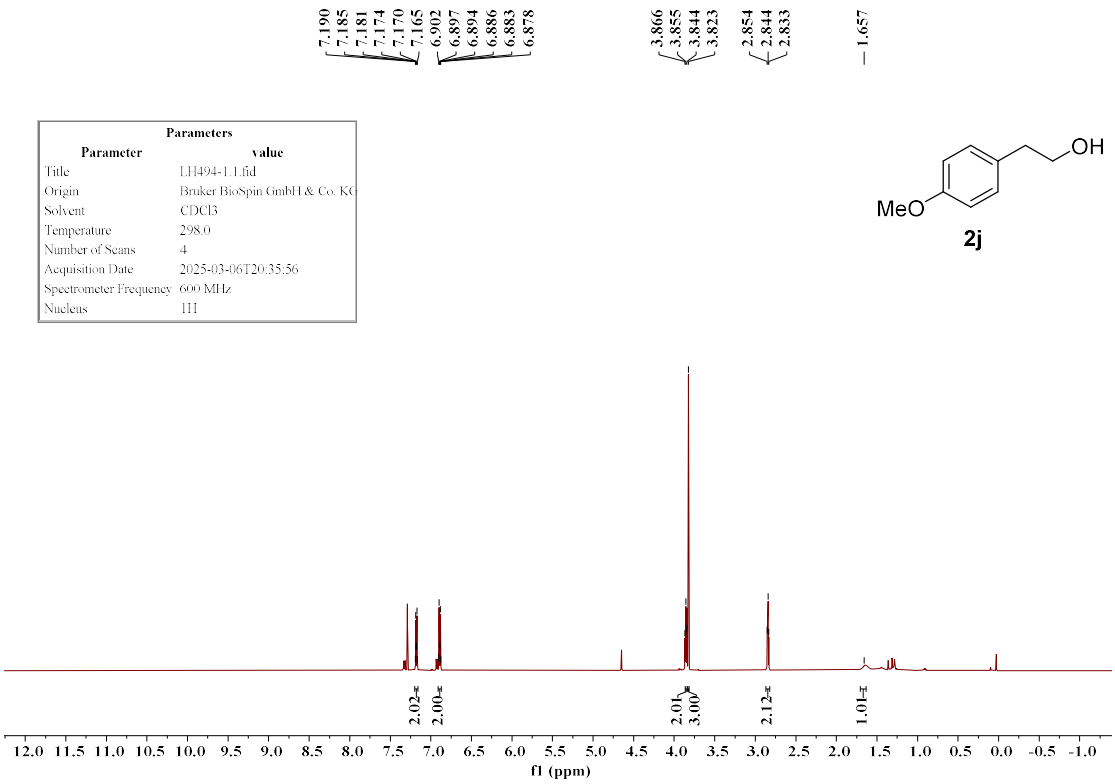

**2f**

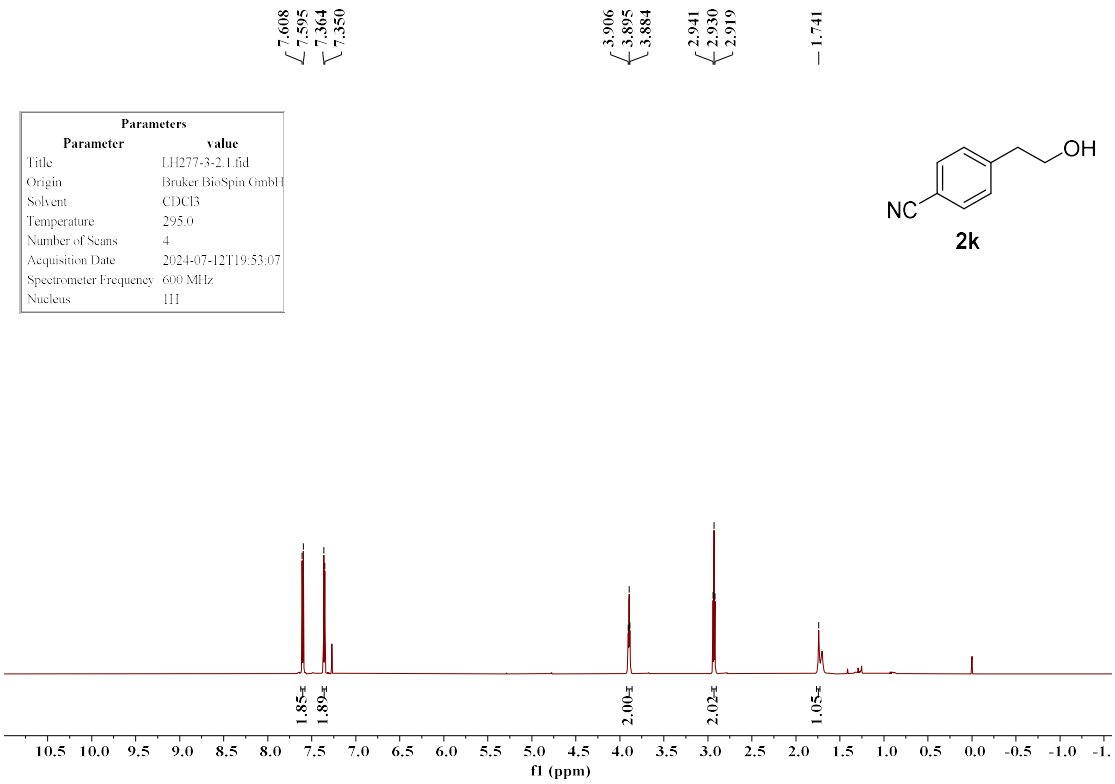


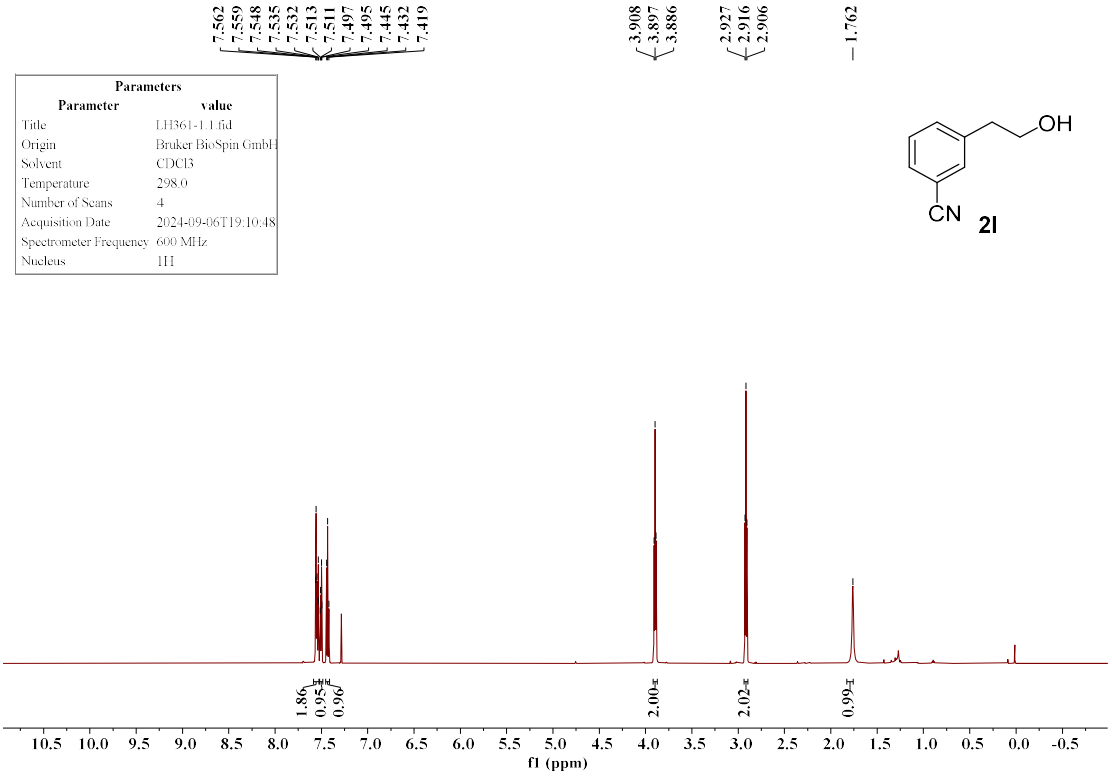

7.372
7.360
7.358
7.347
7.291
7.289
7.276
7.264
3.877
3.863
3.852
2.906
2.895
2.883
2.028
Parameters
Parameter value
Title LH490-1.1.fid
Origin Bruker BioSpin GmbH & Co. KG
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2025-03-03T22:06:05
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
2g
1.94
2.96
2.00
2.01
0.95
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

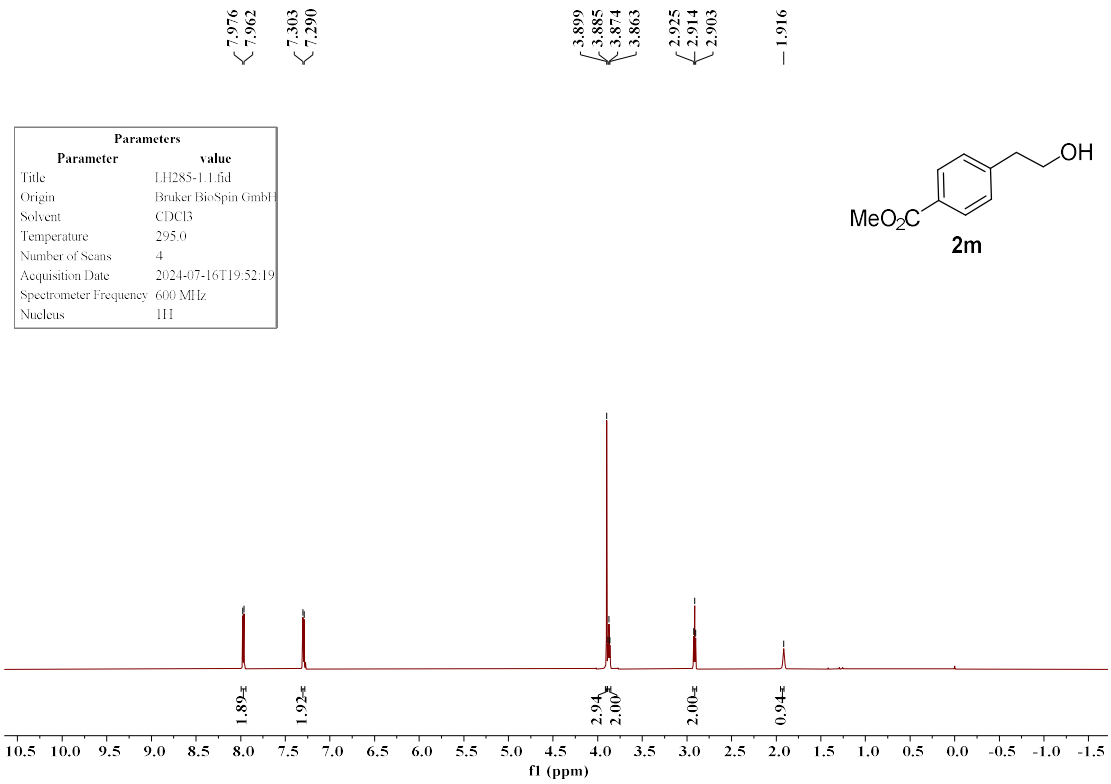

7.166
7.151
7.136
3.882
3.869
3.855
2.873
2.862
2.851
2.355
1.410
Parameters
Parameter value
Title LH224-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-06-04T22:00:15
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
2h
3.83
2.03
2.00
2.98
0.90
f1 (ppm)

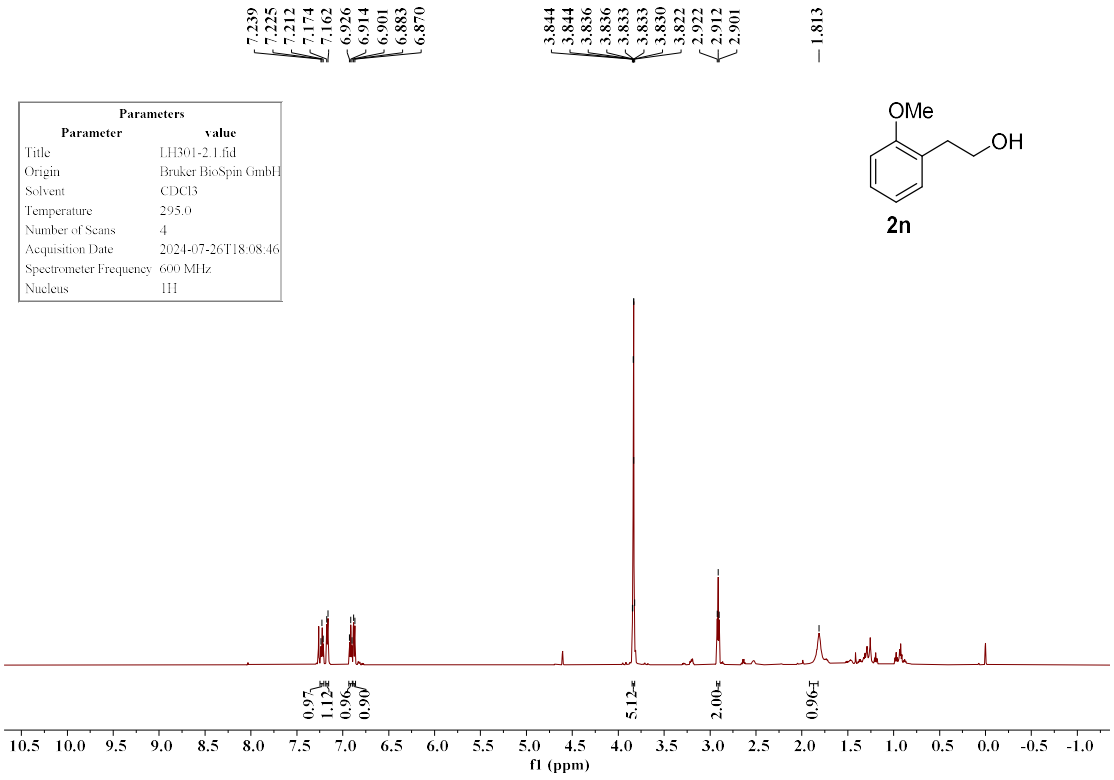

7.208
7.204
7.197
7.192
7.184
7.180
7.175
7.170
7.166
3.881
3.869
3.858
2.941
2.930
2.919
2.368
1.651
Parameters
Parameter value
Title LH363-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-04T18:58:52
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
2i
3.78
2.00
2.00
2.93
0.91
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

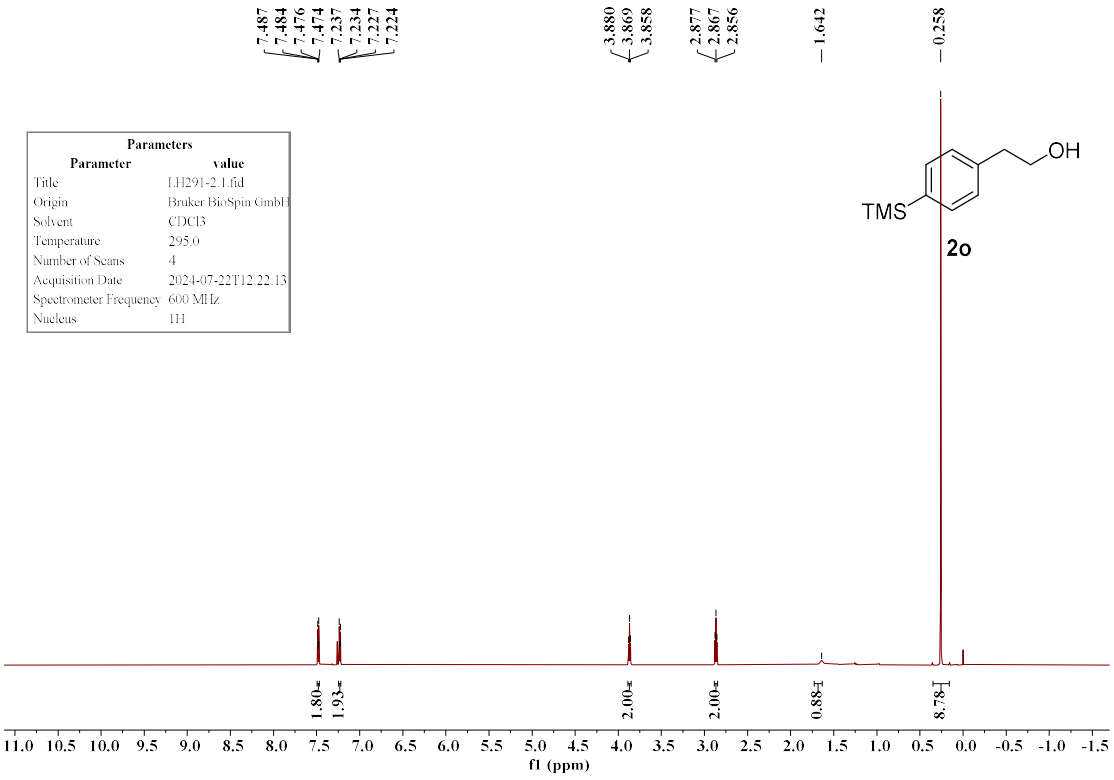

7.190
7.185
7.181
7.174
7.170
7.165
6.902
6.897
6.894
6.886
6.883
6.878
3.866
3.855
3.844
3.823
2.854
2.844
2.833
1.657
Parameters
Parameter value
Title LH494-1.1.fid
Origin Bruker BioSpin GmbH & Co. KG
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2025-03-06T20:35:56
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
MeO
2j
2.02
2.00
2.01
3.00
2.12
1.01
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


7.608
7.595
7.364
7.350
3.906
3.895
3.884
2.941
2.930
2.919
1.741
Parameters
Parameter value
Title LH277-3-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-12T19:53:07
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
NC
2k
1.85
1.89
2.00
2.02
1.05
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.
f1 (ppm)


7.562
7.559
7.548
7.535
7.532
7.513
7.511
7.497
7.495
7.445
7.432
7.419
3.908
3.897
3.886
2.927
2.916
2.906
1.762
Parameters
Parameter value
Title LH361-1-1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-06T19:10:48
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
CN
2l
1.86
0.95
0.96
2.00
2.02
0.99
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

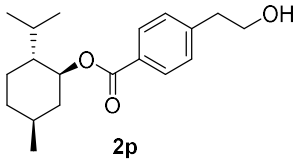

7.976
7.962
7.303
7.290
3.899
3.885
3.874
3.863
2.925
2.914
2.903
1.916
Parameters
Parameter value
Title LH285-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-16T19:52:19
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
MeO2C
2m
1.89
1.92
2.94
2.00
2.00
0.94
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)


7.239
7.225
7.212
7.174
7.162
6.926
6.914
6.901
6.883
6.870
3.844
3.844
3.836
3.836
3.833
3.833
3.830
3.822
2.922
2.912
2.901
1.813
Parameters
Parameter value
Title LH301-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-26T18:08:46
Spectrometer Frequency 600 MHz
Nucleus 1H
OMe
OH
2n
0.97
1.12
0.96
0.90
5.12
2.00
0.96
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

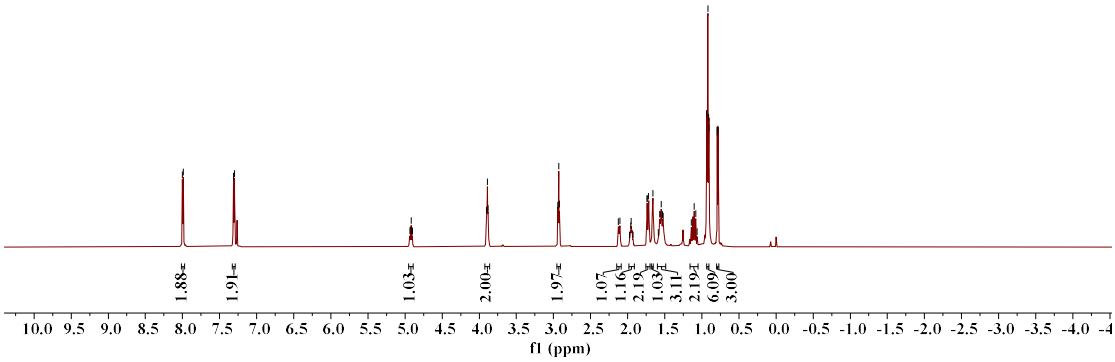

7.487
7.484
7.476
7.474
7.237
7.234
7.227
7.224
3.880
3.869
3.858
2.877
2.867
2.856
1.642
0.258
Parameters
Parameter value
Title LH291-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-22T12:22:13
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
TMS
2o
1.80
1.93
2.00
2.00
0.88
8.78
f1 (ppm)

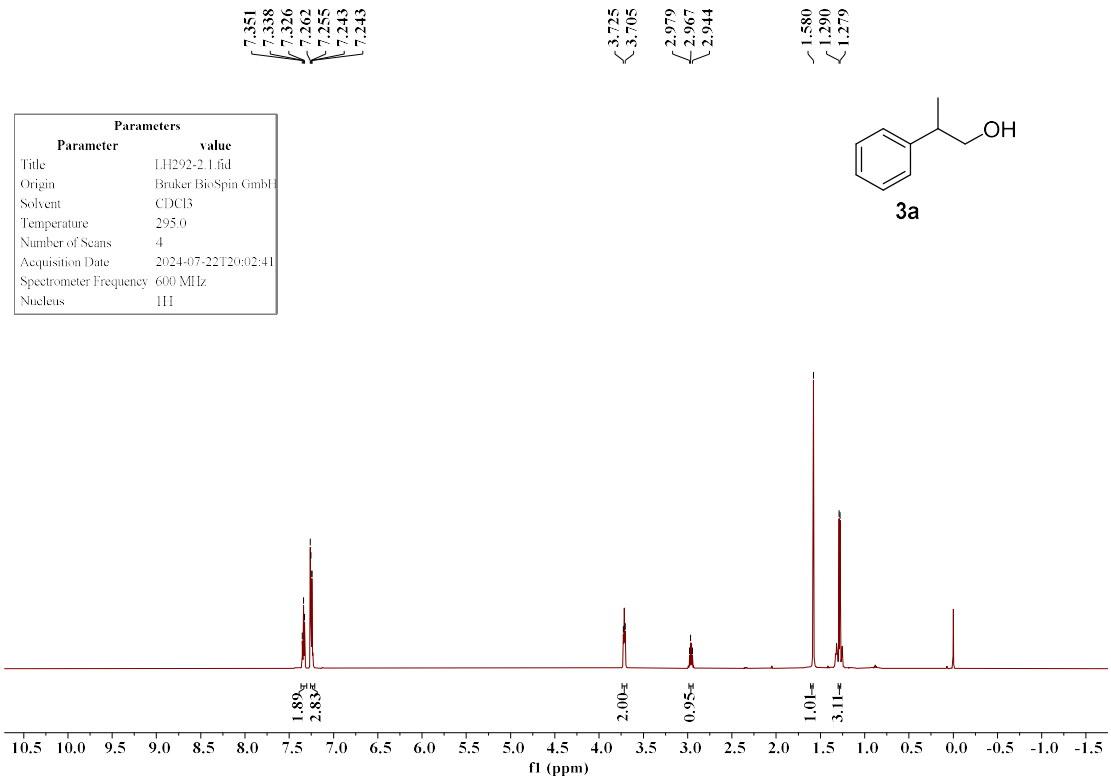
8.000
7.987
7.311
7.300
4.935
4.917
4.907
4.906
4.899
3.902
3.891
3.880
2.942
2.930
2.920
2.125
2.106
1.975
1.956
1.952
1.928
1.737
1.737
1.718
1.661
1.585
1.565
1.565
1.547
1.529
1.523
1.141
1.102
1.083
1.063
0.933
0.919
0.908
0.904
0.794
0.782

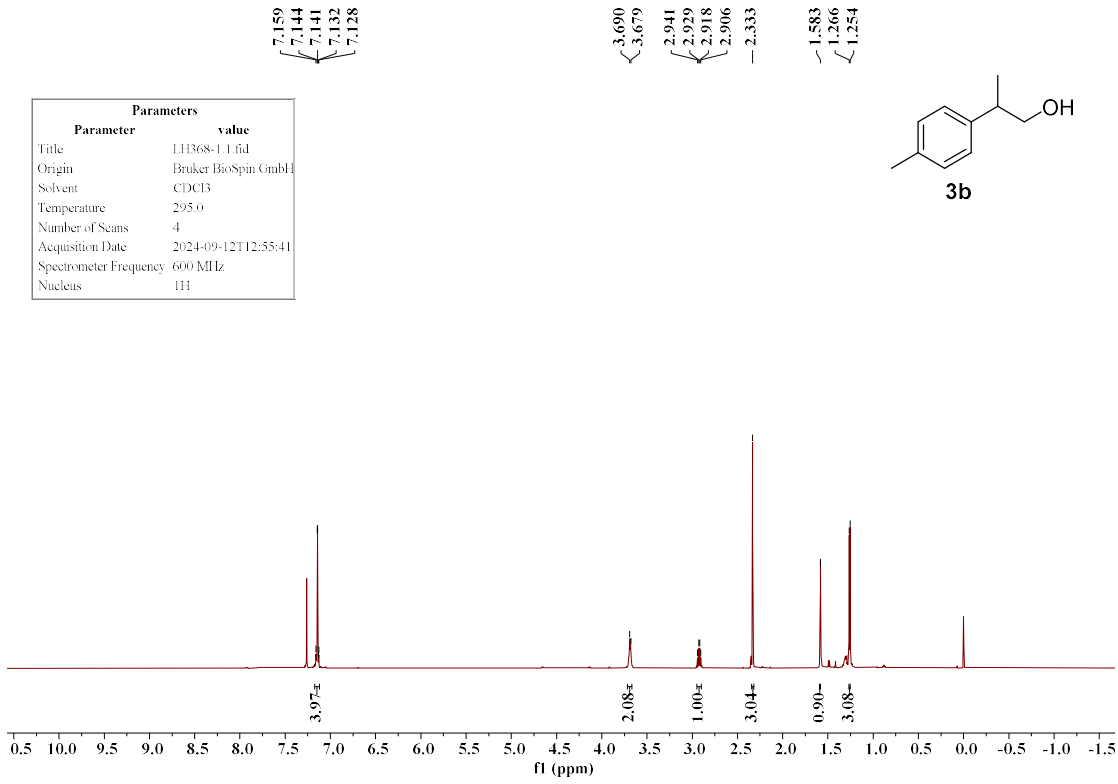
| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH309-1-3.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-08-02T15:52:25 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

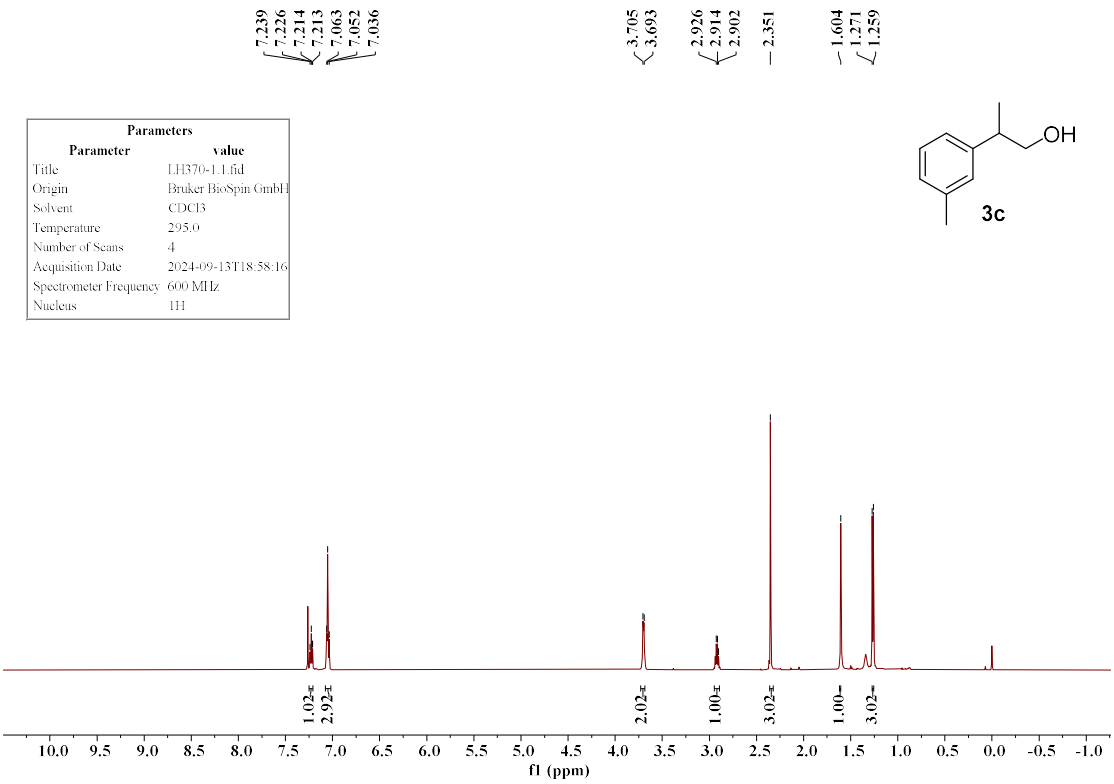


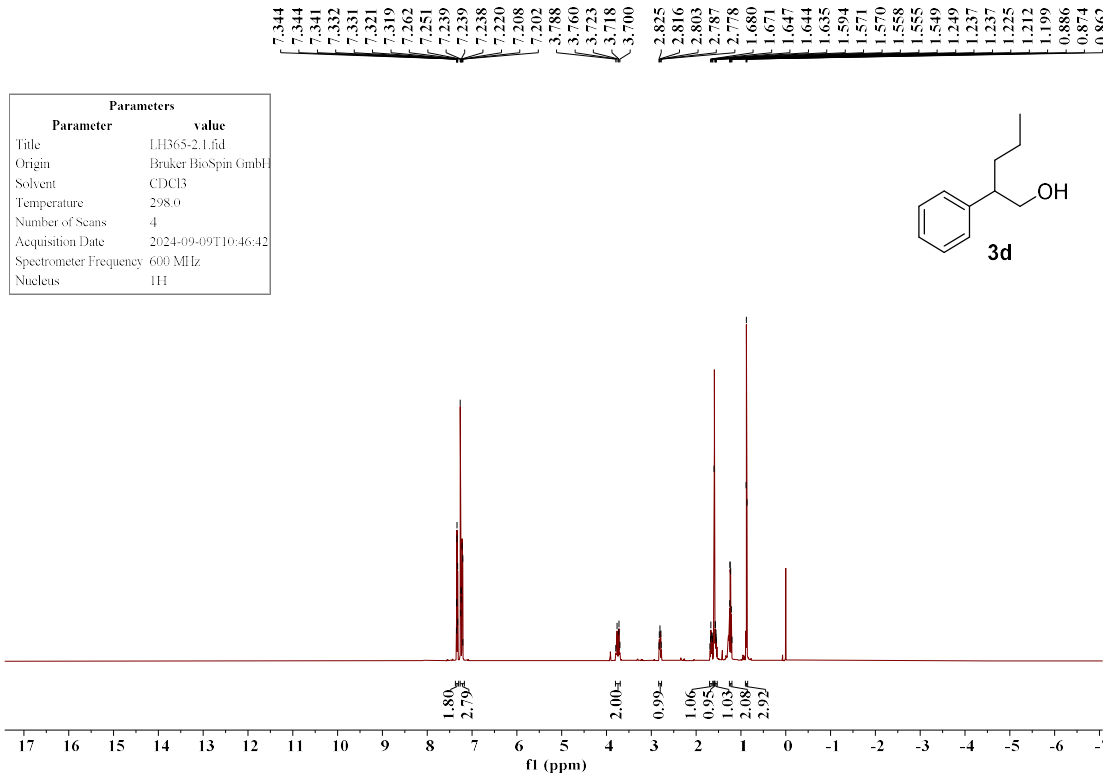

**2p**

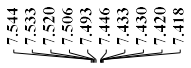



7.351
7.338
7.326
7.262
7.255
7.243
7.243
3.725
3.705
2.979
2.967
2.944
1.580
1.290
1.279
Parameters
Parameter value
Title LH292-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-22T20:02:41
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3a
1.89
2.83
2.00
0.95
1.01
3.11
f1 (ppm)


7.159
7.144
7.141
7.132
7.128
3.690
3.679
2.941
2.929
2.918
2.906
2.333
1.583
1.266
1.254
Parameters
Parameter value
Title LH368-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-09-12T12:55:41
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3b
3.97
2.08
1.00
3.04
0.90
3.08
f1 (ppm)

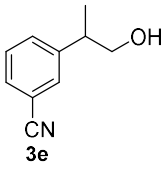

7.239
7.226
7.214
7.213
7.063
7.052
7.036
3.705
3.693
2.926
2.914
2.902
2.351
1.604
1.271
1.259
Parameters
Parameter value
Title LH370-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-09-13T18:58:16
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3c
1.02
2.92
2.02
1.00
3.02
1.00
3.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


7.344
7.344
7.341
7.332
7.331
7.321
7.319
7.262
7.251
7.239
7.239
7.238
7.220
7.208
7.202
3.788
3.760
3.723
3.718
3.700
2.825
2.816
2.803
2.787
2.778
1.680
1.671
1.647
1.644
1.635
1.594
1.571
1.570
1.558
1.555
1.549
1.249
1.237
1.225
1.212
1.199
0.886
0.874
Parameters
Parameter value
Title LH365-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-09T10:46:42
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3d
1.80
2.79
2.00
0.99
1.06
0.95
1.03
2.08
2.92
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6
f1 (ppm)

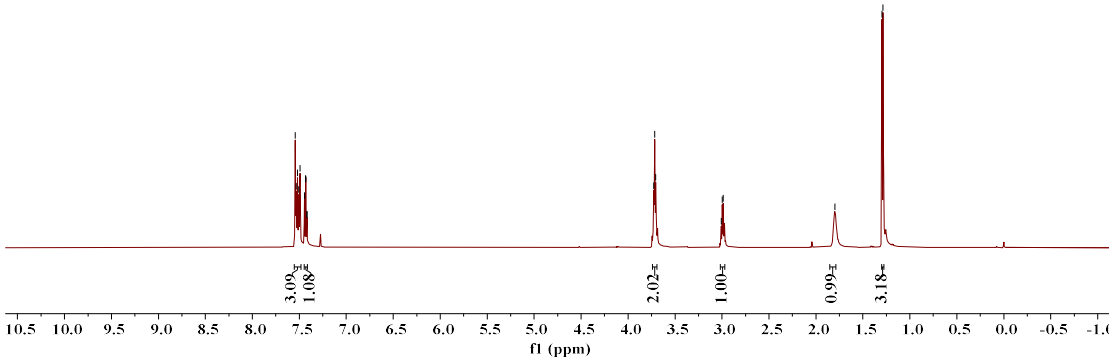




| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH371-2.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-09-18T20:47:27 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |



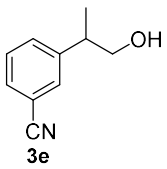

3e



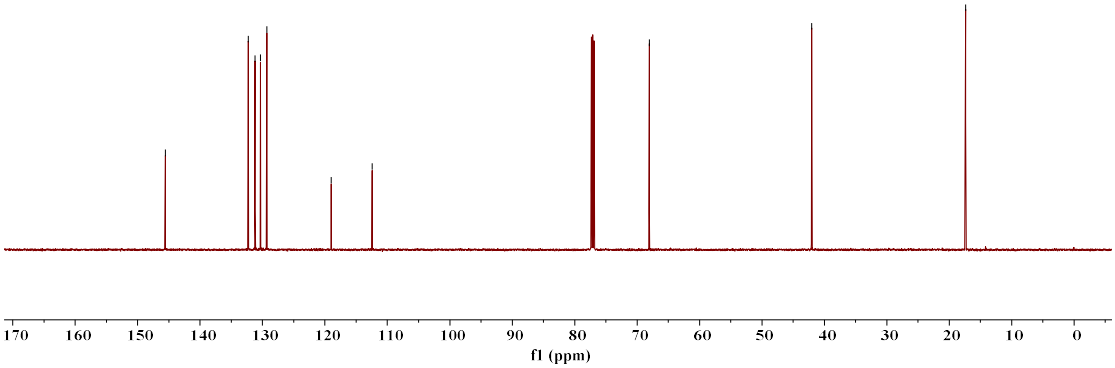


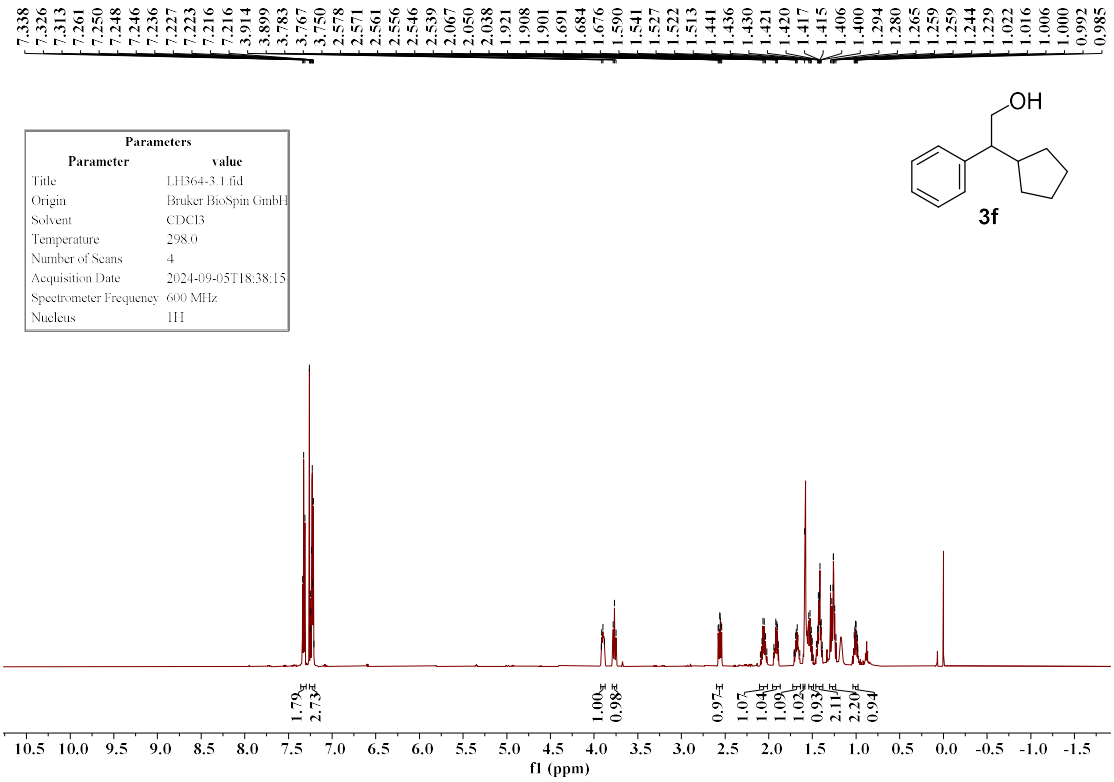


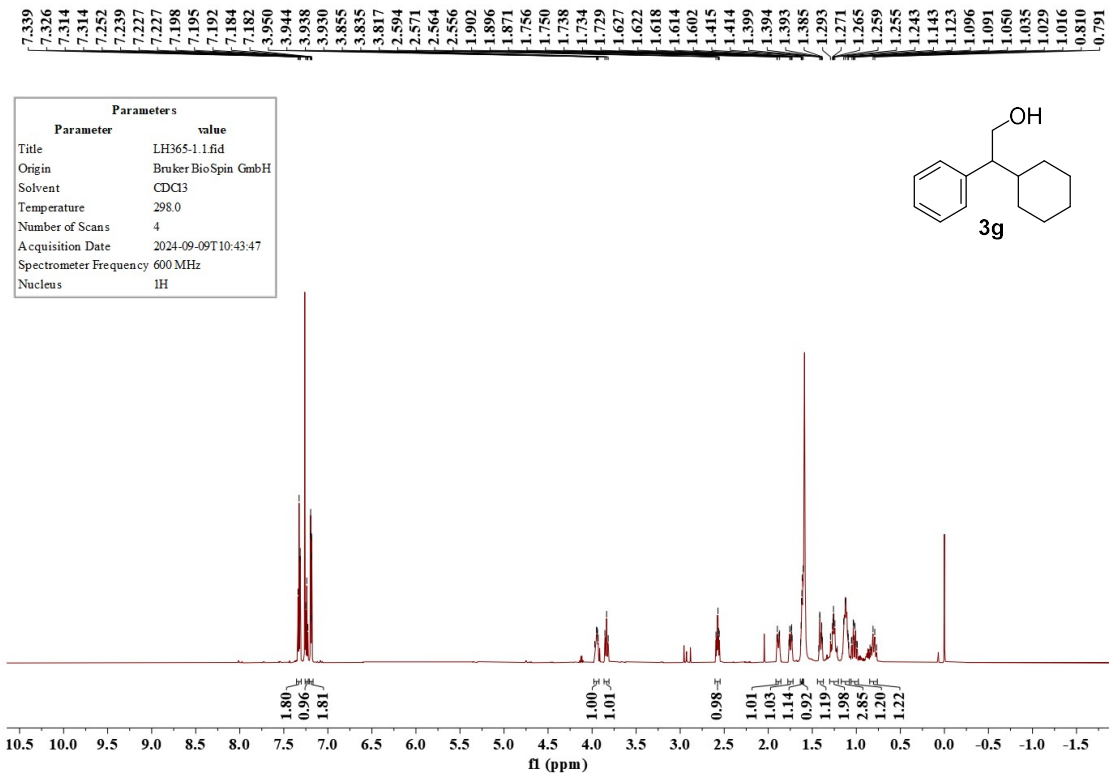

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH371-2.2.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 346 |
| Acquisition Date | 2024-09-19T22:20:38 |
| Spectrometer Frequency | 151 MHz |
| Nucleus | 13C |

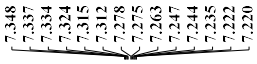


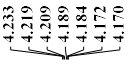

3e




7.338
7.326
7.313
7.261
7.250
7.248
7.246
7.236
7.227
7.223
7.216
7.216
3.914
3.899
3.783
3.767
3.750
2.578
2.571
2.561
2.556
2.546
2.539
2.067
2.050
2.038
1.921
1.908
1.901
1.691
1.684
1.676
1.590
1.541
1.527
1.522
1.513
1.441
1.436
1.430
1.421
1.420
1.417
1.415
1.406
1.400
1.294
1.280
1.265
1.259
1.259
1.244
1.229
1.022
1.016
1.006
1.000
0.992
0.985
Parameters
Parameter value
Title LH364-3 1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-05T18:38:15
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3f
1.79
2.73
1.00
0.98
0.97
1.07
1.04
1.09
1.02
0.93
2.11
2.20
0.94
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)

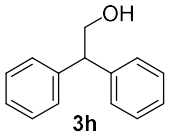

7.339
7.326
7.314
7.314
7.252
7.239
7.227
7.227
7.198
7.195
7.192
7.184
7.182
3.950
3.944
3.938
3.930
3.855
3.835
3.817
2.594
2.571
2.564
2.556
1.902
1.896
1.871
1.756
1.750
1.738
1.734
1.729
1.627
1.622
1.618
1.614
1.602
1.415
1.414
1.399
1.394
1.393
1.385
1.293
1.271
1.265
1.259
1.255
1.243
1.143
1.123
1.096
1.091
1.050
1.035
1.029
1.016
0.810
0.791
Parameters
Parameter value
Title LH365-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-09T10:43:47
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3g
1.80
0.96
1.81
1.00
1.01
0.98
1.01
1.03
1.14
0.92
1.19
1.98
2.85
1.20
1.22
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)



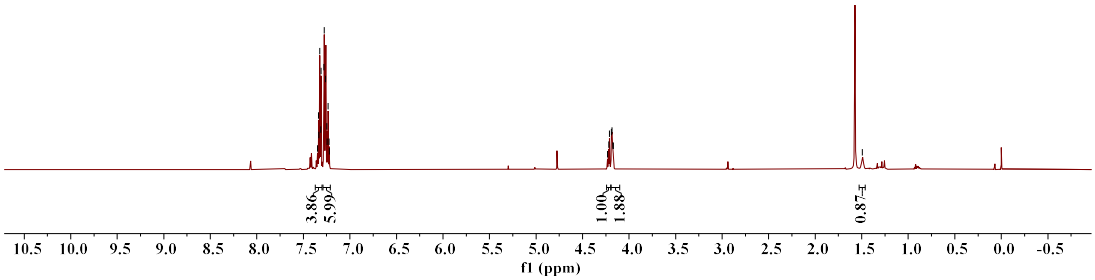



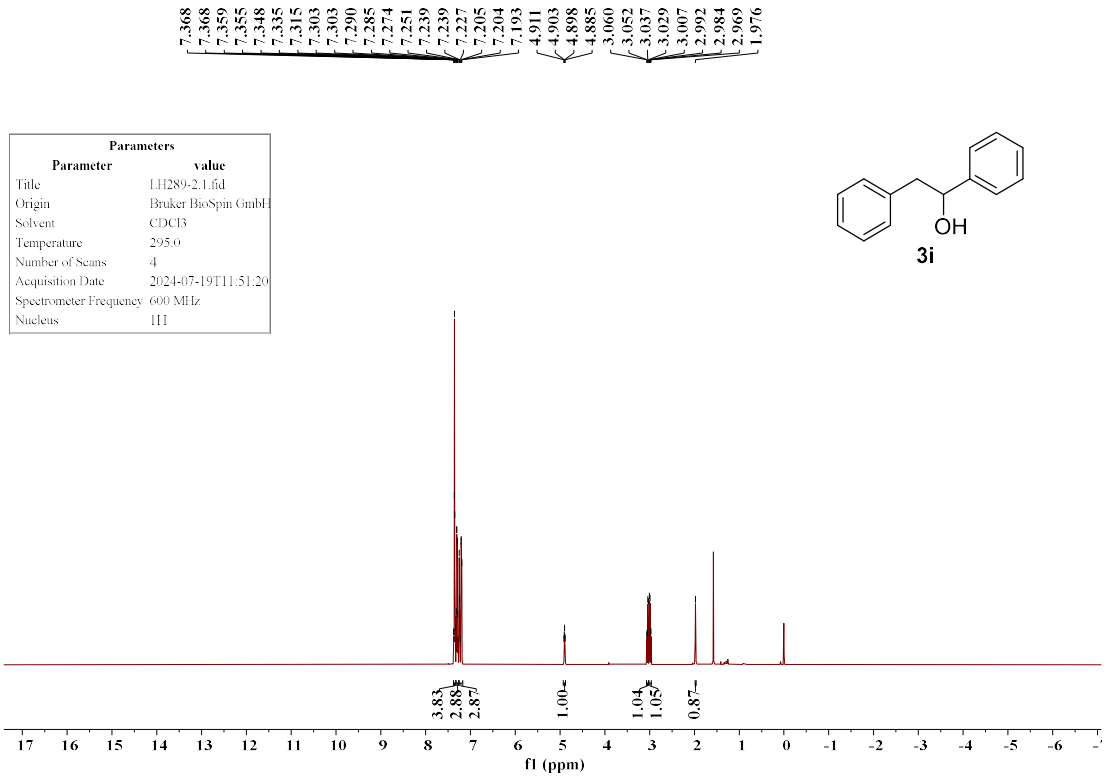


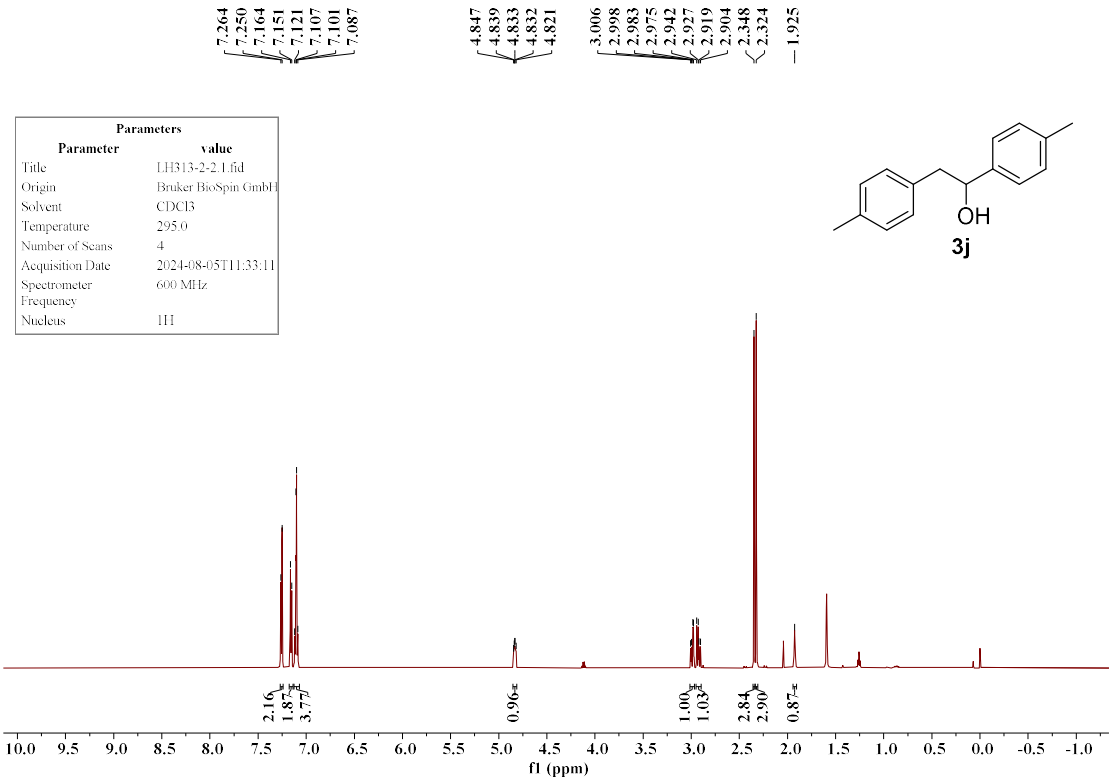
| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH254-1.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-06-27T18:39:20 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

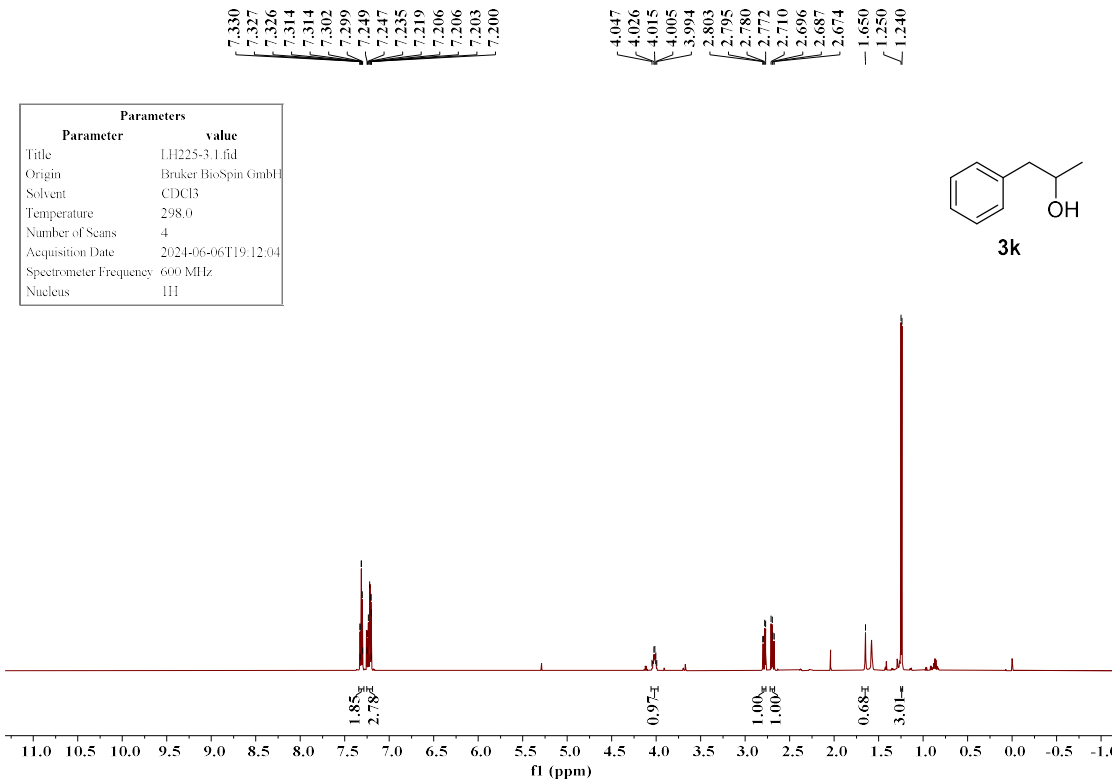


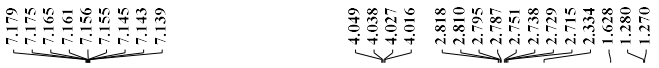

3h



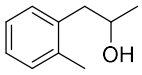

7.368
7.368
7.359
7.355
7.348
7.335
7.315
7.303
7.303
7.290
7.285
7.274
7.251
7.239
7.239
7.227
7.205
7.204
7.193
4.911
4.903
4.898
4.885
3.060
3.052
3.037
3.029
3.007
2.992
2.984
2.969
1.976
Parameters
Parameter value
Title LH289-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-19T11:51:20
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3i
3.83
2.88
2.87
1.00
1.04
1.05
0.87
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6
f1 (ppm)


7.264
7.250
7.164
7.151
7.121
7.107
7.101
7.087
4.847
4.839
4.833
4.832
4.821
3.006
2.998
2.983
2.975
2.942
2.927
2.919
2.904
2.348
2.324
1.925
Parameters
Parameter value
Title LH313-2-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-08-05T11:33:11
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3j
2.16
1.87
3.77
0.96
1.00
1.03
2.84
2.90
0.87
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

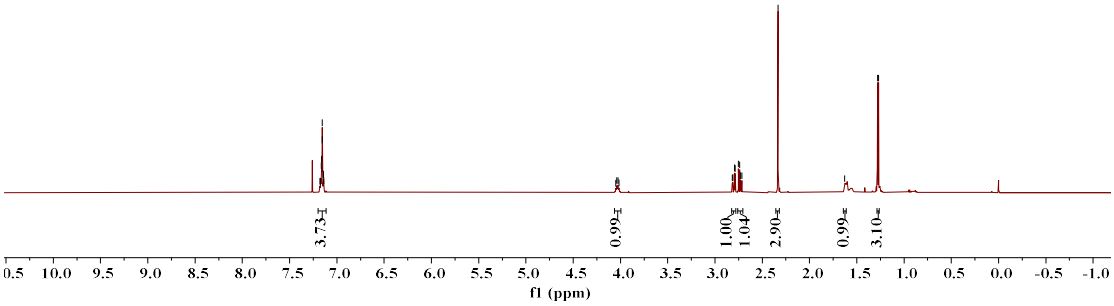

7.330
7.327
7.326
7.314
7.314
7.302
7.299
7.249
7.247
7.235
7.219
7.206
7.206
7.203
7.200
4.047
4.026
4.015
4.005
3.994
2.803
2.795
2.780
2.772
2.710
2.696
2.687
2.674
1.650
1.250
1.240
Parameters
Parameter value
Title LH225-3.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-06-06T19:12:04
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3k
1.85
2.78
0.97
1.00
1.00
0.68
3.01
f1 (ppm)

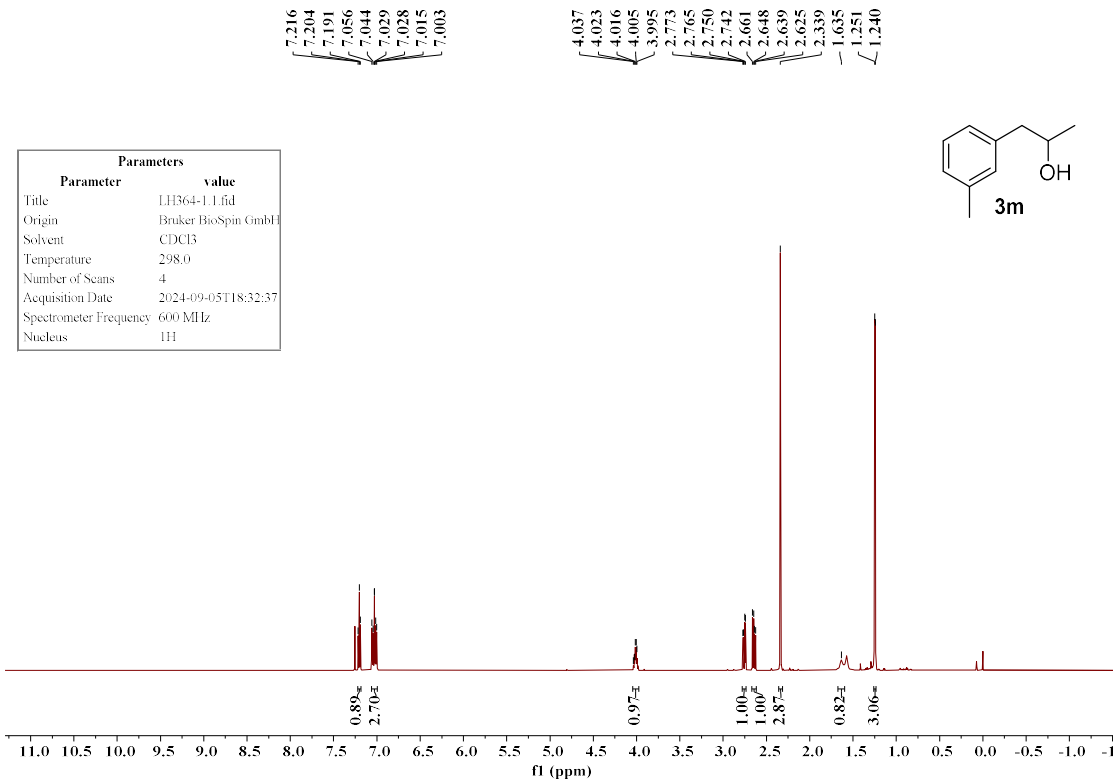


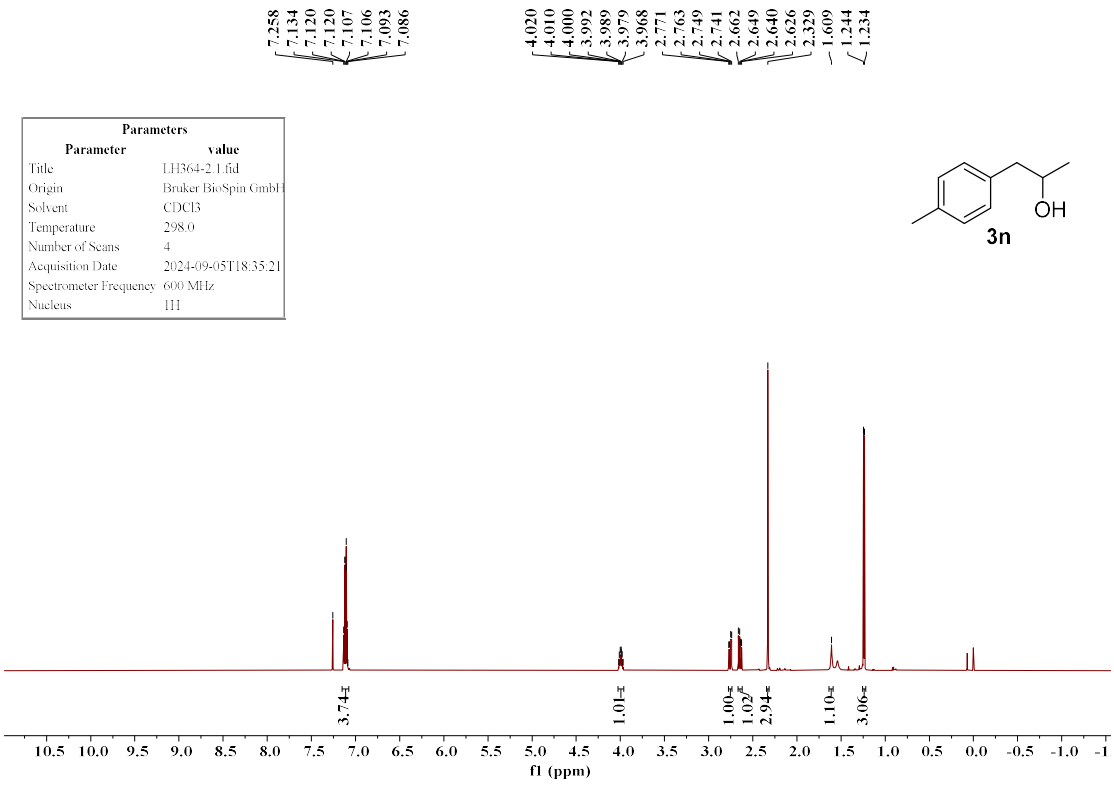

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH361-2.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-09-03T19:37:56 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |



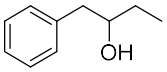

**3l**



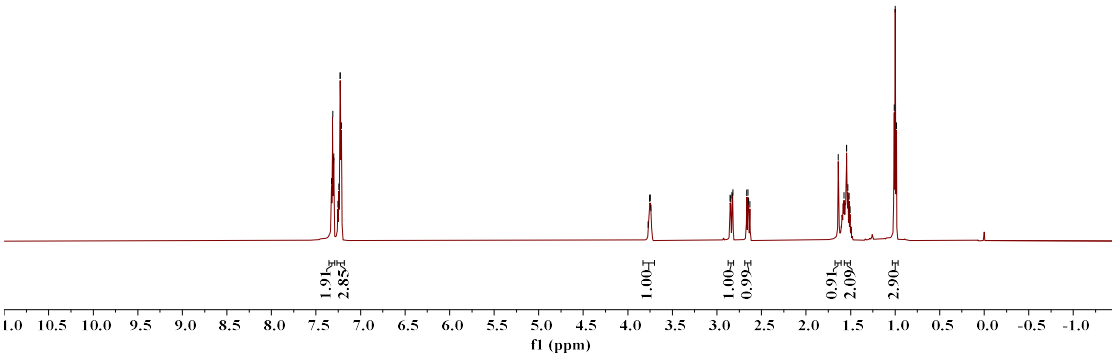

7.216
7.204
7.191
7.056
7.044
7.029
7.028
7.015
7.003
4.037
4.023
4.016
4.005
3.995
2.773
2.765
2.750
2.742
2.661
2.648
2.639
2.625
2.339
1.635
1.251
1.240
Parameters
Parameter value
Title LH364-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-05T18:32:37
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3m
0.89
2.70
0.97
1.00
1.00
2.87
0.82
3.06
f1 (ppm)

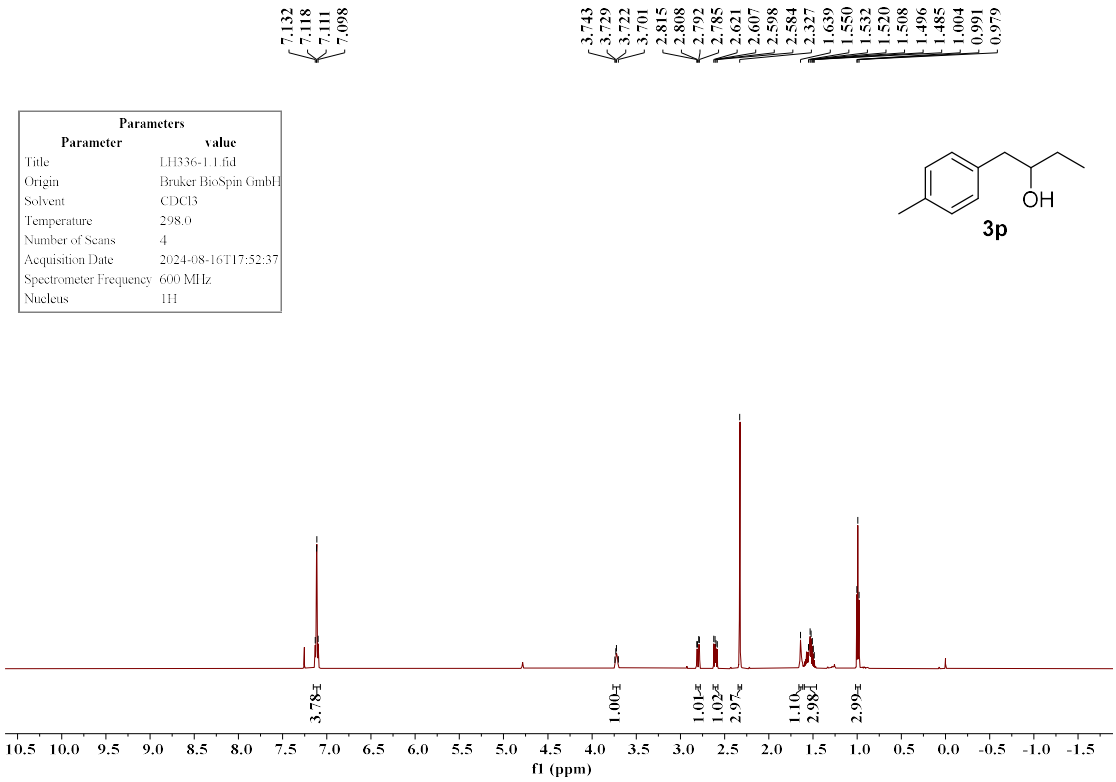

7.258
7.134
7.120
7.120
7.107
7.106
7.093
7.086
4.020
4.010
4.000
3.992
3.989
3.979
3.968
2.771
2.763
2.749
2.741
2.662
2.649
2.640
2.626
2.329
1.609
1.244
1.234
Parameters
Parameter value
Title LH364-2.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-05T18:35:21
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3n
3.74
1.01
1.00
1.02
2.94
1.10
3.06
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1
f1 (ppm)

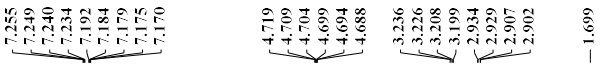

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH330-2-1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-08-15T08:48:22 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |



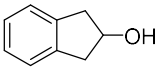

**3o**



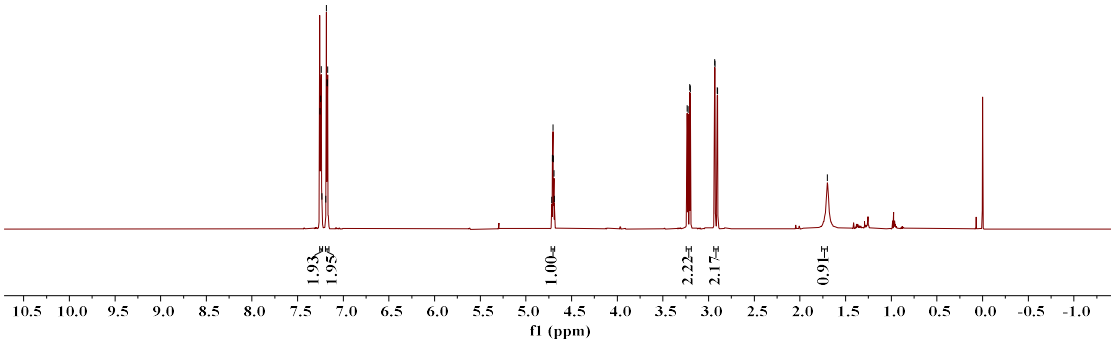

7.132
7.118
7.111
7.098
3.743
3.729
3.722
3.701
2.815
2.808
2.792
2.785
2.621
2.607
2.598
2.584
2.327
1.639
1.550
1.532
1.520
1.508
1.496
1.485
1.004
0.991
0.979
Parameters
Parameter value
Title LH336-1-1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-08-16T17:52:37
Spectrometer Frequency 600 MHz
Nucleus 1H
OH
3p
3.78
1.00
1.01
1.02
2.97
1.10
2.98
2.99
f1 (ppm)

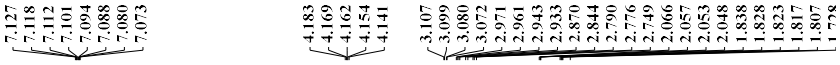



| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH295-1.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-07-24T22:22:23 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

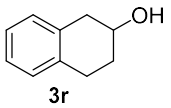



**3q**

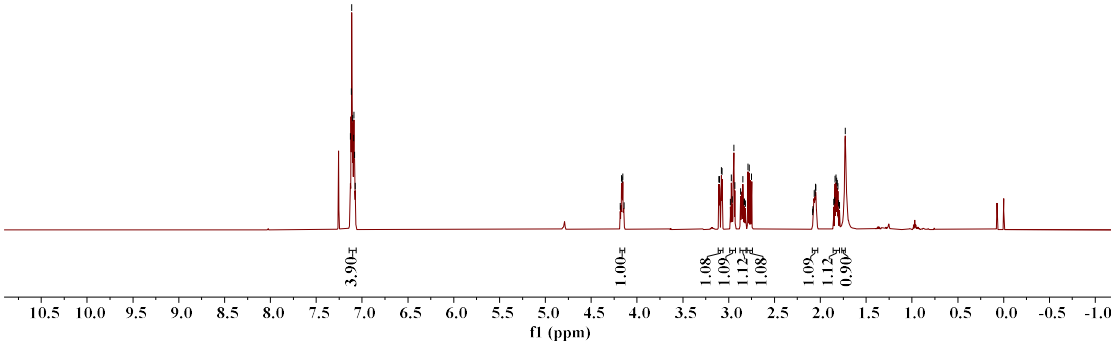


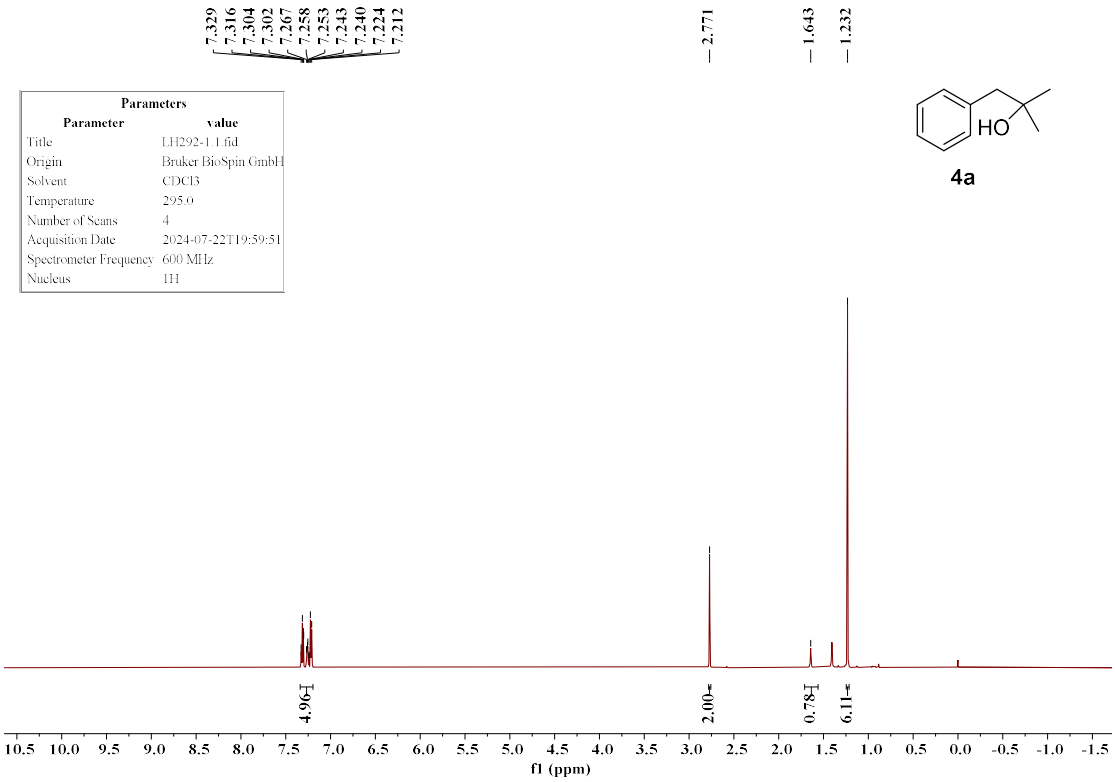


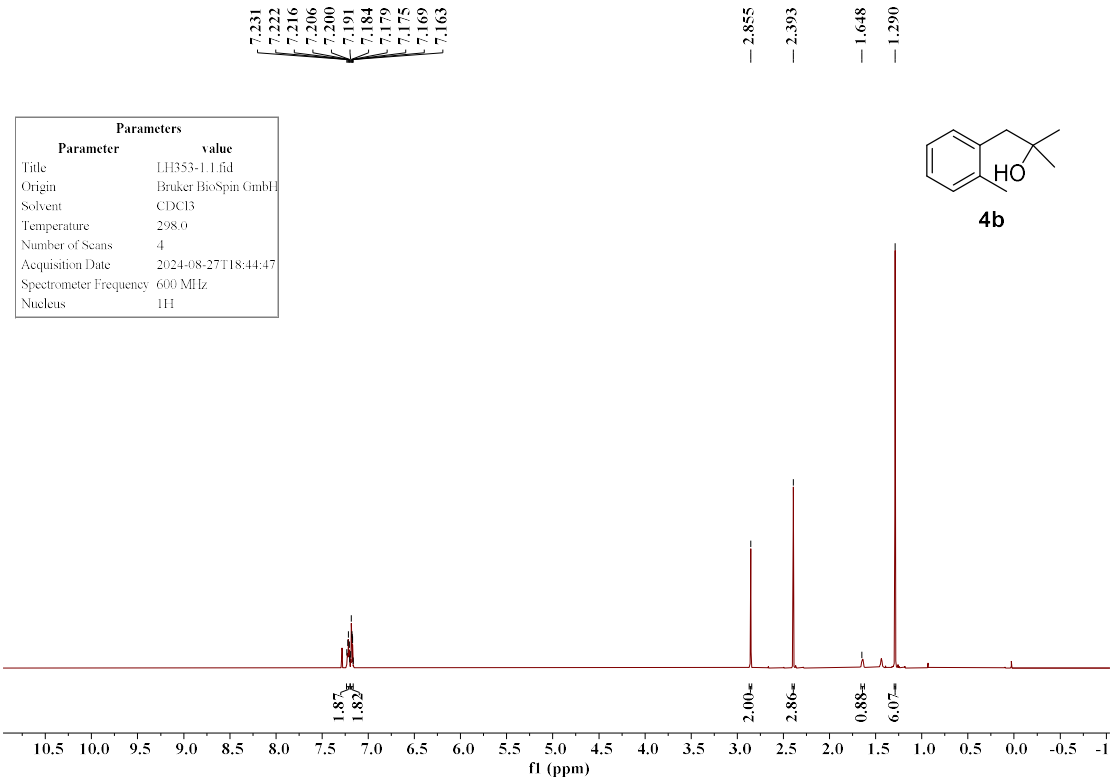

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH313-1.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 295.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-08-05T11:26:04 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |

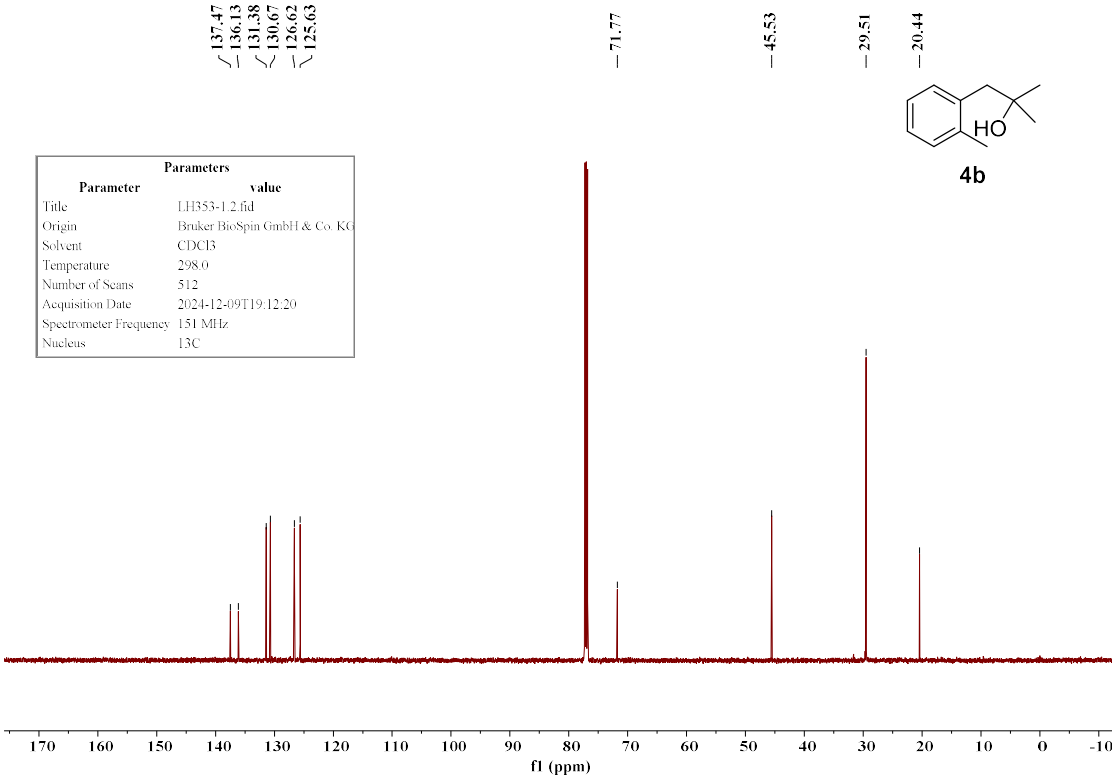


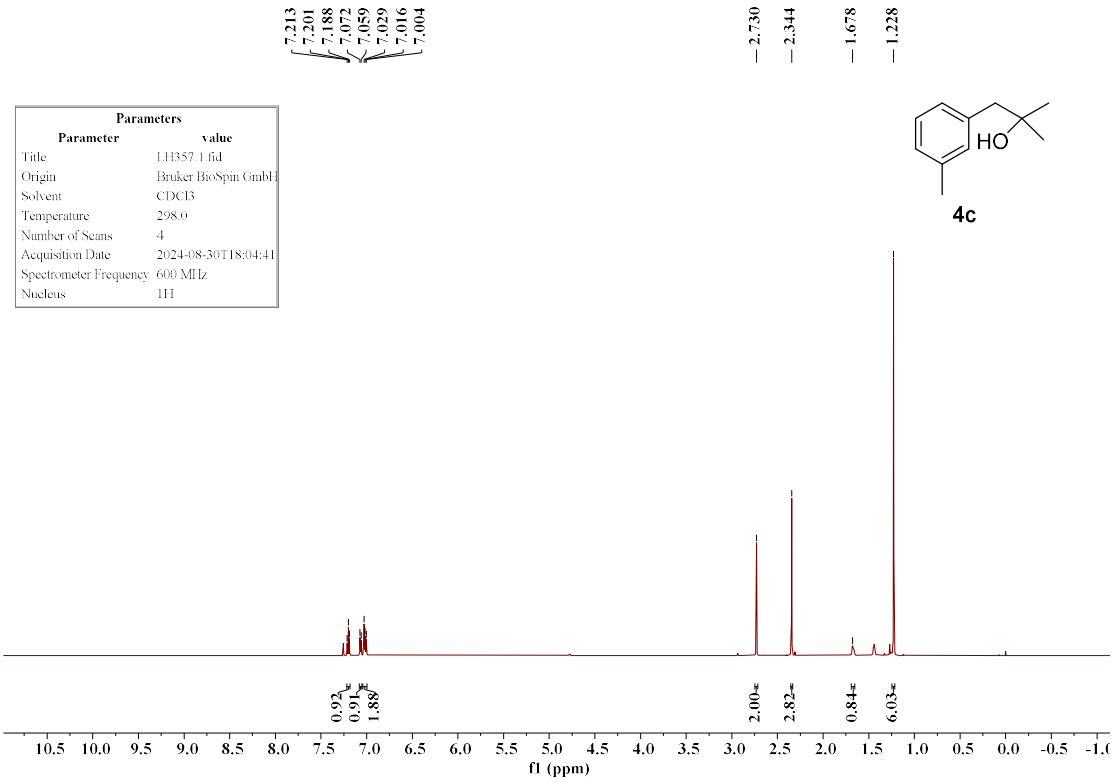

**3r**

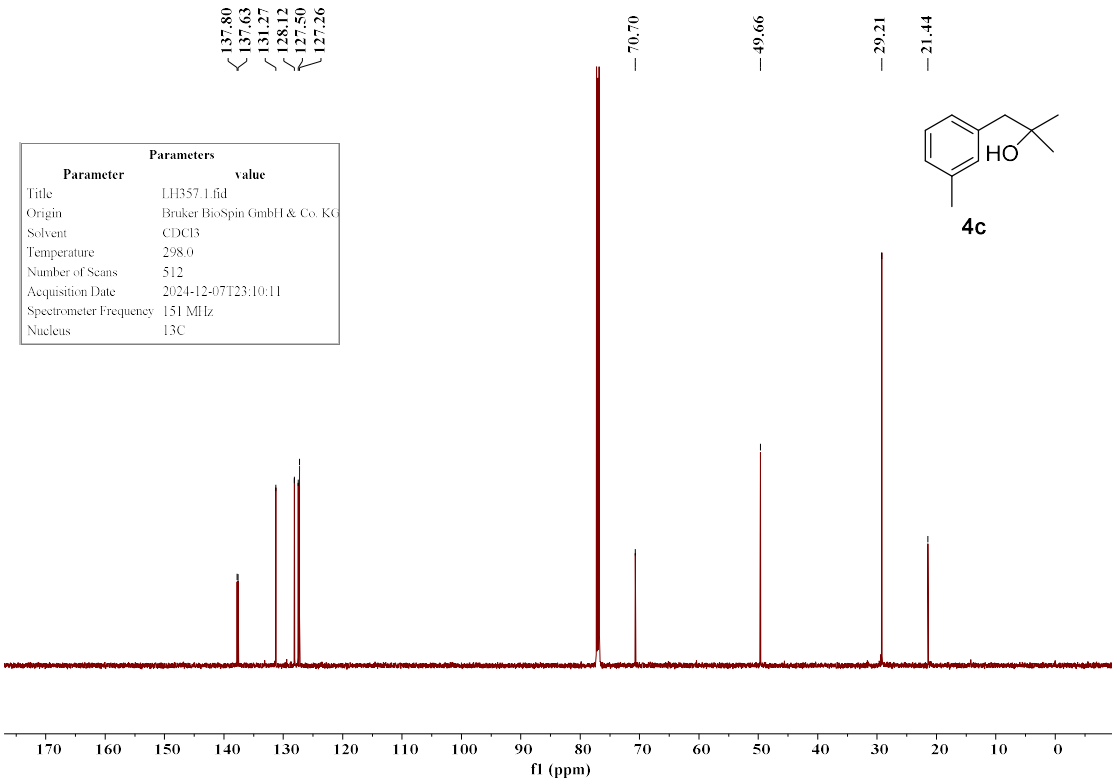


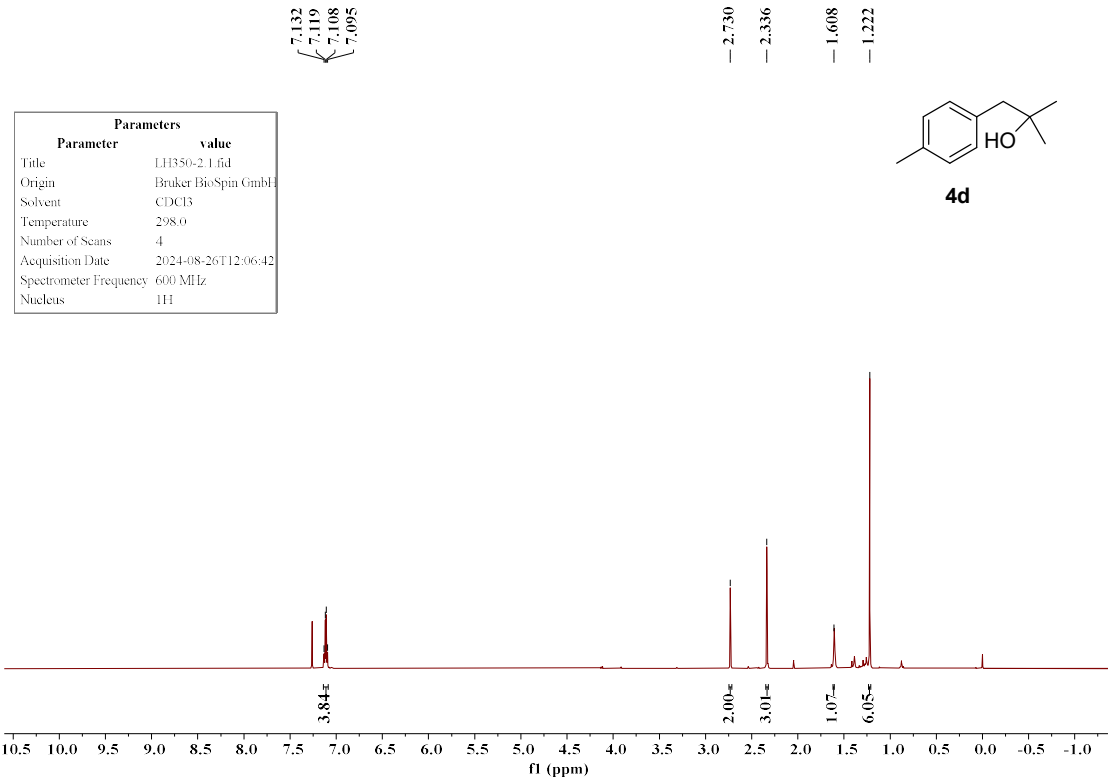

7.329
7.316
7.304
7.302
7.267
7.258
7.253
7.243
7.240
7.224
7.212
2.771
1.643
1.232
Parameters
Parameter value
Title LH292-1-1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-22T19:59:51
Spectrometer Frequency 600 MHz
Nucleus 1H
HO
4a
4.96
2.00
0.78
6.11
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)


7.231
7.222
7.216
7.206
7.200
7.191
7.184
7.179
7.175
7.169
7.163
2.855
2.393
1.648
1.290
Parameters
Parameter value
Title LH353-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-08-27T18:44:47
Spectrometer Frequency 600 MHz
Nucleus 1H
HO
4b
1.87
1.82
2.00
2.86
0.88
6.07
f1 (ppm)

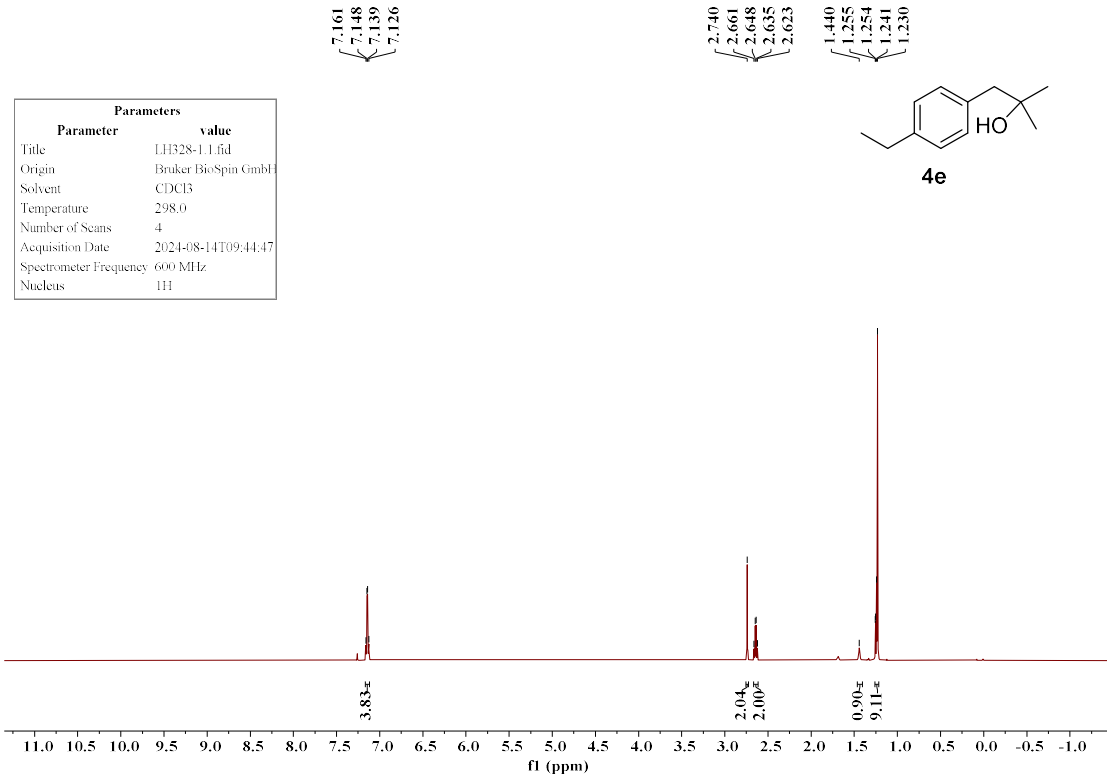

137.47
136.13
131.38
130.67
126.62
125.63
71.77
45.53
29.51
20.44
Parameters
Parameter value
Title LH353-1.2.fid
Origin Bruker BioSpin GmbH & Co. KG
Solvent CDCl3
Temperature 298.0
Number of Scans 512
Acquisition Date 2024-12-09T19:12:20
Spectrometer Frequency 151 MHz
Nucleus 13C
HO
4b
f1 (ppm)

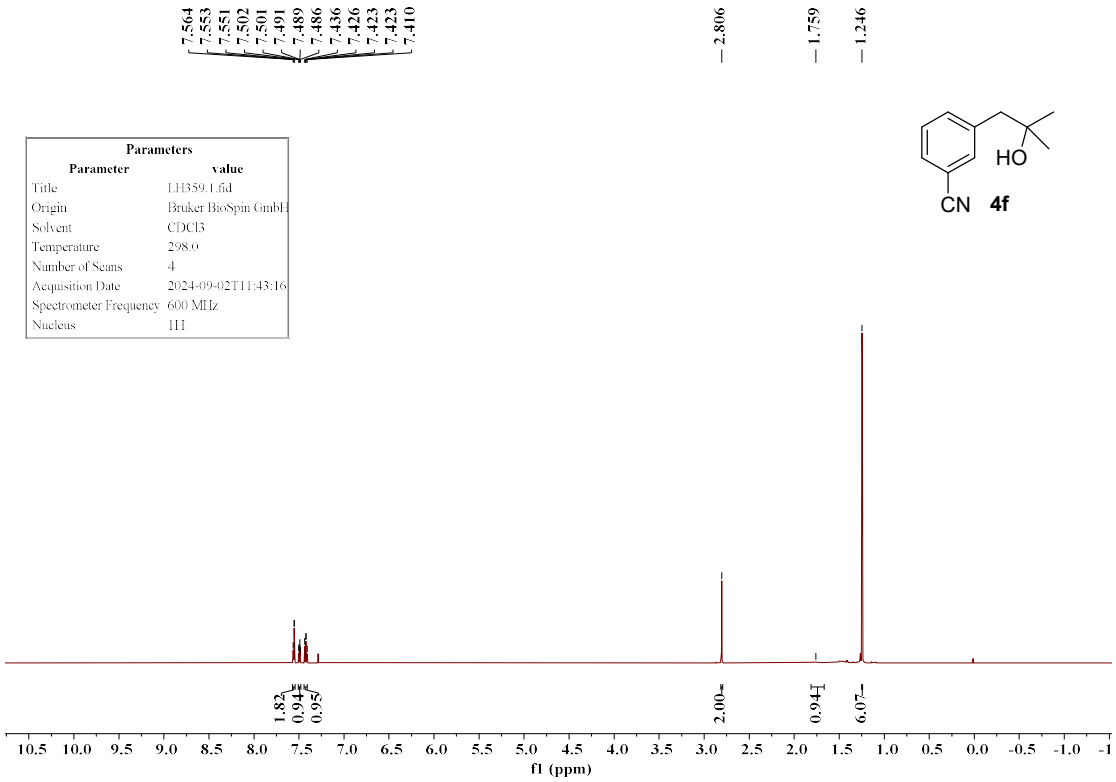

7.213
7.201
7.188
7.072
7.059
7.029
7.016
7.004
2.730
2.344
1.678
1.228
Parameters
Parameter value
Title LH357.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-08-30T18:04:41
Spectrometer Frequency 600 MHz
Nucleus 1H
HO
4c
0.92
0.91
1.88
2.00
2.82
0.84
6.03
f1 (ppm)

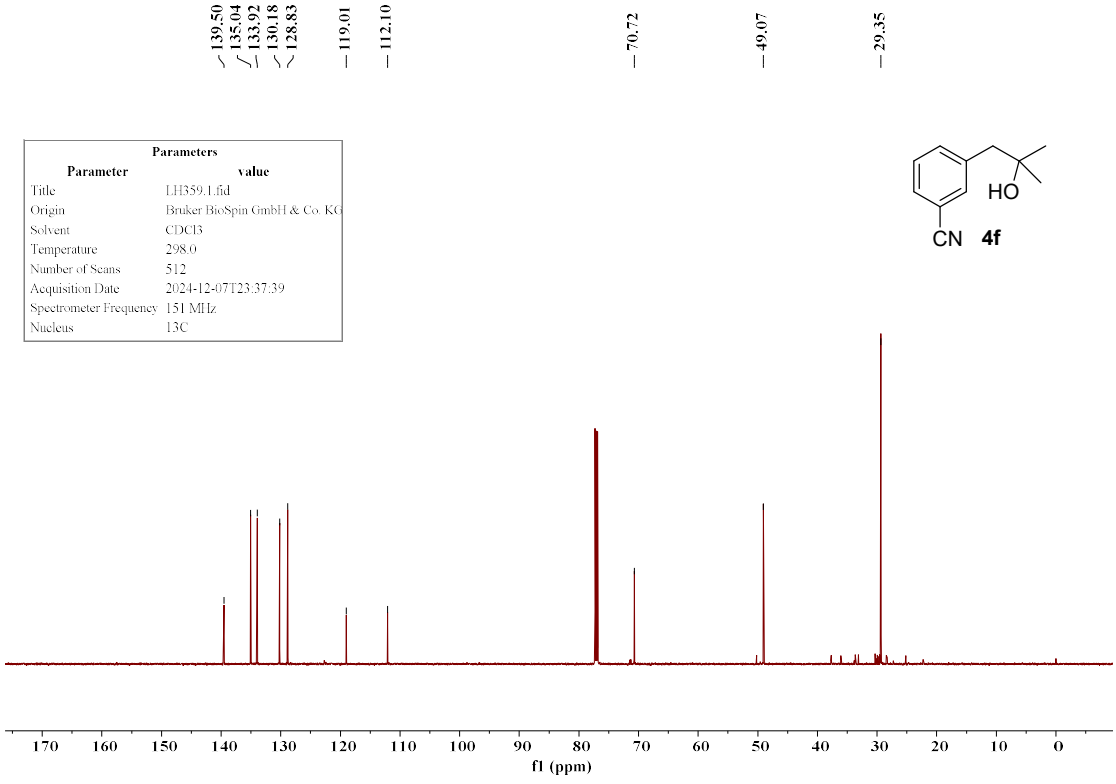

137.80
137.63
131.27
128.12
127.50
127.26
70.70
49.66
29.21
21.44
Parameters
Parameter value
Title LH357.1.fid
Origin Bruker BioSpin GmbH & Co. KG
Solvent CDCl3
Temperature 298.0
Number of Scans 512
Acquisition Date 2024-12-07T23:10:11
Spectrometer Frequency 151 MHz
Nucleus 13C
HO
4c
f1 (ppm)

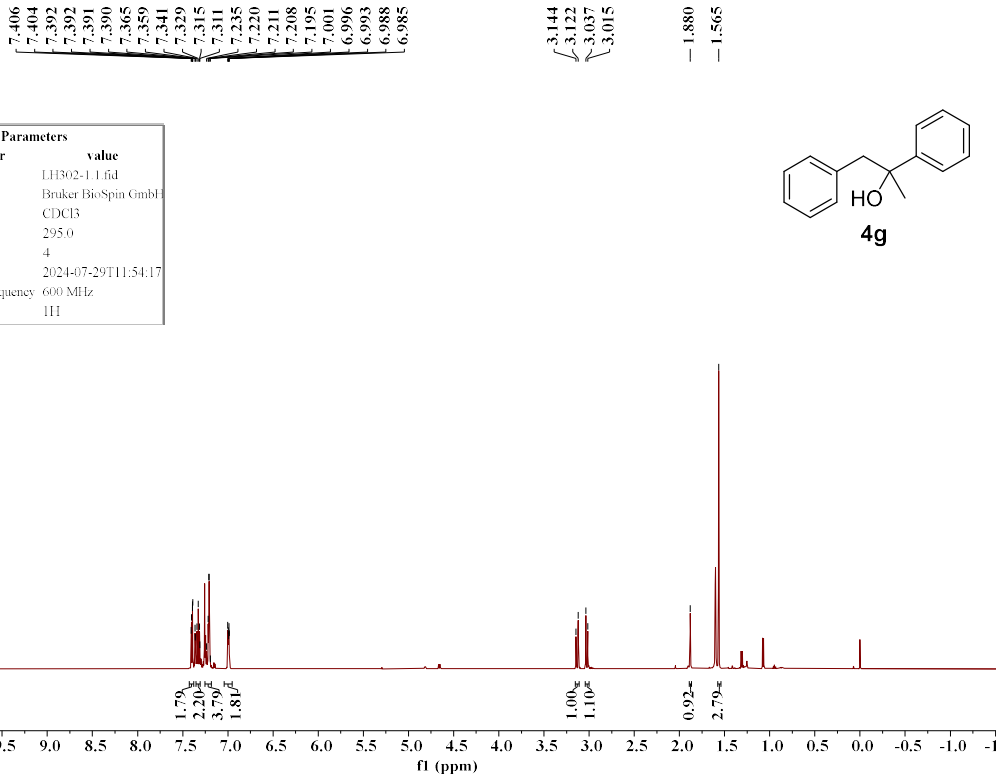

7.132
7.119
7.108
7.095
2.730
2.336
1.608
1.222
Parameters
Parameter value
Title LH350-2 1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-08-26T12:06:42
Spectrometer Frequency 600 MHz
Nucleus 1H
HO
3.84
2.00
3.01
1.07
6.05
f1 (ppm)

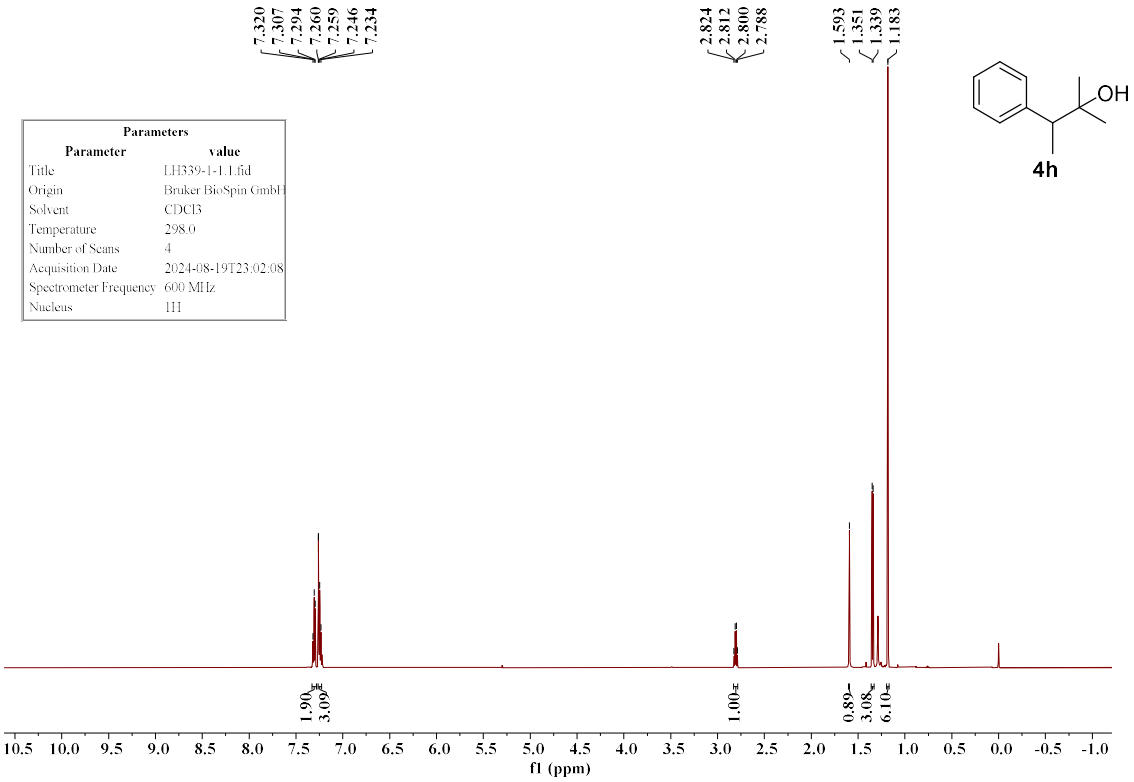
**4d**

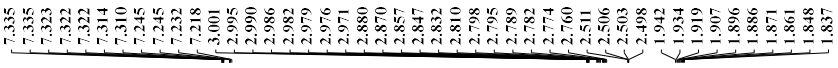

7.161
7.148
7.139
7.126
2.740
2.661
2.648
2.635
2.623
1.440
1.255
1.254
1.241
1.230
HO
4e
Parameters
Parameter value
Title LH328-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-08-14T09:44:47
Spectrometer Frequency 600 MHz
Nucleus 1H
3.83
2.04
2.00
0.90
9.11
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


7.564
7.553
7.551
7.502
7.501
7.491
7.489
7.486
7.436
7.426
7.423
7.423
7.410
2.806
1.759
1.246
Parameters
Parameter value
Title LH359.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-09-02T11:43:16
Spectrometer Frequency 600 MHz
Nucleus 1H
HO
CN 4f
1.82
0.94
0.95
2.00
0.94
6.07
f1 (ppm)

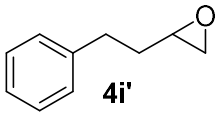

139.50
135.04
133.92
130.18
128.83
119.01
112.10
70.72
49.07
29.35
Parameters
Parameter value
Title LH359.1.fid
Origin Bruker BioSpin GmbH & Co. KG
Solvent CDCl3
Temperature 298.0
Number of Scans 512
Acquisition Date 2024-12-07T23:37:39
Spectrometer Frequency 151 MHz
Nucleus 13C
HO
CN 4f
f1 (ppm)

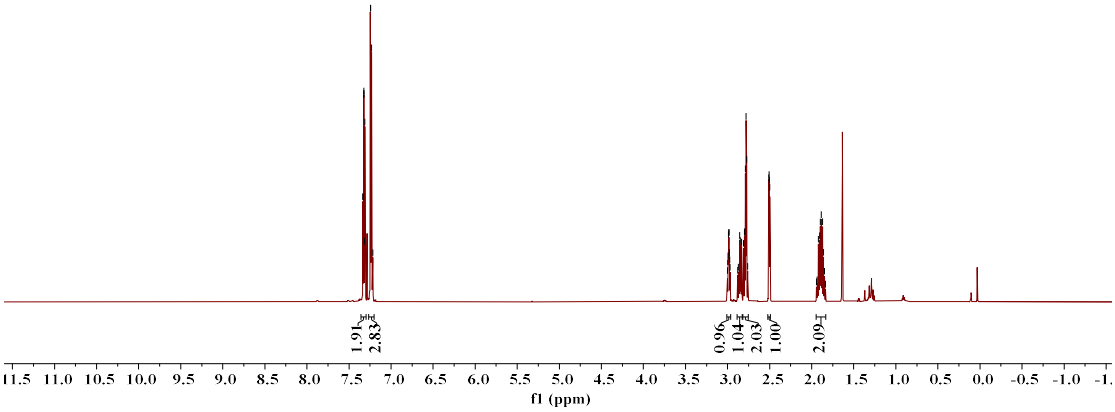

7.406
7.404
7.392
7.392
7.391
7.390
7.365
7.359
7.341
7.329
7.315
7.311
7.235
7.220
7.211
7.208
7.195
7.001
6.996
6.993
6.988
6.985
3.144
3.122
3.037
3.015
1.880
1.565
Parameters
Parameter value
Title LH302-1-1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 295.0
Number of Scans 4
Acquisition Date 2024-07-29T11:54:17
Spectrometer Frequency 600 MHz
Nucleus 1H
HO
4g
1.79
2.20
3.79
1.81
1.00
1.10
0.92
2.79
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1
f1 (ppm)

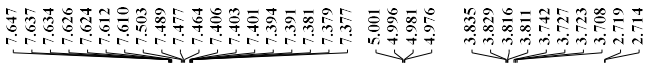

7.320
7.307
7.294
7.260
7.259
7.246
7.234
2.824
2.812
2.800
2.788
1.593
1.351
1.339
1.183
OH
4h
Parameters
Parameter value
Title LH339-1-1.1.fid
Origin Bruker BioSpin GmbH
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-08-19T23:02:08
Spectrometer Frequency 600 MHz
Nucleus 1H
1.90
3.09
1.00
0.89
3.08
6.10
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)



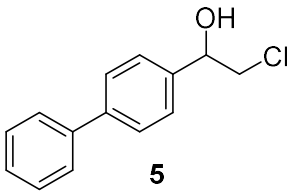

| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH213-1.1.fid |
| Origin | Bruker BioSpin GmbH |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-05-29T18:32:20 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |



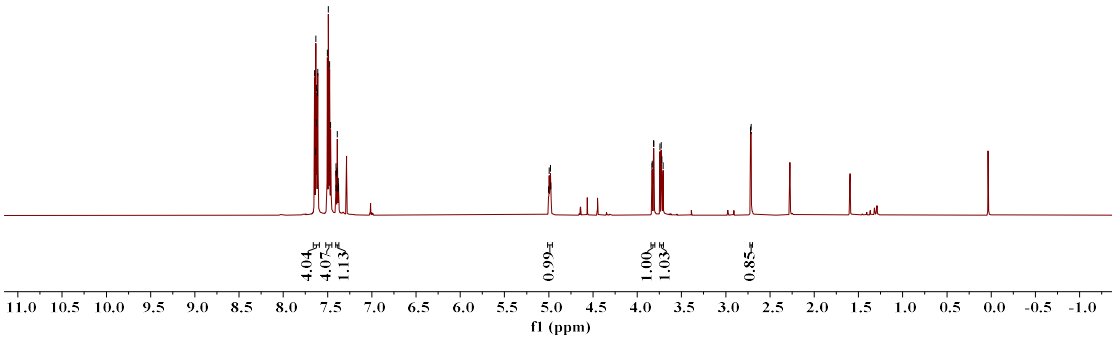



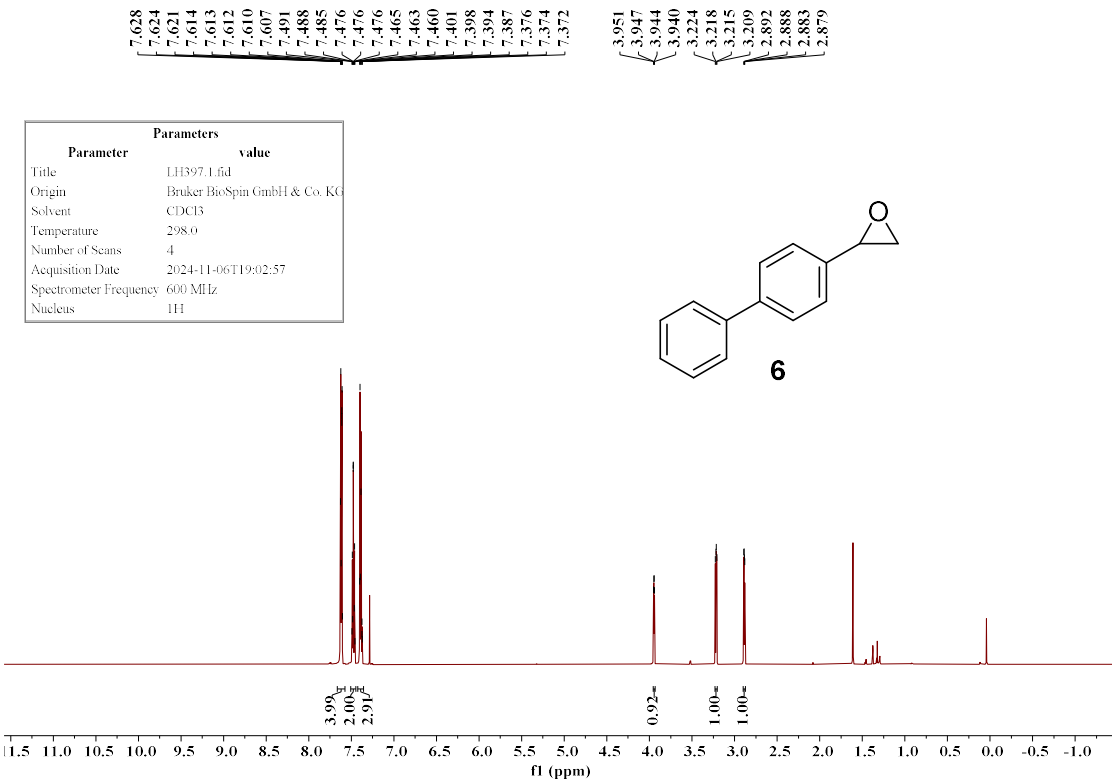



| Parameters | |
|---|---|
| **Parameter** | **value** |
| Title | LH396-1.fid |
| Origin | Bruker BioSpin GmbH & Co. KG |
| Solvent | CDCl3 |
| Temperature | 298.0 |
| Number of Scans | 4 |
| Acquisition Date | 2024-12-12T18:39:42 |
| Spectrometer Frequency | 600 MHz |
| Nucleus | 1H |




**5**




7.628
7.624
7.621
7.614
7.613
7.612
7.610
7.607
7.491
7.488
7.485
7.476
7.476
7.476
7.465
7.463
7.460
7.401
7.398
7.394
7.387
7.376
7.374
7.372
3.951
3.947
3.944
3.940
3.224
3.218
3.215
3.209
2.892
2.888
2.883
2.879
Parameters
Parameter value
Title LH397.1.fid
Origin Bruker BioSpin GmbH & Co. KG
Solvent CDCl3
Temperature 298.0
Number of Scans 4
Acquisition Date 2024-11-06T19:02:57
Spectrometer Frequency 600 MHz
Nucleus 1H
6
3.99
2.00
2.91
0.92
1.00
1.00
f1 (ppm)