Supporting Information

Visible-light-induced C(sp^3)–H functionalizations to 3,3-dichloro-2-hydroxy-piperidines with *N*-chlorosuccinimide

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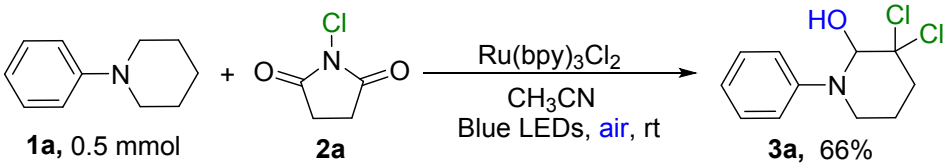
Contents

1. General considerations

The ^{1}H NMR and ^{13}C NMR spectra were recorded on a 400 MHz Bruker FT-NMR spectrometer (400/100 MHz). All chemical shifts are given as δ value (ppm) with reference to tetramethylsilane (TMS) as an internal standard. The peak patterns are indicated as follows: s, singlet; d, doublet; t, triplet; m, multiplet. The coupling constants, *J*, are reported in Hertz (Hz). High resolution mass spectroscopy data of the product were collected on an Agilent Technologies 6540 UHD Accurate-Mass Q-TOF LC/MS (ESI). All the solvents and commercially available reagents were purchased from commercial suppliers. Products were purified by flash chromatography on 200–300 mesh silica gels, SiO_2.

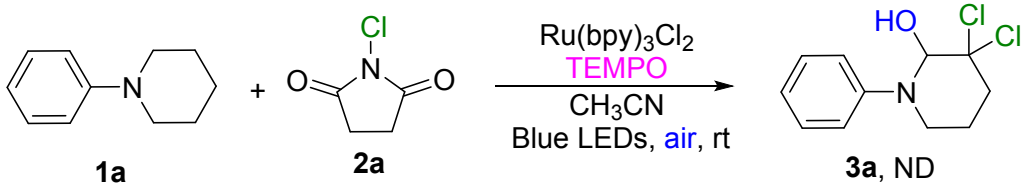
2. Representative procedure for the model reaction



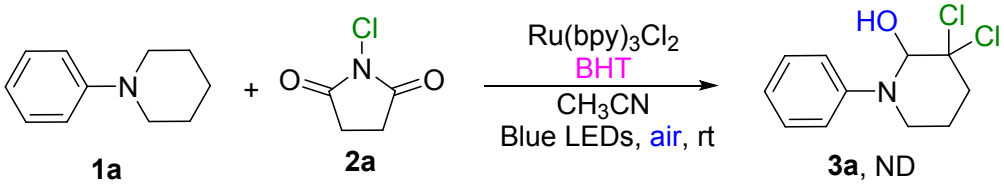
A 5 mL oven-dried reaction vessel equipped with a magnetic stirrer bar was charged with 1-phenylpiperidine (**1a**, 81 mg, 0.50 mmol), CH_3CN (2.0 mL), $Ru(bpy)_3Cl_2$ (1.9 mg, 0.005 mmol) and *N*-chlorosuccinimide (NCS, **2a**, 133 mg, 1.0 mmol). The reaction vessel was exposed to blue LEDs (420−425 nm, 1.5 W) irradiation at room temperature in air with stirring for 12 h. Upon completion, it was quenched with water (3.0 mL), and then extracted with ethyl acetate (10 mL × 3). The combined organic layer was washed with brine, dried over

anhydrous Na_2SO_4, and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel with petroleum ether/ethyl acetate (20:1) as the eluent to give **3a** in 66% yield.

3. Preliminary mechanistic investigation



(a) A 5 mL oven-dried reaction vessel equipped with a magnetic stirrer bar was charged with 1-phenylpiperidine (**1a**, 81 mg, 0.50 mmol), CH_3CN (2.0 mL), *N*-chlorosuccinimide (NCS, **2a**, 133 mg, 1.0 mmol) and TEMPO (156 mg, 1.0 mmol). The reaction vessel was exposed to blue LED (420−425 nm, 1.5 W) irradiation at room temperature in air with stirring for 12 h. TLC analysis of the resulting mixture showed that **3a** was not formed.



(b) A 5 mL oven-dried reaction vessel equipped with a magnetic stirrer bar was charged with 1-phenylpiperidine (**1a**, 81 mg, 0.50 mmol), CH_3CN (2.0 mL), $Ru(bpy)_3Cl_2$ (1.9 mg, 0.005 mmol), *N*-chlorosuccinimide (NCS, **2a**, 133 mg, 1.0 mmol) and BHT (220 mg, 1.0

mmol). The reaction vessel was exposed to blue LEDs (420−425 nm, 1.5 W) irradiation at room temperature in air with stirring for 12 h. TLC analysis of the resulting mixture showed that **3a** was not formed. Meanwhile, enamine intermediate was observed in GC-MS analysis (Figure S1).

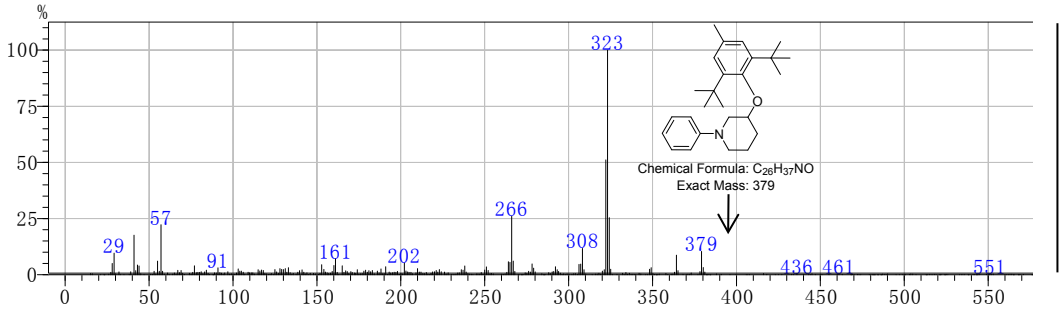
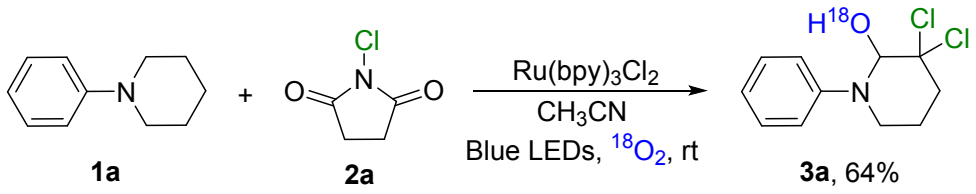


Figure S1. GC-MS analysis of enamine intermediate



1a **2a** **3a**, 64%

(c) A 5 mL oven-dried reaction vessel equipped with a magnetic stirrer bar was charged with 1-phenylpiperidine (**1a**, 81 mg, 0.50 mmol), CH_3CN (2.0 mL), $Ru(bpy)_3Cl_2$ (1.9 mg, 0.005 mmol) and *N*-chlorosuccinimide (NCS, **2a**, 133 mg, 1.0 mmol). The reaction vessel was exposed to blue LEDs (420−425 nm, 1.5 W) irradiation at room temperature under molecular oxygen ($^{18}O_2$) atmosphere at room temperature for 12 h. The ^{18}O-labeling product (^{18}O-**3a**) was isolated in 64% yield, and it was confirmed by GC-MS analysis (Figure S2).

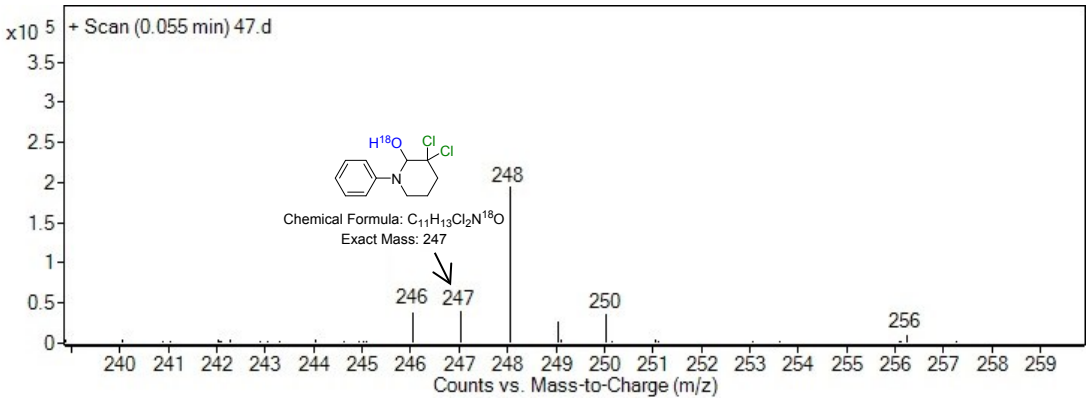
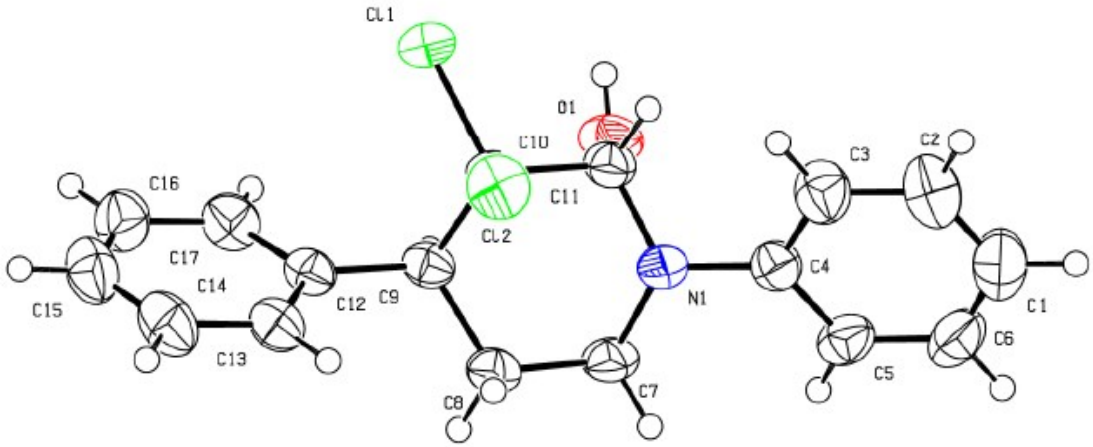


Figure S2. GC-MS analysis of $^{18}O_2$-isotopic labeling product (^{18}O-**3a**)

4. X-Ray single crystal diffraction analysis of 3n

3,3-Dichloro-1-(cyclohexa-1,3-dien-1-yl)-4-phenylpiperidin-2-ol (3n, CCDC: 2081144)



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

No syntax errors found. CIF dictionary Interpreting this report

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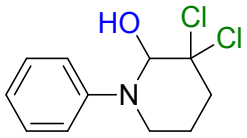
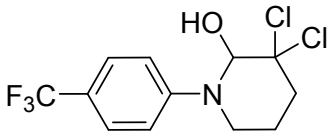
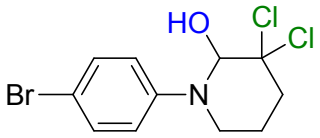
5. Characterization data for the products



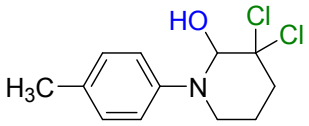
3,3-Dichloro-1-phenylpiperidin-2-ol (3a). Colorless oil (81 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.74–1.81 (m, 1H), 2.09–2.21 (m, 1H), 2.43–2.48 (m, 1H), 2.65–2.71 (m, 1H), 2.72 (d, J = 2.4 Hz, 1H), 3.16–3.20 (m, 1H), 3.38–3.45 (m, 1H), 5.36 (s, 1H), 6.97 (t, J = 7.6 Hz, 1H), 7.05 (d, J = 7.6 Hz, 2H), 7.30 (dd, J_1 = 8.4 Hz, J_2 = 7.6 Hz, 2H).^{13}C NMR (100 MHz, $CDCl_3$) δ: 23.3, 37.8, 41.1, 88.2 90.8, 119.2, 121.8, 129.2, 149.7. HRMS (ESI) calcd for $C_{11}H_{14}Cl_2NO$: 246.0447 $[M+H]^+$, found: 246.0428.



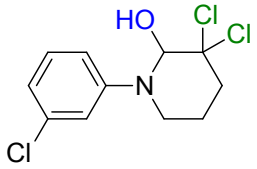
3,3-Dichloro-1-(4-(trifluoromethyl)phenyl)piperidin-2-ol (3b). Colorless oil (102 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.78–1.82 (m, 1H), 2.13–2.19 (m, 1H), 2.46–2.49 (m, 1H), 2.66–2.74 (m, 1H), 2.92 (s, 1H), 3.25–3.32 (m, 1H), 3.38–3.45 (m, 1H), 5.44 (s, 1H), 7.08 (t, J = 8.8 Hz, 2H), 7.53 (d, J = 8.4 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 23.1, 25.4, 37.5, 40.9, 87.1, 90.5, 117.8, 126.5 (q, $^{4}J_{C-F}$ = 3.6 Hz), 126.5 (q, $^{2}J_{C-F}$ = 10.9 Hz), 152.3. HRMS (ESI) calcd for $C_{12}H_{13}Cl_2F_3NO^+$: 314.0321 $[M+H]^+$, found: 314.0326. ^{19}F NMR (376 MHz, $CDCl_3$) δ −61.7.



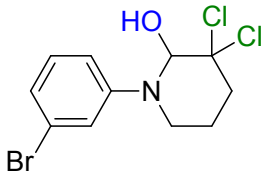
1-(4-Bromophenyl)-3,3-dichloropiperidin-2-ol (3c). Colorless oil (113 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.75–1.80 (m, 1H), 2.10–2.18 (m, 1H), 2.44–2.47 (m, 1H), 2.64–2.69 (m, 1H), 2.77 (s, 1H), 3.11–3.15 (m, 1H), 3.36–3.41 (m, 1H), 5.29 (s, 1H), 6.93 (d, J = 6.0 Hz, 2H), 7.38 (d, J = 6.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.2, 37.6, 41.3, 87.9, 90.6, 114.4, 120.8, 132.1, 148.9. HRMS (ESI) calcd for $C_{11}H_{13}BrCl_2NO$: 323.9552 $[M+H]^+$, found: 323.9548.



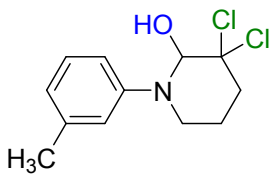
3,3-Dichloro-1-(*p*-tolyl)piperidin-2-ol (3d). Colorless oil (105 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.74–1.78 (m, 1H), 2.10–2.18 (m, 1H), 2.29 (s, 3H), 2.43–2.46 (m, 1H), 2.64–2.69 (m, 1H), 2.71 (d, J = 1.2 Hz, 1H), 3.09–3.11 (m, 1H), 3.37–3.41 (m, 1H), 5.29 (s, 1H), 6.96 (d, J = 5.2 Hz, 2H), 7.10 (d, J = 5.6 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 20.6, 23.4, 37.8, 41.4, 88.5, 90.8, 119.4, 129.8, 131.5, 147.3. HRMS (ESI) calcd for $C_{12}H_{16}Cl_2NO$: 260.0603 $[M+H]^+$, found: 260.0605.



3,3-Dichloro-1-(3-chlorophenyl)piperidin-2-ol (3e). Colorless oil (103 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.77–1.79 (m, 1H), 2.10–2.19 (m, 1H), 2.45–2.47 (m, 1H), 2.65–2.70 (m, 1H), 2.76 (s, 1H), 3.17–3.20 (m, 1H), 3.37–3.41 (m, 1H), 5.35 (s, 1H), 6.92–6.94 (m, 2H), 7.02 (s, 1H), 7.20 (t, J = 5.6 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.2, 37.6, 41.2, 87.7, 90.6, 117.0, 119.1, 121.7, 130.2, 134.9, 151.0. HRMS (ESI) calcd for $C_{11}H_{13}Cl_3NO$: 280.0057 $[M+H]^+$, found: 280.0059.

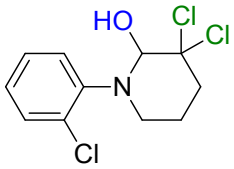


1-(3-Bromophenyl)-3,3-dichloropiperidin-2-ol (3f). Colorless oil (121 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.77–1.79 (m, 1H), 2.10–2.18 (m, 1H), 2.44–2.47 (m, 1H), 2.65–2.70 (m, 1H), 2.79 (s, 1H), 3.17–3.19 (m, 1H), 3.37–3.41 (m, 1H), 5.33 (s, 1H), 6.96–6.98 (m, 1H), 7.08–7.09 (m, 1H), 7.15 (t, J = 5.6 Hz, 1H), 7.18 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.2, 37.6, 41.3, 87.7, 90.6, 117.6, 122.0, 123.1, 124.6, 130.5, 151.1. HRMS (ESI) calcd for $C_{11}H_{13}BrCl_2NO$: 323.9552 $[M+H]^+$, found: 323.9547.

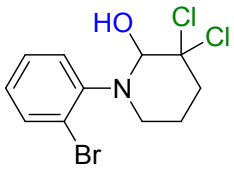


3,3-Dichloro-1-(*m*-tolyl)piperidin-2-ol (3g). Colorless oil (100 mg). ^{1}H NMR

(400 MHz, $CDCl_3$) δ 1.75–1.79 (m, 1H), 2.10–2.19 (m, 1H), 2.33 (s, 3H), 2.43–2.46 (m, 1H), 2.66–2.71 (m, 1H), 2.74 (s, 1H), 3.15–3.18 (m, 1H), 3.38–3.42 (m, 1H), 5.37 (s, 1H), 6.80 (d, *J* = 5.2 Hz, 1H), 6.85–6.87 (m, 2H), 7.18 (t, *J* = 5.2 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.7, 23.4, 37.8, 41.1, 88.2, 90.8, 116.2, 119.9, 122.7, 129.1, 139.1, 149.7. HRMS (ESI) calcd for $C_{12}H_{16}Cl_2NO$: 260.0603 $[M+H]^+$, found: 260.0597.

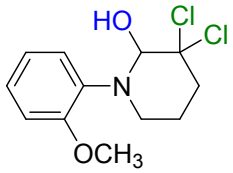


3,3-Dichloro-1-(2-chlorophenyl)piperidin-2-ol (3h). Colorless oil (87 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 1.73–1.77 (m, 1H), 2.25–2.28 (m, 1H), 2.42–2.45 (m, 1H), 2.67–2.72 (m, 1H), 2.85 (s, 1H), 2.99–3.02 (m, 1H), 3.42–3.46 (m, 1H), 5.07 (s, 1H), 7.05 (t, *J* = 5.2 Hz, 1H), 7.22 (t, *J* = 5.2 Hz, 1H), 7.37 (d, *J* = 5.2 Hz, 1H), 7.41 (d, *J*= 5.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.4, 38.5, 43.7, 87.5, 91.1, 124.6, 125.3, 127.5, 130.1, 130.6, 146.7. HRMS (ESI) calcd for $C_{11}H_{13}Cl_3NO$: 280.0057 $[M+H]^+$, found: 280.0059.

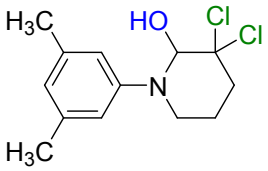


1-(2-Bromophenyl)-3,3-dichloropiperidin-2-ol (3i). Colorless oil (102 mg). ^1H

NMR (400 MHz, $CDCl_3$) δ 1.74–1.77(m, 1H), 2.24–2.32 (m, 1H), 2.44–2.48 (m, 1H), 2.68–2.73 (m, 1H), 2.89 (s, 1H), 2.99–3.02 (m, 1H), 3.38–3.42 (m, 1H), 5.00 (s, 1H), 6.99 (t, *J* = 5.2 Hz, 1H), 7.27 (t, *J* = 5.6 Hz, 1H), 7.48 (d, *J* = 5.2 Hz, 1H), 7.57 (d, *J*= 5.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.3, 38.7, 44.4, 87.7, 91.2, 121.1, 125.3, 125.9, 128.2, 133.8, 148.7. HRMS (ESI) calcd for $C_{11}H_{13}BrCl_2NO$: 323.9552 $[M+H]^+$, found: 323.9547.

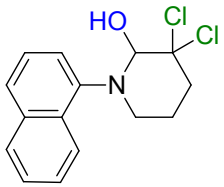


3,3-Dichloro-1-(2-methoxyphenyl)piperidin-2-ol (3j). Colorless oil (76 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 1.73–1.77 (m, 1H), 2.17–2.25 (m, 1H), 2.42–2.45 (m, 1H), 2.68–2.73 (m, 1H), 2.95–2.98 (m, 1H), 3.48–3.53 (m, 1H), 3.87 (s, 3H), 5.17 (s, 1H), 6.88 (d, *J* = 5.6 Hz, 1H), 6.93 (t, *J* = 5.2 Hz, 1H), 7.07 (t, *J* = 5.6 Hz, 1H), 7.11-7.13 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.7, 38.4, 42.9, 55.8, 87.2, 90.7, 111.9, 121.3, 123.5, 124.7, 138.5, 153.2. HRMS (ESI) calcd for $C_{12}H_{16}Cl_2NO_2$: 276.0553 $[M+H]^+$, found: 276.0556.

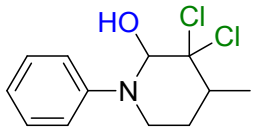


3,3-Dichloro-1-(3,5-dimethylphenyl)piperidin-2-ol (3k). Colorless oil (68 mg). ^1H

NMR (400 MHz, $CDCl_3$) δ 1.75–1.78 (m, 1H), 2.10–2.18 (m, 1H), 2.29 (s, 6H), 2.43–2.46 (m, 1H), 2.65–2.71 (m, 2H), 3.14–3.17 (m, 1H), 3.37–3.41 (m, 1H), 5.36 (s, 1H), 6.63 (s, 1H), 6.68 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.5, 23.4, 37.8, 41.2, 88.2, 90.8, 117.0, 123.7, 138.8, 149.7. HRMS (ESI) calcd for $C_{13}H_{18}Cl_2NO$: 274.0760 $[M+H]^+$, found: 274.0761.

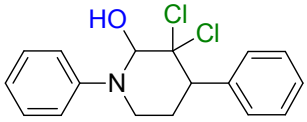


3,3-Dichloro-1-(naphthalen-1-yl)piperidin-2-ol (3l). White solid (84 mg), mp: 95−96 °C. ^1H NMR (400 MHz, $CDCl_3$) δ 1.78–1.80 (m, 1H), 2.37–2.39 (m, 1H), 2.50–2.53 (m, 1H), 2.75 (s, 1H), 2.93–2.95 (m, 1H), 3.60 (m, 1H), 5.09 (s, 1H), 7.41 (t, *J* = 5.2 Hz, 1H), 7.46–7.53 (m, 3H), 7.64 (d, *J* = 5.6 Hz, 1H), 7.83 (d, *J*= 5.6 Hz, 2H), 8.50 (d, *J* = 4.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 23.7, 38.1, 43.9, 88.3, 120.1, 123.7, 125.3, 125.7, 126.0, 126.1, 128.4, 134.8, 146.4. HRMS (ESI)calcd for $C_{15}H_{16}Cl_2NO$: 296.0603 $[M+H]^+$, found: 296.0602.



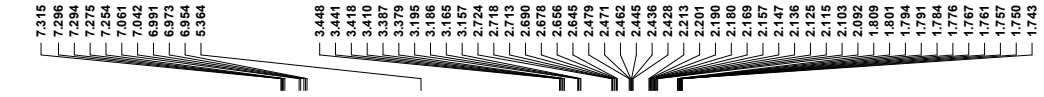
3,3-Dichloro-4-methyl-1-phenylpiperidin-2-ol (3m). Colorless oil (92 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 1.28 (d, *J* = 4.4 Hz, 3H), 1.68–1.72 (m, 1H), 1.79–1.86 (m,

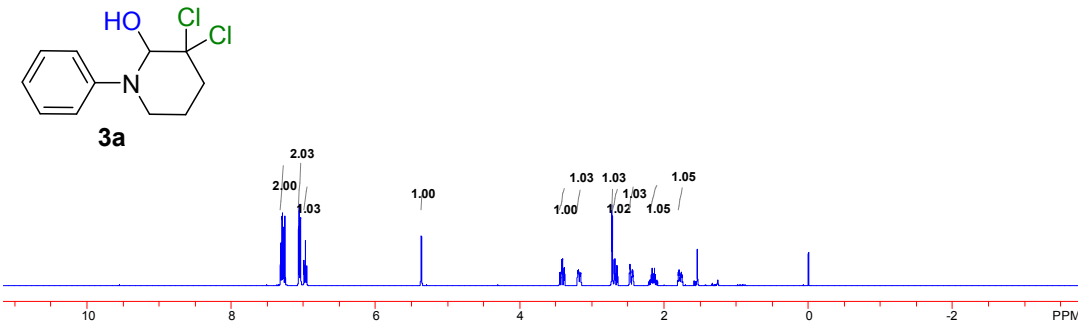
1H), 2.63–2.69 (m, 1H), 2.75 (s, 1H), 3.16–3.19 (m, 1H), 3.46–3.51 (m, 1H), 5.46 (s, 1H), 6.96 (t, *J* = 5.2 Hz, 1H), 7.05 (d, *J* = 5.2 Hz, 2H), 7.29 (t, *J*= 5.2 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 16.0, 31.0, 38.6, 41.8, 88.9, 97.2, 118.9, 121.7, 129.2, 149.5. HRMS (ESI) calcd for $C_{12}H_{16}Cl_2NO$: 260.0603 $[M+H]^+$, found: 260.0607.

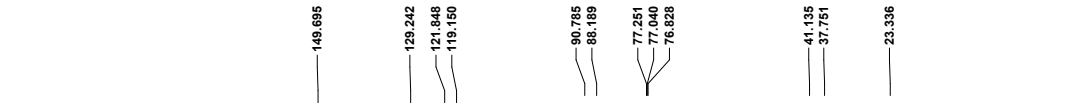


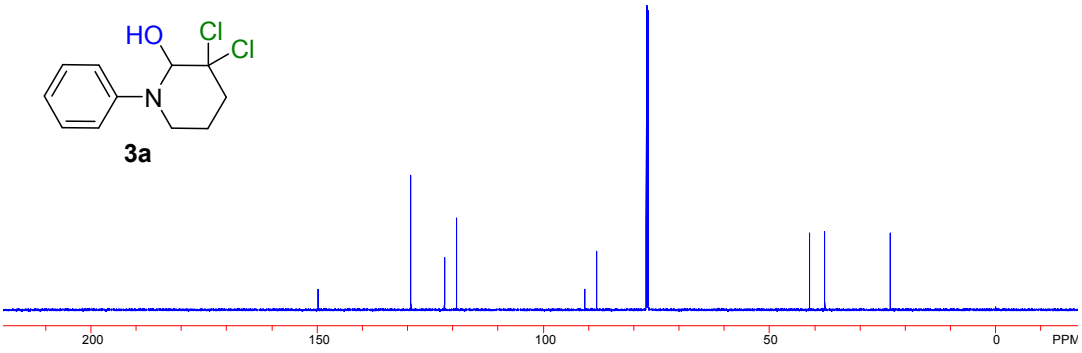
3,3-Dichloro-1,4-diphenylpiperidin-2-ol (3n). White solid (119 mg), mp: 85−86 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.89–1.92 (m, 1H), 2.53–2.60 (m, 1H), 2.93 (s, 1H), 3.34–3.36 (m, 1H), 3.60–3.65 (m, 1H), 3.78–3.80 (m, 1H), 5.56 (s, 1H), 7.00 (t, *J* = 5.2 Hz, 1H), 7.10 (d, *J* = 5.6 Hz, 1H), 7.32 (t, *J*= 5.2 Hz, 2H), 7.35–7.39 (m, 1H), 7.46–7.47 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 29.3, 42.2, 48.9, 89.6, 94.6, 119.0, 121.9, 127.9, 128.0, 130.4, 137.8, 149.5. HRMS (ESI) calcd for $C_{17}H_{18}Cl_2NO$: 322.0760 $[M+H]^+$, found: 322.0757.

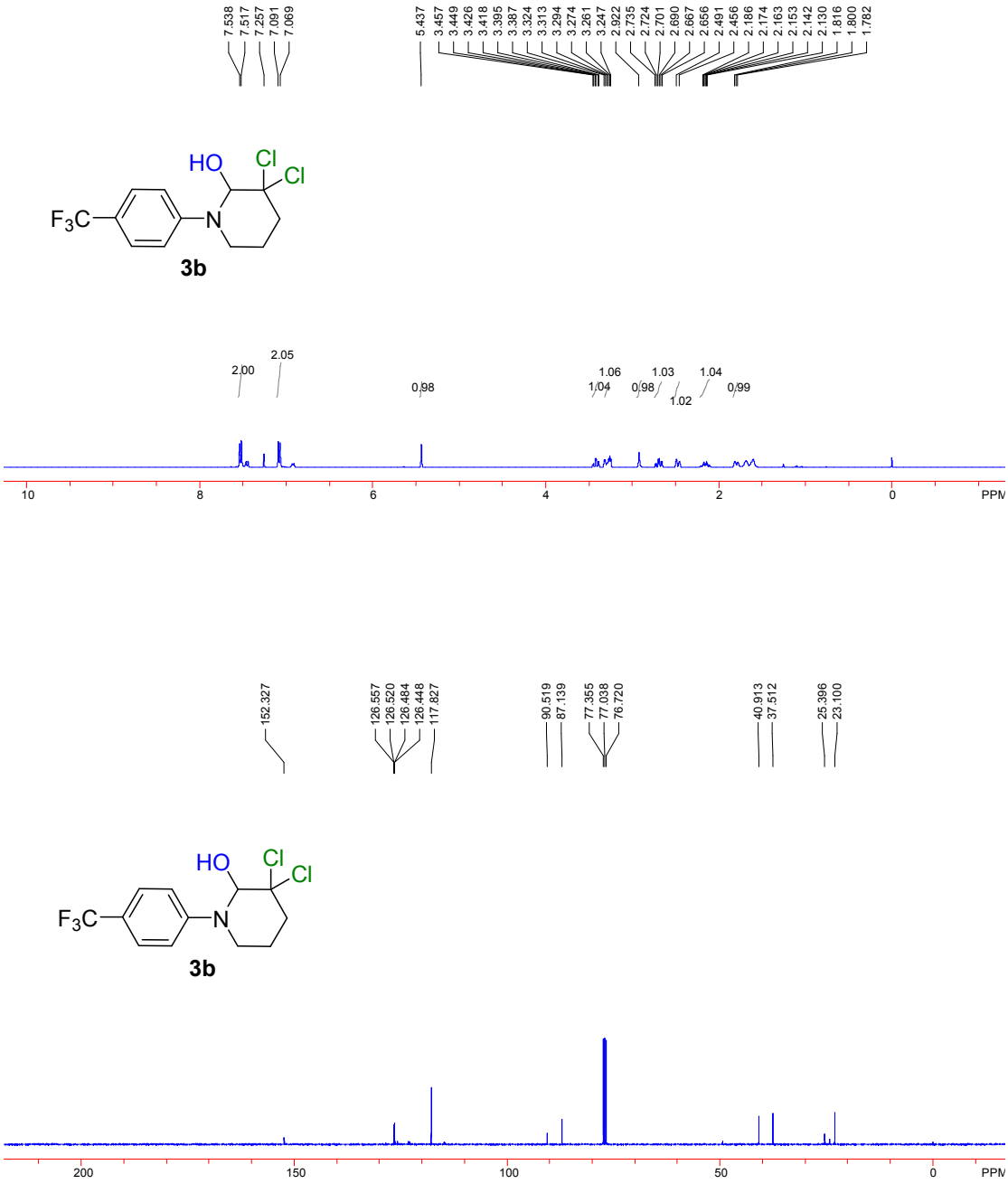
6. ^{1}H and ^{13}C NMR spectra of the products







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3.274
3.261
3.247
2.922
2.735
2.724
2.701
2.690
2.667
2.656
2.491
2.456
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2.163
2.153
2.142
2.130
1.816
1.800
1.782
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Cl
Cl
F3C
N
3b
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0.98
1.06
1.04
1.03
0.98
1.02
1.04
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10
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6
4
2
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PPM
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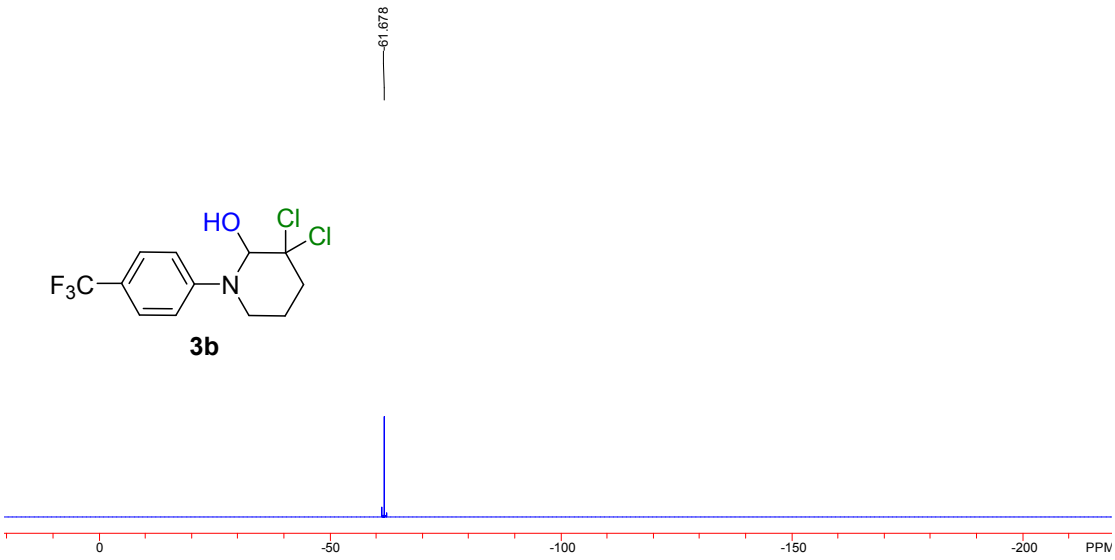
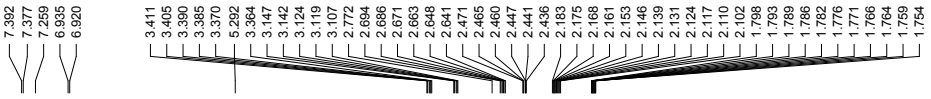


3b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5.292
3.364
3.147
3.142
3.124
3.119
3.107
2.772
2.694
2.686
2.671
2.663
2.648
2.641
2.471
2.465
2.460
2.447
2.441
2.436
2.183
2.175
2.168
2.161
2.153
2.146
2.139
2.131
2.124
2.117
2.110
2.102
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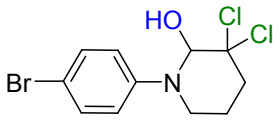
1.754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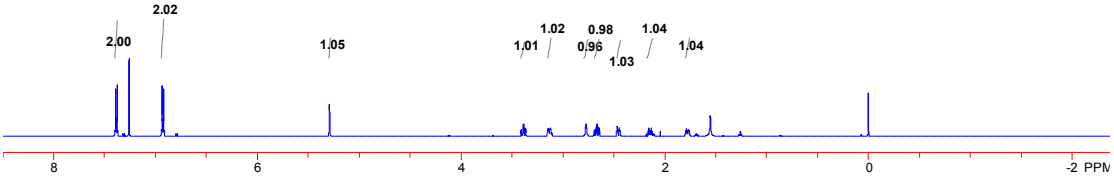
Cl
Br
N

3c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1.03
1.04
1.04
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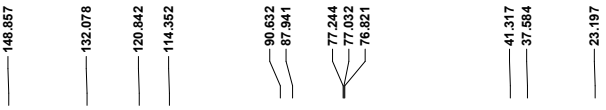
-2 PPM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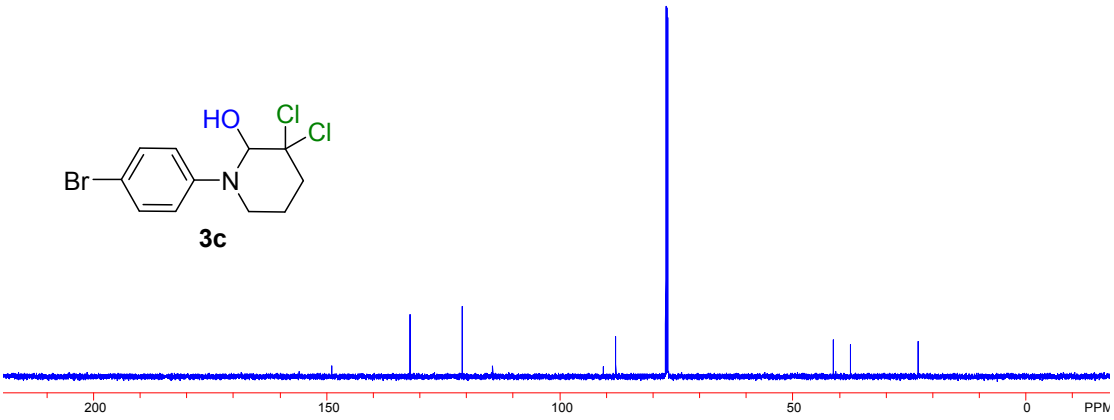
37.584
23.197

HO
Cl
Cl
Br
N

3c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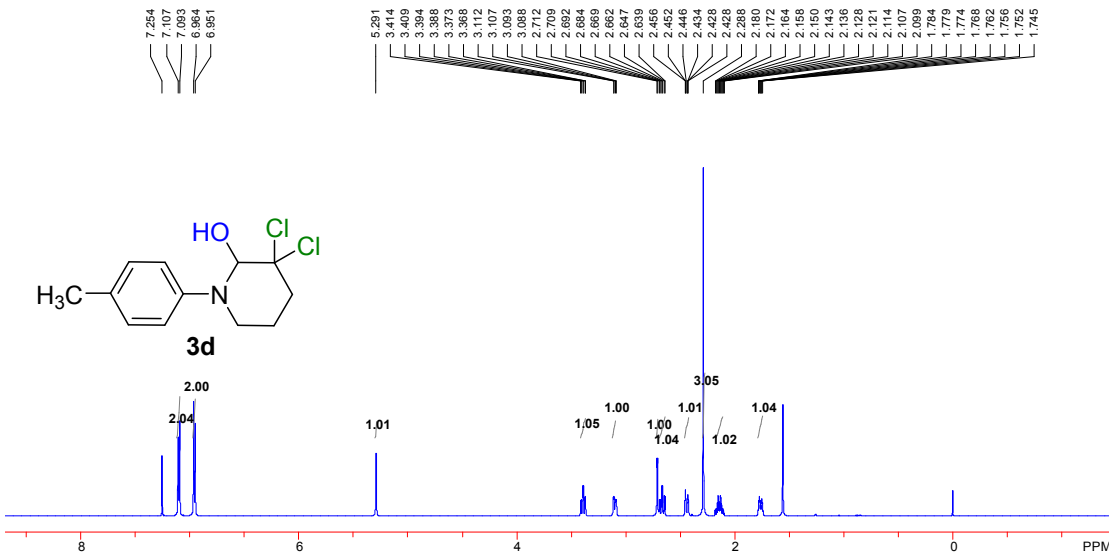
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3.112
3.107
3.093
3.088
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2.709
2.692
2.684
2.669
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2.647
2.639
2.456
2.452
2.446
2.434
2.428
2.428
2.288
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2.172
2.164
2.158
2.150
2.143
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2.128
2.121
2.114
2.107
2.099
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1.779
1.774
1.768
1.762
1.756
1.752
1.745
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Cl
Cl
H3C
N
3d
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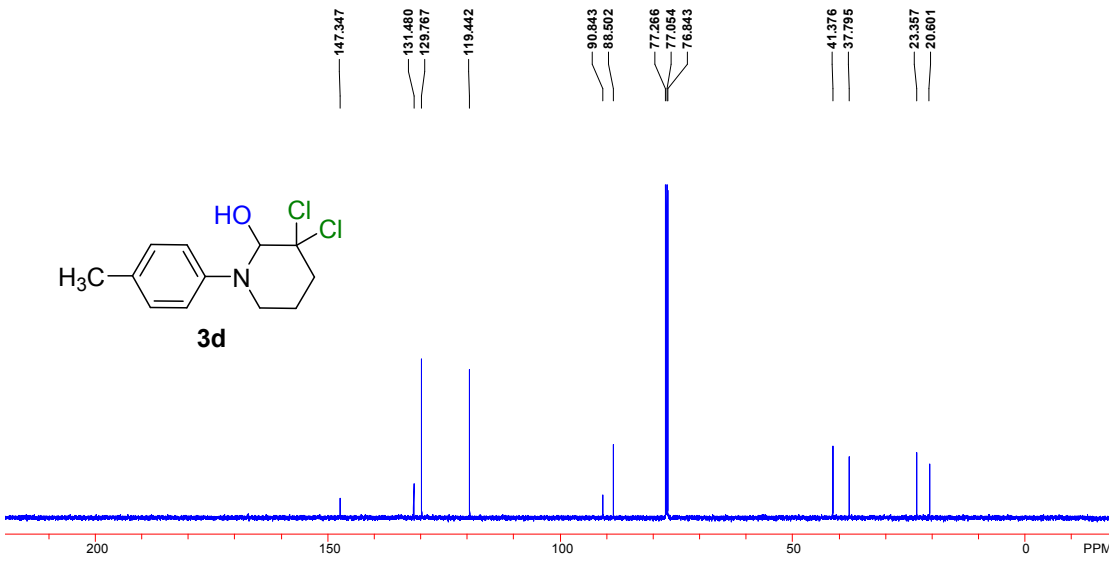
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20.601
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Cl
Cl
H3C
N
3d
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50
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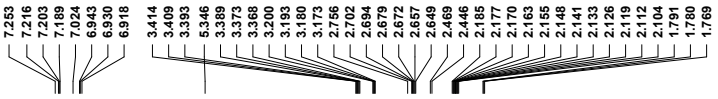
PPM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6.930
6.918
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5.346
3.389
3.373
3.368
3.200
3.193
3.180
3.173
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2.702
2.694
2.679
2.672
2.657
2.649
2.469
2.446
2.185
2.177
2.170
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2.155
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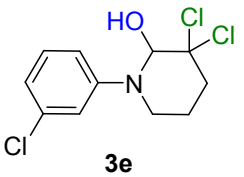
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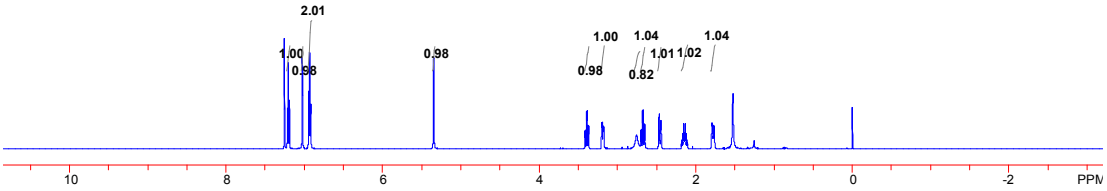
Cl
Cl
N
Cl

3e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1.02
1.04
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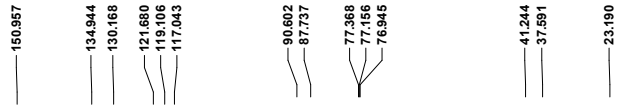
PPM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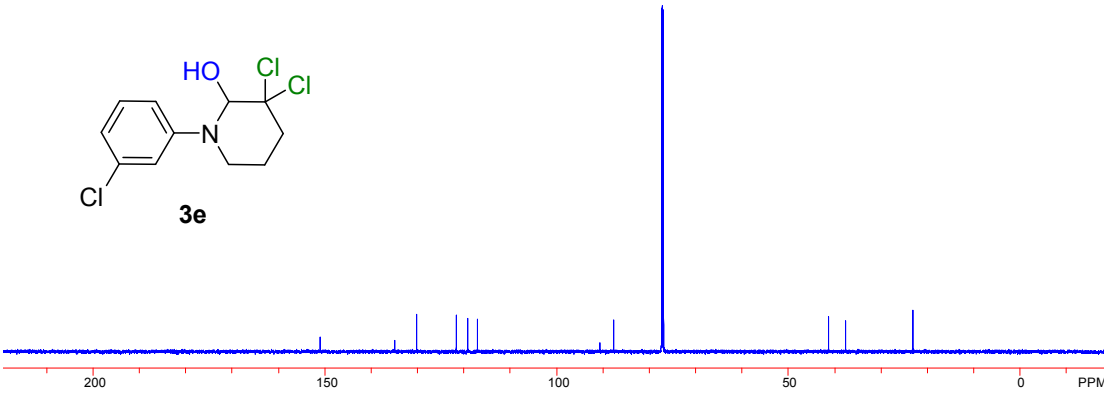
41.244
37.591
23.190

HO
Cl
Cl
N
Cl

3e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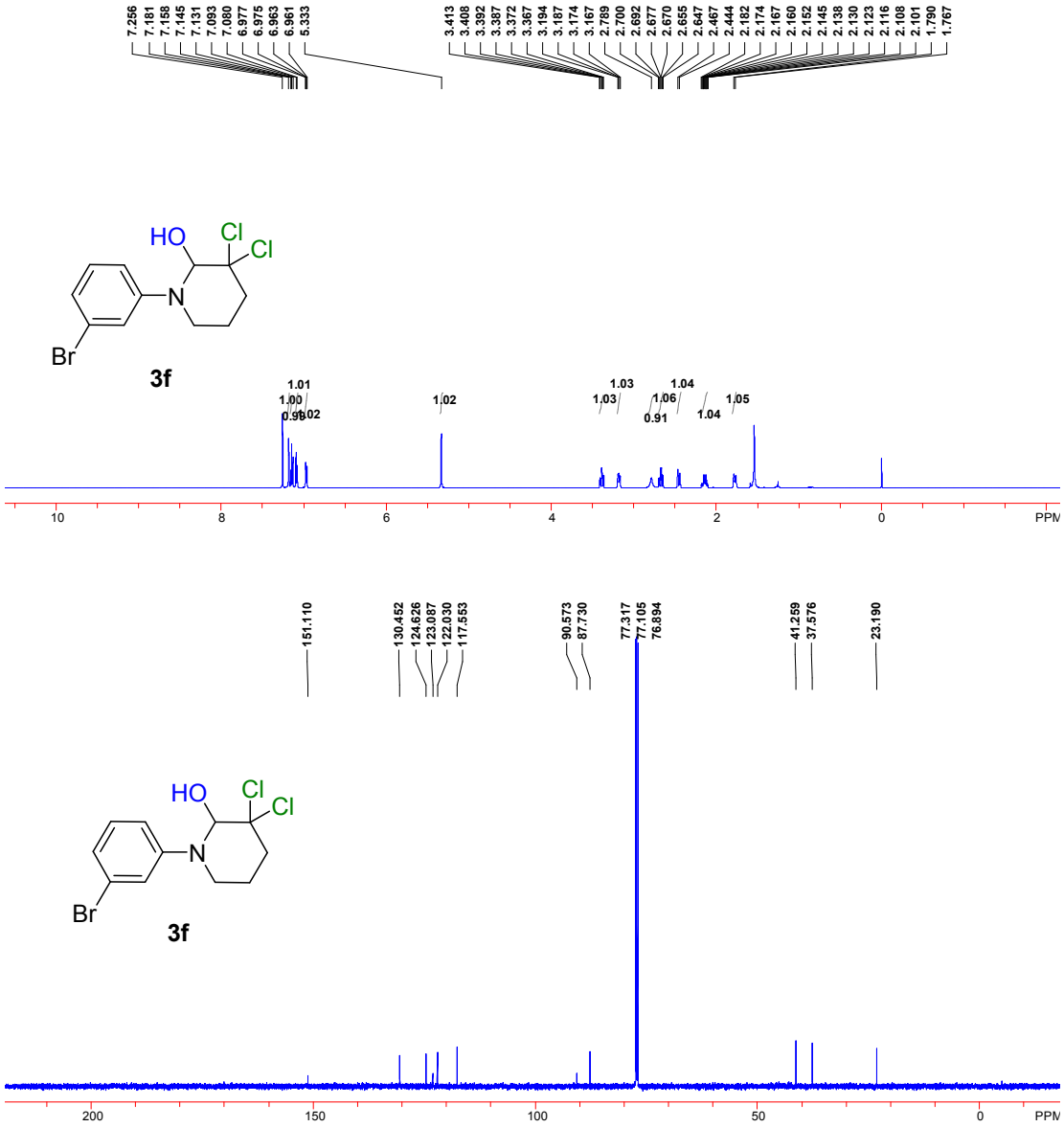
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2.670
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2.145
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2.123
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1.767
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Cl
Cl
N
Br
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1.02
1.03
1.03
1.06
0.91
1.04
1.04
1.05
10
8
6
4
2
0
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123.087
122.030
117.553
90.573
87.730
77.317
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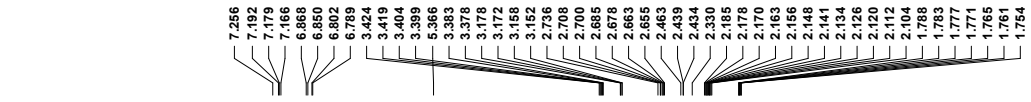
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2.178
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2.148
2.141
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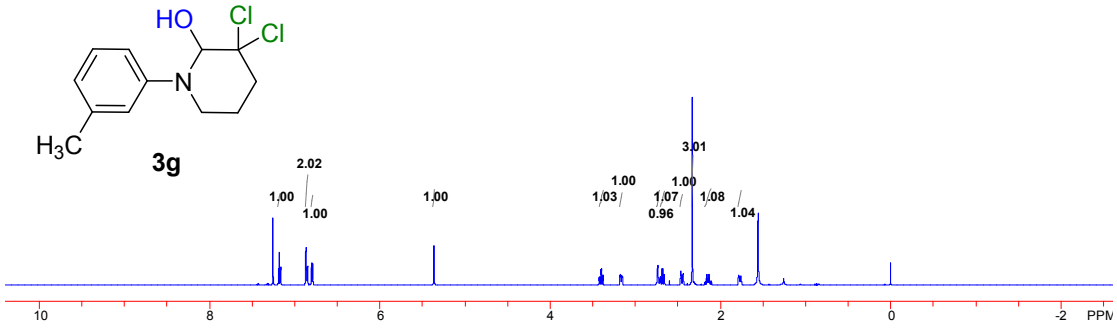
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H3C
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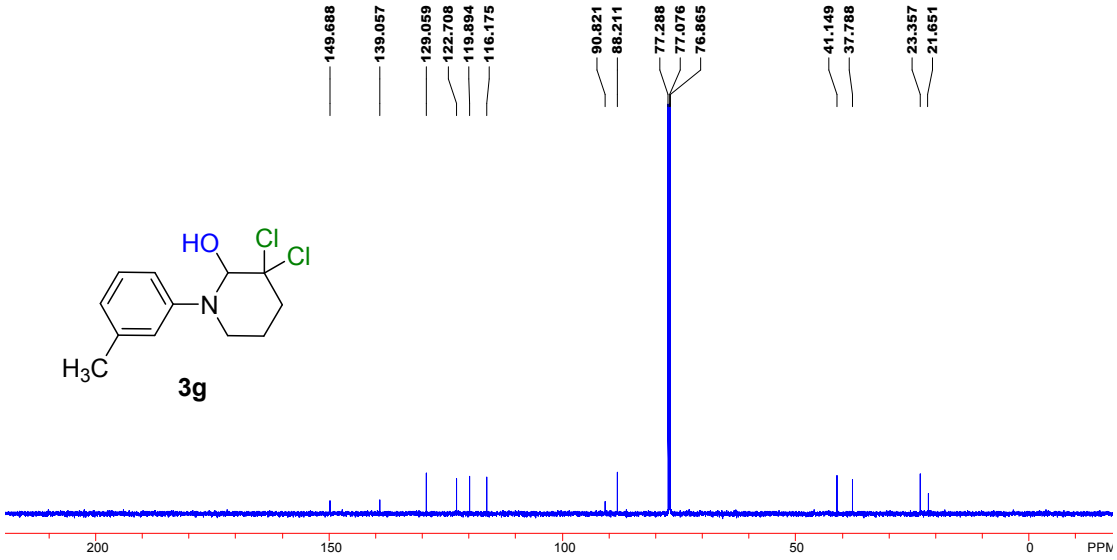
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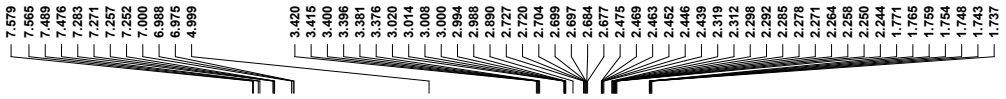
PPM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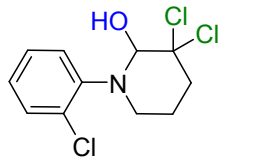
1.737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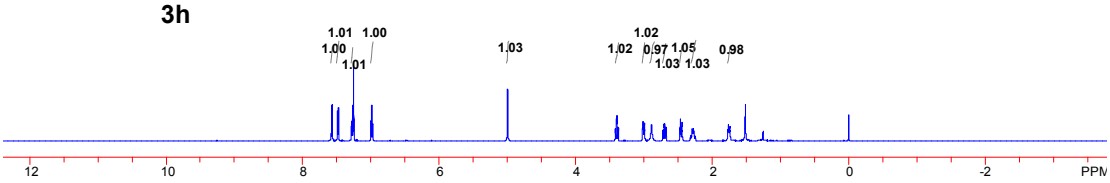
Cl
Cl
N
Cl

3h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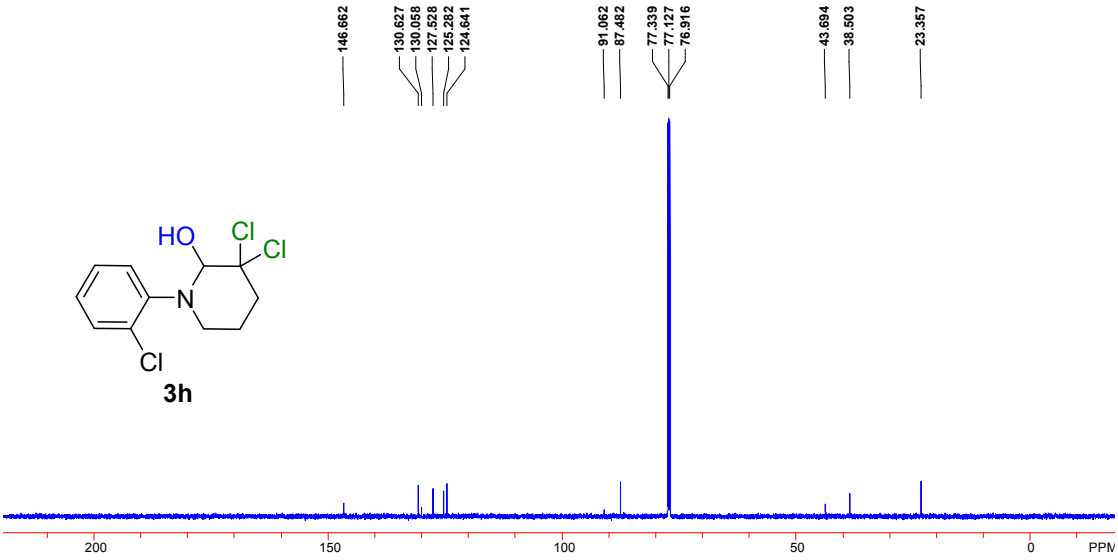
PPM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100
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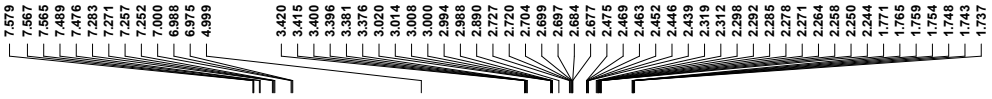
3h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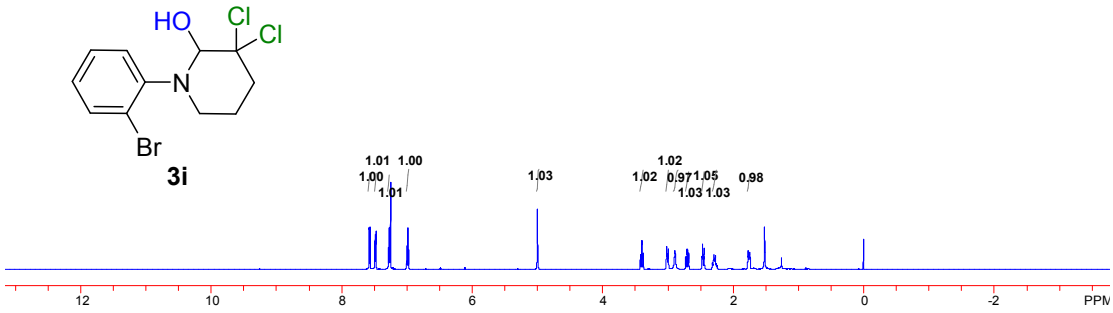
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Cl
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Br
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1.00
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0.98
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10
8
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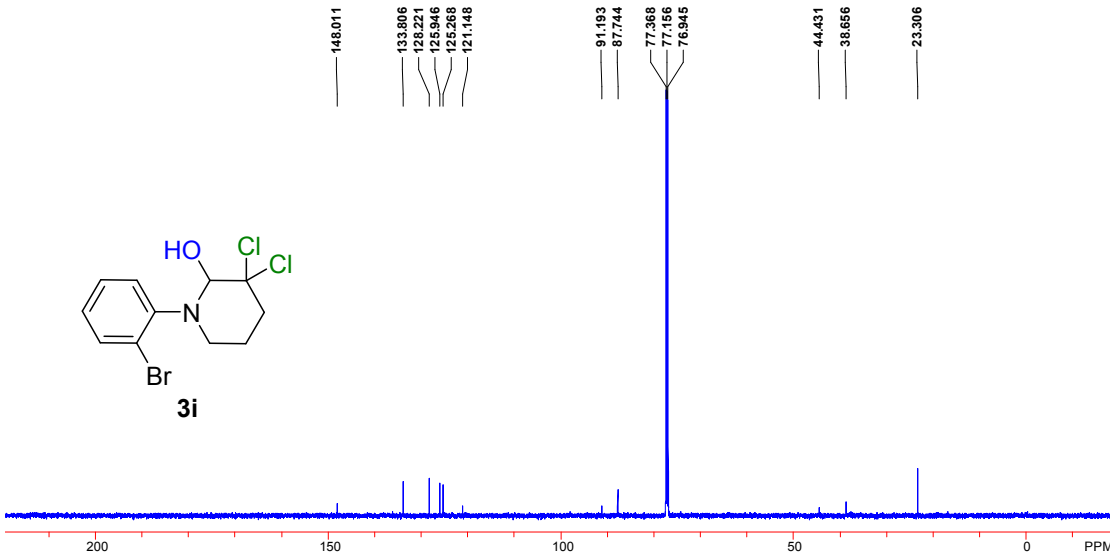
PPM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Cl
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N
Br
3i
200
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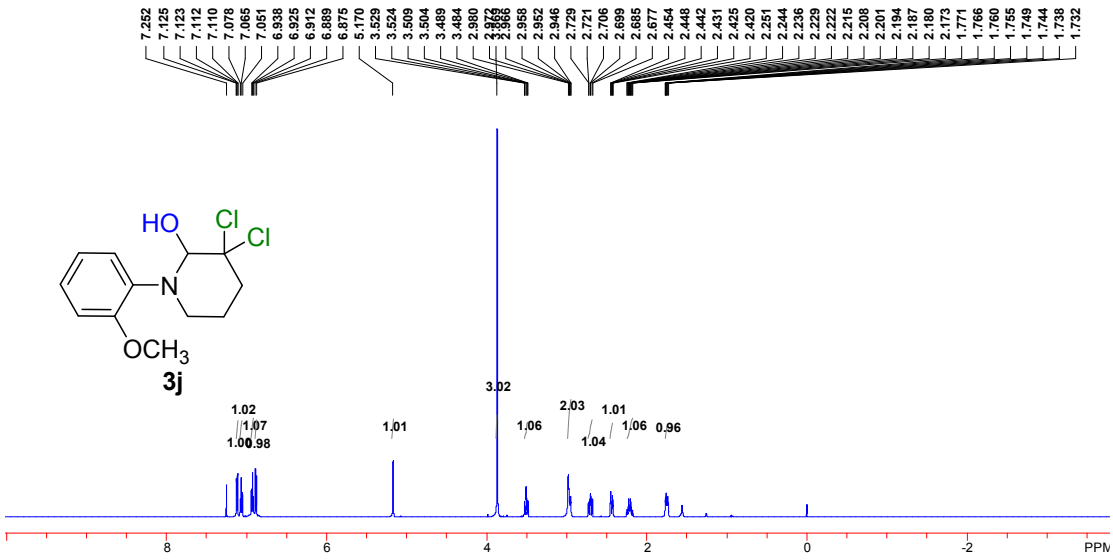
7.252 7.125 7.123 7.112 7.110 7.078 7.065 7.051 6.938 6.925 6.912 6.889 6.875 5.170 3.529 3.524 3.509 3.504 3.489 3.484 2.980 2.966 2.958 2.952 2.946 2.729 2.721 2.706 2.699 2.685 2.677 2.454 2.448 2.442 2.431 2.425 2.420 2.251 2.244 2.236 2.229 2.222 2.215 2.208 2.201 2.194 2.187 2.180 2.173 1.771 1.766 1.760 1.755 1.749 1.744 1.738 1.732
HO
Cl
Cl
N
OCH3
3j
1.02
1.07
1.00
0.98
1.01
3.02
1.06
2.03
1.04
1.01
1.06
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8
6
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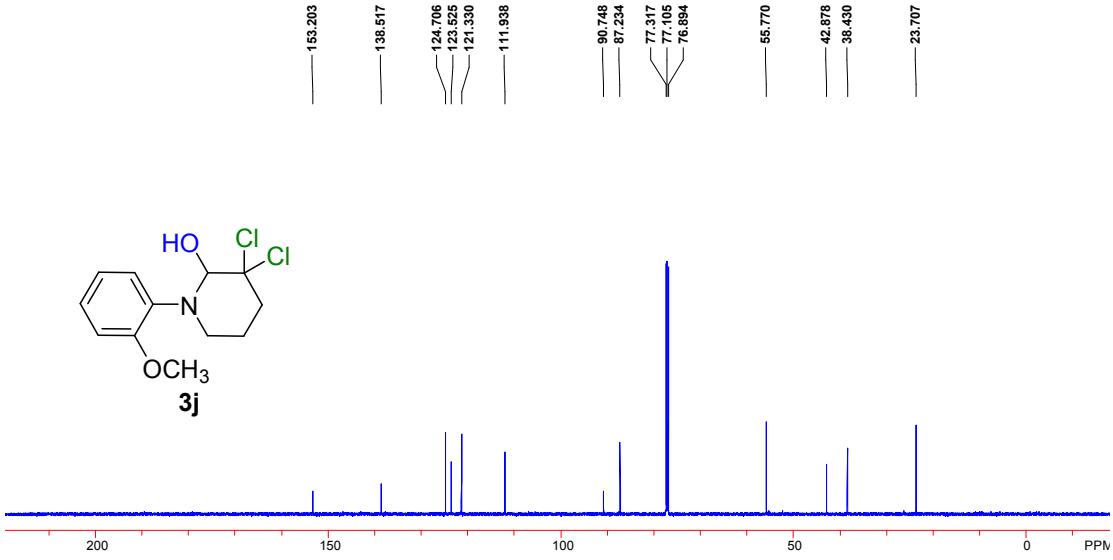
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HO
Cl
Cl
N
OCH3
3j
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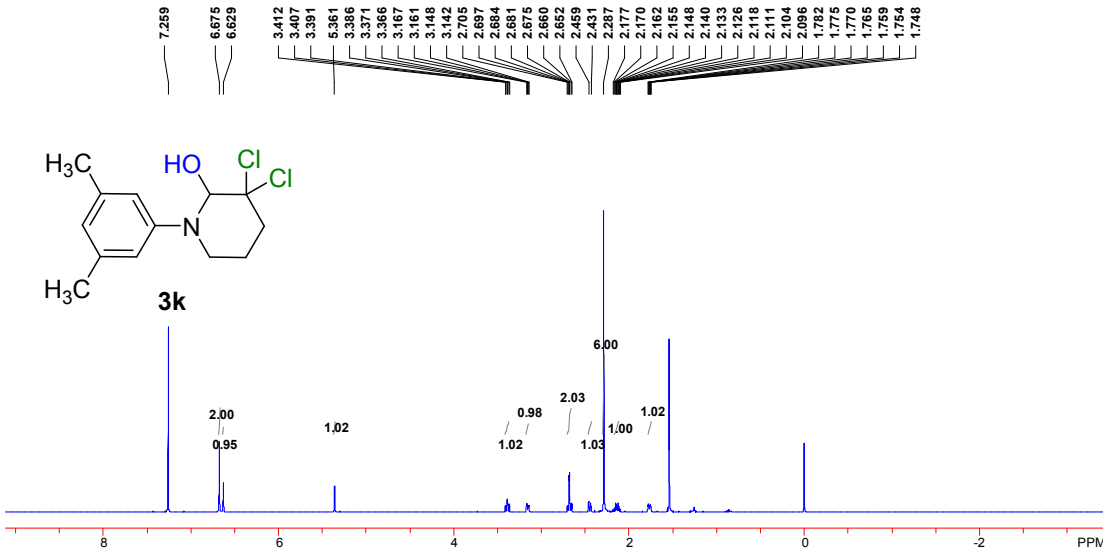
100
50
0
PPM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3.386
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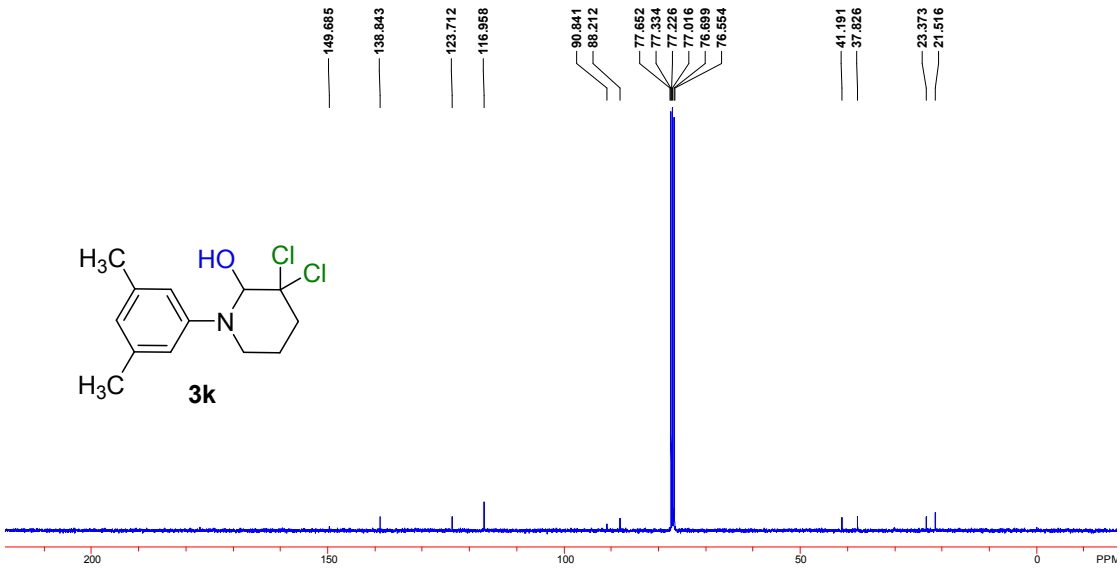
3.148
3.142
2.705
2.697
2.684
2.681
2.675
2.660
2.652
2.459
2.431
2.287
2.177
2.170
2.162
2.155
2.148
2.140
2.133
2.126
2.118
2.111
2.104
2.096
1.782
1.775
1.770
1.765
1.759
1.754
1.748
H3C
HO
Cl
Cl
N
H3C
3k
6.00
2.03
2.00
0.98
1.02
1.02
0.95
1.02
1.00
1.03
8
6
4
2
0
-2
PPM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123.712
116.958
90.841
88.212
77.652
77.334
77.226
77.016
76.699
76.554
41.191
37.826
23.373
21.516
H3C
HO
Cl
Cl
N
H3C
3k
200
150
100
50
0
PPM


8.502
8.490
7.832
7.818
7.646
7.643
7.526
7.515
7.501
7.484
7.472
7.460
7.417
7.405
7.392
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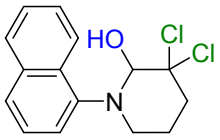
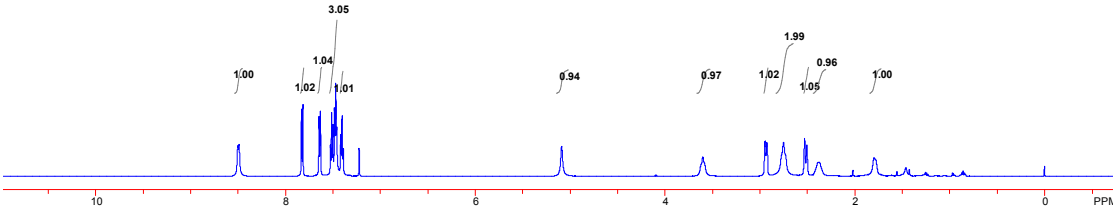
3.602
2.945
2.926
2.751
2.538
2.504
2.387
2.372
1.796
1.782


HO
Cl
Cl
N

3l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1.99
1.04
0.96
1.00
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0.94
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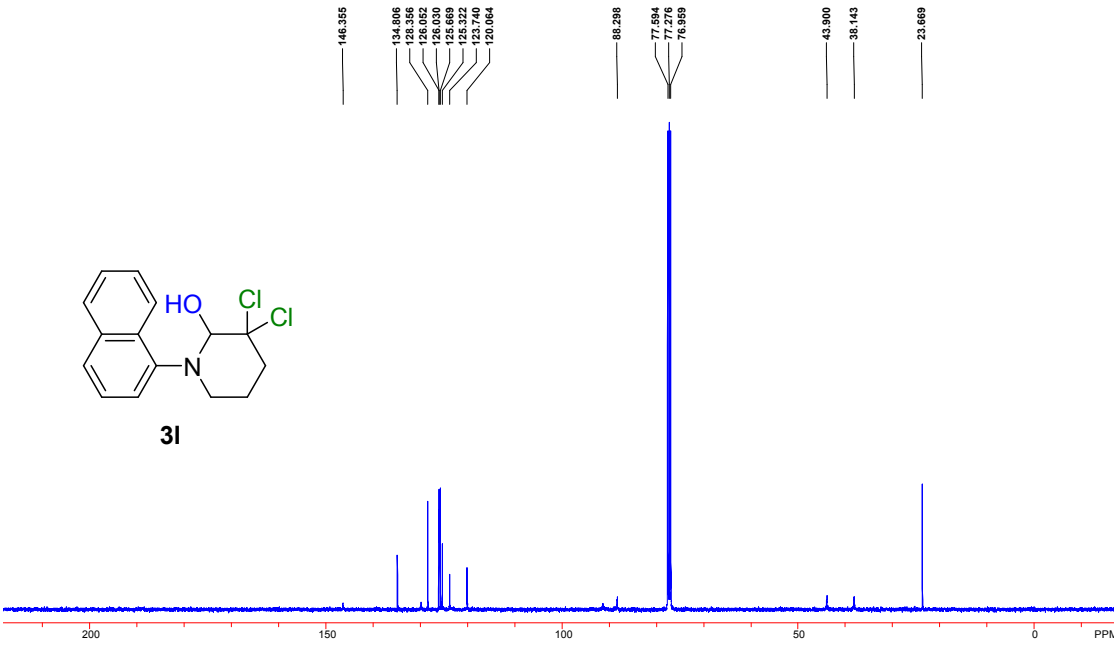
1.02
1.05
1.00
10
8
6
4
2
0
PPM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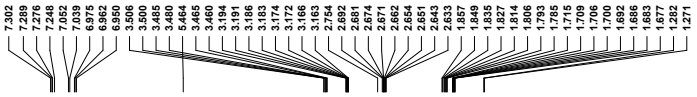
134.806
128.356
126.052
126.030
125.669
125.322
123.740
120.064
88.298
77.594
77.276
76.959
43.900
38.143
23.669
200
150
100
50
0
PPM

HO
Cl
Cl
N

3l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7.276
7.248
7.052
7.039
6.975
6.962
6.950
3.506
3.500
3.485
3.480
3.464
3.460
3.194
3.191
3.186
3.183
3.174
3.172
3.166
3.163
2.754
2.692
2.681
2.674
2.671
2.662
2.654
2.651
2.643
2.633
1.857
1.849
1.835
1.827
1.814
1.806
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1.706
1.700
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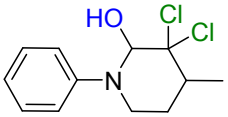
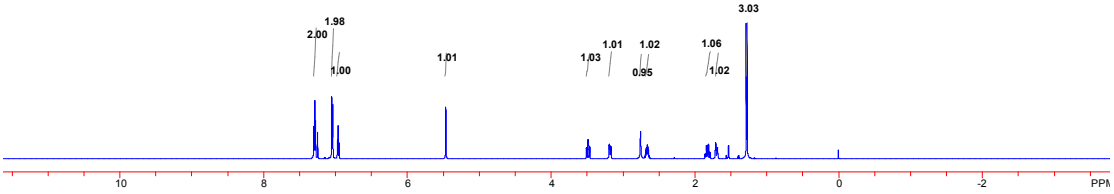
1.677
1.262
1.271


HO
Cl
Cl
N

3m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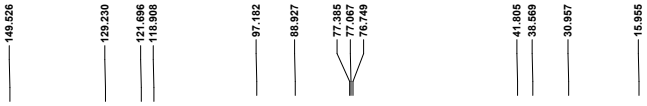
2.00
1.00
1.01
1.03
1.01
1.02
0.95
1.06
1.02
3.03
10
8
6
4
2
0
-2
PPM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97.182
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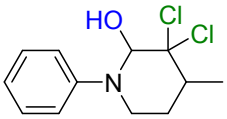
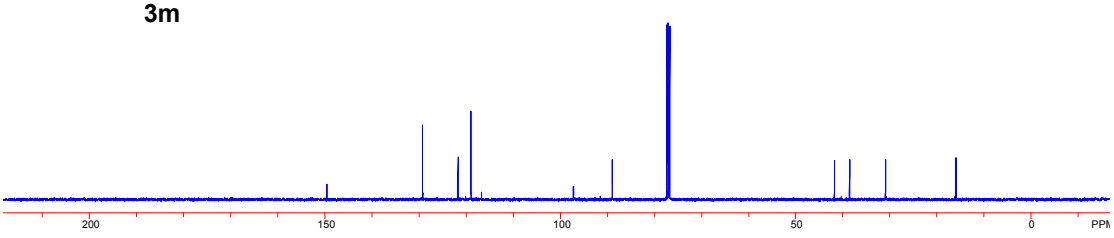
77.067
76.749
41.805
38.569
30.957
15.955


HO
Cl
Cl
N

3m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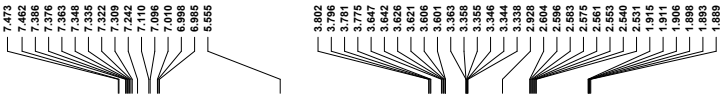
150
100
50
0
PPM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7.348
7.335
7.322
7.309
7.242
7.110
7.096
7.010
6.998
6.985
5.555
3.802
3.796
3.781
3.775
3.647
3.642
3.626
3.621
3.606
3.601
3.363
3.358
3.355
3.346
3.344
3.338
2.928
2.604
2.586
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2.575
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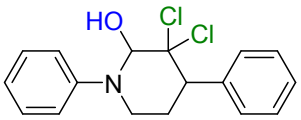
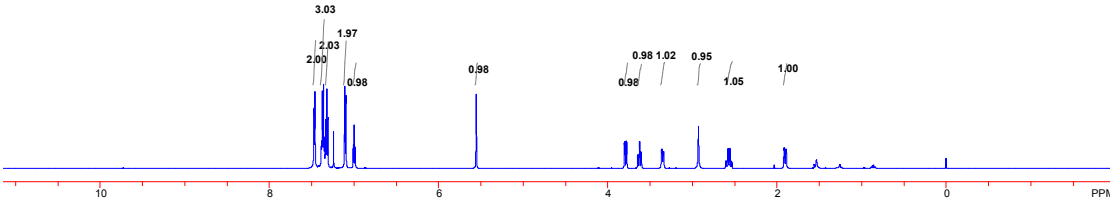
2.553
2.540
2.531
1.915
1.911
1.906
1.898
1.893
1.889


HO
Cl
Cl
N

3n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1.97
2.03
2.00
0.98
0.98
0.98
1.02
0.95
0.98
1.05
1.00
10
8
6
4
2
0
PPM


149.461
137.760
130.407
129.316
127.959
127.865
121.935
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48.884
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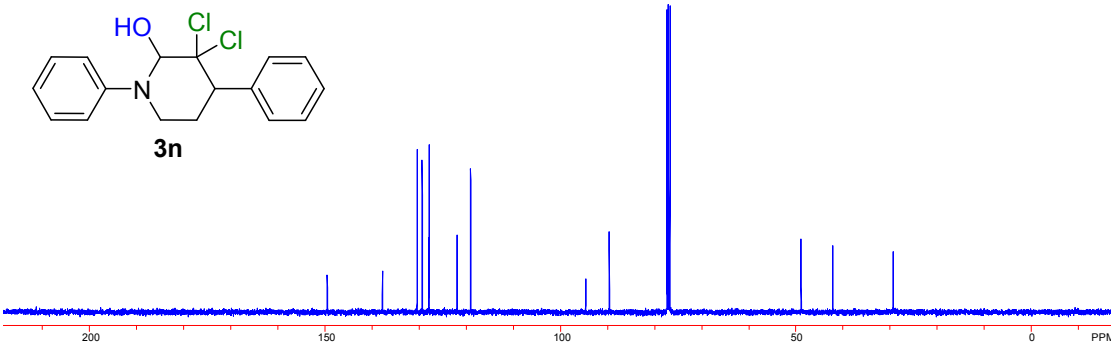
29.332

HO
Cl
Cl
N

3n


200
150
100
50
0
PPM