A facile catalyst-free synthesis of 2-vinylquinolines via direct deamination reaction occurring during Mannich synthesis

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1. General information

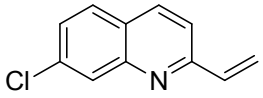
All reagents and solvents were purchased from commercial suppliers and used without further purification except as otherwise noted. Reactions were monitored through thin-layer chromatography (TLC)，spots were visualized using UV radiation (254 nm). Flash chromatography was performed using 200-300 mesh silica gel with distilled solvents. ^{1}H NMR and ^{13}C NMR spectra were recorded using Bruker Advance 400M NMR spectrometers. Chemical shifts for ^{1}H NMR spectra are reported as δ in units of parts per million (ppm) downfield from $SiMe_4$ (δ 0.0) and relative to the signal of chloroform-*d* (δ 7.260, singlet). Data are reported as follows: chemical shift, multiplicity (s=singlet, d=doublet, t=triplet, q=quartet, m=multiplet and br=broad), coupling constants in Hz and integration. Carbon nuclear magnetic resonance spectra (^{13}C NMR) are reported as δ in units of parts per million (ppm) downfield from $SiMe_4$ (δ 0.0) and relative to the signal of chloroform-*d* (δ 77.03, triplet). The mass spectra were recorded using FAB ionization techniques.

2. General experimental procedure

The mixture of **1** (5 mmol, 1 equiv), formaldehyde solution (6.5 mmol, 1.3 equiv), **2** (6.5 mmol, 1.3 equiv), and trimethylamine (0.1 ml) in 1,4-dioxane (2 ml) was heated at 100^{o}C in a round bottom flask until the starting material **1** was completely consumed as indicated by TLC analysis. After being cooled down to room temperature, the solvent was removed under reduced pressure, water was added to the round bottom flask, extracted with CH_2Cl_2, the solvent removed and the residue was purified by silica gel column chromatography (n-heptane/EtOAc) to afford the desired 2-Vinylquinolines **3**.

3. Characterization of products:

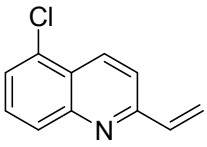
7-chloro-2-vinylquinoline (3a)：



Following the general procedure, **3a** was obtained as an off-white solid (900 mg, 95%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 (dd, *J* = 8.7, 2.7 Hz, 2H), 7.71 (d, *J* = 8.7 Hz, 1H), 7.58 (d, *J*

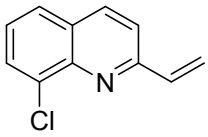
= 8.7 Hz, 1H), 7.45 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.02 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.32 (d, *J* = 17.7 Hz, 1H), 5.70 (d, *J* = 10.9 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.9, 148.4, 137.5, 136.1, 135.4, 128.6, 128.3, 125.7, 120.6, 118.7, 118.7. HRMS (ESI): calculated for $C_{11}H_8ClN$ $(M+H)^+$: 190.0424.

5-chloro-2-vinylquinoline (3b)



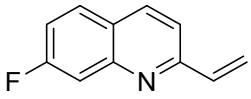
Following the general procedure, **3b** was obtained as a white solid (690 mg, 73%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13–7.99 (m, 2H), 7.68 (d, *J* = 8.6 Hz, 1H), 7.55 (d, *J* = 8.6 Hz, 1H), 7.42 (dd, *J* = 8.7, 2.0 Hz, 1H), 7.00 (dd, *J* = 17.6, 10.8 Hz, 1H), 6.30 (d, *J* = 17.6 Hz, 1H), 5.68 (d, *J* = 10.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.9, 148.3, 137.5, 136.2, 135.4, 128.6, 128.2, 127.3, 125.7, 120.7, 118.7. HRMS (ESI): calculated for $C_{11}H_8ClN$ $(M+H)^+$: 190.0424.

8-chloro-2-vinylquinoline (3c)：



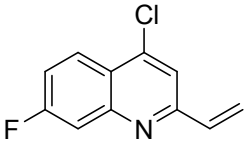
Following the general procedure, **3c** was obtained as a white solid (803 mg, 85%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.11 (d, *J* = 8.5 Hz, 1H), 7.80 (d, *J* = 7.5 Hz, 1H), 7.69 (d, *J* = 8.1 Hz, 1H), 7.64 (d, *J* = 8.5 Hz, 1H), 7.39 (t, *J* = 7.8 Hz, 1H), 7.11 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.37 (d, *J* = 17.6 Hz, 1H), 5.70 (d, *J* = 10.9 Hz, 1H). ^{13}C NMR (100MHz, $CDCl_3$) δ 156.6, 144.1, 137.7, 136.7, 133.4, 129.7, 128.7, 126.6, 126.1, 120.7, 119.2. HRMS (ESI): calculated for $C_{11}H_8ClN$ $(M+H)^+$: 190.0424.

7-fluoro-2-vinylquinoline (3d)



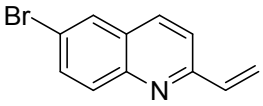
Following the general procedure, **3d** was obtained as an off-white solid (735 mg, 85%); ^{1}H NMR (400 MHz, $CDCl_3$):δ 8.06 (d, *J* = 8.5 Hz, 1H), 7.70 (m, 2H), 7.52 (d, *J* = 8.5 Hz, 1H), 7.26 (dd, *J* = 8.8, 2.5 Hz, 1H), 6.99 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.29 (d, *J* = 17.7 Hz, 1H), 5.67 (d, *J* = 10.9 Hz, 1H). ^{13}C NMR (100MHz, $CDCl_3$) δ 164.4, 161.9, 156.9, 149.1, 137.7, 136.2, 129.4, 124.5, 120.5, 116.6, 113.1. HRMS (ESI): calculated for $C_{11}H_8FN$ $(M+H)^+$: 174.0725.

4-chloro-7-fluoro-2-vinylquinoline (3e)



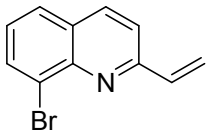
Following the general procedure, **3e** was obtained as an off-white solid (787 mg, 76%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.16 (dd, *J* = 9.2, 6.0 Hz, 1H), 7.69 (dd, *J* = 9.9, 2.5 Hz, 1H), 7.60 (s, 1H), 7.35 (dd, *J* = 8.7, 2.4 Hz, 1H), 6.93 (dd, *J* = 17.6, 10.8 Hz, 1H), 6.30 (d, *J* = 17.7 Hz, 1H), 5.71 (d, *J* = 10.8 Hz, 1H). ^{13}C NMR (100MHz, $CDCl_3$) δ 164.9, 162.5, 157.1, 142.8, 136.7, 126.4, 121.4, 118.1, 117.6, 117.4, 113.5. HRMS (ESI): calculated for $C_{11}H_7ClFN$ $(M+H)^+$: 208.0323.

6-bromo-2-vinylquinoline (3f)



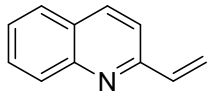
Following the general procedure, **3f** was obtained as a white solid (990 mg, 85%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.03 (d, *J* = 8.6 Hz, 1H), 7.98 – 7.90 (m, 2H), 7.76 (dd, *J* = 9.0, 2.1 Hz, 1H), 7.61 (d, *J* = 8.6 Hz, 1H), 7.02 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.31 (d, *J* = 17.7 Hz, 1H), 5.70 (d, *J* = 10.9 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 146.5, 137.5, 135.3, 133.1, 131.1, 129.5, 128.5, 120.4, 120.1, 119.3. HRMS (ESI): calculated for $C_{11}H_8BrN$ $(M+H)^+$: 234.9946.

8-bromo-2-vinylquinoline (3g)



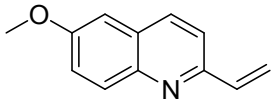
Following the general procedure, **3g** was obtained as a white solid (760 mg, 65%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 (d, *J* = 8.5 Hz, 1H), 8.02 (d, *J* = 7.5 Hz, 1H), 7.73 (d, *J* = 8.1 Hz, 1H), 7.61 (d, *J* = 8.5 Hz, 1H), 7.33 (d, *J* = 7.8 Hz, 1H), 7.10 (dd, *J* = 17.7, 10.8 Hz, 1H), 6.41 (d, *J* = 17.6 Hz, 1H), 5.70 (d, *J* = 10.8 Hz, 1H). ^{13}C NMR (100MHz, $CDCl_3$) δ 156.8, 144.9, 137.6, 136.8, 133.3, 128.7, 127.35, 126.6, 125.1, 120.7, 119.4. HRMS (ESI): calculated for $C_{11}H_8BrN$ $(M+H)^+$: 234.9956.

2-vinylquinoline (3h)



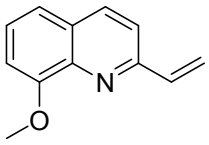
Following the general procedure, **3h** was obtained as an off-white solid (566 mg, 73%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.07 (d, *J* = 8.5 Hz, 1H), 8.01 (dd, *J* = 8.5, 2.8 Hz, 1H), 7.70 (d, *J* = 8.2 Hz, 1H), 7.65 (d, *J* = 7.7 Hz, 1H), 7.52 (dd, *J* = 8.5, 2.4 Hz, 1H), 7.44 (d, *J* = 7.5 Hz, 1H), 7.03 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.25 (d, *J* = 17.7 Hz, 1H), 5.63 (d, *J* = 10.9 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 147.9, 137.9, 136.24, 129.6, 129.3, 127.4, 126.2, 120.7, 119.8, 118.3. HRMS (ESI): calculated for $C_{11}H_9N$ $(M+H)^+$: 156.0818.

6-methoxy-2-vinylquinoline (3i)



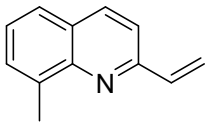
Following the general procedure, **3i** was obtained as an off-white solid (805 mg, 87%); ^{1}H NMR (400 MHz, $CDCl_3$):δ 7.96 (dd, *J* = 8.9, 4.9 Hz, 2H), 7.53 (d, *J* = 8.5 Hz, 1H), 7.33 (dd, *J* = 9.2, 2.8 Hz, 1H), 7.02 (d, *J* = 4.8 Hz, 1H), 7.03 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.20 (d, *J* = 17.7 Hz, 1H), 5.58 (d, *J* = 10.9 Hz, 1H), 3.90 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.6,153.7, 143.9, 137.9, 135.1, 130.7, 128.4, 122.2, 118.6, 118.6, 105.1, 55.5. HRMS (ESI): calculated for $C_{12}H_{11}NO$ $(M+H)^+$: 186.0923.

8-methoxy-2-vinylquinoline (3j)



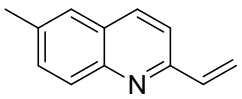
Following the general procedure, **3j** was obtained as a white solid (832 mg, 90%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.03 (d, *J* = 8.6 Hz, 1H), 7.64 (d, *J* = 8.7 Hz, 1H), 7.38 (d, *J* = 7.9 Hz, 1H), 7.31 (d, *J* = 8.2 Hz, 1H), 7.13 (dd, *J* = 17.8, 10.9 Hz, 1H), 7.00 (d, *J* = 7.6 Hz, 1H), 6.17 (d, *J* = 17.8 Hz, 1H), 5.62 (d, *J* = 11.2 Hz, 1H), 4.05 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.2, 155.2, 139.7, 138.5, 136.2, 128.5, 126.5, 119.4, 119.3, 118.4, 107.9, 56.1. HRMS (ESI): calculated for $C_{12}H_{11}NO$ $(M+H)^+$: 186.0925.

8-methyl-2-vinylquinoline (3k)



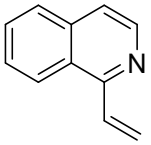
Following the general procedure, **3k** was obtained as an off-white solid (676 mg, 80%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.06 (d, *J* = 8.5 Hz, 1H), 7.62 (d, *J* = 8.1 Hz, 1H), 7.55 (d, *J* = 7.0 Hz, 2H), 7.40 (d, *J* = 7.7 Hz, 1H), 7.10 (dd, *J* = 17.8, 10.8, 1H), 6.39 (d, *J* = 17.6 Hz, 1H), 5.66 (d, *J* = 10.8 Hz, 1H), 2.89 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.8, 147.1, 138.4, 137.4, 136.5, 129.7, 127.5, 126.1, 125.5, 119.2, 118.4, 17.9. HRMS (ESI): calculated for $C_{12}H_{11}N$ $(M+H)^+$: 170.0969.

6-methyl-2-vinylquinoline (3l)



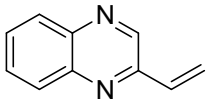
Following the general procedure, **3l** was obtained as an off-white solid (777 mg, 92%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.97 (d, *J* = 8.1 Hz, 2H), 7.58 – 7.43 (m, 3H), 7.02 (dd, *J* = 17.7, 10.9 Hz, 1H), 6.24 (d, *J* = 17.7 Hz, 1H), 5.61 (d, *J* = 10.9 Hz, 1H), 2.51 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.3, 146.6, 138.1, 136.2, 135.7, 131.9, 129.06, 127.5, 126.4, 119.3, 118.3, 21.58. HRMS (ESI): calculated for $C_{12}H_{11}N$ $(M+H)^+$: 170.0969.

1-vinylisoquinoline (3q)



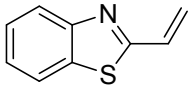
Following the general procedure, **3q** was obtained as an off-white solid (572 mg, 80%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.53 (d, *J* = 5.6 Hz, 1H), 8.25 (d, *J* = 8.4 Hz, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.71 – 7.63 (m, 1H), 7.67 – 7.59 (m, 1H), 7.59 (d, *J* = 5.5 Hz, 1H), 7.57 (dd, *J* = 16.9, 10.8 Hz, 1H), 6.53 (d, *J* = 16.9 Hz, 1H), 5.72 (d, *J* = 10.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.8, 142.3, 136.6, 132.2, 129.9, 127.2, 127.2, 126.4, 124.6, 121.7, 120.3. HRMS (ESI): calculated for $C_{11}H_9N$ $(M+H)^+$: 156.0818.

2-vinylquinoxaline (3r)



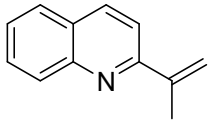
Following the general procedure, **3r** was obtained as a yellow solid (491 mg, 63%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.97 (d, *J* = 2.3 Hz, 1H), 8.04 (d, *J* = 7.3 Hz, 2H), 7.78 – 7.65 (m, 2H), 7.02 (dd, *J* = 17.9, 11.1 Hz, 1H), 6.45 (d, *J* = 17.9 Hz, 1H), 5.77 (d, *J* = 11.1 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.4, 143.5, 142.1, 141.7, 134.8, 130.2, 129.5, 129.3, 129.1, 122.1. HRMS (ESI): calculated for $C_{10}H_8N_2$ $(M+H)^+$: 157.0759.

2-vinylbenzothiazole (3s)



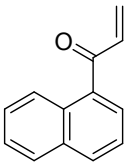
Following the general procedure, **3s** was obtained as a white solid (603 mg, 75%); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 (d, *J* = 8.1 Hz, 1H), 7.84 (d, *J* = 8.0 Hz, 1H), 7.46 (d, *J* = 7.7 Hz, 1H), 7.37 (d, *J* = 7.6 Hz, 1H), 7.04 (dd, *J* = 17.5, 10.9 Hz, 1H), 6.18 (d, *J* = 17.5 Hz, 1H), 5.75 (d, *J* = 10.9 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.1, 153.6, 134.3, 131.4, 126.2, 125.6, 123.2, 123.2, 121.5. HRMS (ESI): calculated for C_9H_7NS $(M+H)^+$: 162.0376.

2-isopropenyl-quinoline (3t)



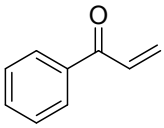
Following the general procedure, **3t** was obtained as a yellow oil (558 mg, 66%); ^{1}H NMR (400 MHz, $CDCl_3$):δ 8.12 (d, *J* = 8.4 Hz, 1H), 8.06 (dd, *J* = 8.6, 2.8 Hz, 1H), 7.76 (d, *J* = 8.1 Hz, 1H), 7.69 (dd, *J* = 11.5, 8.1 Hz, 2H), 7.49 (t, *J* = 7.5 Hz, 1H), 5.94 (s, 1H), 5.50 (s, 1H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.9, 143.2, 139.9, 131.4, 125.2, 124.8, 122.8, 122.6, 121.6, 113.7, 112.4,, 16.1. HRMS (ESI): calculated for $C_{12}H_{11}N$ $(M+H)^+$: 170.0959.

1-(1-naphthalenyl)propen-1-one (3u)



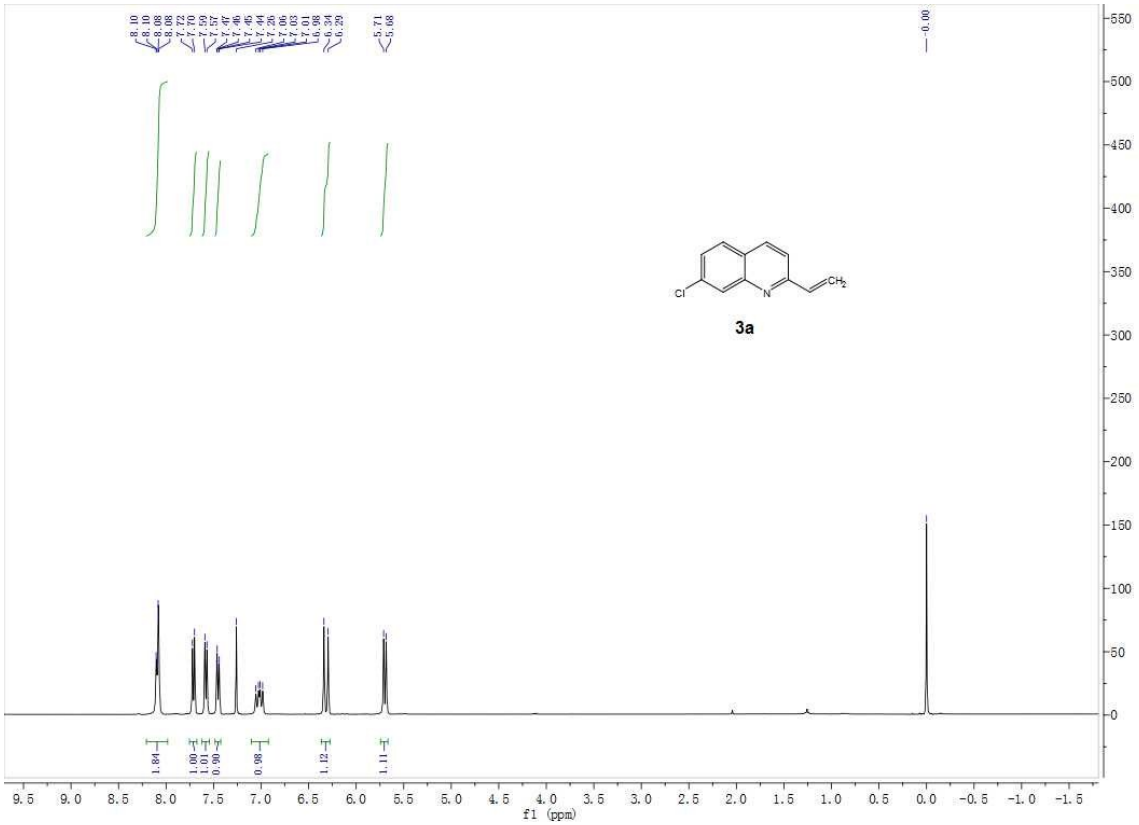
Following the general procedure, **3u** was obtained as a colorless oil (100 mg, 15%); ^{1}H NMR (400 MHz, $CDCl_3$):δ 8.35 (dd, *J* = 8.2, 1.8 Hz, 1H), 7.98 (d, *J* = 8.3 Hz, 1H), 7.89 (d, *J* = 7.9 Hz, 1H), 7.72 (dd, *J* = 7.1, 1.2 Hz, 1H), 7.53 (m, 3H), 6.95 (dd, *J* = 17.4, 10.6 Hz, 1H), 6.27 (d, *J* = 17.3 Hz, 1H), 6.04 (d, *J* = 10.5 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.5, 161.9, 156.9, 148.9, 137.6, 136.3, 129.4, 124.5, 120.5, 117.9, 116.8, 116.6, 113.1. HRMS (ESI): calculated for $C_{13}H_{10}O$ $(M+H)^+$: 183.0357

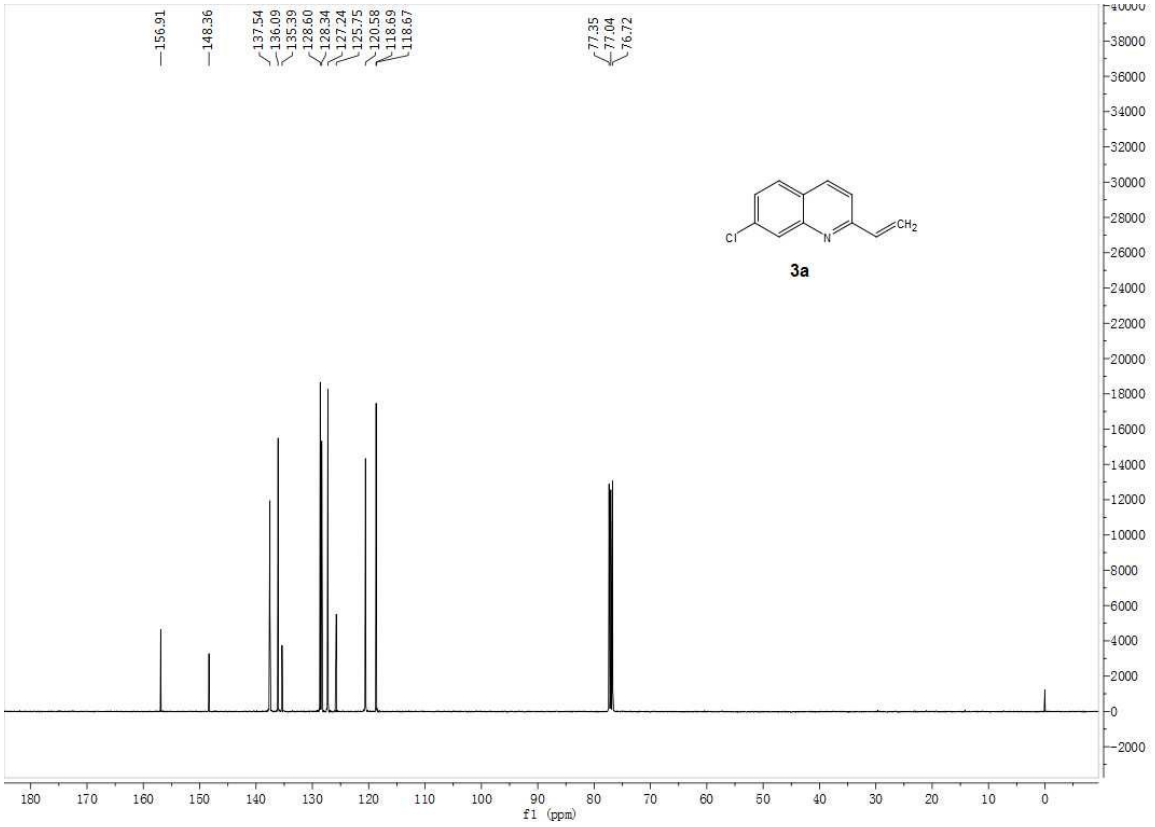
Phenyl vinyl ketone (3v)

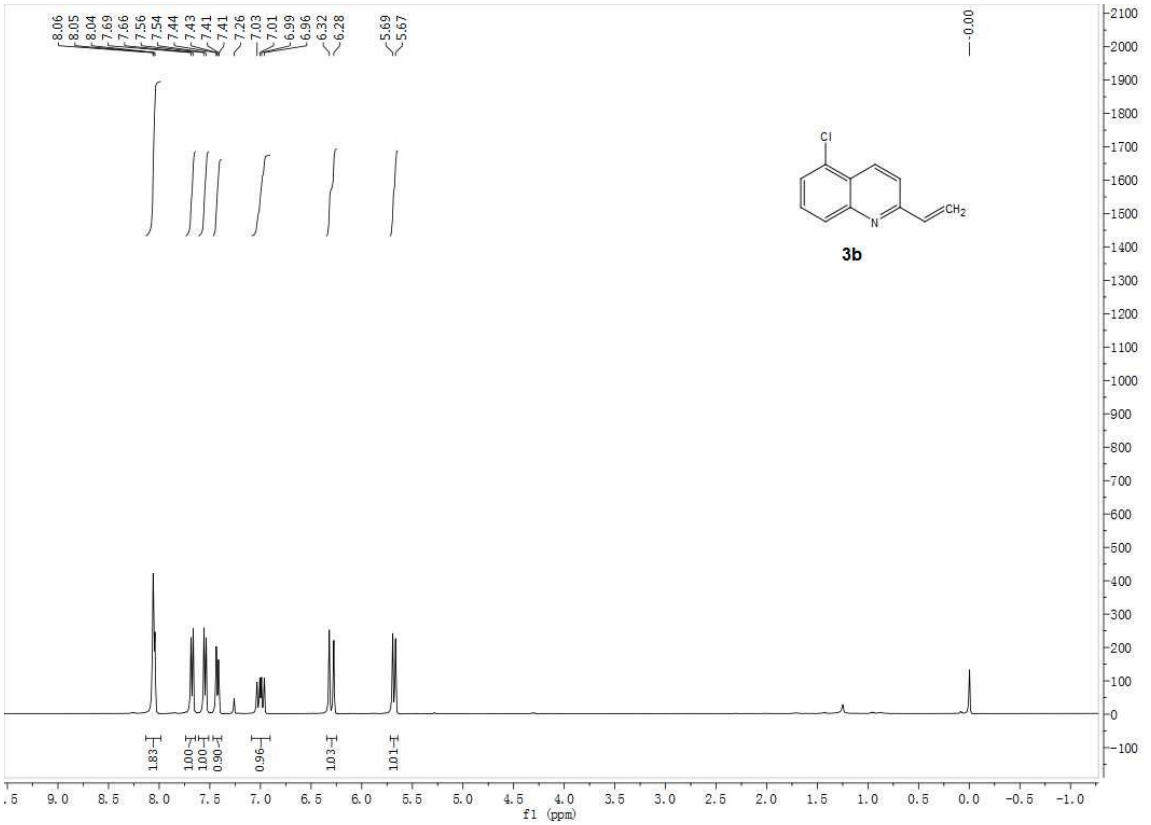


Following the general procedure, 3v was obtained as a yellow oil (72.6 mg, 13%); ^{1}H NMR (400 MHz, $CDCl_3$):δ 7.89 (dd, *J* = 8.0, 3.4 Hz, 2H), 7.50 (m, 1H), 7.40 (m, 2H), 7.12 (dd, *J* = 17.2, 11 Hz, 1H), 6.38 (d, *J* = 17.2 Hz, 1H), 5.85 (dd, *J* = 11.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.1, 137.4, 134.2, 133.2, 132.5, 130.3, 129.1, 128.9, 128.8, 77.80, 77.47, 77.15. HRMS (ESI): calculated for C_9H_8O $(M+H)^+$: 133.0648.

4. ^{1}H and ^{13}C NMR spectra of products



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8.05
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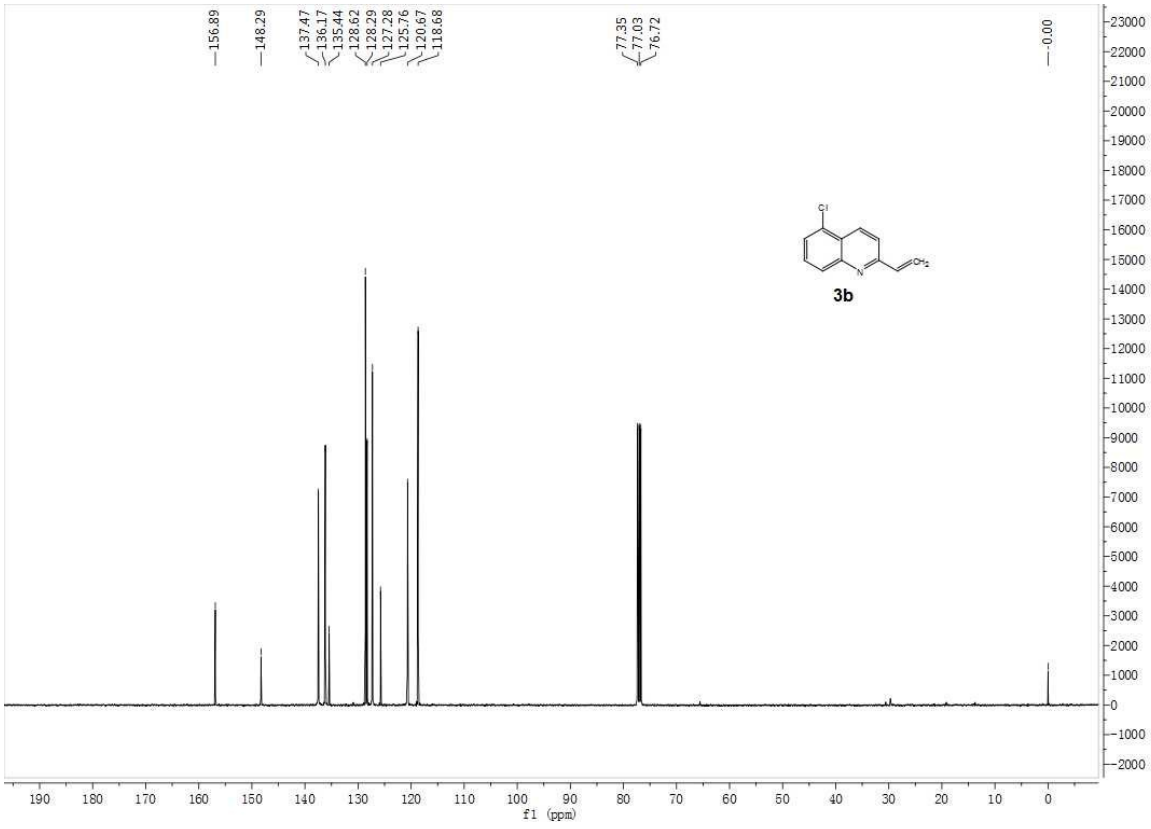
7.56
7.54
7.44
7.43
7.41
7.41
7.26
7.03
7.01
6.99
6.96
6.32
6.28
5.69
5.67
0.00
Cl
N
CH2
3b
1.83
1.00
1.00
0.90
0.96
1.03
1.01
f1 (ppm)


156.89
148.29
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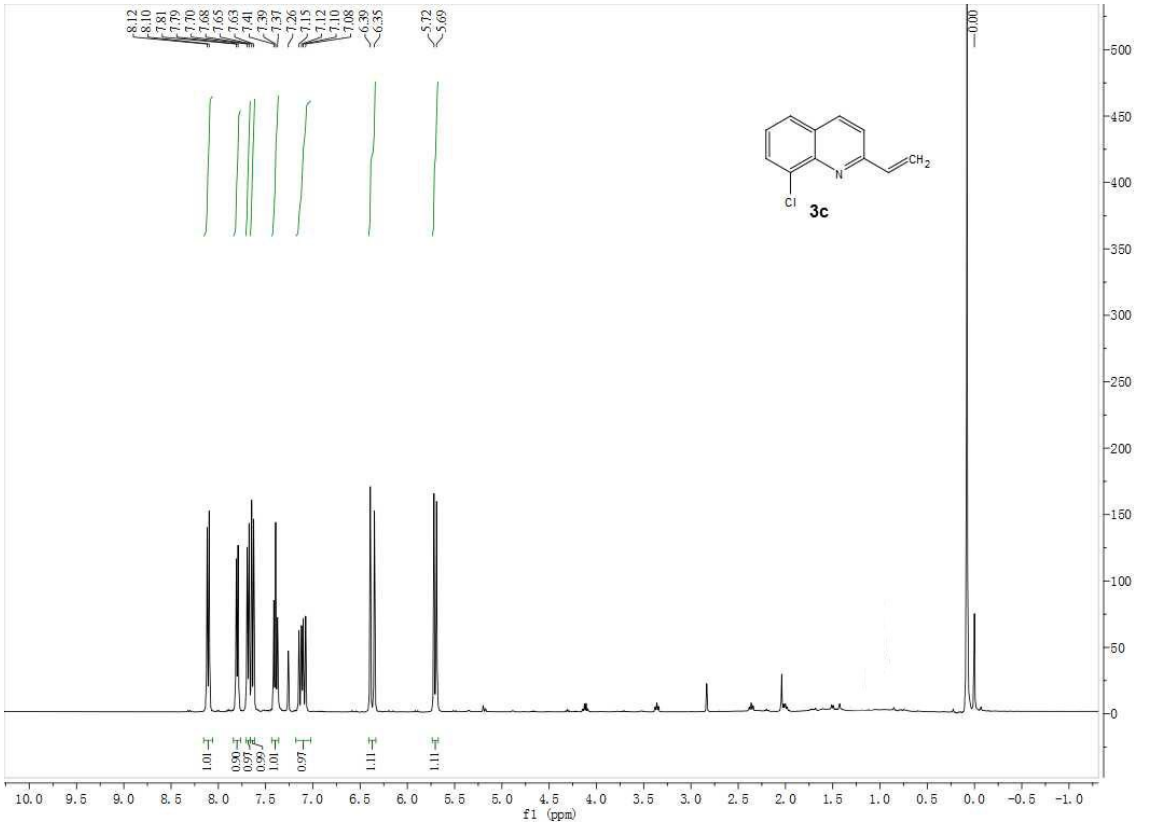
136.17
135.44
128.62
128.29
127.28
125.76
120.67
118.68
77.35
77.03
76.72
0.00
Cl
N
CH2
3b
f1 (ppm)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8.10
7.81
7.79
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7.65
7.63
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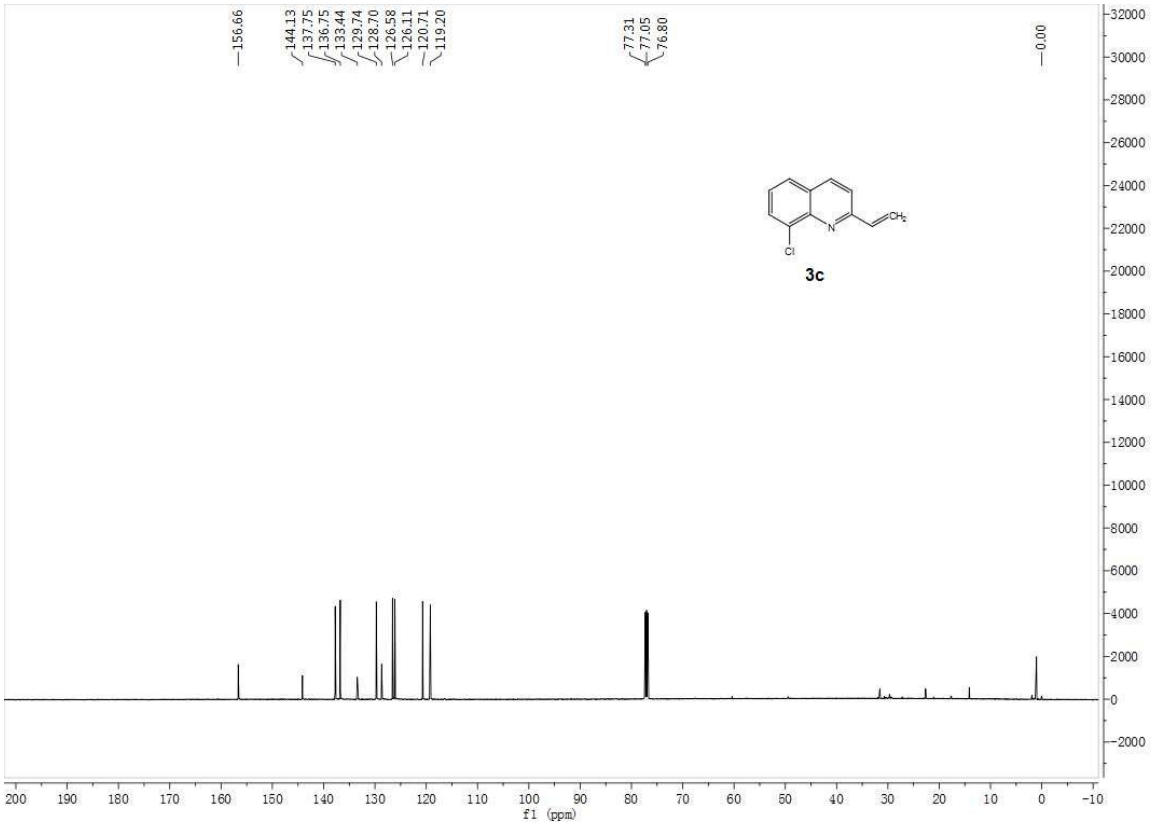
7.39
7.37
7.26
7.15
7.12
7.10
7.08
6.39
6.35
5.72
5.69
0.00
1.01
0.90
0.97
0.99
1.01
0.97
1.11
1.11
3c
f1 (ppm)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119.20
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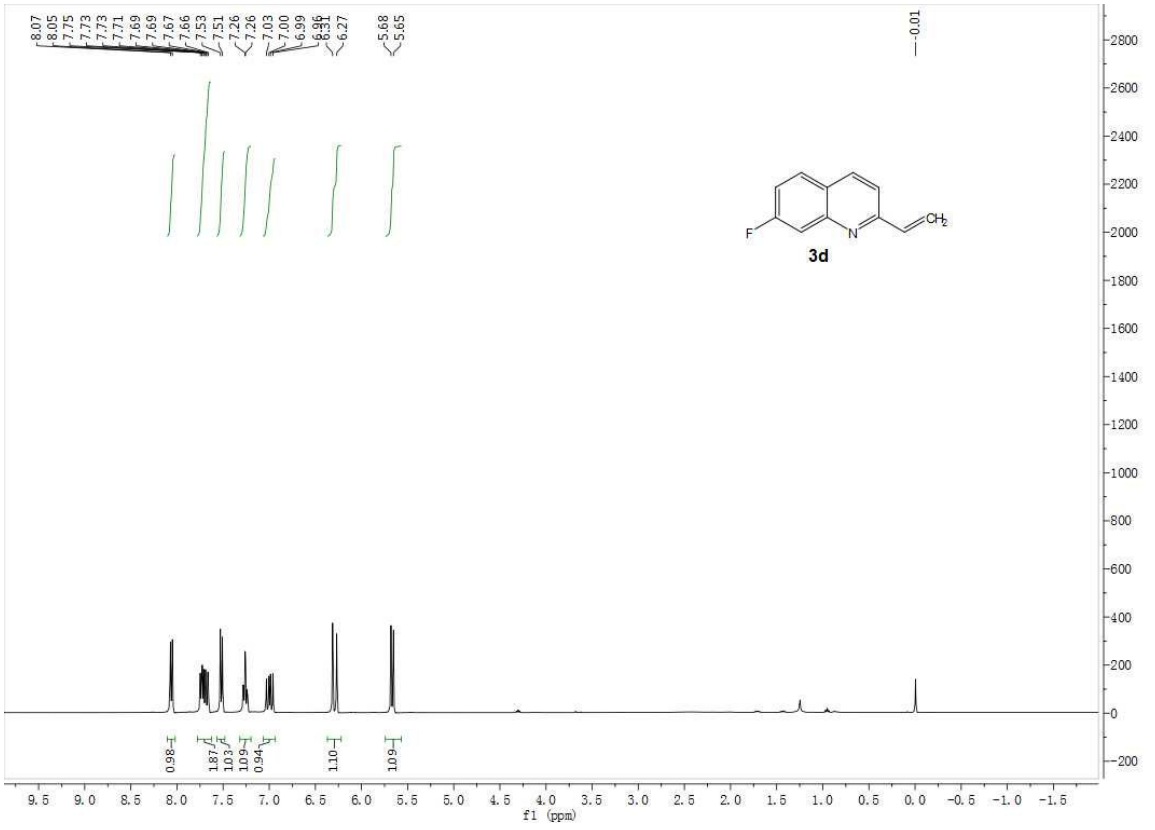
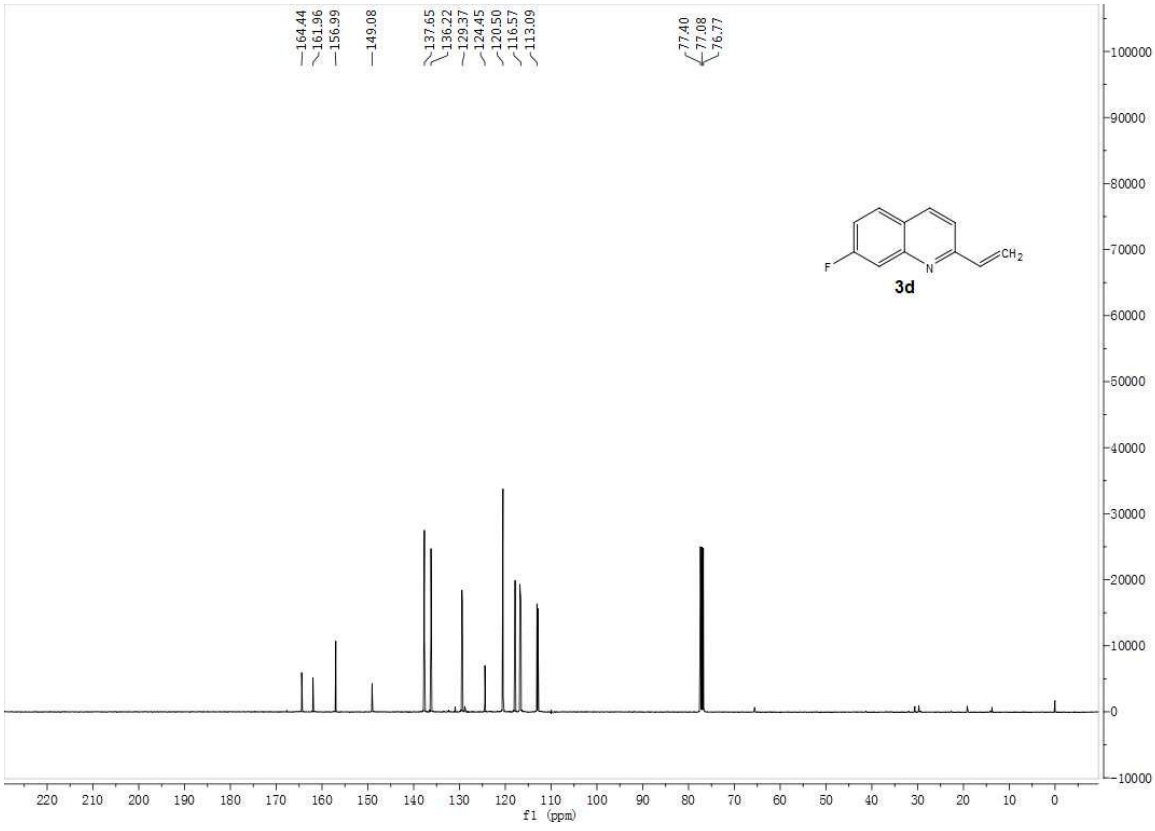
77.05
76.80
0.00
3c
f1 (ppm)


8.07
8.05
7.75
7.73
7.73
7.71
7.69
7.69
7.67
7.66
7.53
7.51
7.26
7.26
7.03
7.00
6.99
6.96
6.31
6.27
5.68
5.65
-0.01
F
N
CH2
3d
0.98
1.87
1.03
1.09
0.94
1.10
1.09
f1 (ppm)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161.96
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136.22
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124.45
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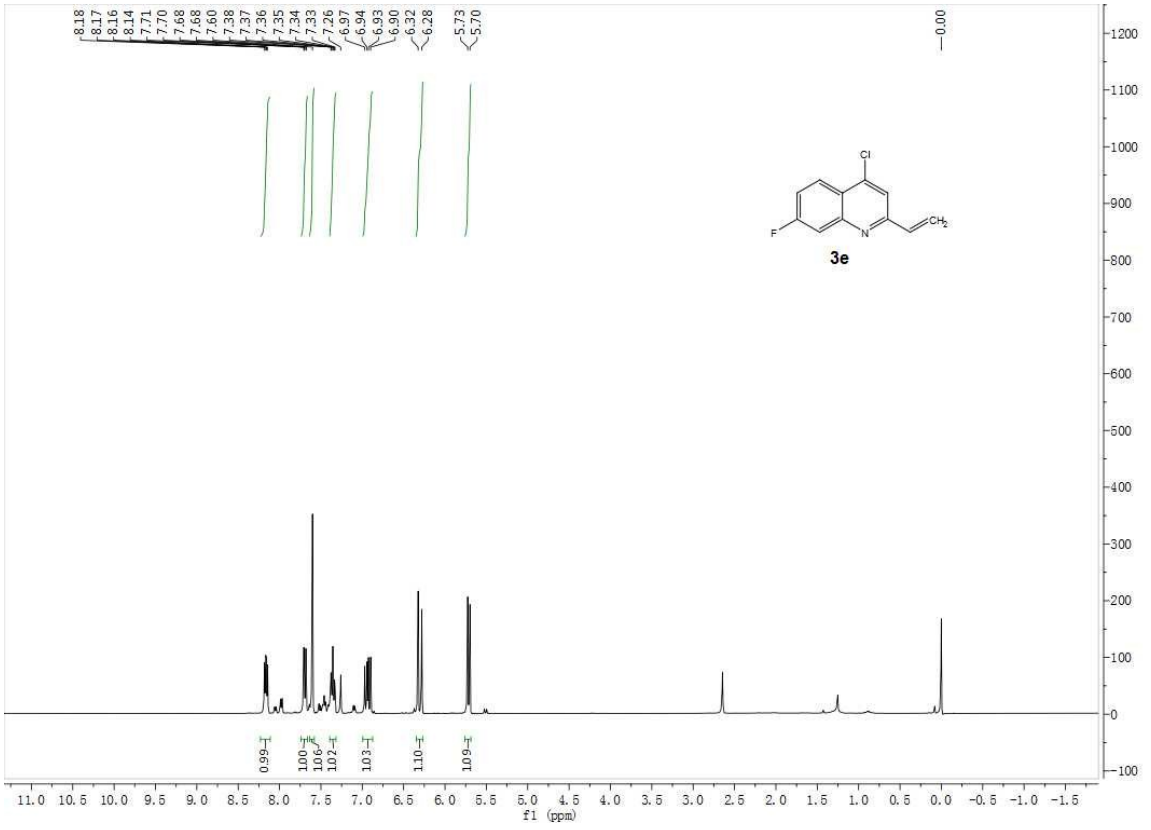
113.09
77.40
77.08
76.77
F
N
CH2
3d
f1 (ppm)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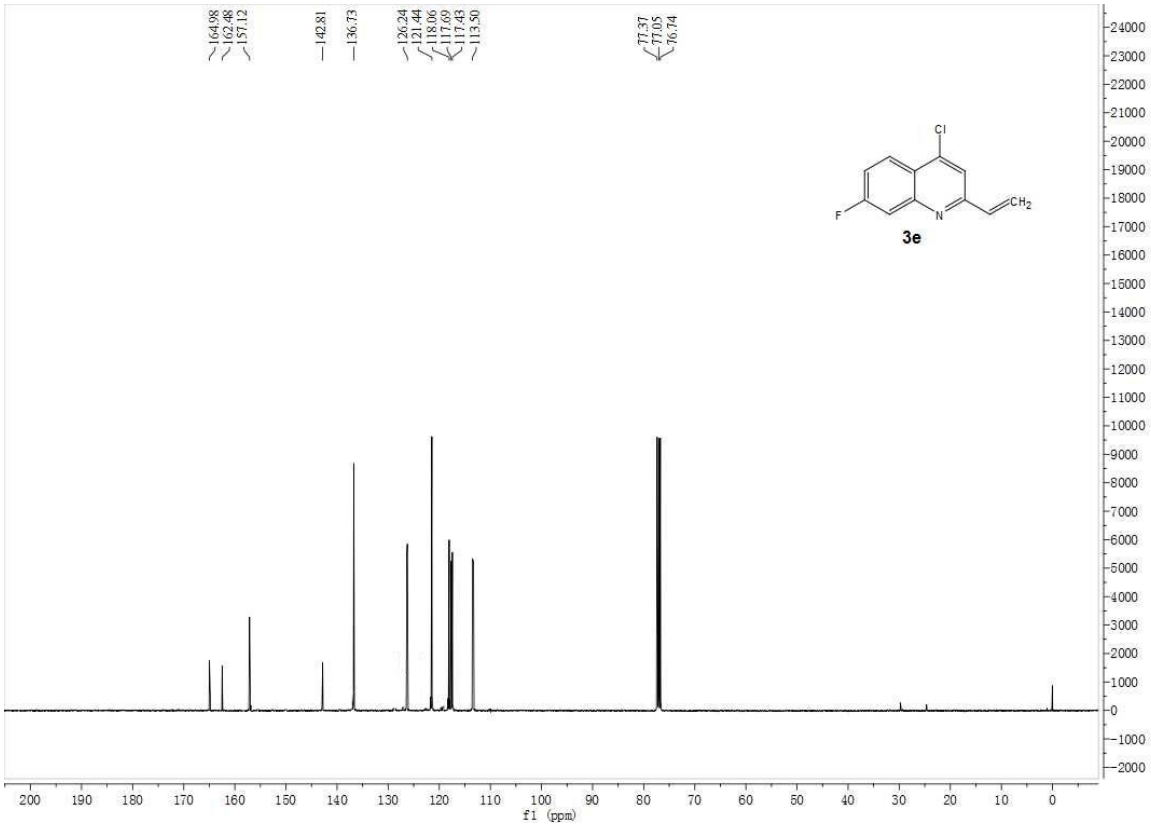
7.70
7.68
7.68
7.60
7.38
7.37
7.36
7.35
7.34
7.33
7.26
6.97
6.94
6.93
6.90
6.32
6.28
5.73
5.70
0.00
Cl
F
N
CH2
3e
0.99
1.00
1.06
1.02
1.03
1.10
1.09
f1 (ppm)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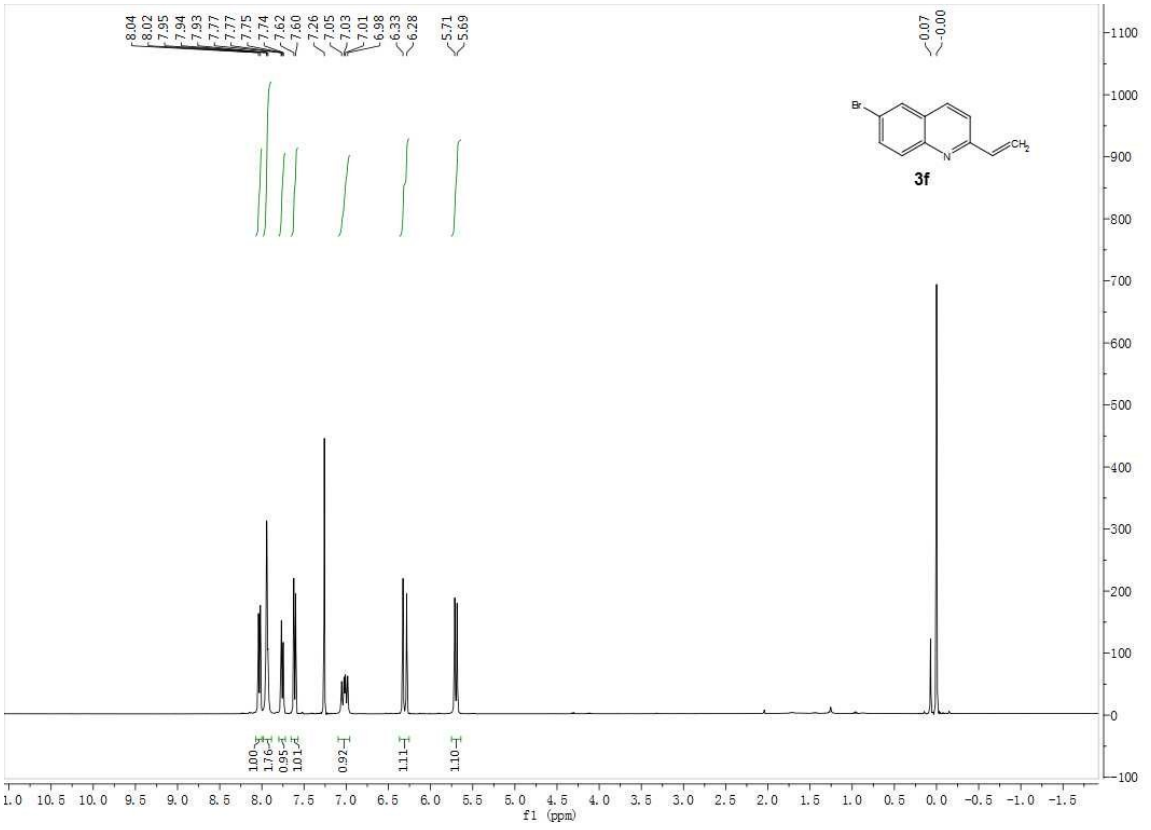
136.73
126.24
121.44
118.06
117.69
117.43
113.50
77.37
77.05
76.74
Cl
F
N
CH2
3e
f1 (ppm)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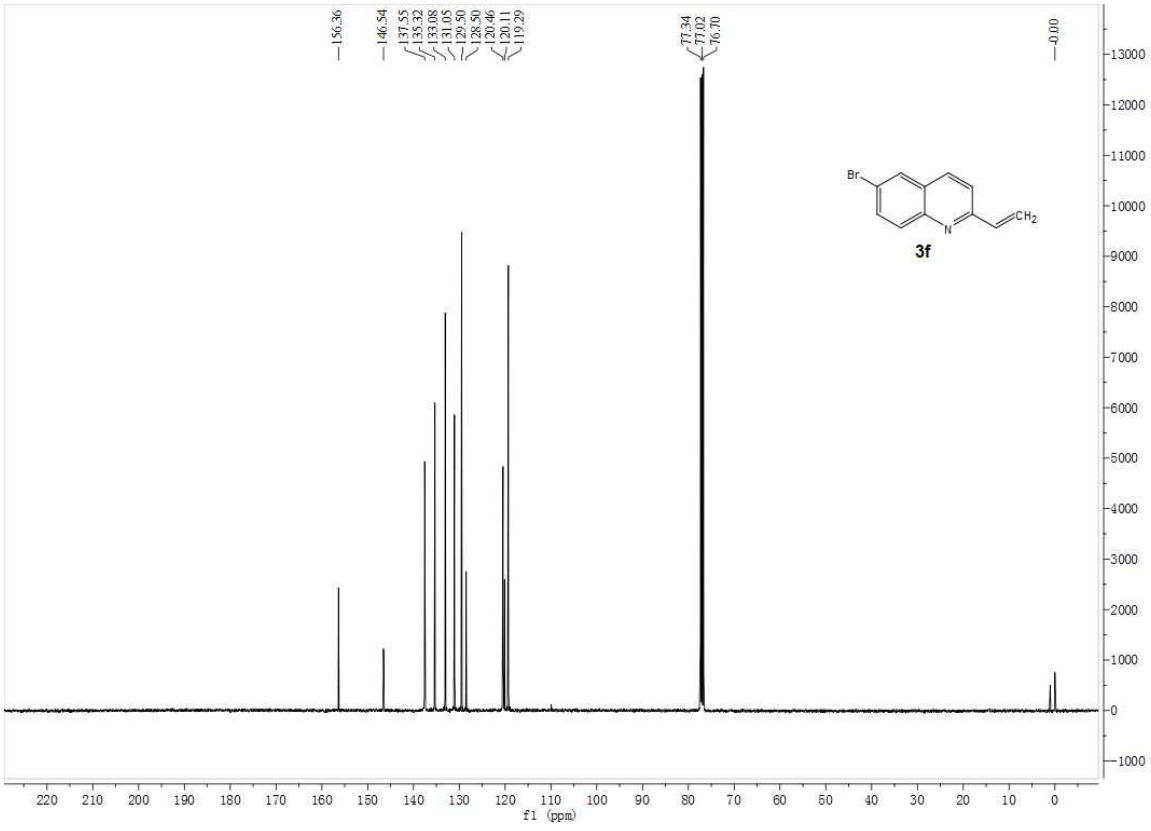
8.02
7.95
7.94
7.93
7.77
7.77
7.75
7.74
7.62
7.60
7.26
7.05
7.03
7.01
6.98
6.33
6.28
5.71
5.69
0.07
0.00
Br
N
CH2
3f
1.00
1.76
0.95
1.01
0.92
1.11
1.10
f1 (ppm)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129.50
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119.29
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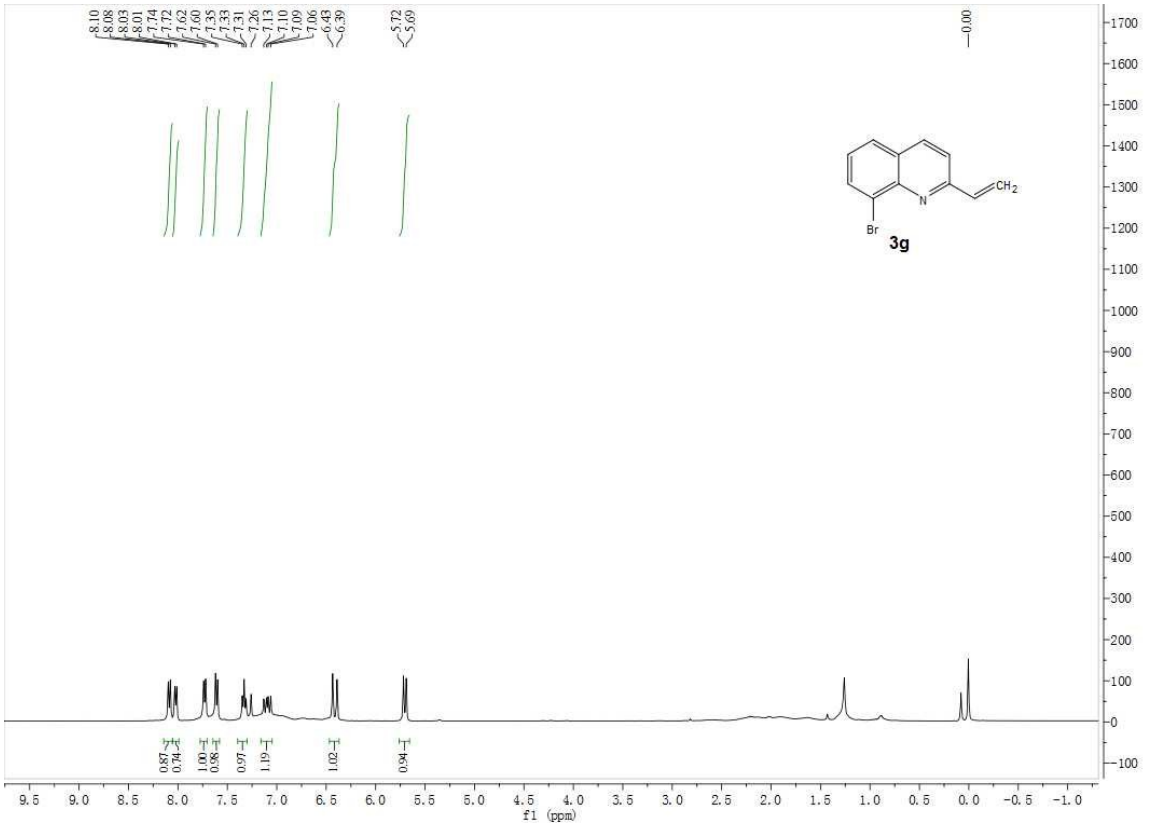
77.02
76.70
0.00
Br
N
CH2
3f
f1 (ppm)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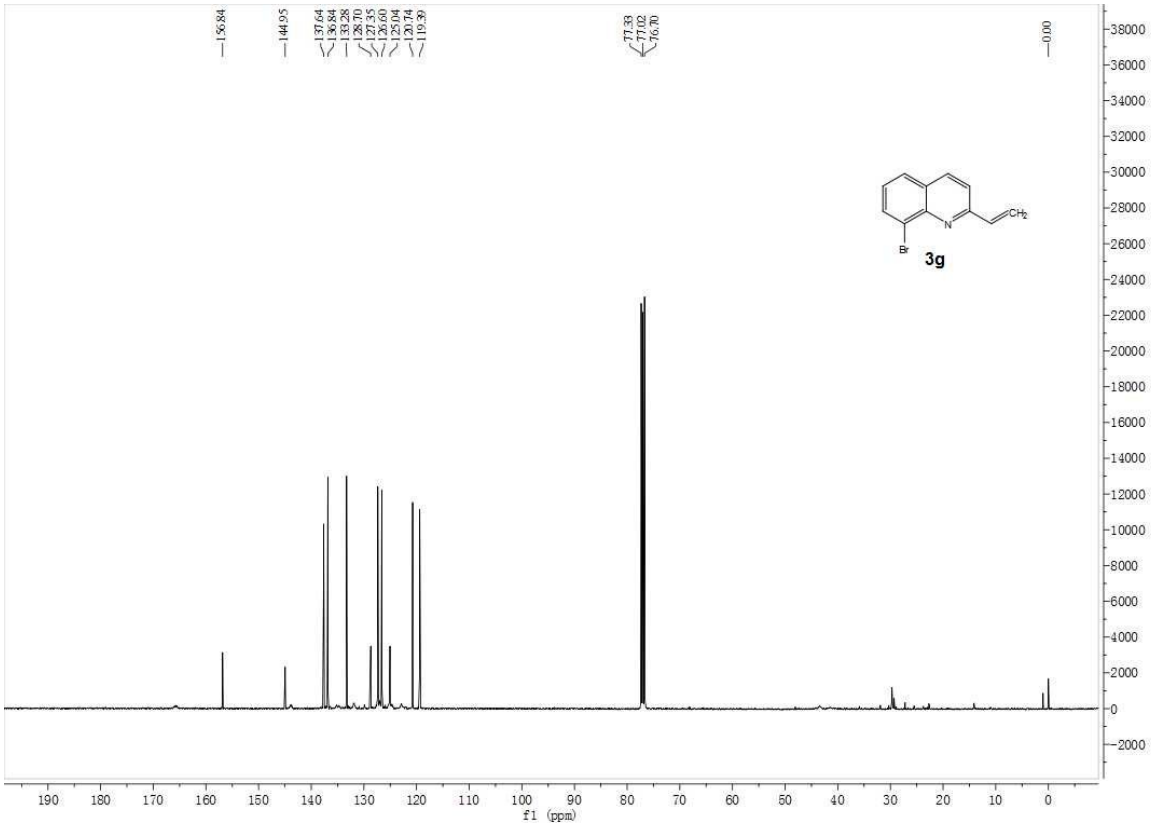
8.08
8.03
8.01
7.74
7.72
7.62
7.60
7.35
7.33
7.31
7.26
7.13
7.10
7.09
7.06
6.43
6.39
5.72
5.69
0.00
Br
N
CH2
3g
0.87
0.74
1.00
0.98
0.97
1.19
1.02
0.94
f1 (ppm)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137.64
136.84
133.28
128.70
127.35
126.60
125.04
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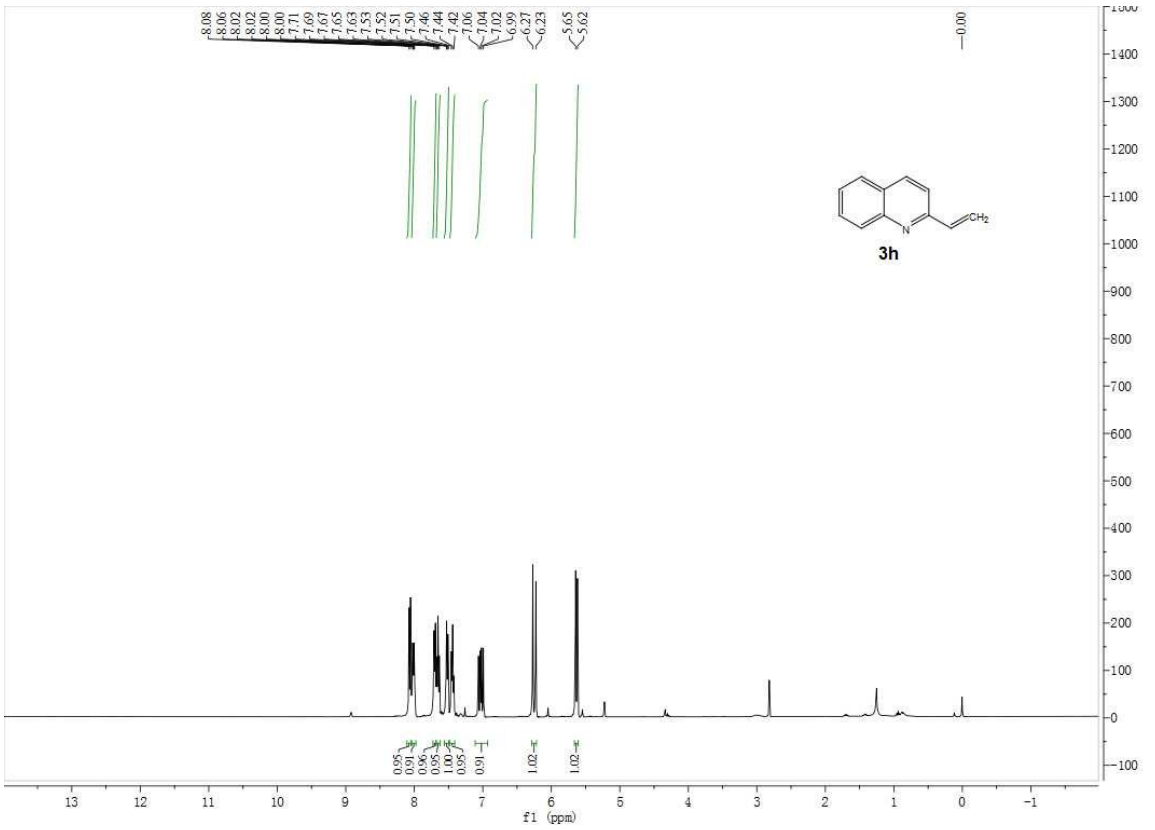
119.39
77.33
77.02
76.70
0.00
Br
N
CH2
3g
f1 (ppm)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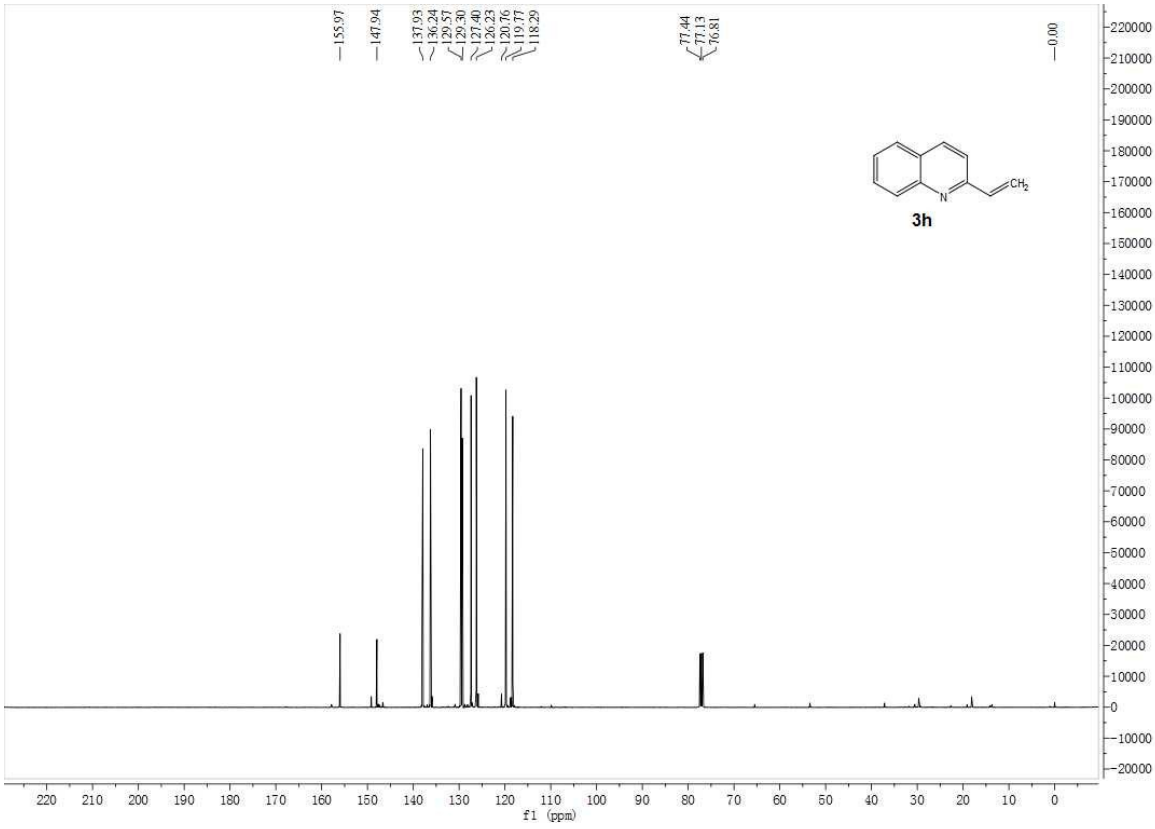
8.06
8.02
8.02
8.00
8.00
7.71
7.69
7.67
7.65
7.63
7.53
7.52
7.51
7.50
7.46
7.44
7.42
7.06
7.04
7.02
6.99
6.27
6.23
5.65
5.62
0.00
3h
0.95
0.91
0.96
0.95
1.00
0.95
0.91
1.02
1.02
f1 (ppm)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136.24
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127.40
126.23
120.76
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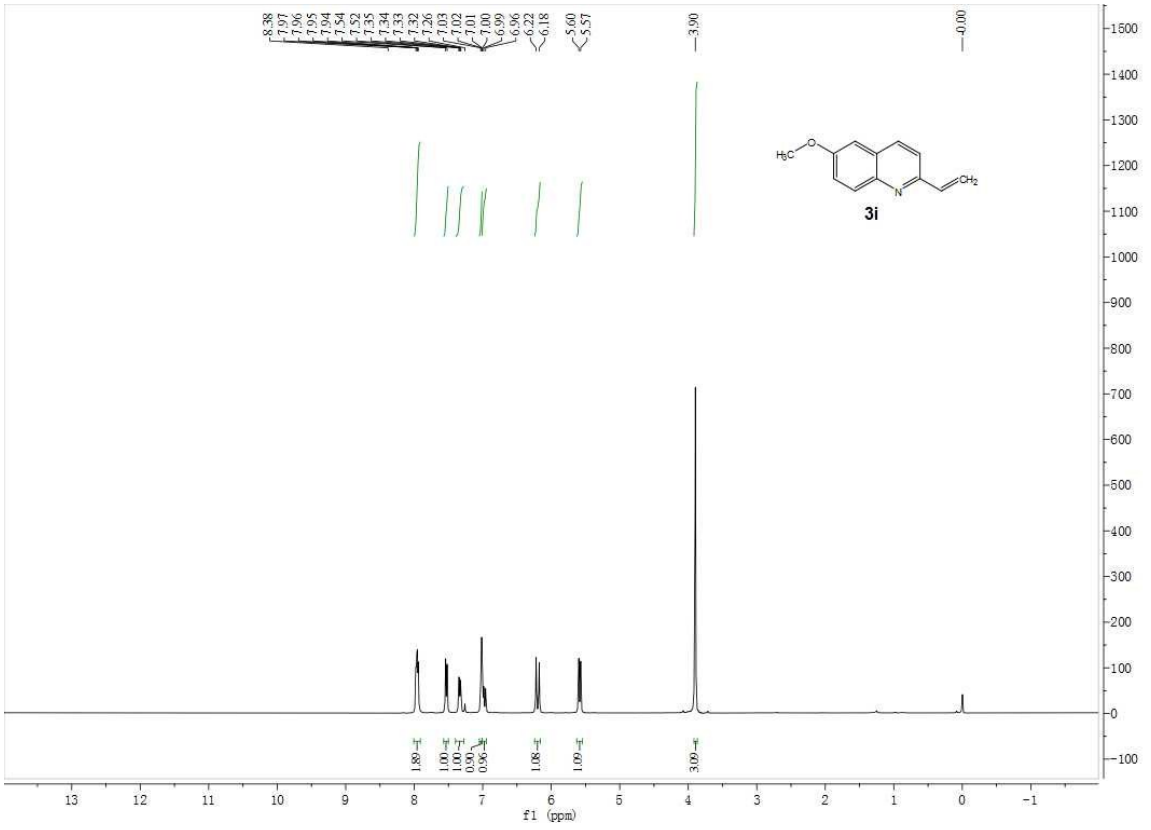
118.29
77.44
77.13
76.81
0.00
3h
f1 (ppm)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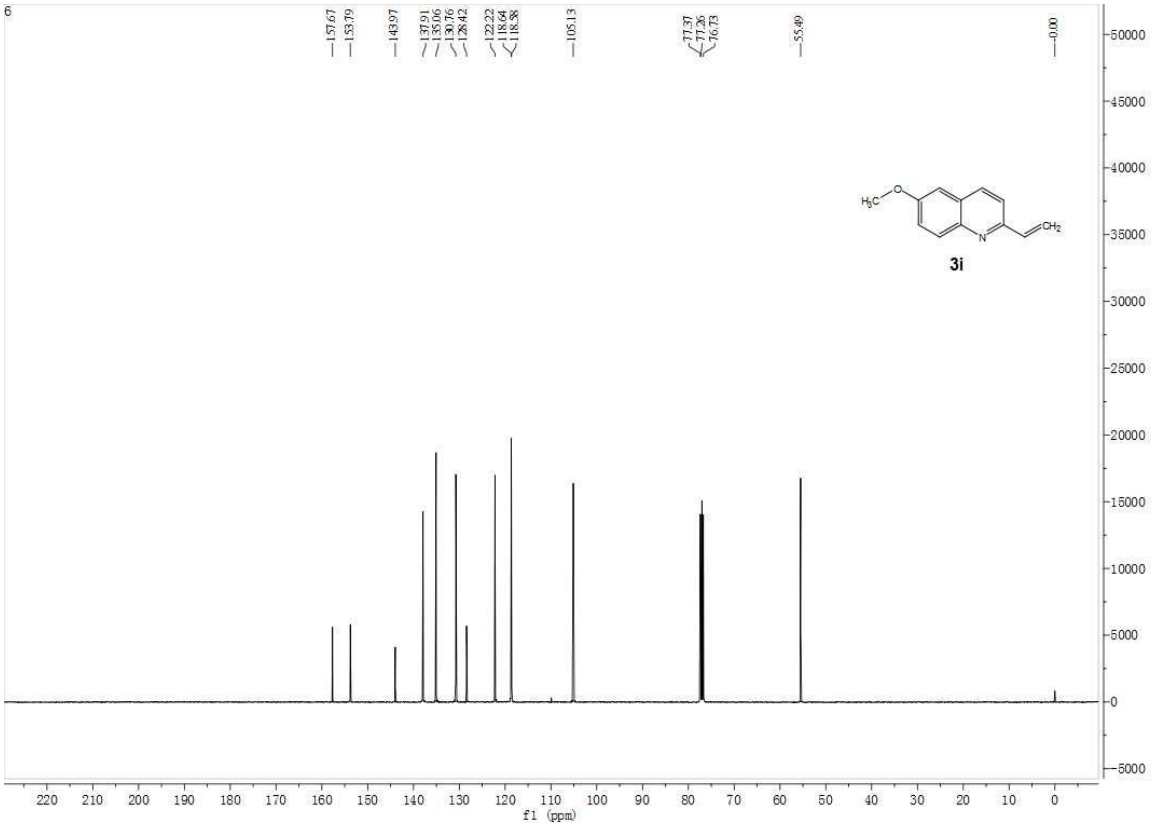
7.97
7.96
7.95
7.94
7.54
7.52
7.35
7.34
7.33
7.32
7.26
7.03
7.02
7.01
7.00
6.99
6.96
6.22
6.18
5.60
5.57
3.90
0.00
H3C
O
N
CH2
3i
1.89
1.00
1.00
0.90
0.96
1.08
1.09
3.09
f1 (ppm)


6
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130.76
128.42
122.22
118.64
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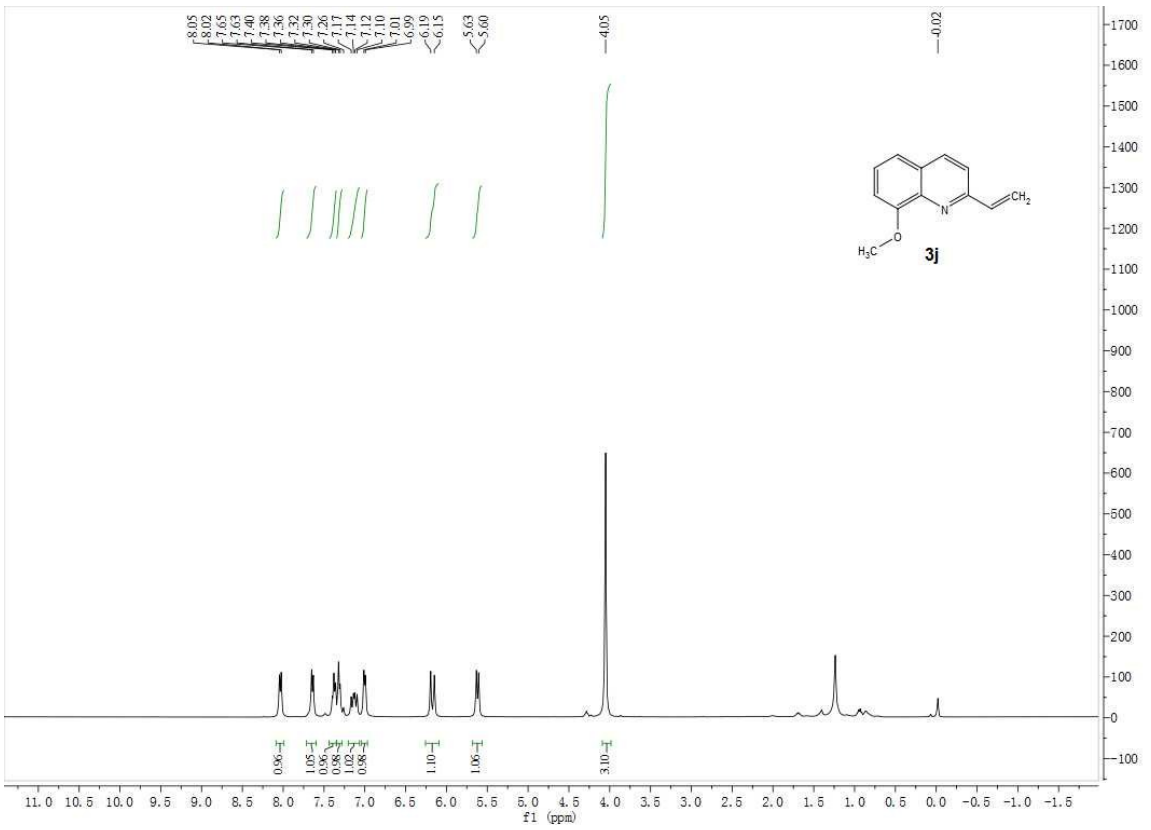
77.37
77.26
76.73
55.49
0.00
H3C
O
N
CH2
3i
f1 (ppm)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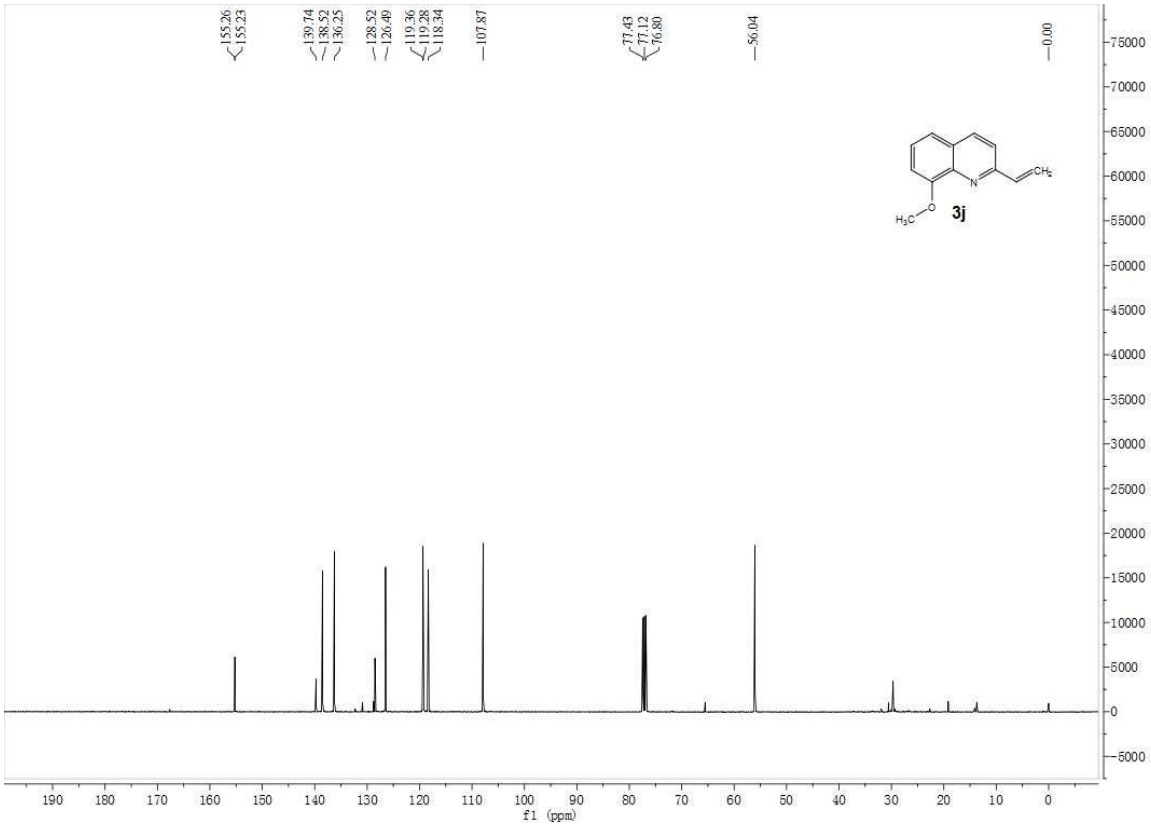
7.63
7.40
7.38
7.36
7.32
7.30
7.26
7.17
7.14
7.12
7.10
7.01
6.99
6.19
6.15
5.63
5.60
4.05
0.02
3j
0.96
1.05
0.96
0.98
1.02
0.98
1.10
1.06
3.10
f1 (ppm)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128.52
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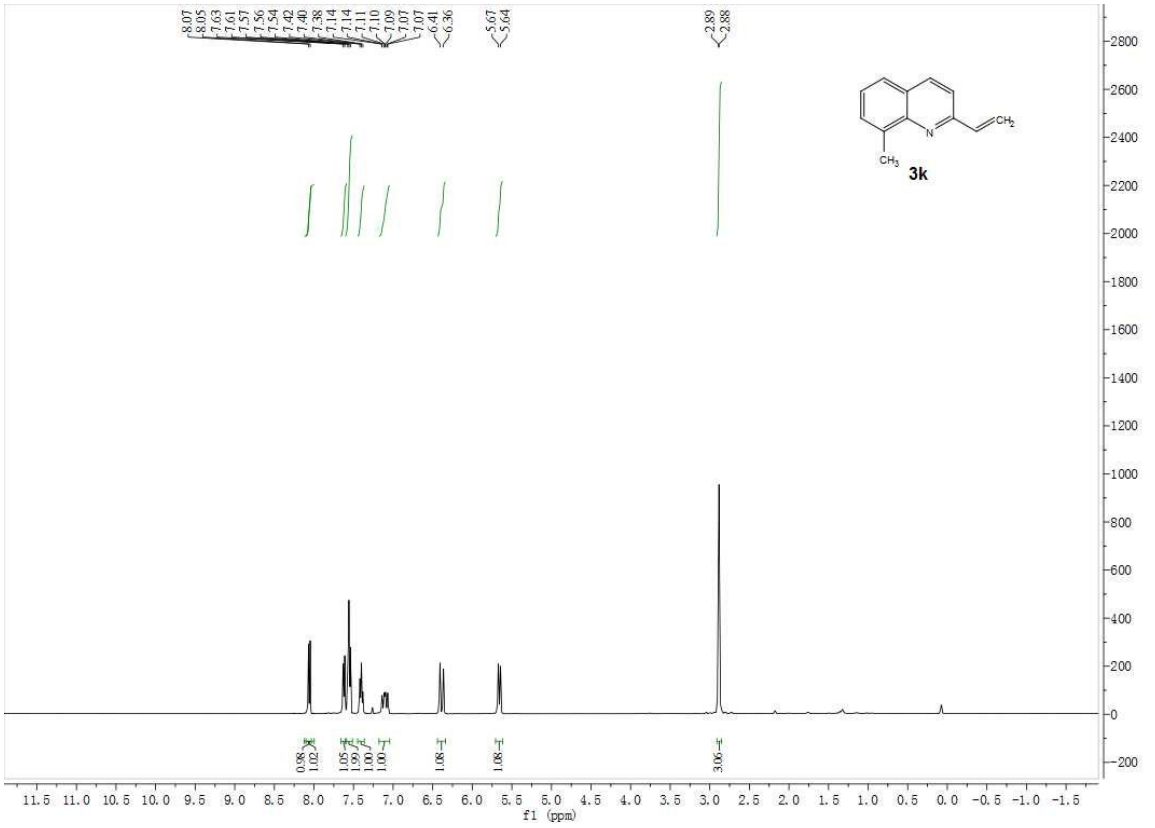
77.12
76.80
56.04
0.00
3j
f1 (ppm)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7.42
7.40
7.38
7.14
7.14
7.11
7.10
7.09
7.07
7.07
7.07
6.41
6.36
5.67
5.64
2.89
2.88
3k
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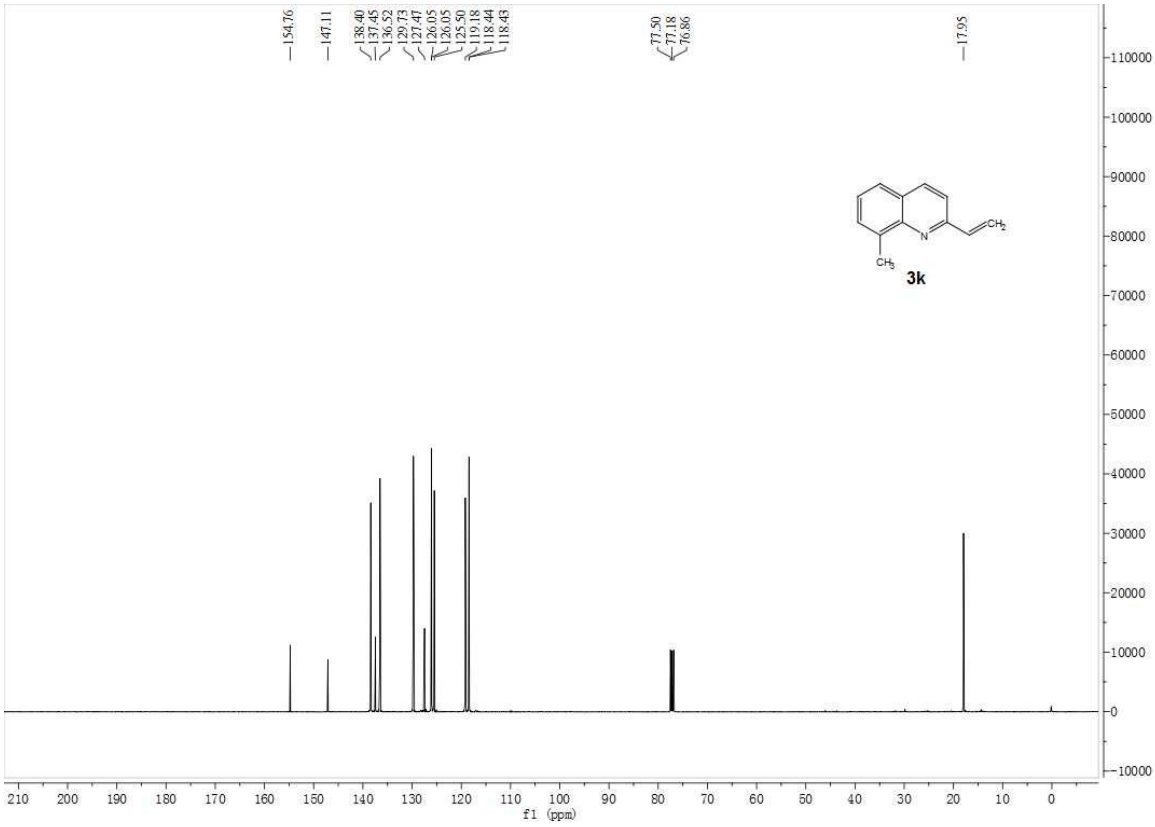
1.02
1.05
1.99
1.00
1.00
1.08
1.08
3.06
f1 (ppm)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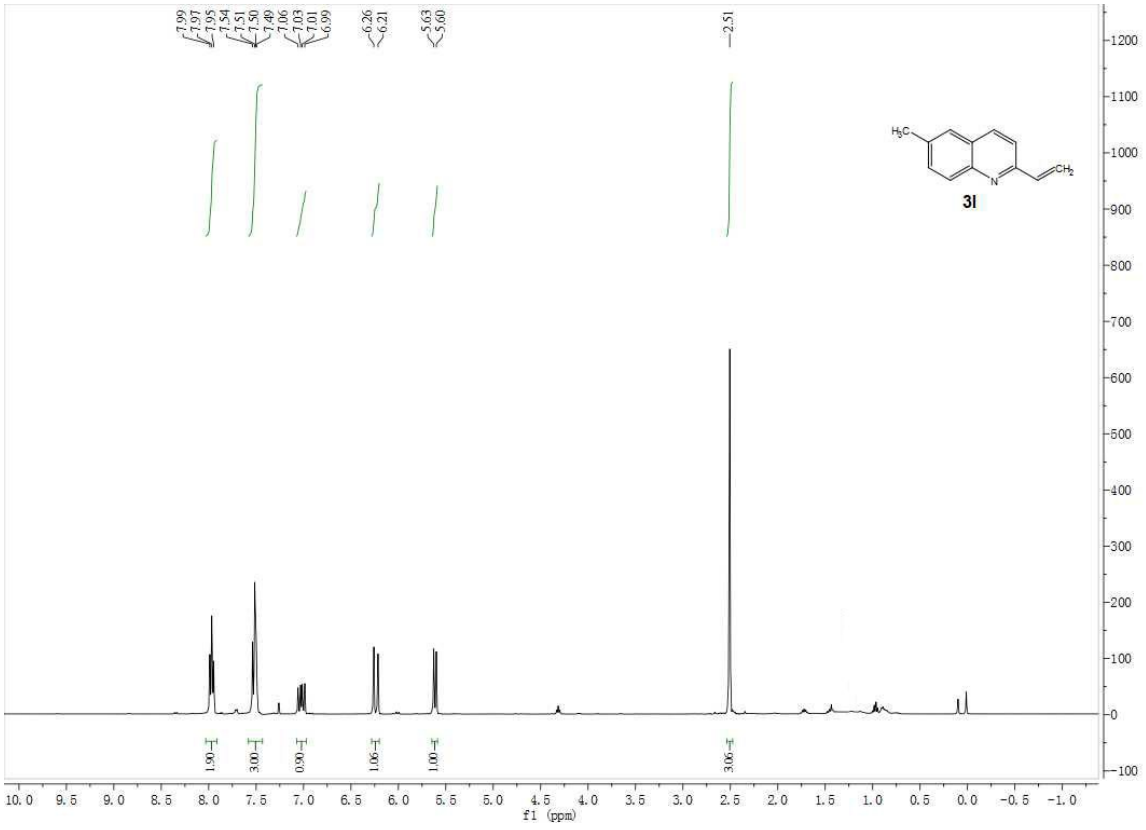
118.43
77.50
77.18
76.86
17.95
3k
f1 (ppm)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7.50
7.49
7.06
7.03
7.01
6.99
6.26
6.21
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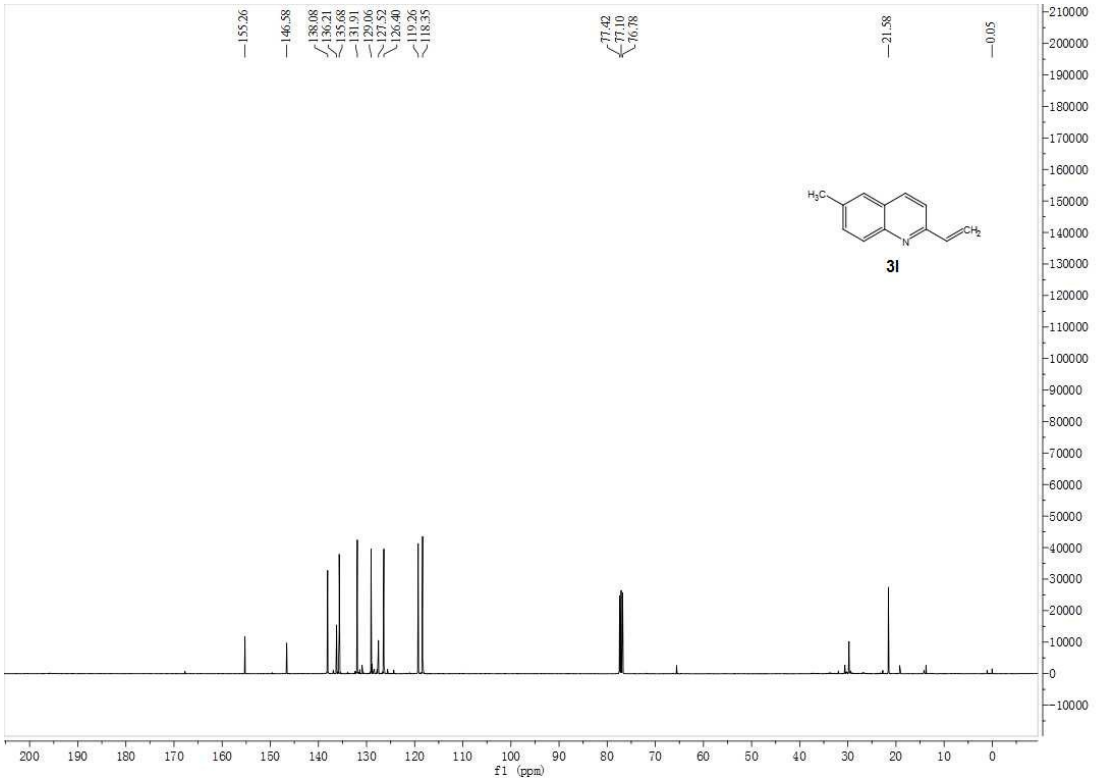
5.60
2.51
1.90
3.00
0.90
1.06
1.00
3.06
f1 (ppm)
3l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136.21
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131.91
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127.52
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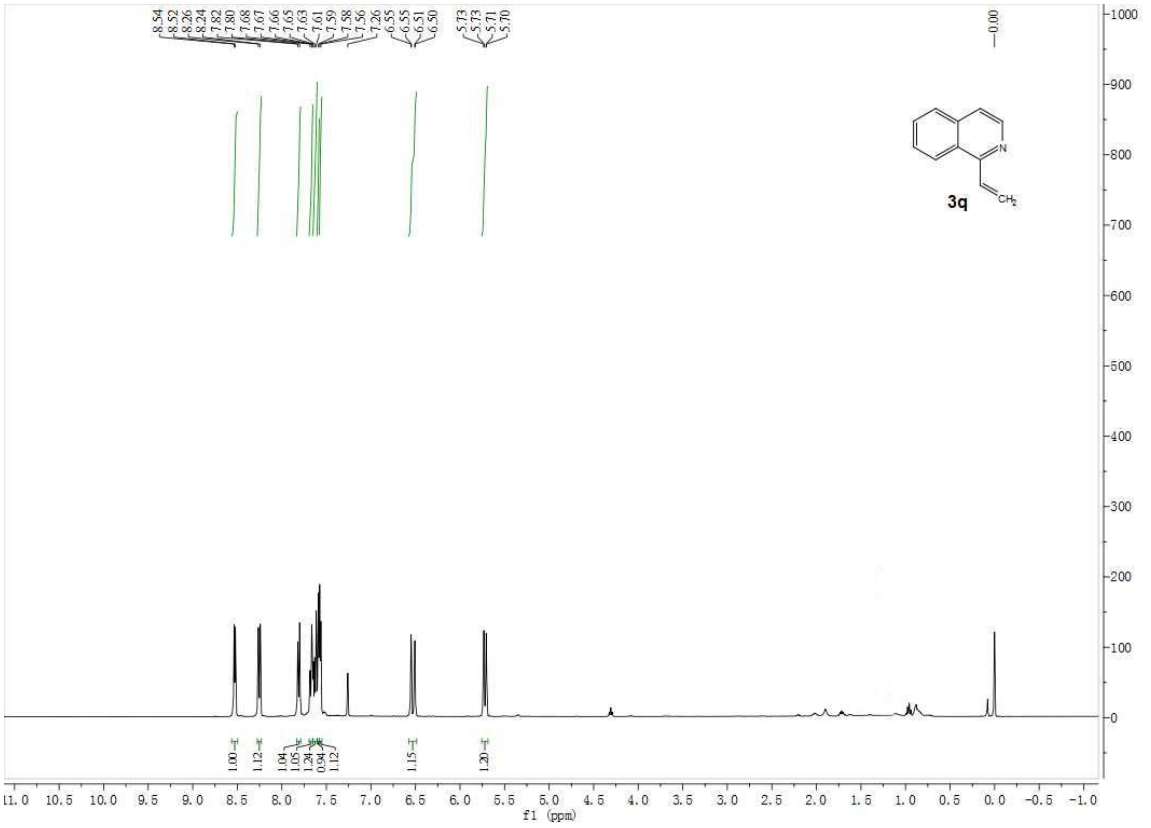
119.26
118.35
77.42
77.10
76.78
21.58
0.05
f1 (ppm)
3l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7.63
7.61
7.59
7.58
7.56
7.26
6.55
6.55
6.51
6.50
5.73
5.73
5.71
5.70
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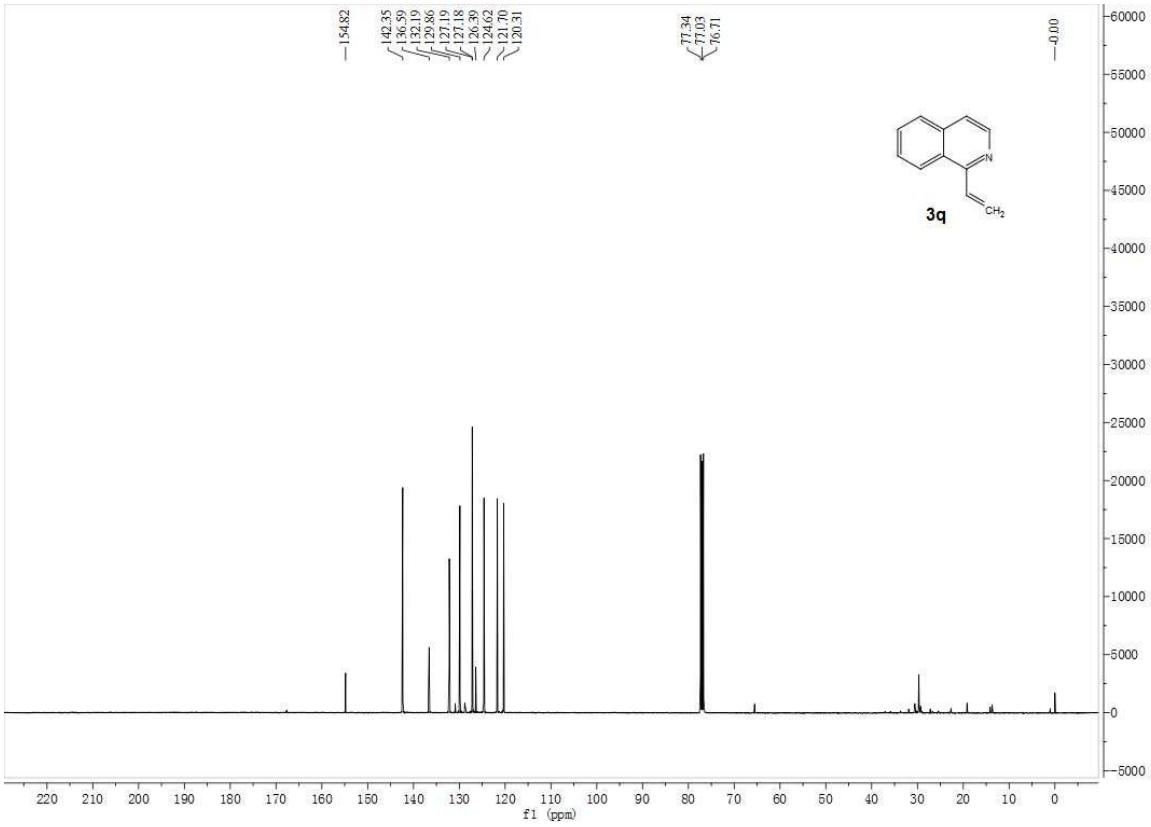
3q
1.00
1.12
1.04
1.05
1.24
0.94
1.12
1.15
1.20
f1 (ppm)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132.19
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127.19
127.18
126.39
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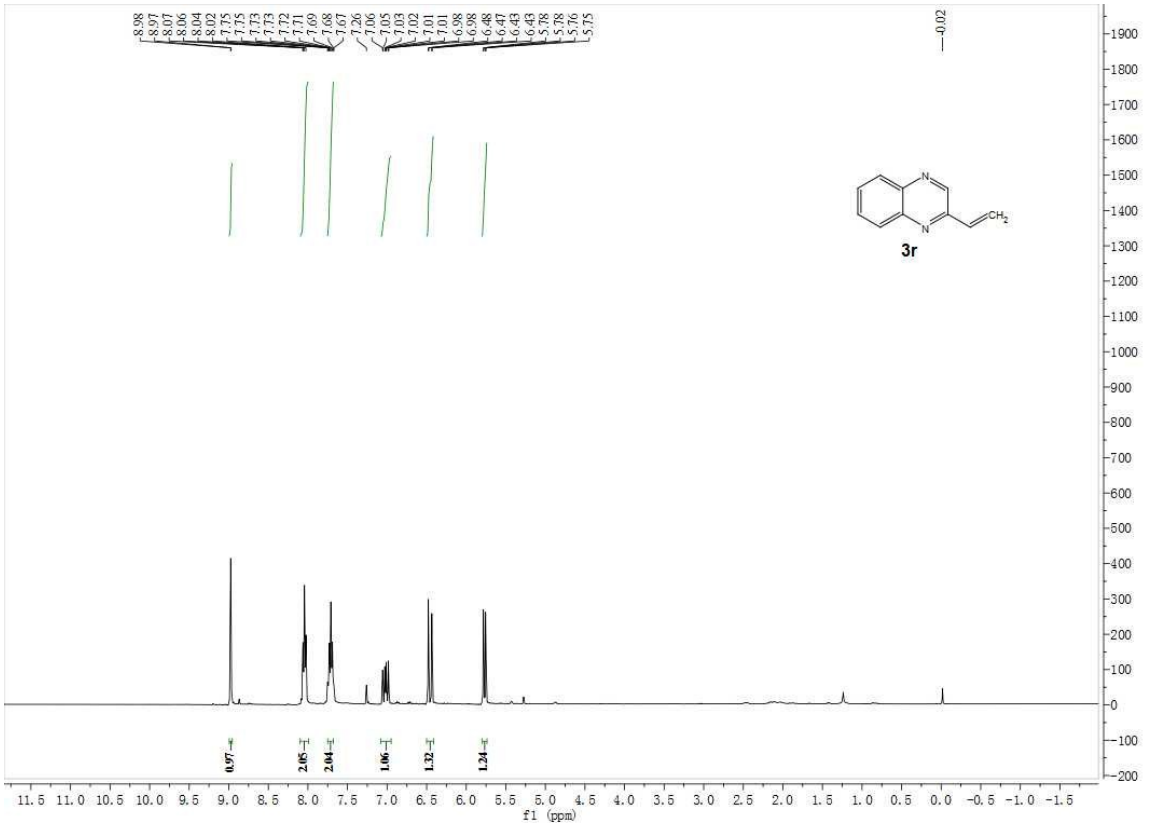
121.70
120.31
77.34
77.03
76.71
0.00
3q
f1 (ppm)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7.73
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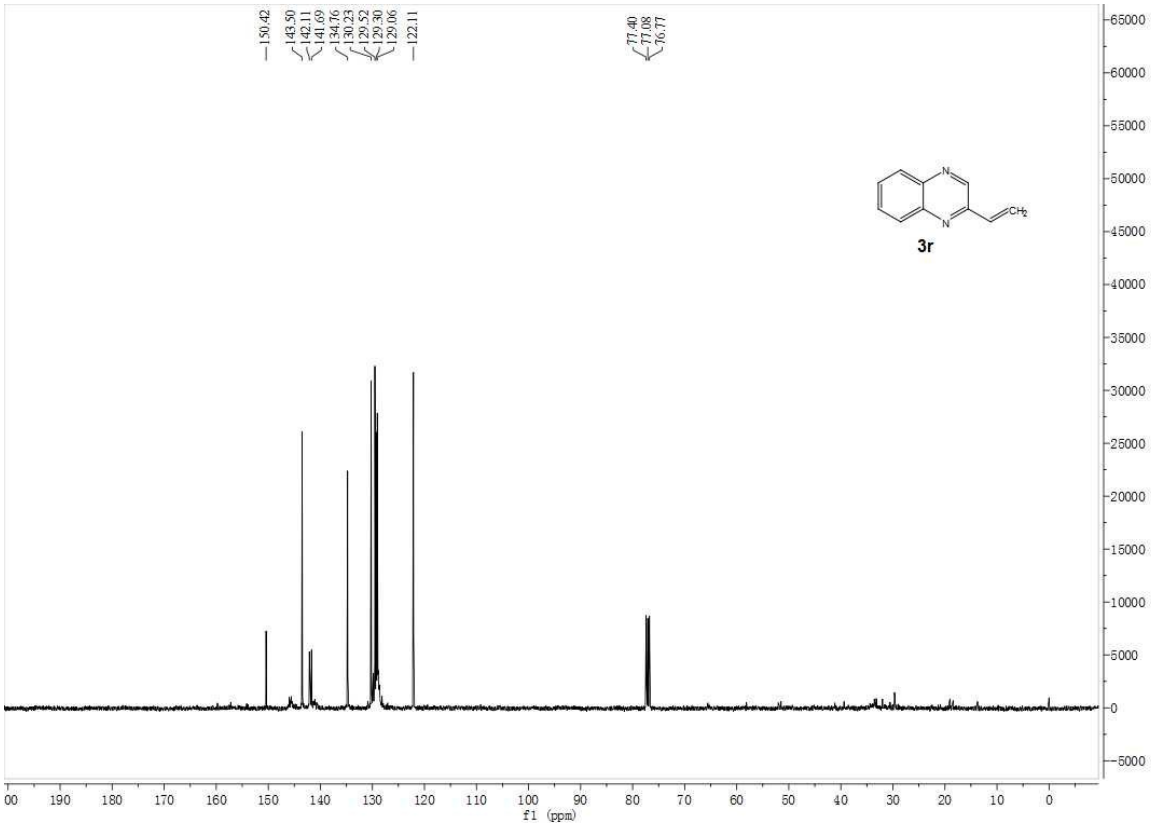
7.71
7.69
7.68
7.67
7.26
7.06
7.05
7.03
7.02
7.01
7.01
6.98
6.98
6.48
6.47
6.43
6.43
5.78
5.78
5.76
5.75
0.02
3r
0.97
2.05
2.04
1.06
1.32
1.24
f1 (ppm)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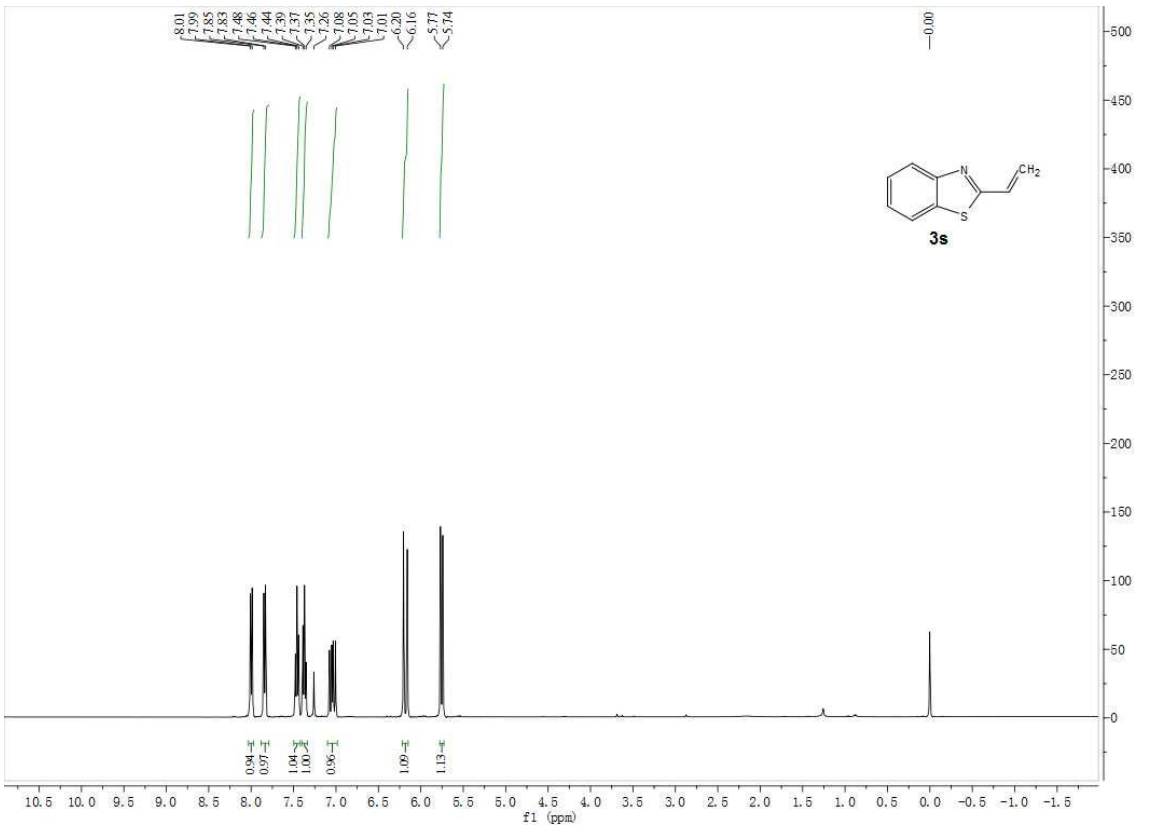
129.30
129.06
122.11
77.40
77.08
76.77
3r
f1 (ppm)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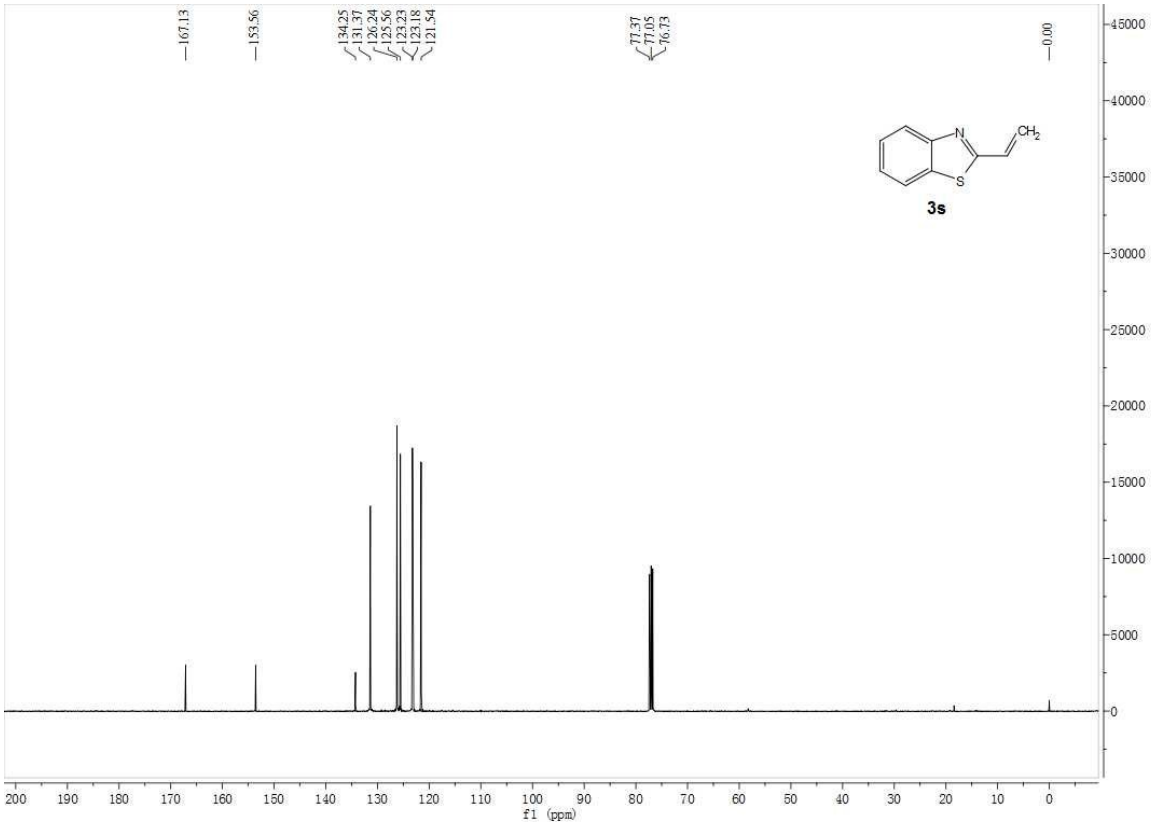
7.46
7.44
7.39
7.37
7.35
7.26
7.08
7.05
7.03
7.01
6.20
6.16
5.77
5.74
0.00
N
S
CH2
3s
0.94
0.97
1.04
1.00
0.96
1.09
1.13
f1 (ppm)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126.24
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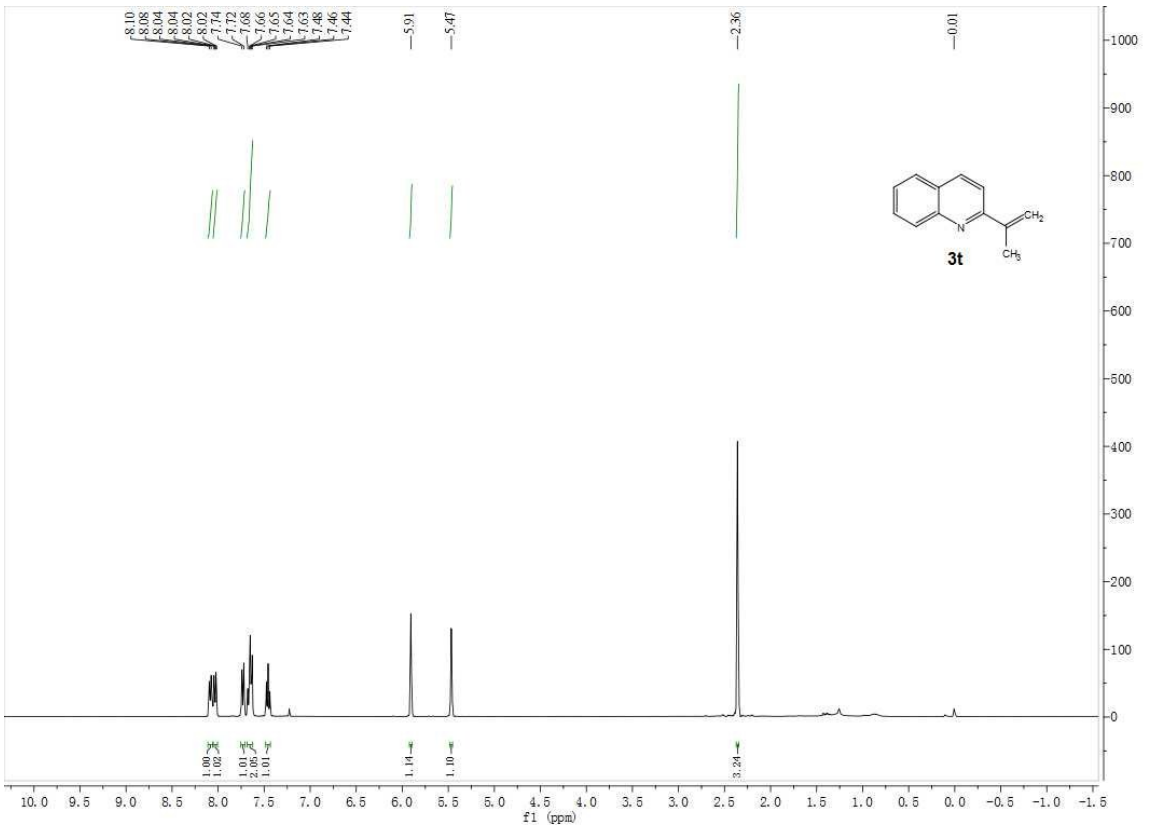
77.05
76.73
0.00
N
S
CH2
3s
f1 (ppm)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8.04
8.02
8.02
7.74
7.72
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7.66
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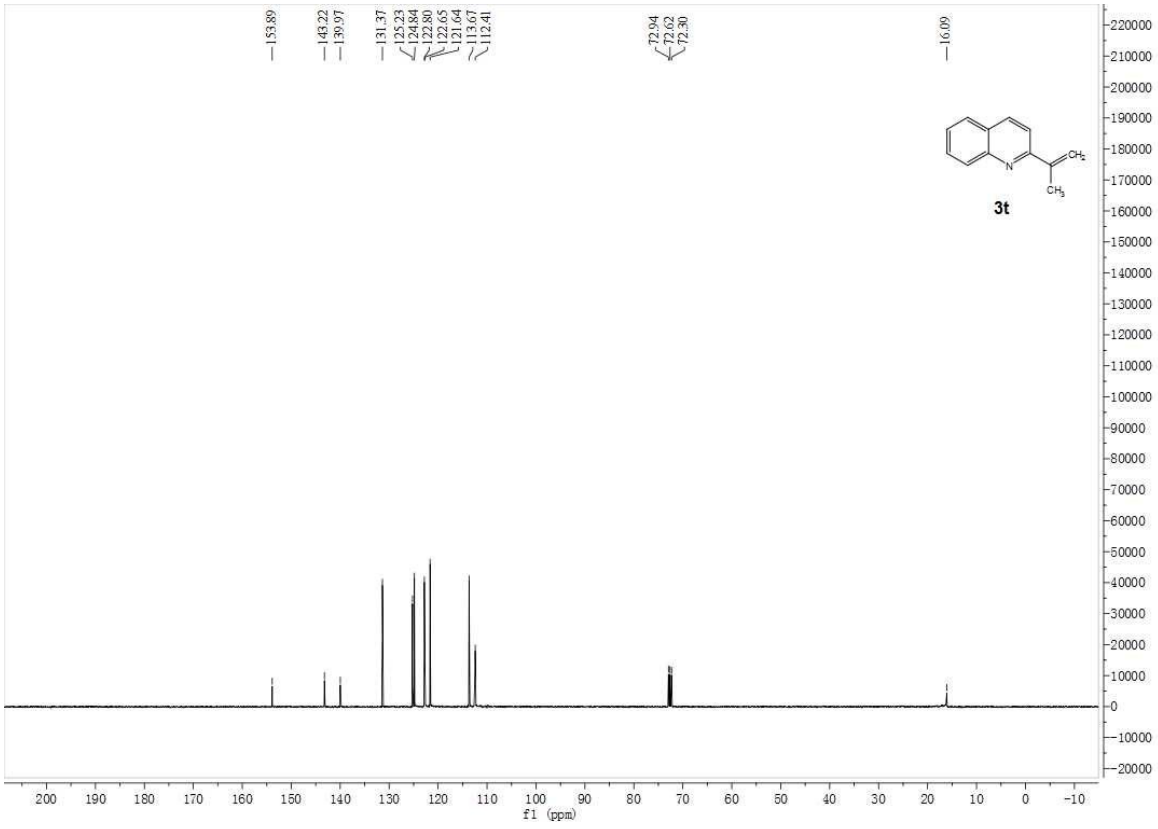
7.48
7.46
7.44
5.91
5.47
2.36
0.01
3t
f1 (ppm)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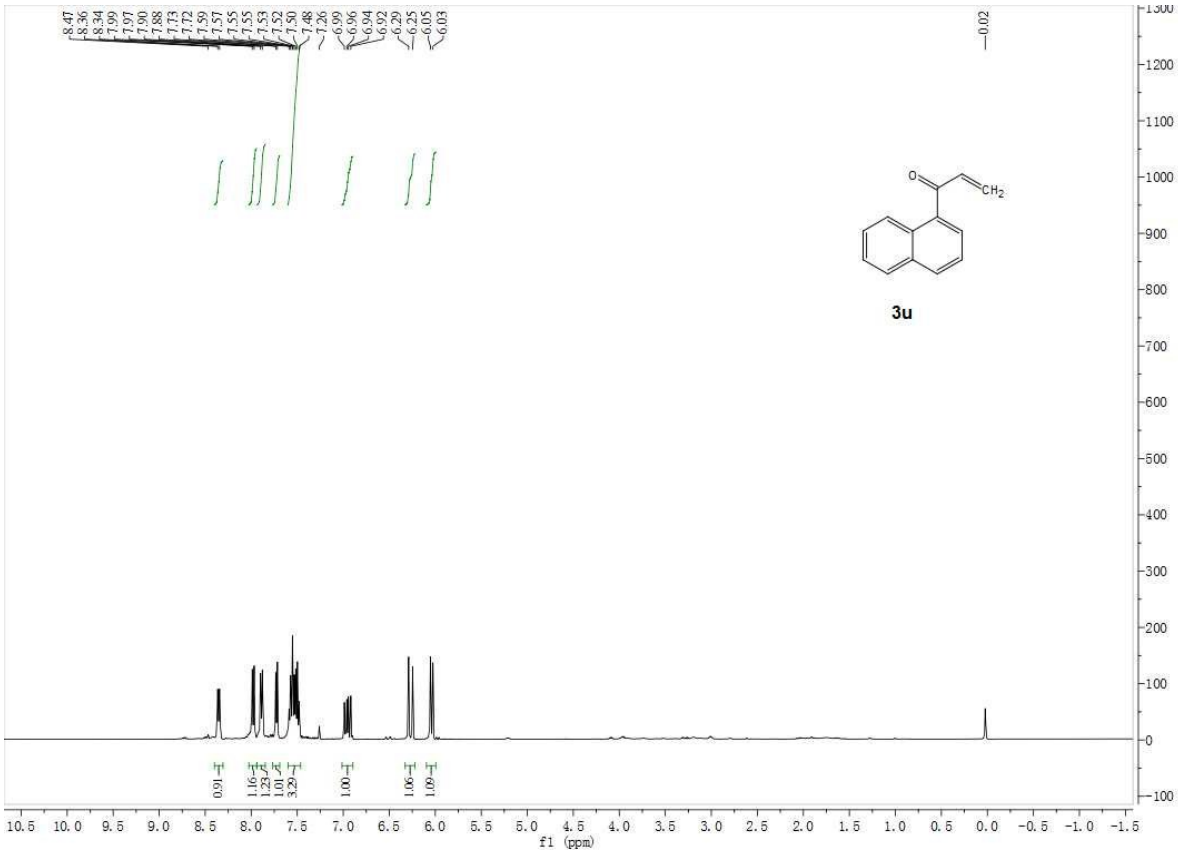
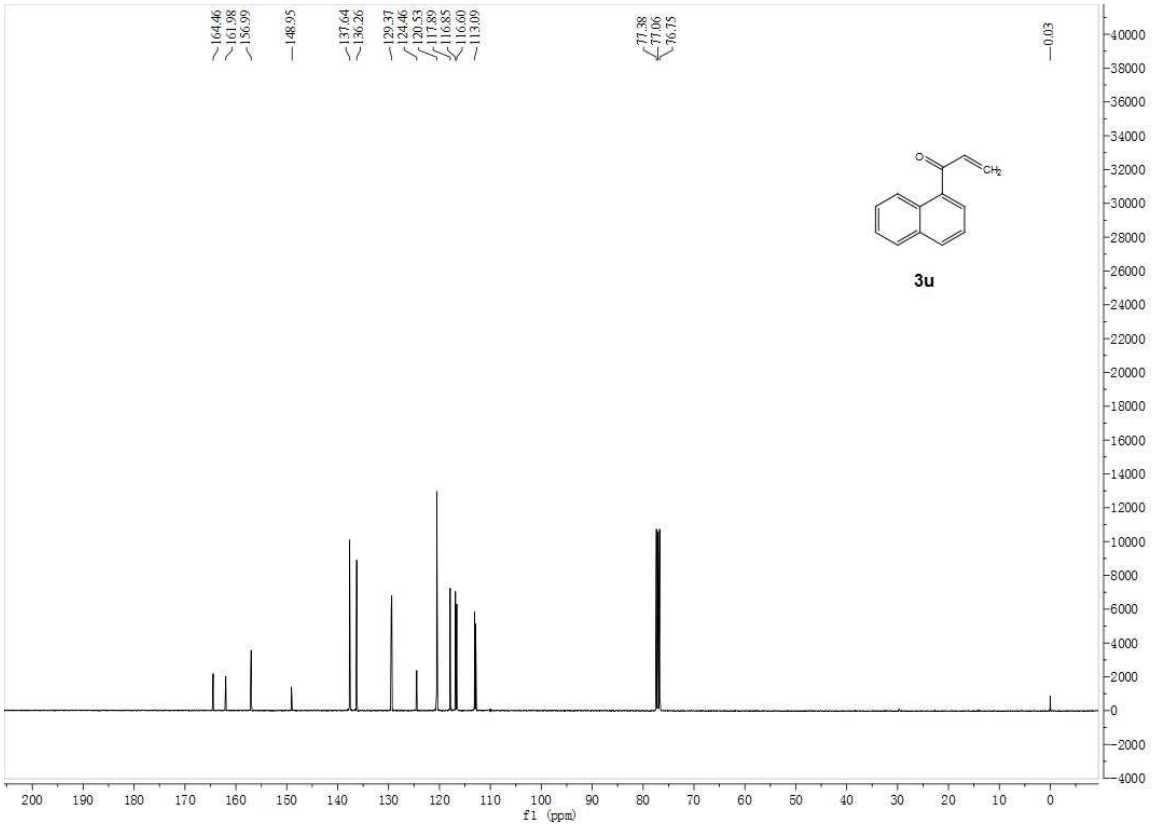
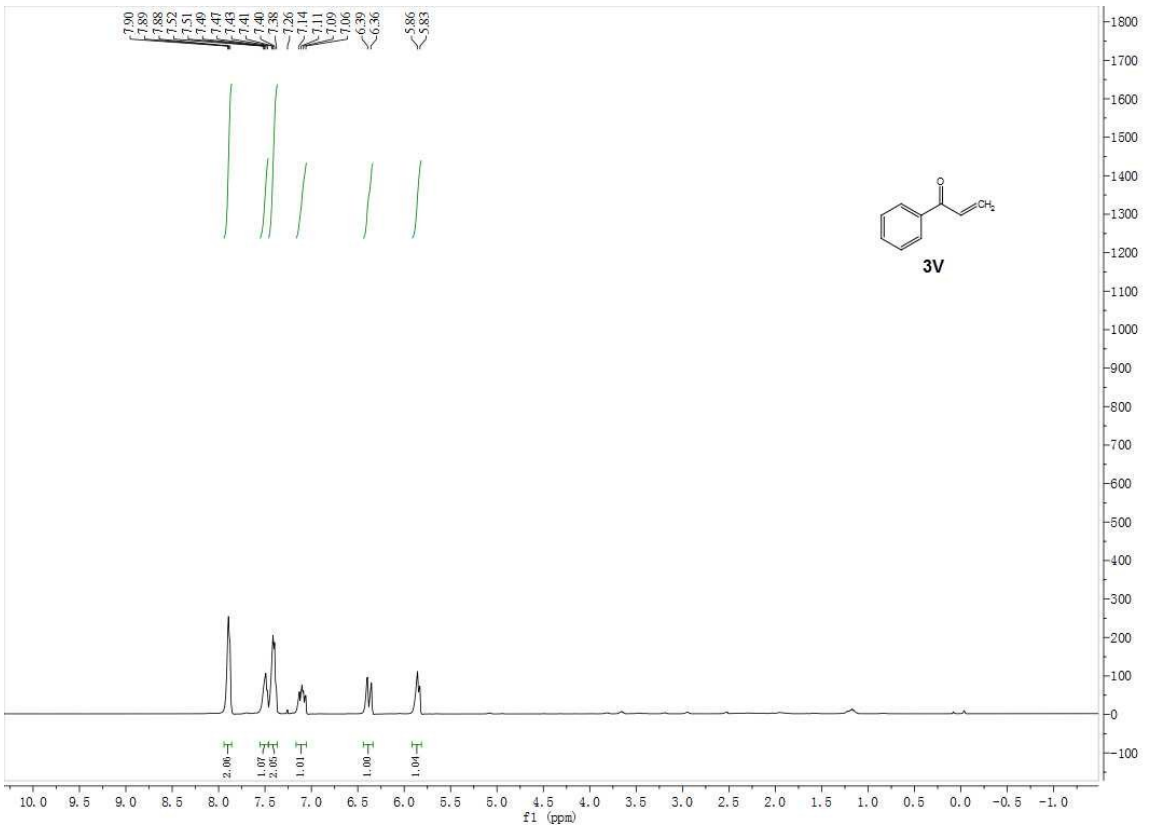
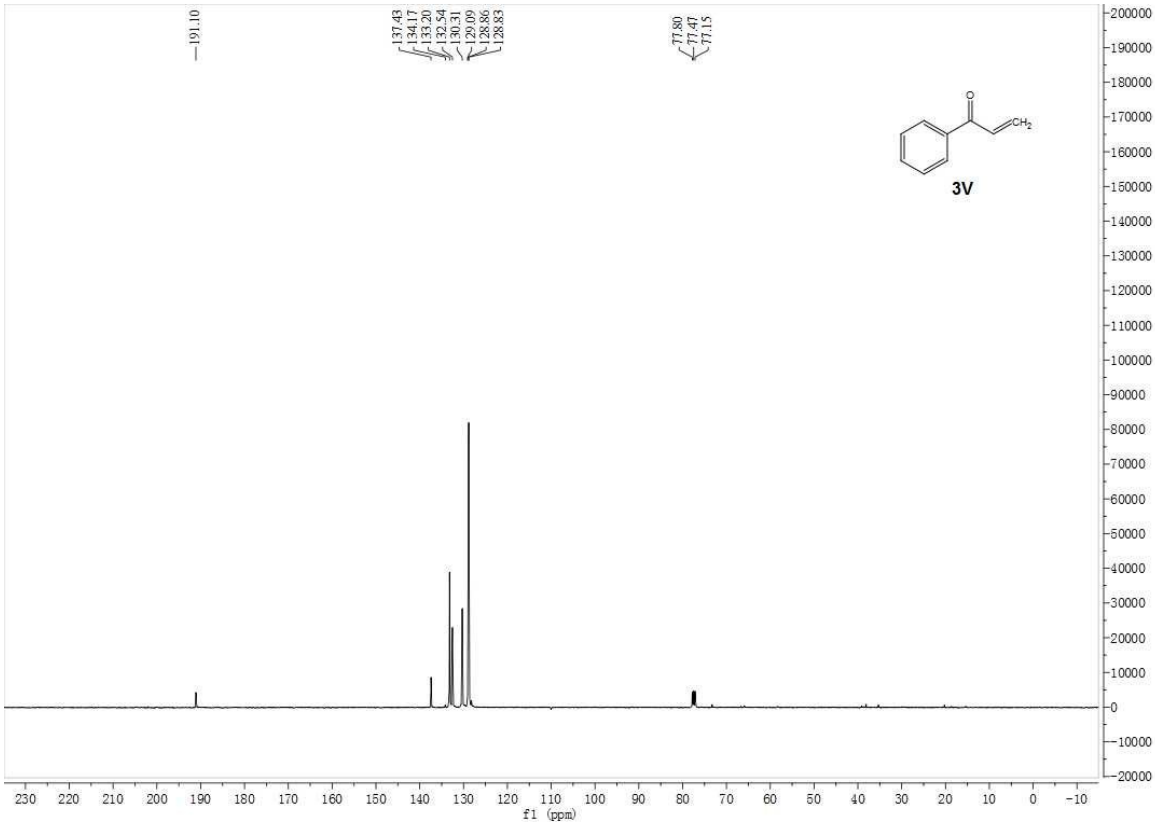
124.84
122.80
122.65
121.64
113.67
112.41
72.94
72.62
72.30
16.09
3t
f1 (ppm)


8.47
8.36
8.34
7.99
7.97
7.90
7.88
7.73
7.72
7.59
7.57
7.55
7.55
7.53
7.52
7.50
7.48
7.26
6.99
6.96
6.94
6.92
6.29
6.25
6.05
6.03
0.02
0.91
1.16
1.23
1.01
3.29
1.00
1.06
1.09
f1 (ppm)
3u


164.46
161.98
156.99
148.95
137.64
136.26
129.37
124.46
120.53
117.89
116.85
116.60
113.09
77.38
77.06
76.75
0.03
f1 (ppm)
3u


7.90
7.89
7.88
7.52
7.51
7.49
7.47
7.43
7.41
7.40
7.38
7.26
7.14
7.11
7.09
7.06
6.39
6.36
5.86
5.83
3V
2.06
1.07
2.05
1.01
1.00
1.04
f1 (ppm)


191.10
137.43
134.17
133.20
132.54
130.31
129.09
128.86
128.83
77.80
77.47
77.15
3V
f1 (ppm)