Ni(II)/BINOL-Catalyzed Alkenylation of Unactivated C(sp^3)–H Bonds

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Supporting Information

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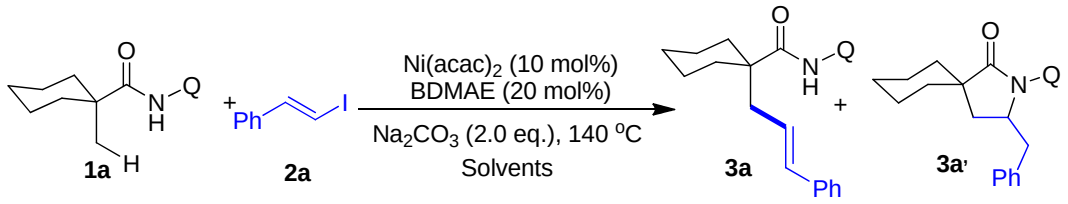
1. General Information

Anhydrous dimethyl sulfoxide, $Ni(acac)_2$, BINOL and Li_2CO_3 were purchased from Adamas-beta® and Aladdin® without additional purification. KTFA was obtained from Aldrich®. The other materials and solvents were purchased from Aladdin and other commercial suppliers and used without additional purification. NMR spectra were recorded on a Bruke Avance operating for ^1H NMR at 400 MHz and ^{13}C NMR at 100 MHz, using TMS as internal standard. The peaks were internally referenced to TMS (0.00 ppm) or residual undeuterated solvent signal (77.16 ppm for ^{13}C NMR). The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, m = multiplet, b = broad. Mass spectroscopy data of the products were collected on an HRMS-TOF instrumentor a low-resolution MS instrument using EI ionization and ESI ionization.

2. Experimental Section

2.1 Optimization of Reaction Conditions

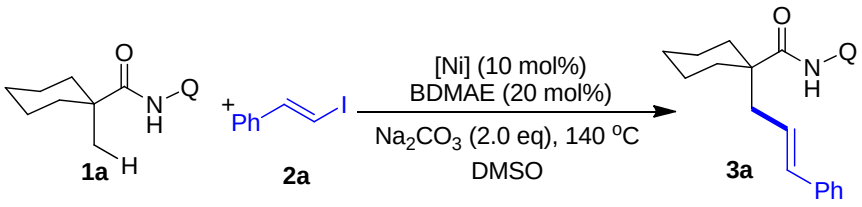
Screening of Solvents



Entry[a]	Solvent	Yield[b]	
		3a	3a'
1	DMF	17%	N.D.
2	DMSO	23%	N.D.
3	1,4-dioxane	trace	N.D.
4	Toluene	trace	N.D.
5	Pivalonitrile	15%	N.D.
6	DCE	trace	N.D.
7	NMP	23%	N.D.

[a] The reactions were carried out **1a** (0.1 mmol), **2a** (0.2 mmol), $Ni(acac)_2$ (0.01 mmol), BDMAE (0.02 mmol), Na_2CO_3 (0.2 mmol), solvent (1 mL), N_2, 140 °C. [b] Yield of ^1H NMR. N.D. = No Detection.

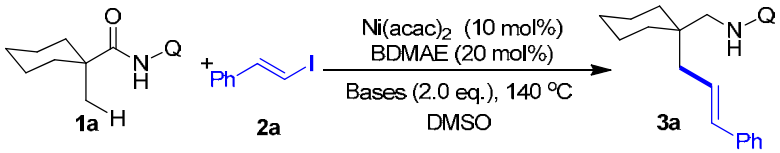
Screening of Ni Salts



Entry[a]	Ni (10%)	Yield[b] of 3a
1	$Ni(OTf)_2$	N.D.
2	$NiCp_2$	trace
3	$NiBr_2$	N.D.
4	$NiCl_2$	trace
5	$(dppe)NiCl_2$	10%
6	$(dppp)NiCl_2$	18%
7	$(PPh_3)_2NiCl_2$	8%
8	$Ni(acac)_2$	23%
9	$(DME)NiCl_2$	N.D.

[a] The reactions were carried out **1a** (0.1 mmol), **2a** (0.2 mmol), [Ni] (0.01 mmol), BDMAE (0.02 mmol), Na_2CO_3 (0.2 mmol), DMSO (1 mL), N_2, 140 °C. [b] Yield of ^1H NMR. N.D. = No Detection.

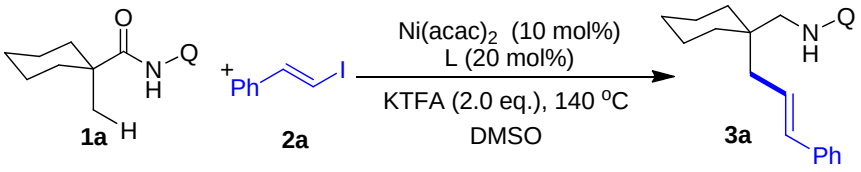
Screening of Bases



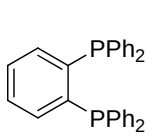
Entry[a]	Bases (2.0 eq.)	Yield[b] of 3a
1	Li_2CO_3	11%
2	Na_2CO_3	23%
3	K_2CO_3	8%
4	Cs_2CO_3	7%
5	$NaHCO_3$	8%
6	$KHCO_3$	12%
7	NaOAc	10%
8	NaTFA	22%
9	KTFA	25%
10	NaOTf	N.D.

[a] The reactions were carried out **1a** (0.1 mmol), **2a** (0.2 mmol), $Ni(acac)_2$ (0.01 mmol), BDMAE (0.02 mmol), base (0.2 mmol), DMSO (1 mL), N_2, 140 °C. [b] Yield of ^1H NMR. N.D. = No detection.

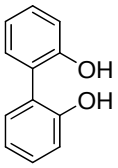
Screening of Ligands



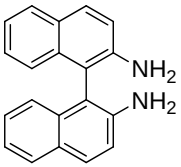
Entry[a]	L (20%)	Yield[b] of 3a	Entry[a]	L (20%)	Yield[b] of 3a
1	BINAP	10%	7	XPhos	13%
2	PPh_3	9%	8	BDMAE	26%
3	DPPM	15%	9	DME	25%
4	DPPE	17%	10	TMEDA	17%
5	DPPB	13%	11	1,10-Phen	trace
6	DPPF	12%	12	BPy	trace



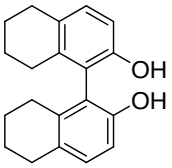
L13 24%



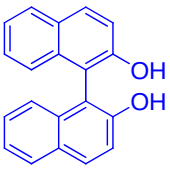
L14 38%



L15 34%



L16 48%



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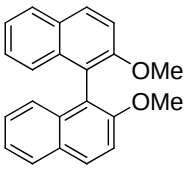
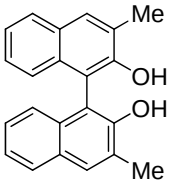
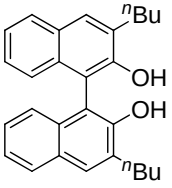


L18 43%



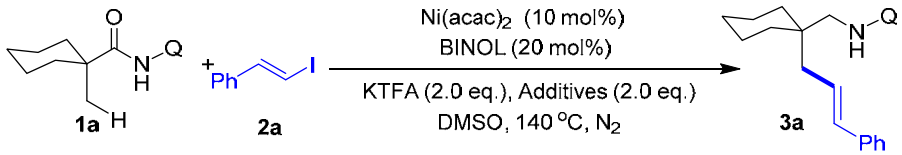
L19 63%



L20 58%

[a] The reactions were carried out **1a** (0.1 mmol), **2a** (0.2 mmol), $Ni(acac)_2$ (0.01 mmol), Ligands (0.02 mmol), KTFA (0.2 mmol), DMSO (1 mL), N_2, 140 °C. [b] Yield of ^1H NMR. N.D. = No Detection.

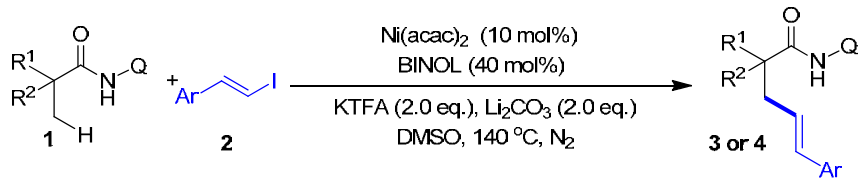
Screening of Additives



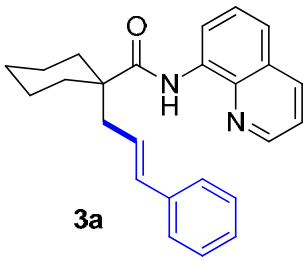
Entry[a]	Additives (2.0 eq.)	Yield[b] of 3a
1	Li_2CO_3	78%[c]
2	Na_2CO_3	35%
3	K_2CO_3	37%
4	$NaHCO_3$	23%
5	$KHCO_3$	21%
6	K_3PO_4	8%
7	K_2HPO_4	58%

[a] The reactions were carried out **1a** (0.1 mmol), **2a** (0.2 mmol), $Ni(acac)_2$ (0.01 mmol), BINOL (0.02 mmol), KTFA (0.2 mmol), Additives (2.0 eq.), DMSO (1 mL), N_2, 140°C. [b] Yield of ^1H NMR. [c]Isolated yield. N.D. = No detection.

2.2 General Procedure for the Alkynylation



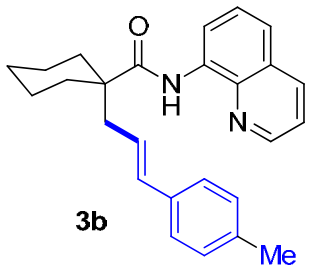
Condtion : To an oven-dried 50 mL screw-capped vial was added substrate **1** (0.1 mmol, 1.0 eq.), **2** (0.2 mmol, 2.0 eq.), $Ni(acac)_2$ (0.002 mmol, 0.1 eq.), Li_2CO_3 (0.2 mmol, 2.0 eq.), potassium trifluoroacetate (0.2 mmol, 2.0 eq.), in DMSO (1.0 mL). The mixture was stirred for 10 h at 140 °C under N_2 followed by cooling. The resulting mixture was added water (3 mL), then extracted with EtOAc (10 mL) for three times. The combined organic phase washed with brine (10 mL) for three times and concentrated in *vacuo*. The residue was purified by preparative TLC using hexane/EtOAc = 20:1 as the eluent to afford the product.



3a

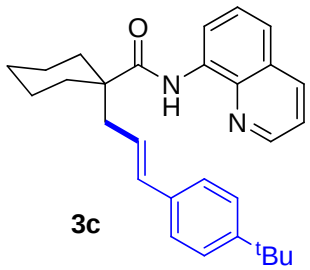
1-cinnamyl-N-(quinolin-8-yl)cyclohexanecarboxamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.29 (br, 1H), 8.83 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.70 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.56-7.48 (m, 2H), 7.41 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.24-7.11 (m, 5H), 6.42 (d, *J* = 15.6 Hz, 1H), 6.26-6.18 (m, 1H), 2.57 (d, *J* = 7.6 Hz, 2H), 2.30-2.24 (m, 2H), 1.73-1.69 (m, 2H), 1.63-1.56 (m, 5H), 1.41-1.37 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.07, 148.38, 139.00, 137.60, 136.35, 134.77, 133.37, 128.44, 128.10, 127.60, 127.12, 126.34, 125.66, 121.62, 121.35, 116.53, 48.75, 44.04, 34.34, 26.10, 23.16; **HRMS** (EI-TOF) calcd for $C_{25}H_{26}N_2O$ (M^+): 370.2045, found: 370.2047.



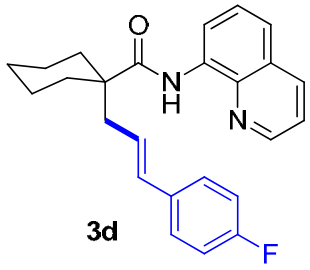
(E)-N-(quinolin-8-yl)-1-(3-(p-tolyl)allyl)cyclohexanecarboxamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.29 (br, 1H), 8.83 (d, *J* = 7.2 Hz, 1H), 8.71 (dd, *J* = 7.6, 0.8 Hz, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 7.56-7.47 (m, 2H), 7.41 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.13 (d, *J* = 8.0 Hz, 2H), 6.99 (d, *J* = 7.6 Hz, 2H), 6.39 (d, *J* = 15.6 Hz, 1H), 6.20-6.12 (m, 1H), 2.56 (d, *J* = 7.6 Hz, 2H), 2.30-2.20 (m, 5H), 1.70-1.68 (m, 2H), 1.60-1.58 (m, 5H), 1.41-1.38 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.14, 148.36, 138.99, 136.83, 136.34, 134.81, 133.19, 129.13, 128.08, 127.58, 126.39, 126.22, 124.55, 121.59, 121.32, 116.50, 48.73, 44.03, 34.29, 26.09, 23.15, 21.24; **HRMS** (EI-TOF) calcd for $C_{26}H_{28}N_2O$ (M^+): 384.2202, found: 384.2205.



(E)-1-(3-(4-(tert-butyl)phenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

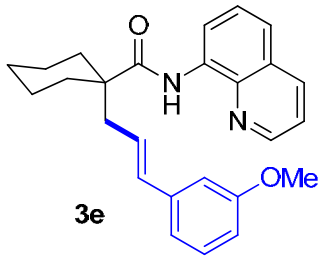
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.29 (br, 1H), 8.83 (d, *J* = 7.6 Hz, 1H), 8.69 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.56-7.42 (m, 2H), 7.40 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.22-7.16 (m, 4H), 6.40 (d, *J* = 15.6 Hz, 1H), 6.22-6.14 (m, 1H), 2.56 (d, *J* = 7.6 Hz, 2H), 2.28-2.22 (m, 2H), 1.70-1.67 (m, 2H), 1.63-1.58 (m, 5H), 1.42-1.34 (m, 1H), 1.27 (s, 9H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.17, 150.15, 148.35, 139.00, 136.33, 134.83, 134.78, 133.11, 128.08, 127.59, 126.03, 125.35, 124.79, 121.58, 121.32, 116.52, 48.76, 44.01, 34.59, 34.26, 31.42, 26.10, 23.15; **HRMS** (EI-TOF) calcd for $C_{29}H_{34}N_2O$ (M^+): 426.2671, found: 426.2672.



3d

(E)-1-(3-(4-fluorophenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

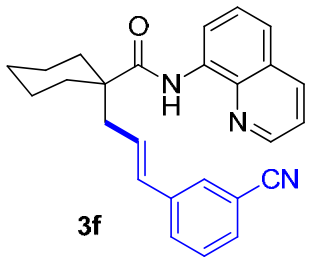
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.28 (br, 1H), 8.82 (d, *J* = 7.6 Hz, 1H), 8.70 (d, *J* = 4.0 Hz, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 7.56-7.48 (m, 2H), 7.42 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.18-7.14 (m, 2H), 6.85 (t, *J* = 8.4 Hz, 2H), 6.37 (d, *J* = 15.6 Hz, 1H), 6.16-6.09 (m, 1H), 2.55 (d, *J* = 7.6 Hz, 2H), 2.29-2.26 (m, 2H), 1.71-1.68 (m, 2H), 1.60-1.54 (m, 5H), 1.39 (s, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.95, 162.09 (d, *J* = 244.4 Hz), 148.35, 138.97, 136.39, 134.71, 133.75 (d, *J* = 3.2 Hz), 132.12, 128.09, 127.70, 127.68 (d, *J* = 18.1 Hz), 125.41 (d, *J* = 1.9 Hz), 121.51 (d, *J* = 24.8 Hz), 116.53, 115.35, 115.13, 48.78, 44.00, 34.39, 26.09, 23.16; **HRMS** (EI-TOF) calcd for $C_{25}H_{25}FN_2O$ (M^+): 388.1951, found: 388.1952.



3e

(E)-1-(3-(3-methoxyphenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

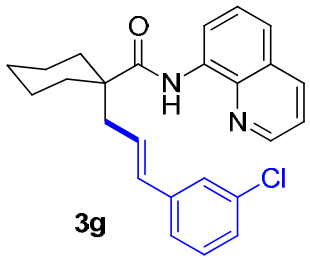
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.29 (br, 1H), 8.83 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.70 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.56-7.47 (m, 2H), 7.40 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.09 (t, *J* = 8.0 Hz, 1H), 6.83 (d, *J* = 7.6 Hz, 1H), 6.73 (s, 1H), 6.68 (dd, *J* = 8.0, 1.6 Hz, 1H), 6.39 (d, *J* = 15.6 Hz, 1H), 6.25-6.17 (m, 1H), 3.66 (s, 3H), 2.57 (d, *J* = 7.6 Hz, 2H), 2.30-2.21 (m, 2H), 1.71-1.68 (m, 2H), 1.63-1.58 (m, 5H), 1.46-1.33 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.02, 159.75, 148.40, 139.05, 138.97, 136.31, 134.72, 133.27, 129.38, 128.06, 127.56, 126.00, 121.60, 121.35, 119.02, 116.51, 112.90, 111.53, 55.19, 48.76, 43.98, 34.31, 26.08, 23.15; **HRMS** (EI-TOF) calcd for $C_{26}H_{28}N_2O_2$ (M^+): 400.2151, found: 400.2154.



3f

(E)-1-(3-(3-cyanophenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

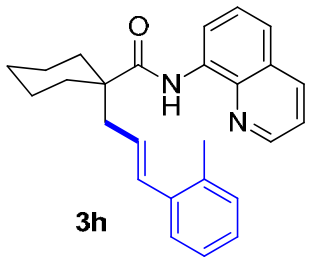
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.27 (br, 1H), 8.81 (d, *J* = 7.6 Hz, 1H), 8.72 (d, *J* = 4.0 Hz, 1H), 8.15 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.57-7.49 (m, 2H), 7.45-7.37 (m, 4H), 7.24 (t, *J* = 8.0, 1H), 6.39-6.28 (m, 2H), 2.57 (d, *J* = 6.8 Hz, 2H), 2.35-2.28 (m, 2H), 1.80-1.69 (m, 2H), 1.65-1.54 (m, 5H), 1.46-1.36 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.57, 148.45, 138.88, 138.72, 136.46, 134.52, 131.16, 130.49, 130.35, 129.64, 129.17, 128.85, 128.09, 127.57, 121.76, 121.56, 118.90, 116.56, 112.58, 48.90, 44.02, 34.47, 26.05, 23.15; **HRMS** (ESI-TOF) calcd for $C_{26}H_{26}N_3O$ $(M+H)^+$: 396.2070, found: 396.2088.



3g

(E)-1-(3-(3-chlorophenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

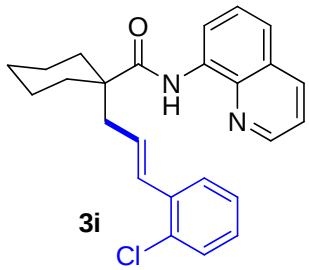
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.28 (br, 1H), 8.81 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.71 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.56-7.48 (m, 2H), 7.41 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.18 (s, 1H), 7.09-7.05 (m, 3H), 6.34 (d, *J* = 15.6 Hz, 1H), 6.28-6.20 (m, 1H), 2.55 (d, *J* = 7.2 Hz, 2H), 2.31-2.27 (m, 2H), 1.78-1.69 (m, 2H), 1.60-1.54 (m, 5H), 1.46-1.34 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.80, 148.46, 139.44, 138.94, 136.37, 134.63, 134.36, 132.07, 129.61, 128.09, 127.55, 127.36, 127.04, 126.13, 124.60, 121.67, 121.45, 116.55, 48.81, 44.00, 34.42, 26.07, 23.16; **HRMS** (ESI-TOF) calcd for $C_{25}H_{26}ClN_2O$ $(M+H)^+$: 405.1728, found: 405.1741.



3h

(E)-N-(quinolin-8-yl)-1-(3-(o-tolyl)allyl)cyclohexanecarboxamide

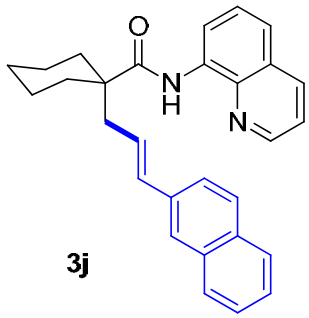
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.30 (br, 1H), 8.83 (d, *J* = 7.6 Hz, 1H), 8.72 (d, *J* = 4.0 Hz, 1H), 8.13 (d, *J* = 8.4 Hz, 1H), 7.55-7.47 (m, 2H), 7.41 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.30 (d, *J* = 7.6 Hz, 1H), 7.06-6.97 (m, 3H), 6.60 (d, *J* = 15.6 Hz, 1H), 6.12-6.04 (m, 1H), 2.60 (d, *J* = 7.6 Hz, 2H), 2.31-2.22 (m, 2H), 2.13 (s, 3H), 1.79-1.70 (m, 2H), 1.66-1.58 (m, 5H), 1.47-1.34 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.02, 148.35, 138.99, 136.88, 136.35, 135.13, 134.74, 131.47, 130.05, 128.08, 127.58, 127.06, 126.97, 126.08, 125.95, 121.61, 121.32, 116.52, 48.84, 44.32, 34.36, 26.13, 23.16, 19.74; **HRMS** (ESI-TOF) calcd for $C_{26}H_{29}N_2O$ $(M+H)^+$: 385.2274, found: 385.2273.



3i

(E)-1-(3-(2-chlorophenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

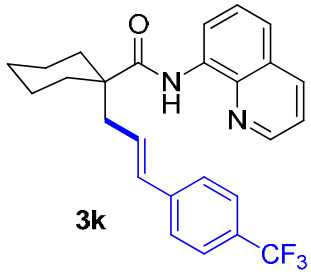
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.30 (br, 1H), 8.83 (d, *J* = 7.6 Hz, 1H), 8.72 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.15 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.56-7.48 (m, 2H), 7.42 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.38 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.24 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.08-7.01 (m, 2H), 6.79 (d, *J* = 15.6 Hz, 1H), 6.23-6.15 (m, 1H), 2.62 (d, *J* = 7.6 Hz, 2H), 2.31-2.24 (m, 2H), 1.72-1.69 (m, 2H), 1.64-1.57 (m, 5H), 1.45-1.37 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.88, 148.36, 139.01, 136.39, 135.75, 134.70, 132.72, 129.64, 129.51, 128.73, 128.16, 128.09, 127.60, 127.25, 126.71, 121.63, 121.40, 116.59, 48.70, 44.12, 34.41, 26.09, 23.13; **HRMS** (ESI-TOF) calcd for $C_{25}H_{26}ClN_2O$ $(M+H)^+$: 405.1728, found: 405.1723.



3j

(E)-1-(3-(naphthalen-2-yl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

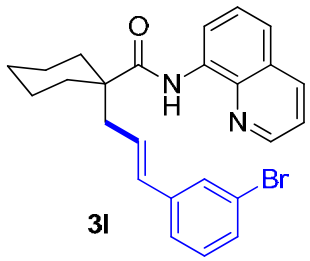
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.32 (br, 1H), 8.85 (d, *J* = 7.2 Hz, 1H), 8.65 (d, *J* = 4.0 Hz, 1H), 8.09 (d, *J* = 8.0 Hz, 1H), 7.72-7.32 (m, 10H), 6.57 (d, *J* = 16.0 Hz, 1H), 6.39-6.31 (m, 1H), 2.62 (d, *J* = 7.6 Hz, 2H), 2.34-2.24 (m, 2H), 1.73-1.60 (m, 6H), 1.41-1.33 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.03, 148.37, 138.97, 136.30, 135.06, 134.75, 133.66, 133.47, 132.84, 128.07, 127.96, 127.67, 127.57, 126.14, 125.74, 125.62, 123.94, 121.56, 121.37, 116.53, 48.87, 44.20, 34.40, 26.11, 23.19; **HRMS** (ESI-TOF) calcd for $C_{29}H_{29}N_2O$ $(M+H)^+$: 421.2274, found: 421.2285.



3k

(E)-N-(quinolin-8-yl)-1-(3-(4-(trifluoromethyl)phenyl)allyl)cyclohexanecarboxamide

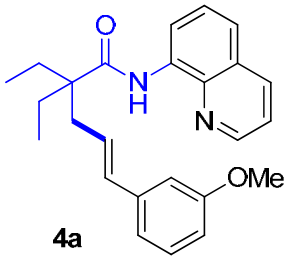
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.28 (br, 1H), 8.81 (d, *J* = 7.6 Hz, 1H), 8.67 (d,d, *J* = 4.0, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.56-7.48 (m, 2H), 7.42-7.38 (m, 3H), 7.26 (d, *J* = 7.2 Hz, 2H), 6.42 (d, *J* = 15.6 Hz, 1H), 6.36-6.28 (m, 1H), 2.58 (d, *J* = 7.2 Hz, 2H), 2.322.28 (m, 2H), 1.79-1.69 (m, 2H), 1.65-1.55 (m, 5H), 1.47-1.34 (s, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.73, 148.34, 140.99, 138.93, 136.40, 134.61, 132.05, 128.67, 128.09, 127.58, 126.37, 125.34 (q, *J* = 3.8), 121.66, 121.48, 116.56, 48.90, 44.07, 34.44, 26.07, 23.16; **HRMS** (ESI-TOF) calcd for $C_{26}H_{26}F_3N_2O$ $(M+H)^+$: 439.1992, found: 439.1996.



3l

(E)-1-(3-(3-bromophenyl)allyl)-N-(quinolin-8-yl)cyclohexanecarboxamide

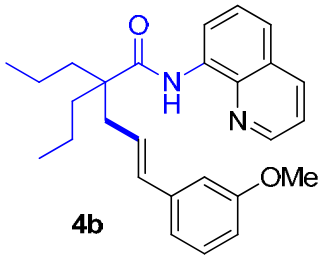
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.27 (br, 1H), 8.81 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.72 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.56-7.48 (m, 2H), 7.42 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.33 (s, 1H), 7.24 (d, *J* = 8.0 Hz, 1H), 7.11-7.00 (m, 2H), 6.33 (d, *J* = 15.6 Hz, 1H), 6.27-6.20 (m, 1H), 2.56 (d, *J* = 6.7 Hz, 2H), 2.31-2.27 (m, 2H), 1.77-1.66 (m, 2H), 1.63-1.56 (m, 5H), 1.43-1.35 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.80, 148.49, 139.73, 138.94, 136.38, 134.64, 131.98, 129.97, 129.91, 129.06, 128.09, 127.56, 127.43, 125.04, 122.66, 121.69, 121.46, 116.55, 48.85, 44.01, 34.42, 26.08, 23.17; **HRMS** (ESI-TOF) calcd for $C_{25}H_{26}BrN_2O$ $(M+H)^+$: 449.1263, found: 449.1264.



4a

(E)-2,2-diethyl-5-(3-methoxyphenyl)-N-(quinolin-8-yl)pent-4-enamide

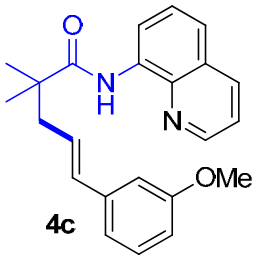
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.27 (br, 1H), 8.84 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.77 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.14 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.56-7.48 (m, 2H), 7.43 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.16 (t, *J* = 8.0 Hz, 1H), 6.91 (d, *J* = 7.6 Hz, 1H), 6.83 (s, 1H), 6.73 (dd, *J* = 8.4, 1.6 Hz, 1H), 6.49 (d, *J* = 15.6 Hz, 1H), 6.24-6.16 (m, 1H), 3.74 (s, 3H), 2.69 (d, *J* = 7.2 Hz, 2H), 1.85 (q, 7.2 Hz, 4H), 0.97 (t, *J* = 7.4 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.22, 159.87, 148.39, 139.15, 138.98, 136.38, 134.69, 133.11, 129.52, 128.10, 127.59, 126.34, 121.65, 121.36, 118.96, 116.46, 112.81, 111.69, 55.30, 51.53, 37.05, 28.10, 8.71; **HRMS** (EI-TOF) calcd for $C_{25}H_{28}N_2O_2$ (M^+): 388.2151, found: 388.2151.



4b

(E)-5-(3-methoxyphenyl)-2,2-dipropyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.28 (br, 1H), 8.82 (d, *J* = 7.6 Hz, 1H), 8.78 (d, *J* = 4.0 Hz, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.56-7.42 (m, 3H), 7.18 (t, *J* = 7.6 Hz, 1H), 6.92 (d, *J* = 7.6 Hz, 1H), 6.85 (s, 1H), 6.74 (dd, *J* = 8.0, 1.6 Hz, 1H), 6.48 (d, *J* = 16.0 Hz, 1H), 6.24-6.17 (m, 1H), 3.75 (s, 3H), 2.70 (d, *J* = 7.6 Hz, 2H), 1.78-1.74 (m, 4H), 1.45-1.34 (m, 4H), 0.95 (t, *J* = 7.2 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.41, 159.87, 148.41, 139.22, 139.00, 136.38, 134.70, 133.13, 129.53, 128.10, 127.59, 126.45, 121.66, 121.35, 118.96, 116.46, 112.71, 111.79, 55.31, 51.07, 38.54, 37.91, 17.60, 14.85; **HRMS** (EI-TOF) calcd for $C_{27}H_{32}N_2O_2$ (M^+): 416.2464, found: 416.2468.

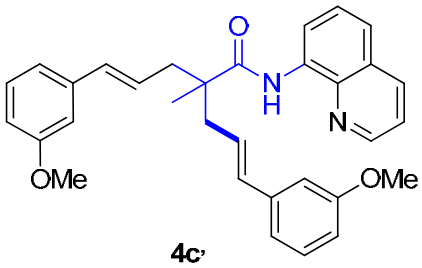


4c

(E)-5-(3-methoxyphenyl)-2,2-dimethyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.27 (br, 1H), 8.81 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.15 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.56-7.48 (m, 2H), 7.43 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.26 (s, 1H), 7.15 (t, *J* = 8.0 Hz, 1H), 6.90 (d, *J* = 7.6 Hz, 1H), 6.82 (s, 1H), 6.72 (dd, *J* = 8.0, 2.0 Hz, 1H), 6.47 (d, *J* = 16.0 Hz, 1H), 6.30-6.22 (m, 1H), 3.73 (s, 3H), 2.63 (d, *J* = 7.2 Hz, 2H), 1.46 (s, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 176.20 (s, 1H), 159.87 (s, 1H), 148.39 (s, 2H), 139.04 (d, *J* = 9.0 Hz, 2H), 136.41 (s, 2H), 134.76 (s, 2H), 133.45 (s, 2H), 129.50 (s, 2H), 128.10 (s, 1H), 127.58 (s, 2H), 126.54 (s, 2H), 121.57 (d, *J* = 19.3 Hz, 4H), 119.04 (s, 2H), 116.50 (s, 2H), 112.94 (s,

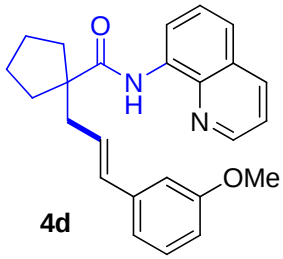
2H), 111.67 (s, 2H), 55.30 (s, 2H), 44.59 (s, 2H), 44.32 (s, 1H), 25.60 (s, 4H); **HRMS** (EI-TOF) calcd for $C_{23}H_{24}N_2O_2$ (M^+): 360.1838, found: 360.1837.



4c'

(E)-5-(3-methoxyphenyl)-2-((E)-3-(3-methoxyphenyl)allyl)-2-methyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.28 (br, 1H), 8.82 (d, *J* = 7.6 Hz, 1H), 8.69 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.13 (d, *J* = 8.0 Hz, 1H), 7.56-7.49 (m, 2H), 7.41 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.15 (t, *J* = 8.0 Hz, 2H), 6.90 (d, *J* = 7.6 Hz, 2H), 6.82 (s, 2H), 6.72 (dd, *J* = 8.4, 2.0 Hz, 2H), 6.49 (d, *J* = 15.6 Hz, 2H), 6.31-6.23 (m, 2H), 3.72 (s, 6H), 2.69 (ddd, *J* = 21.6, 14.0, 7.6 Hz, 4H), 1.50 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.98, 159.88, 148.43, 139.02, 136.35, 134.60, 133.73, 129.52, 128.09, 127.54, 126.12, 121.67, 121.59, 119.05, 116.64, 112.99, 111.68, 55.29, 48.13, 43.11, 22.11; **HRMS** (EI-TOF) calcd for $C_{32}H_{32}N_2O_3$ (M^+): 492.2413, found: 492.2414.

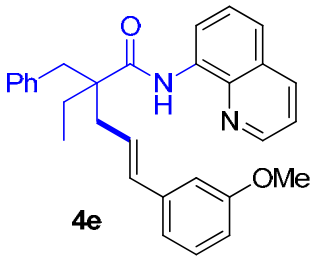


4d

(E)-1-(3-(3-methoxyphenyl)allyl)-N-(quinolin-8-yl)cyclopentanecarboxamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.19 (br, 1H), 8.78 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.73 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.55-7.47 (m, 2H), 7.42 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.12 (t, *J* = 7.6 Hz, 1H), 6.87 (d, *J* = 7.6 Hz, 1H), 6.78 (s, 1H), 6.70 (dd, *J* = 8.0, 2.0 Hz, 1H), 6.45 (d, *J* = 16.0 Hz, 1H), 6.29-6.22 (m, 1H), 3.70 (s, 3H), 2.70 (d, *J* = 6.8 Hz, 2H), 2.32-2.29 (m, 2H), 1.86-1.74 (m, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 176.05, 159.79, 148.37, 139.04, 138.88, 136.37, 134.85, 133.13, 129.43, 128.07, 127.57, 126.87, 121.63, 121.32, 119.05, 116.40, 112.92, 111.61, 56.21,

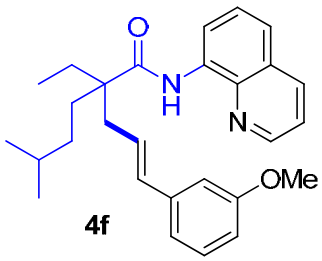
55.26, 42.68, 35.84, 24.91; **HRMS** (EI-TOF) calcd for $C_{25}H_{26}N_2O_2$ (M^+): 386.1994, found: 386.1996.



4e

(E)-2-benzyl-2-ethyl-5-(3-methoxyphenyl)-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.16 (br, 1H), 8.84 (dd, *J* = 7.2, 0.8 Hz, 1H), 8.68 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.57-7.48 (m, 2H), 7.40 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.21-7.09 (m, 6H), 6.93 (d, *J* = 7.6 Hz, 1H), 6.85 (s, 1H), 6.75 (dd, *J* = 8.4, 2.0 Hz, 1H), 6.53 (d, *J* = 16.0 Hz, 1H), 6.32-6.25 (m, 1H), 3.75 (s, 3H), 3.16-3.09 (m, 2H), 2.69 (ddd, *J* = 65.2, 14.4, 7.6 Hz, 2H), 1.97-1.90 (m, 1H), 1.85-1.76 (m, 1H), 1.08 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.51, 159.89, 148.32, 139.11, 138.94, 137.66, 136.30, 134.49, 133.66, 130.32, 129.57, 128.22, 128.04, 127.56, 126.55, 126.02, 121.62, 121.49, 118.98, 116.54, 112.83, 111.78, 55.33, 52.55, 42.13, 37.31, 27.77, 8.85; **HRMS** (EI-TOF) calcd for $C_{30}H_{30}N_2O_2$ (M^+): 450.2307, found: 450.2307.

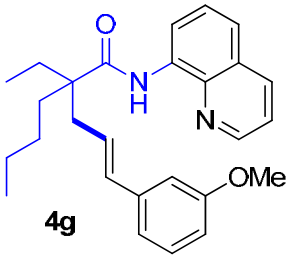


4f

(E)-2-ethyl-2-(3-(3-methoxyphenyl)allyl)-5-methyl-N-(quinolin-8-yl)hexanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.28 (br, 1H), 8.82 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.77 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.15 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.56-7.42 (m, 3H), 7.17 (t, *J* = 8.0 Hz, 1H), 6.91 (d, *J* = 7.6 Hz, 1H), 6.83 (s, 1H), 6.74 (dd, *J* = 8.0, 2.0 Hz, 1H), 6.49 (d, *J* = 15.6 Hz, 1H), 6.23-6.15 (m, 1H), 3.75 (s, 3H), 2.74-2.64 (m, 2H), 1.87-1.75 (m, 4H), 1.59-1.50 (m, 1H), 1.31-1.21 (m, 2H), 0.97 (t, *J* = 7.2 Hz, 3H), 0.89 (dd, *J* = 6.8, 2.4 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.32, 159.88,

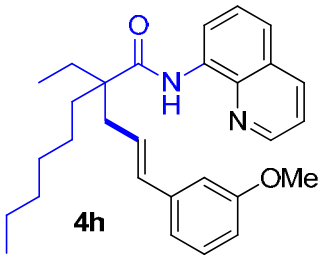
148.37, 139.21, 139.00, 136.37, 134.72, 133.18, 129.52, 128.11, 127.60, 126.37, 121.65, 121.33, 118.96, 116.46, 112.77, 111.72, 55.29, 51.11, 37.32, 33.48, 33.12, 28.72, 28.52, 22.74, 8.69; **HRMS** (EI-TOF) calcd for $C_{28}H_{34}N_2O_2$ (M^+): 430.2620, found: 430.2619.



4g

(E)-2-ethyl-2-(3-(3-methoxyphenyl)allyl)-N-(quinolin-8-yl)hexanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.27 (br, 1H), 8.83 (d, *J* = 7.6 Hz, 1H), 8.77 (d, *J* = 2.8 Hz, 1H), 8.15 (d, *J* = 8.0 Hz, 1H), 7.56-7.48 (m, 2H), 7.43 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.17 (t, *J* = 8.0 Hz, 1H), 6.91 (d, *J* = 7.6 Hz, 1H), 6.84 (s, 1H), 6.74 (d, *J* = 8.4 Hz, 1H), 6.49 (d, *J* = 15.6 Hz, 1H), 6.26-6.14 (m, 1H), 3.75 (s, 3H), 2.74-2.64 (m, 2H), 1.85 (q, *J* = 7.6 Hz, 2H), 1.77 (t, *J* = 4.4 Hz, 2H), 1.36-1.35 (m, 4H), 0.97 (t, *J* = 7.2 Hz, 3H), 0.89 (t, *J* = 6.8 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.36, 159.87, 148.39, 139.20, 138.99, 136.38, 134.71, 133.13, 129.53, 128.10, 127.60, 126.39, 121.66, 121.35, 118.96, 116.46, 112.76, 111.73, 55.31, 51.18, 37.39, 35.55, 28.45, 26.42, 23.41, 14.14, 8.70; **HRMS** (EI-TOF) calcd for $C_{27}H_{32}N_2O_2$ (M^+): 416.2464, found: 416.2464.

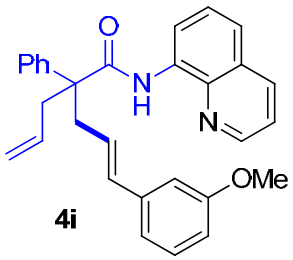


4h

(E)-2-ethyl-2-(3-(3-methoxyphenyl)allyl)-N-(quinolin-8-yl)octanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.27 (br, 1H), 8.83 (d, *J* = 7.6 Hz, 1H), 8.77 (d, *J* = 2.8 Hz, 1H), 8.15 (d, *J* = 8.0 Hz, 1H), 7.56-7.48 (m, 2H), 7.44 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.17 (t, *J* = 8.0 Hz, 1H), 6.91 (d, *J* = 7.6 Hz, 1H), 6.84 (s, 1H), 6.74 (dd, *J* = 8.4, 2.0 Hz, 1H), 6.49 (d, *J* = 15.6 Hz, 1H), 6.223-6.16 (m, 1H), 3.75 (s, 3H), 2.74-2.64 (m,

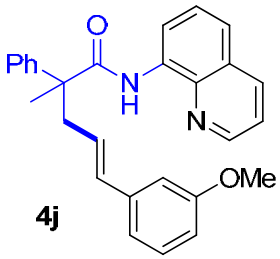
2H), 1.85 (q, *J* = 7.2 Hz, 2H), 1.79-1.75 (m, 2H), 1.39-1.25 (m, 8H), 0.97 (t, *J* = 7.2 Hz, 3H), 0.83 (t, *J* = 6.4 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.35, 159.87, 148.38, 139.20, 138.99, 136.38, 134.72, 133.13, 129.52, 128.10, 127.60, 126.42, 121.66, 121.34, 118.96 116.46, 112.77, 111.72, 55.31, 51.22, 37.39, 35.83, 31.79 (s, 2H), 30.00 (s, 2H), 28.50 (s, 2H), 24.16 (s, 2H), 22.75 (s, 2H), 14.17, 8.72; **HRMS** (EI-TOF) calcd for $C_{29}H_{36}N_2O_2$ (M^+): 444.2777, found: 444.2774.



4i

(E)-2-allyl-5-(3-methoxyphenyl)-2-phenyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.85 (br, 1H), 8.76 (d, *J* = 7.6 Hz, 1H), 8.58 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.08 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.54-7.28 (m, 8H), 7.14 (t, *J* = 7.6 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.73-6.71 (m, 2H), 6.42 (d, *J* = 15.6 Hz, 1H), 6.01-5.94 (m, 1H), 5.77-5.66 (m, 1H), 5.17-5.08 (m, 2H), 3.74 (s, 3H), 3.17-2.95 (m, 4H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 173.79, 159.82, 148.30, 142.24, 139.11, 138.81, 136.19, 134.70, 133.78, 133.60, 129.48, 128.90, 128.01, 127.46, 127.38, 127.33, 125.91, 121.57, 121.42, 119.04, 118.94, 116.30, 112.73, 111.82, 55.56, 55.30, 40.10, 39.23; **HRMS** (EI-TOF) calcd for $C_{30}H_{28}N_2O_2$ (M^+): 448.2151, found: 448.2151.

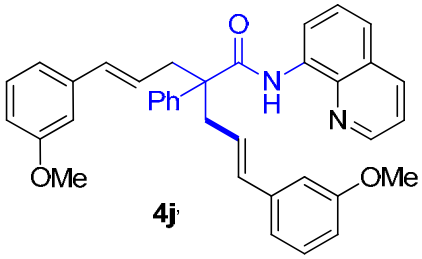


4j

(E)-5-(3-methoxyphenyl)-2-methyl-2-phenyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.89 (br, 1H), 8.78 (d, *J* = 7.6 Hz, 1H), 8.58 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.07 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.54-7.29 (m, 8H), 7.14 (t, *J* = 8.0 Hz, 1H), 6.84 (d, *J* = 7.6 Hz, 1H), 6.77 (s, 1H), 6.72 (dd, *J* = 8.0, 1.6 Hz, 1H), 6.44 (d, *J* = 15.6 Hz, 1H), 6.10-6.02 (m, 1H), 3.74 (s, 3H), 3.09 (ddd, *J* = 20.8, 14.0, 7.6 Hz, 2H),

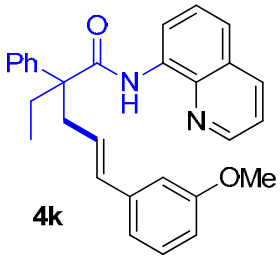
1.80 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.98, 159.85, 148.26, 143.37, 139.12, 138.83, 136.20, 134.78, 133.57, 129.48, 128.94, 127.99, 127.45, 127.29, 126.96, 126.62, 121.57, 121.45, 118.97, 116.23, 112.78, 111.76, 55.31, 52.12, 43.24, 23.71; **HRMS** (EI-TOF) calcd for $C_{28}H_{26}N_2O_2$ (M^+): 422.1994, found: 422.1995.



4j

(E)-5-(3-methoxyphenyl)-2-((E)-3-(3-methoxyphenyl)allyl)-2-phenyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.91 (br, 1H), 8.78 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.53 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.07 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.54-7.30 (m, 8H), 7.25 (s, 1H), 7.15 (t, *J* = 7.6 Hz, 2H), 6.83 (d, *J* = 7.6 Hz, 2H), 6.75-6.71 (m, 4H), 6.45 (d, *J* = 15.6 Hz, 2H), 6.09-6.02 (m, 2H), 3.74 (s, 6H), 3.14 (ddd, *J* = 21.2, 14.4, 7.6 Hz, 4H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 173.74, 159.85, 148.31, 142.17, 139.08, 138.82, 136.17, 134.70, 133.93, 129.51, 128.97, 128.01, 127.45, 127.38, 125.84, 121.57, 121.47, 118.98, 116.38, 112.81, 111.83, 55.92, 55.31, 39.68; **HRMS** (EI-TOF) calcd for $C_{37}H_{34}N_2O_3$ (M^+): 554.2569, found: 554.2565.

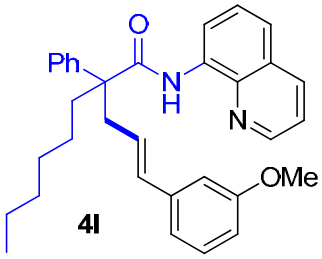


4k

(E)-2-ethyl-5-(3-methoxyphenyl)-2-phenyl-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.84 (br, 1H), 8.78 (d, *J* = 7.6 Hz, 1H), 8.58 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.07 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.53-7.27 (m, 8H), 7.14 (t, *J* = 8.0 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.74-6.70 (m, 2H), 6.41 (d, *J* = 16.0 Hz, 1H), 5.98-5.90 (m, 1H), 3.74 (s, 3H), 3.10 (ddd, *J* = 20.8, 14.4, 7.6 Hz, 2H), 2.33-2.21 (m, 2H), 0.96 (t, *J* = 7.6 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.39, 159.81, 148.29, 142.72,

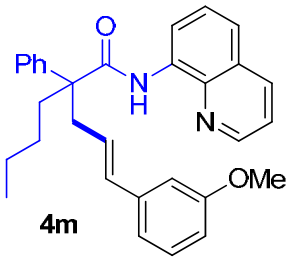
139.13, 138.79, 136.18, 134.77, 133.18, 129.47, 128.81, 128.00, 127.45, 127.39, 127.21, 126.26, 121.55, 121.33, 118.91, 116.20, 112.70, 111.75, 56.12, 55.30, 38.68, 28.02, 8.78; **HRMS** (EI-TOF) calcd for $C_{29}H_{28}N_2O_2$ (M^+): 436.2151, found: 436.2152.



4l

(E)-2-(3-(3-methoxyphenyl)allyl)-2-phenyl-N-(quinolin-8-yl)octanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.83 (br, 1H), 8.77 (d, *J* = 7.6 Hz, 1H), 8.58 (d, *J* = 4.0 Hz, 1H), 8.07 (d, *J* = 8.0 Hz, 1H), 7.54-7.26 (m, 8H), 7.14 (t, *J* = 8.0 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.74-6.71 (m, 2H), 6.39 (d, *J* = 15.6 Hz, 1H), 5.96-5.89 (m, 1H), 3.74 (s, 3H), 3.09 (ddd, *J* = 20.8, 14.4, 7.6 Hz, 2H), 2.20 (t, *J* = 6.8 Hz, 2H), 1.33-1.23 (m, 8H), 0.79 (t, *J* = 6.6 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.50, 159.81, 148.26, 142.96, 139.21, 138.82, 136.17, 134.80, 133.20, 129.46, 128.80, 128.00, 127.46, 127.33, 127.18, 126.40, 121.55, 121.31, 118.93, 116.22, 112.64, 111.79, 55.78, 55.30, 39.41, 35.29, 31.68, 29.93, 24.09, 22.71, 14.12; **HRMS** (EI-TOF) calcd for $C_{33}H_{36}N_2O_2$ (M^+): 492.2777, found: 492.2777.

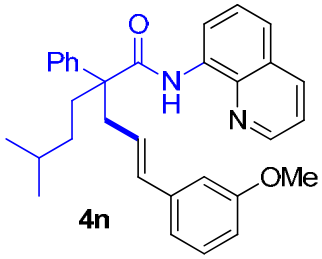


4m

(E)-2-(3-(3-methoxyphenyl)allyl)-2-phenyl-N-(quinolin-8-yl)hexanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.84 (br, 1H), 8.77 (d, *J* = 7.6 Hz, 1H), 8.58 (d, *J* = 4.0 Hz, 1H), 8.07 (d, *J* = 8.0 Hz, 1H), 7.54-7.27 (m, 8H), 7.14 (t, *J* = 8.0 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.74-6.71 (m, 2H), 6.39 (d, *J* = 16.0 Hz, 1H), 5.97-5.89 (m, 1H), 3.74 (s, 3H), 3.10 (ddd, *J* = 20.8, 14.4, 7.6 Hz, 2H), 2.23-2.19 (m, 2H), 1.40-1.28 (m, 4H), 0.87 (t, *J* = 6.4 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.50, 159.80,

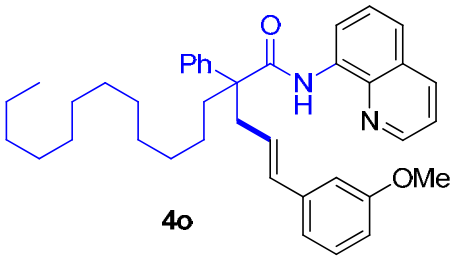
148.27, 142.94, 139.20, 138.80, 136.17, 134.78, 133.20, 129.47, 128.80, 128.00, 127.45, 127.33, 127.18, 126.36, 121.56, 121.32, 118.92, 116.21, 112.61, 111.80, 55.73, 55.30, 39.38, 35.05, 26.38, 23.37, 14.11; **HRMS** (EI-TOF) calcd for $C_{31}H_{32}N_2O_2$ (M^+): 464.2464, found: 464.2460.



4n

(E)-2-(3-(3-methoxyphenyl)allyl)-5-methyl-2-phenyl-N-(quinolin-8-yl)hexanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.83 (br, 1H), 8.77 (dd, *J* = 7.6, 0.8 Hz, 1H), 8.58 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.07 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.54-7.26 (m, 8H), 7.14 (t, *J* = 7.6 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.74-6.70 (m, 2H), 6.40 (d, *J* = 16 Hz, 1H), 5.96-5,88 (m, 1H), 3.74 (s, 3H), 3.17-3.01 (m, 2H), 2.24-2.20 (m, 2H), 1.57-1.51 (m, 1H), 1.26-1.22 (m, 2H), 0.86 (dd, *J* = 6.4, 2.4 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.50, 159.80, 148.26, 143.00, 139.21, 138.81, 136.16, 134.79, 133.26, 129.47, 128.80, 128.00, 127.45, 127.29, 127.18, 126.34, 121.56, 121.32, 118.92, 116.22, 112.60, 111.80, 55.60, 55.29, 39.21, 33.06, 32.99, 28.70, 22.74; **HRMS** (EI-TOF) calcd for $C_{32}H_{34}N_2O_2$ (M^+): 478.2620, found: 478.2621.

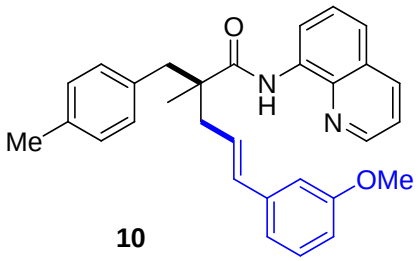


4o

(E)-2-(3-(3-methoxyphenyl)allyl)-2-phenyl-N-(quinolin-8-yl)tetradecanamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.83 (br, 1H), 8.77 (d, *J* = 7.6 Hz, 1H), 8.58 (d, *J* = 2.4 Hz, 1H), 8.07 (d, *J* = 8.0 Hz, 1H), 7.54-7.26 (m, 8H), 7.14 (t, *J* = 8.0 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.74-6.71 (m, 2H), 6.39 (d, *J* = 16.0 Hz, 1H), 5.96-5.89 (m, 1H), 3.74 (s, 3H), 3.09 (ddd, *J* = 20.4, 14.4, 7.6 Hz, 2H), 2.20 (t, *J* = 7.5 Hz, 2H),

1.32-1.16 (m, 20H), 0.87 (t, *J* = 6.8 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.50, 159.82, 148.26, 142.97, 139.21, 138.82, 136.16, 134.80, 133.20, 129.46, 128.80, 128.01, 127.46, 127.33, 127.18, 126.40, 121.54, 121.31, 118.93, 116.22, 112.63, 111.80, 55.78, 55.29, 39.40, 35.25, 32.05, 30.24, 29.76, 29.73, 29.69, 29.46, 24.09, 22.82, 14.25; **HRMS** (ESI-TOF) calcd for $C_{39}H_{48}N_2O_2$ (M^+): 576.3716, found: 576.3714.

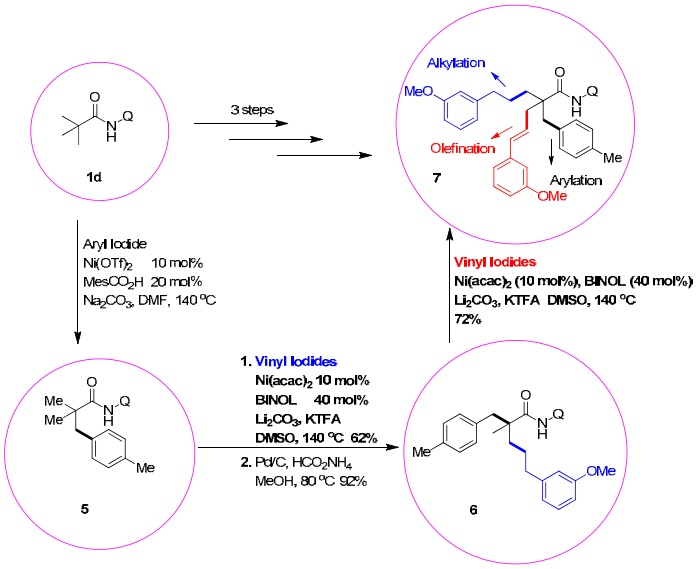


10

(E)-5-(3-methoxyphenyl)-2-methyl-2-(4-methylbenzyl)-N-(quinolin-8-yl)pent-4-enamide

^{1}H NMR (400 MHz, $CDCl_3$) δ 10.12 (br, 1H), 8.84 (d, *J* = 7.6 Hz, 1H), 8.66 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.10 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.56-7.46 (m, 2H), 7.37 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.14-7.08 (m, 3H), 6.98 (d, *J* = 7.6 Hz, 2H), 6.87 (d, *J* = 7.2 Hz, 1H), 6.79 (s, 1H), 6.70 (dd, *J* = 8.0, 2.0 Hz, 1H), 6.47 (d, *J* = 15.6 Hz, 1H), 6.29-6.22 (m, 1H), 3.68 (s, 3H), 3.26 (d, *J* = 13.2 Hz, 1H), 2.93-2.85 (m, 2H), 2.43 (dd, *J* = 13.6, 8.4 Hz, 1H), 2.22 (s, 3H), 1.41 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.95, 159.80, 148.27, 139.03, 138.92, 136.26, 136.03, 134.52, 133.61, 130.33, 129.46, 128.87, 128.00, 127.51, 126.31, 121.57, 121.51, 119.00, 116.52, 112.90, 111.60, 55.22, 49.02, 45.76, 43.39, 21.14, 21.09; **HRMS** (EI-TOF) calcd for $C_{30}H_{30}N_2O_2$ (M^+): 450.2307, found: 450.2305.

2.3 Sequential C(sp^3)-H Bonds Functionalizaion of Product



Synthesis of compound 5[1]

To an oven-dried 50 mL screw-capped vial was added substrate **1d** (5.0 mmol, 1.0 eq.), aryl iodide (7.5 mmol, 1.5 eq.), $Ni(OTf)_2$ (0.25 mmol, 0.05 eq.), MesCOOH (0.5 mmol, 0.1 eq.), Na_2CO_3 (10.0 mmol, 2.0 eq.), in DMF (10 mL). The mixture was stirred for 24 h at 160 °C under N_2 followed by cooling. The resulting mixture was added water (10 mL), then extracted with EtOAc (20 mL) for three times. The combined organic phase washed with brine (20 mL) for three times and concentrated in *vacuo*. The residue was purified by flash chromatography using hexane/EtOAc as the eluent to afford the product. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.16 (br, 1H), 8.82 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.75 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.57-7.48 (m, 2H), 7.43 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.07 (d, *J* = 8.0 Hz, 2H), 6.99 (d, *J* = 8.0 Hz, 2H), 3.00 (s, 2H), 2.24 (s, 3H), 1.40 (s, 6H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 176.28, 148.24, 138.92, 136.33, 135.91, 134.91, 134.68, 130.26, 128.80, 128.01, 127.55, 121.59, 121.41, 116.40, 46.60, 45.07, 25.34, 21.08; **HRMS** (EI-TOF) calcd for $C_{21}H_{22}N_2O_2$ (M^+): 318.1732, found: 318.1730.

Synthesis of compound 6

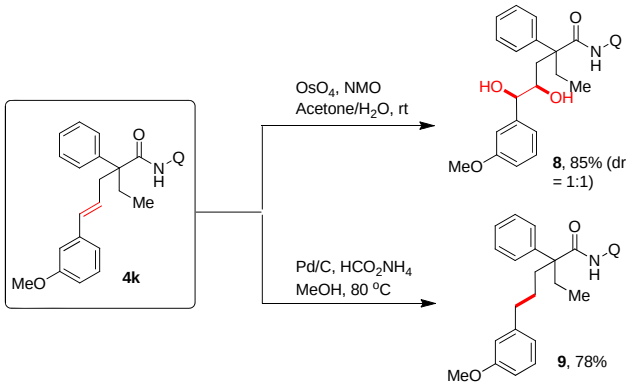
To an oven-dried 50 mL screw-capped vial was added substrate **10** (0.1 mmol, 1.0 eq.), HCO_2NH_4 (1.0 mmol, 10.0 eq.), Pd/C (0.01 mmol, 0.1 eq.), in MeOH (1.0 mL). The mixture was stirred for 8 h at 80 °C under air followed by cooling. The resulting mixture was filtered through a celite pad and concentrated in *vacuo*. The residue was purified by preparative TLC using hexane/EtOAc as the eluent to afford the product **6**. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.10 (br, 1H), 8.83 (d, *J* = 7.6 Hz, 1H), 8.71 (d, *J* = 2.8 Hz, 1H), 8.11 (d, *J* = 7.2 Hz, 1H), 7.55-7.46 (m, 2H), 7.39 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.12 (t, *J* = 7.6 Hz, 1H), 7.03 (d, *J* = 8.0 Hz, 2H), 6.96 (d, *J* = 8.0 Hz, 2H), 6.73 (d, *J* = 7.2 Hz, 1H), 6.67 (d, *J* = 7.6 Hz, 2H), 3.70 (s, 3H), 3.19 (d, *J* = 13.2 Hz, 1H), 2.78 (d, *J* = 13.2 Hz, 1H), 2.68-2.54 (m, 2H), 2.21 (s, 3H), 2.03 (td, *J* = 12.4, 3.6 Hz, 1H), 1.77-1.69 (m, 2H), 1.58 (td, *J* = 12.4, 3.6 Hz, 1H), 1.34 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 175.37, 159.65, 148.26, 143.96, 138.88, 136.30, 135.89, 134.64, 134.53, 130.28, 129.30, 128.79, 127.99, 127.52, 121.58, 121.41, 120.95, 116.36, 114.16, 111.20, 55.15, 48.63, 45.97, 39.85, 36.54, 26.71, 21.09, 20.86; **HRMS** (EI-TOF) calcd for $C_{30}H_{32}N_2O_2$ (M^+): 452.2464, found: 452.2467.

Synthesis of compound 7

To an oven-dried 50 mL screw-capped vial was added substrate **6** (0.1 mmol, 1.0 eq.), **2a** (0.2 mmol, 2.0 eq.), $Ni(acac)_2$ (0.002 mmol, 0.1 eq.), Li_2CO_3 (0.2 mmol, 2.0 eq.), potassium trifluoroacetate (0.2 mmol, 2.0 eq.), in DMSO (1.0 mL). The mixture was stirred for 10 h at 140 °C under N_2 followed by cooling. The resulting mixture was added water (3 mL), then extracted with EtOAc (10 mL) for three times. The combined organic phase washed with brine (10 mL) for three times and concentrated in *vacuo*. The residue was purified by preparative TLC using hexane/EtOAc = 20:1 as the eluent to afford the product **7**. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.14 (br, 1H), 8.81 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.67 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.57-7.39 (m, 2H), 7.41 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.18 (t, *J* = 8.0 Hz, 1H), 7.12 (t, *J* = 8.0 Hz, 1H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.94 (d, *J* = 8.0 Hz, 2H), 6.89 (d, *J* = 7.6 Hz, 1H), 6.81 (s, 1H), 6.76-6.66 (m, 4H), 6.49 (d, *J* = 15.6 Hz, 1H), 6.25-6.18 (m, 1H), 3.76 (s, 3H), 3.69 (s, 3H), 3.06 (q, *J* = 13.6 Hz, 2H), 2.76-2.56 (m, 4H), 2.21 (s, 3H),

1.89-1.74 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.47, 159.86, 159.70, 148.31, 143.81, 139.08, 138.92, 136.29, 136.05, 134.47, 134.29, 133.70, 130.13, 129.54, 129.38, 128.95, 128.03, 127.56, 125.96, 121.62, 121.47, 120.99, 118.95, 116.52, 114.28, 112.75, 111.86, 111.26, 55.33, 55.16, 52.14, 42.03, 37.52, 36.40, 35.00, 26.09, 21.10; **HRMS** (EI-TOF) calcd for $C_{39}H_{40}N_2O_3$ (M^+): 584.3039, found: 584.3041.

2.4 Transformation of Product



Synthesis of compound 8

To an oven-dried 50 mL screw-capped vial was added substrate **4k** (0.1 mmol, 1.0 eq.), NMO (1.5 mmol, 1.5 eq.), OsO_4 (0.01 mmol, 0.1 eq.), in Acetone/H_2O = 1.0 mL/0.2 mL. The mixture was stirred for 1.5 h at rt under air. The resulting mixture was added water (10 mL), then extracted with EtOAc (10 mL) for three times. The combined organic phase washed with brine (10 mL) for three times and concentrated in *vacuo*. The residue was purified by preparative TLC using hexane/EtOAc as the eluent to afford the product **8**. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 10.01 (br, 0.5H), 9.79 (s, 0.5H), 8.78 (d, *J* = 7.2 Hz, 0.5 H) 8.76 (d, *J* = 7.2 Hz, 0.5 H), 8.59 (dd, *J* = 4.4, 0.8 Hz, 0.5H), 8.54 (dd, *J* = 4.4, 0.8 Hz, 0.5H), 8.12 (d, *J* = 8.4 Hz, 0.5H), 8.07 (d, *J* = 8.4 Hz, 0.5H), 7.58-7.44 (m, 2H), 7.39-7.24 (m, 5H), 7.20-7.10 (m, 2H), 6.87-6.69 (m, 3H), 4.67 (d, *J* = 2.4 Hz, 1H), 4.45 (d, *J* = 6.0 Hz, 0.5H), 4.36 (d, *J* = 6.0 Hz, 0.5H), 3.77 (t, *J* = 8.8 Hz, 0.5H), 3.75 (s, 1.5H), 3.69 (s, 1.5H), 3.68 (s, 0.5H), 3.47 (t, *J* = 7.6 Hz, 1H), 3.31 (br, 0.5H), 3.19 (br, 0.5H), 2.54-2.17 (m, 3H), 2.11 (d, *J* = 14.8 Hz, 0.5H), 2.11 (d, *J* = 14.8 Hz, 0.5H), 1.75 (d, *J* = 14.8 Hz, 1H), 1.19-1.15 (m, 1H),

0.92 (dt, *J* = 7.6 Hz, 1.5H), 0.73 (dt, *J* = 7.6 Hz, 1.5H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 176.20, 175.91, 159.83, 159.68, 148.50, 148.34, 142.61, 142.51, 142.41, 142.29, 138.89, 138.81, 136.32, 136.25, 134.40, 134.16, 129.54, 129.28, 128.92, 128.79, 128.70, 128.06, 128.00, 127.41, 127.36, 127.24, 122.05, 121.79, 121.74, 121.60, 119.98, 119.71, 116.85, 116.65, 114.01, 113.95, 112.24, 112.19, 78.54, 78.22, 72.67, 72.40, 56.97, 55.30, 55.20, 55.01, 40.52, 37.88, 33.29, 28.11, 18.81, 18.79, 9.13, 8.70; **HRMS** (ESI-TOF) calcd for $C_{29}H_{31}N_2O_4$ $(M+H)^+$: 471.2278, found: 471.2295.

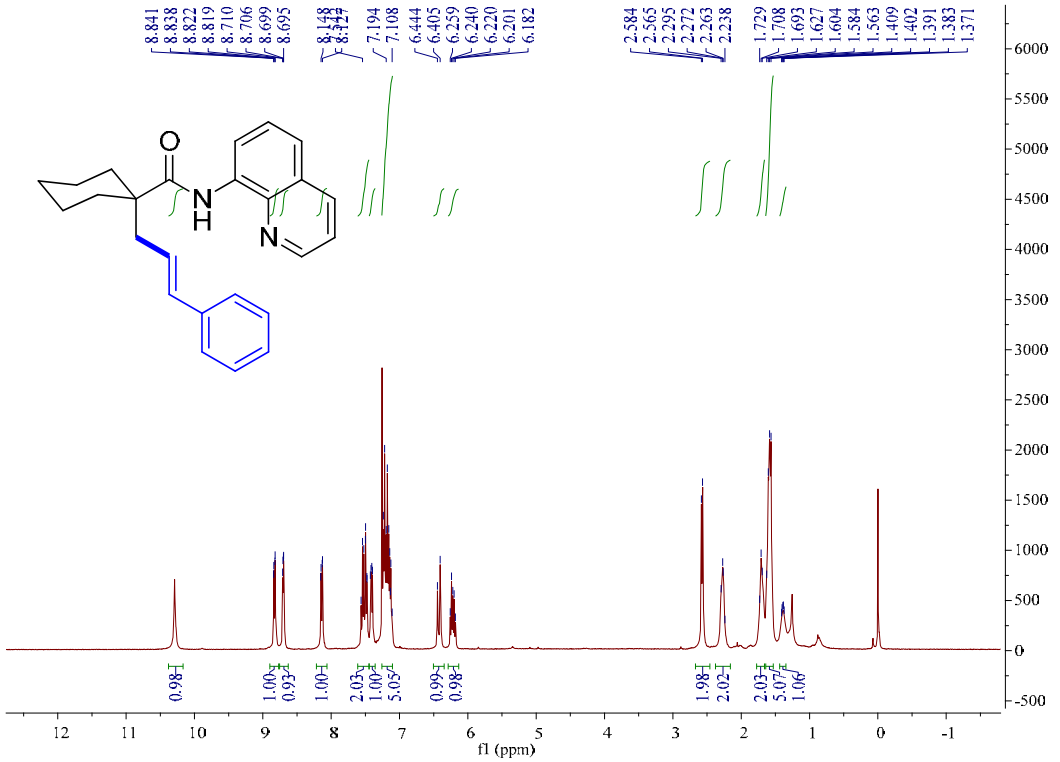
Synthesis of compound 9

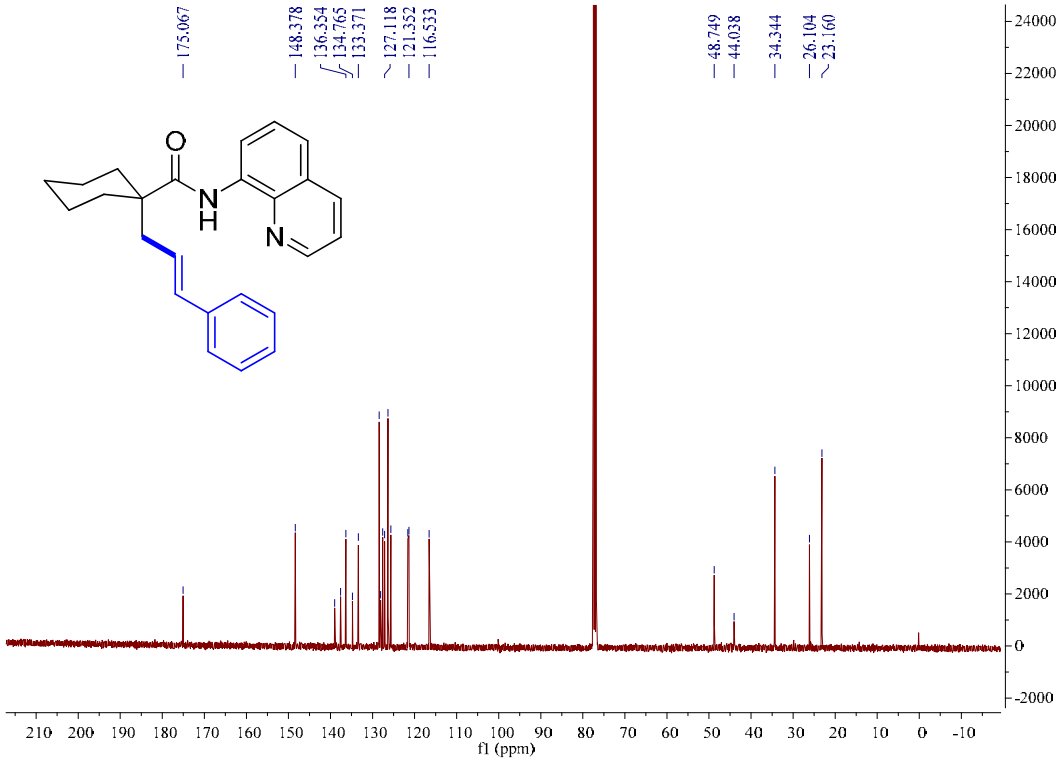
To an oven-dried 50 mL screw-capped vial was added substrate **4k** (0.1 mmol, 1.0 eq.), HCO_2NH_4 (1.0 mmol, 10.0 eq.), Pd/C (0.01 mmol, 0.1 eq.), in MeOH (1.0 mL). The mixture was stirred for 8 h at 80 °C under air followed by cooling. The resulting mixture was filtered through a celite pad and concentrated in *vacuo*. The residue was purified by preparative TLC using hexane/EtOAc as the eluent to afford the product **9**. **^{1}H NMR (400 MHz, $CDCl_3$)** δ 9.79 (br, 1H), 8.75 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.58 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.07 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.50 (t, *J* = 7.8 Hz, 1H), 7.44-7.41 (m, 3H), 7.36-7.32 (m, 3H), 7.26-7.23 (m, 2H), 7.12-7.08 (m, 1H), 6.70 (d, *J* = 7.2 Hz, 1H), 6.65-6.64 (m, 2H), 3.71 (s, 3H), 2.62 (t, *J* = 6.4 Hz, 2H), 2.31-2.14 (m, 4H), 1.62-1.46 (m, 2H), 0.81 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$)** δ 174.94, 159.68, 148.25, 143.88, 143.17, 138.80, 136.16, 134.84, 129.28, 128.70, 127.99, 127.46, 127.31, 126.98, 121.53, 121.22, 120.97, 116.09, 114.17, 111.22, 55.79, 55.20, 36.44, 34.00, 27.87, 25.67, 8.66; **HRMS** (ESI-TOF) calcd for $C_{29}H_{31}N_2O_2$ (M^+): 439.2380, found: 439.2377.

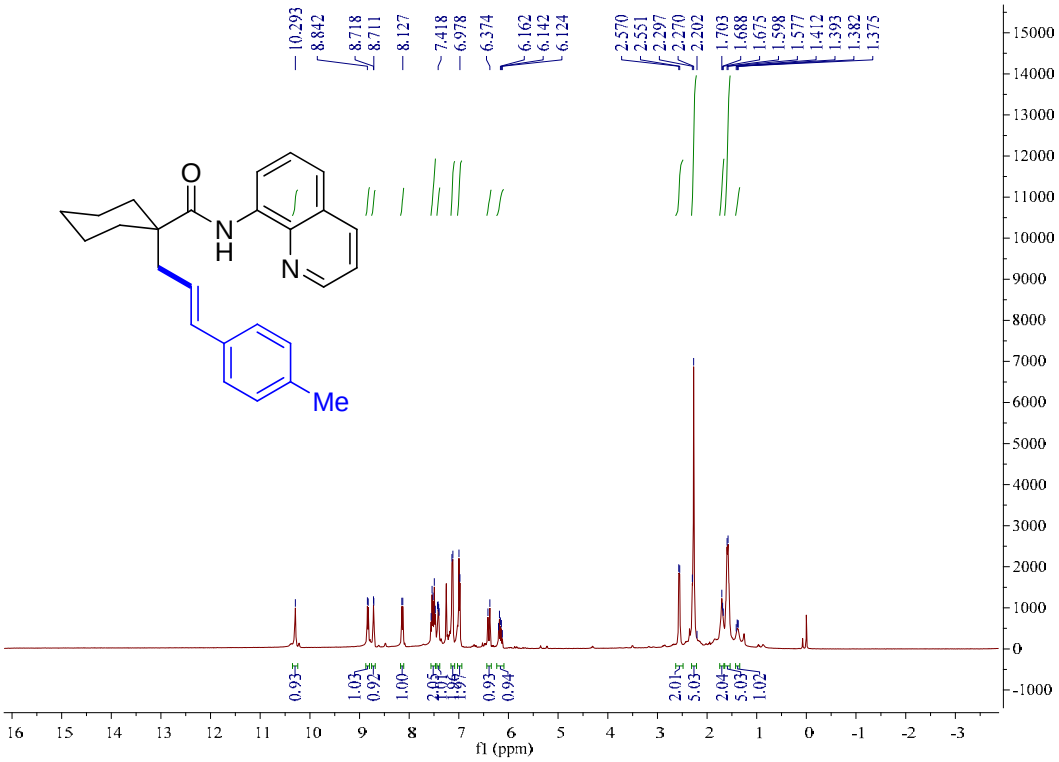
3. Reference

1. Y. Aihara, N. Chatani, *J. Am. Chem. Soc.* 2014, **136**, 898.

4. NMR Spectra



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2.297
2.270
2.202
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1.688
1.675
1.598
1.577
1.412
1.393
1.382
1.375
0.93
1.03
0.92
1.00
2.05
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2.04
5.03
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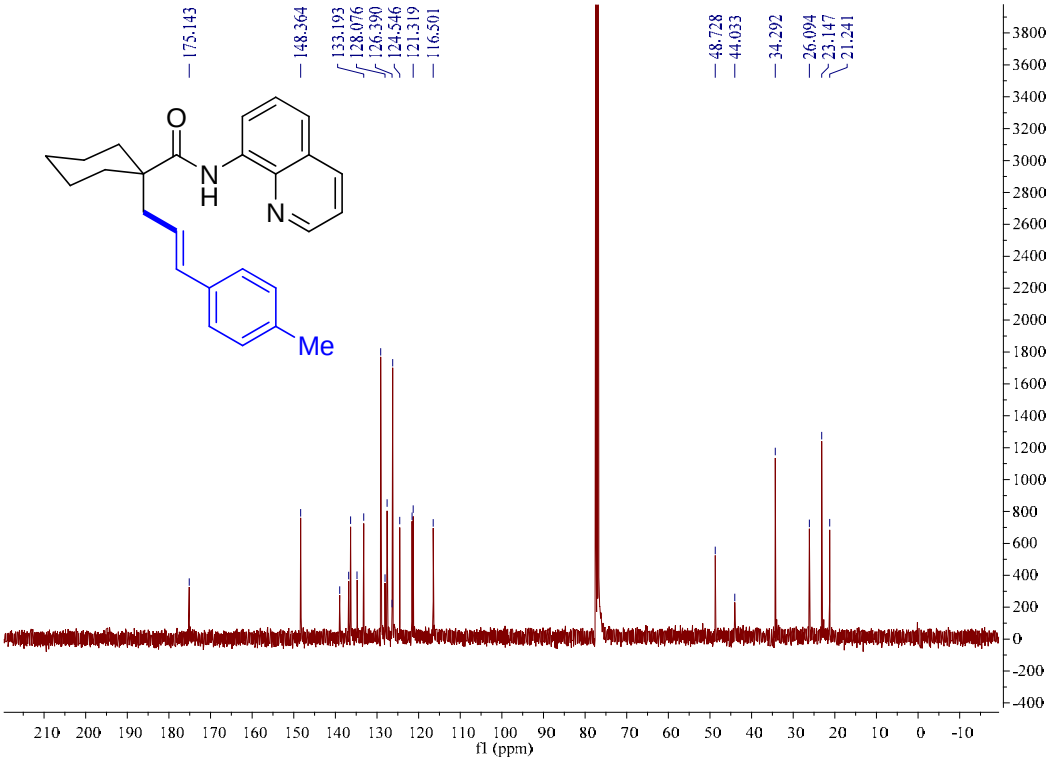
N
Me
f1 (ppm)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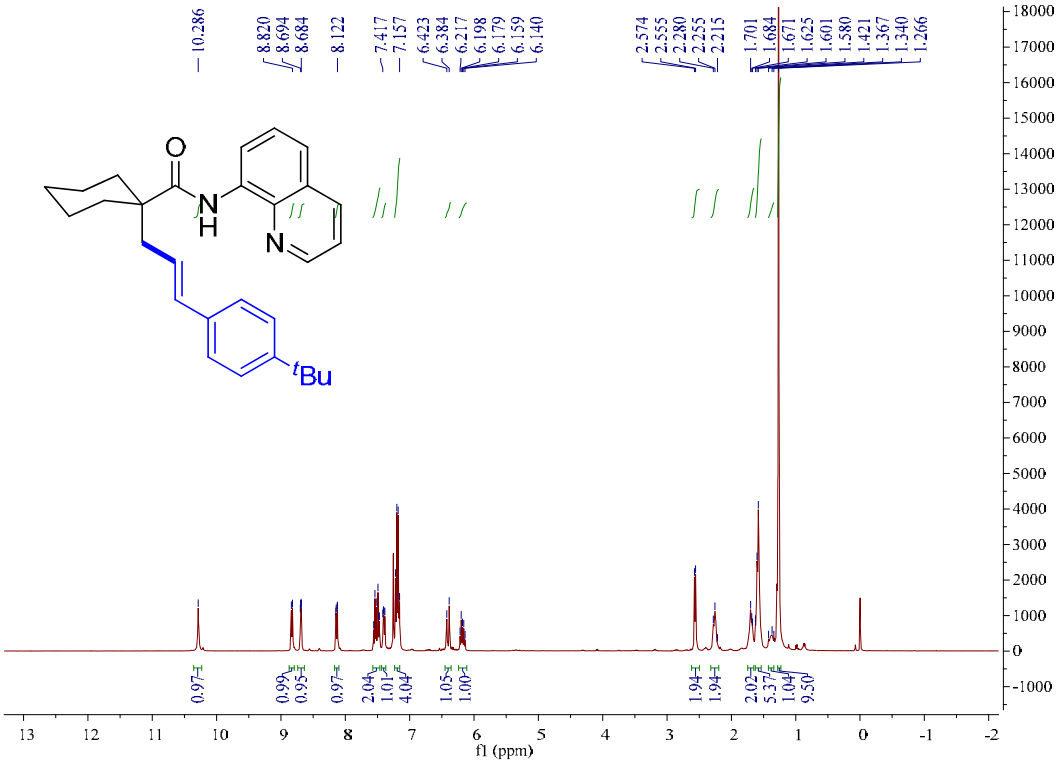
N
Me
f1 (ppm)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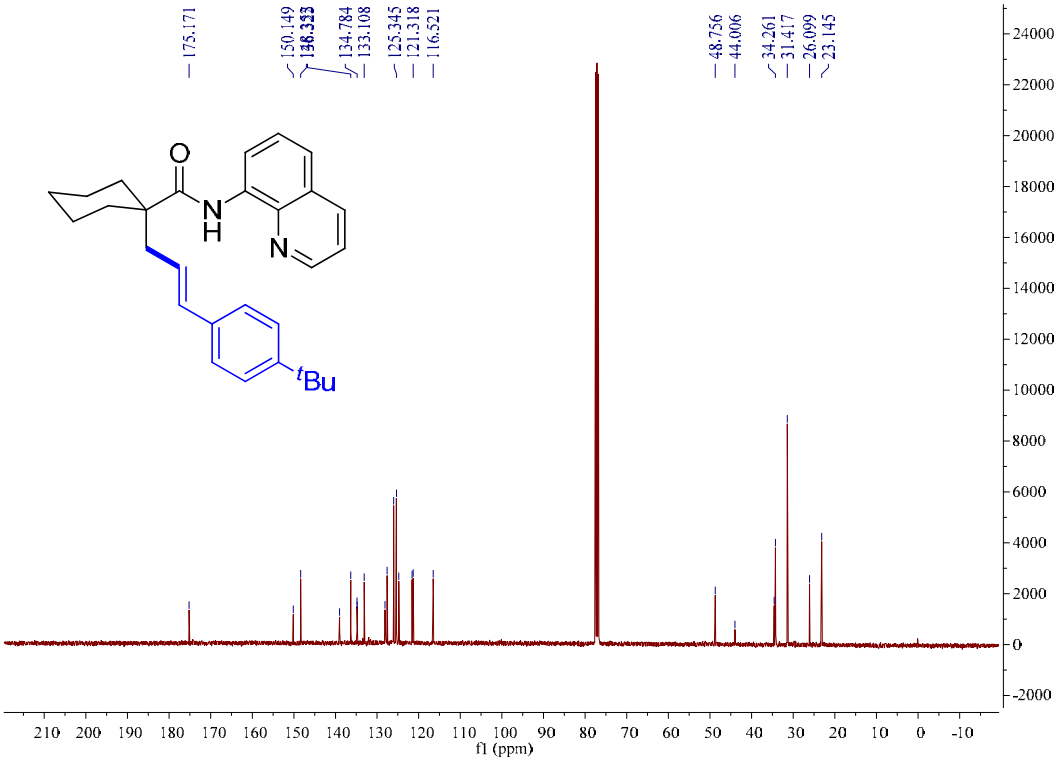
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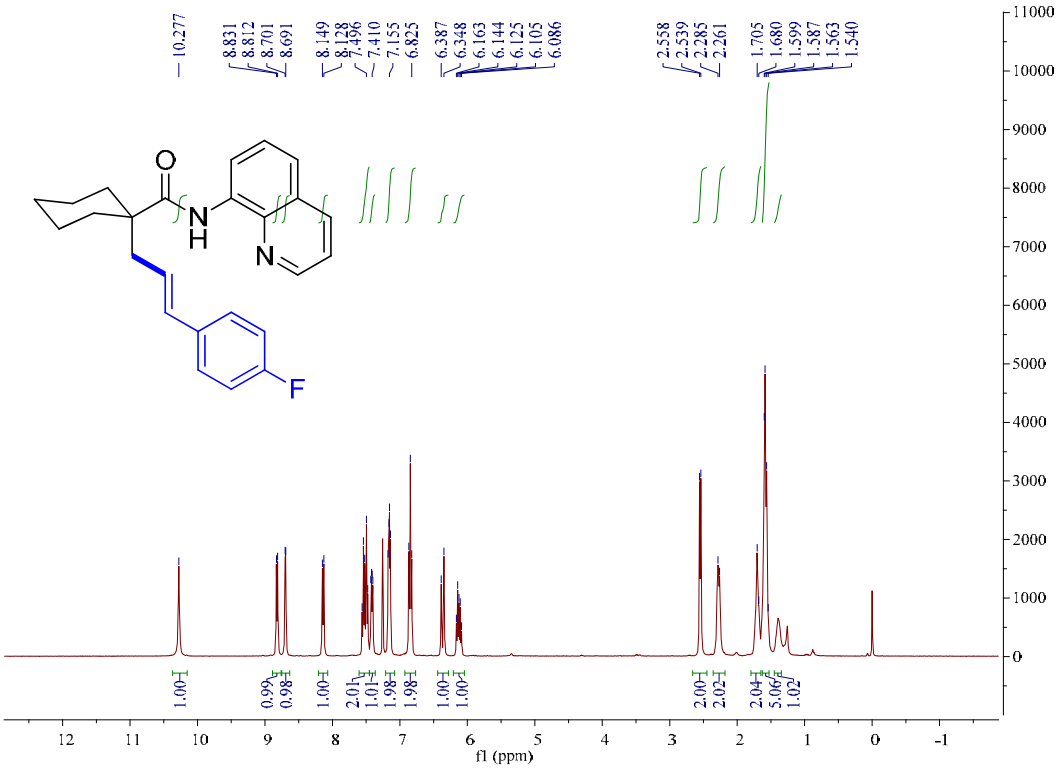
N
tBu
f1 (ppm)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6.163
6.144
6.125
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6.086
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2.285
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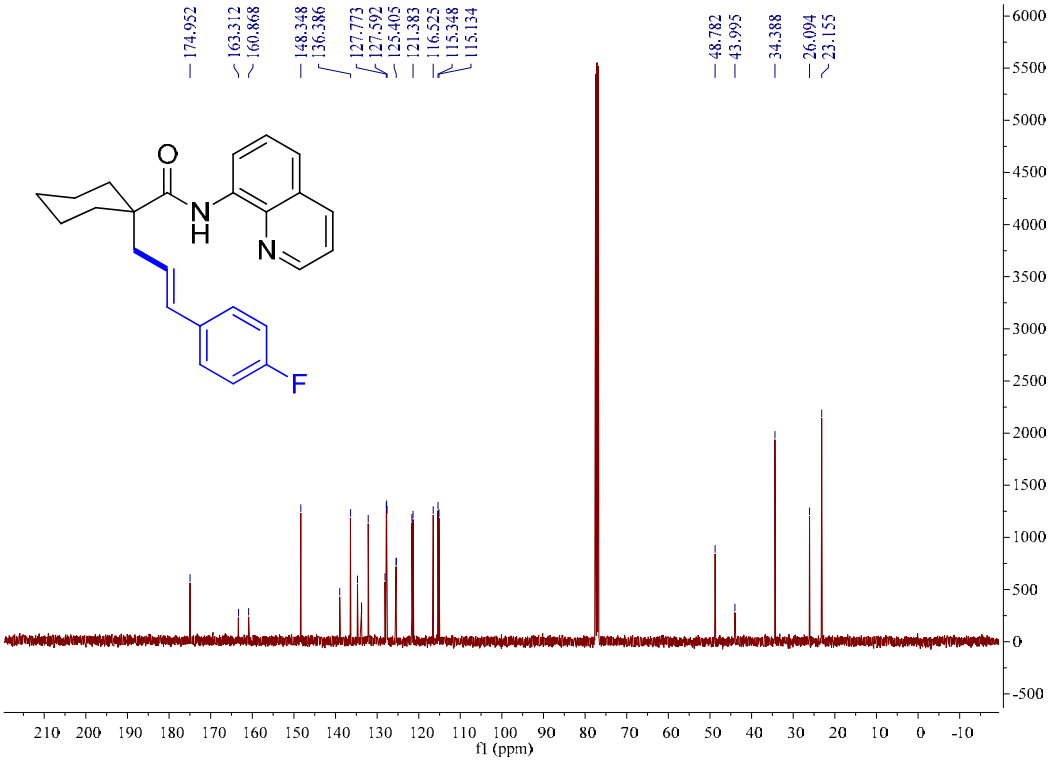
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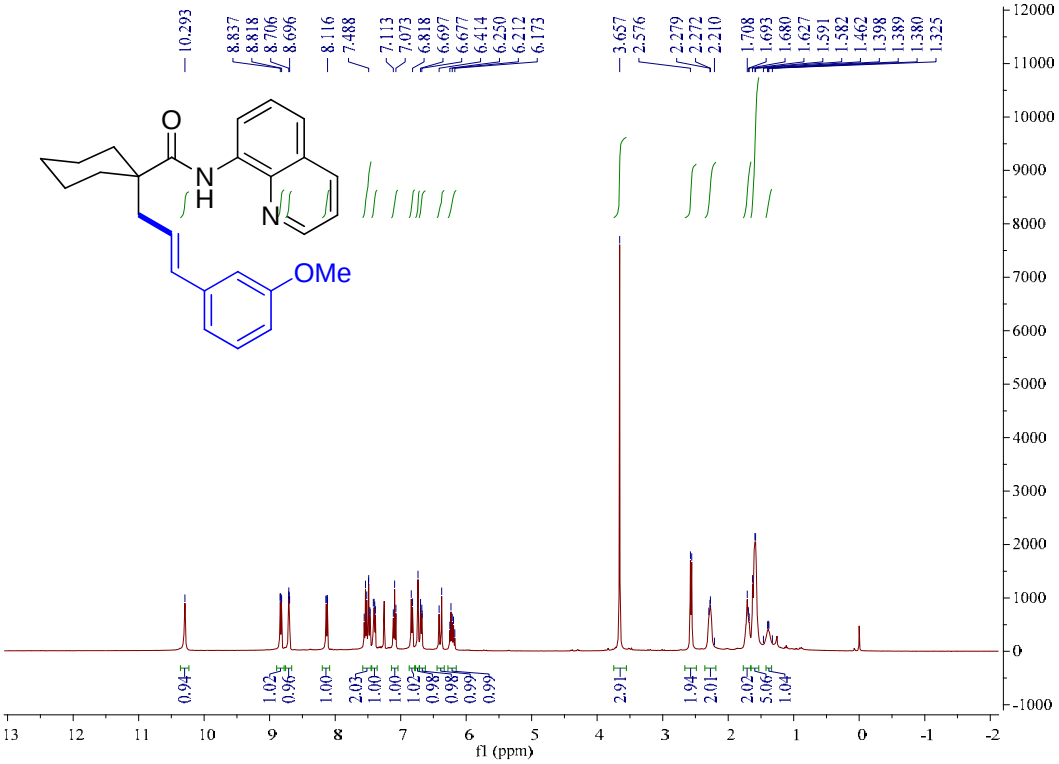
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0.96
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1.00
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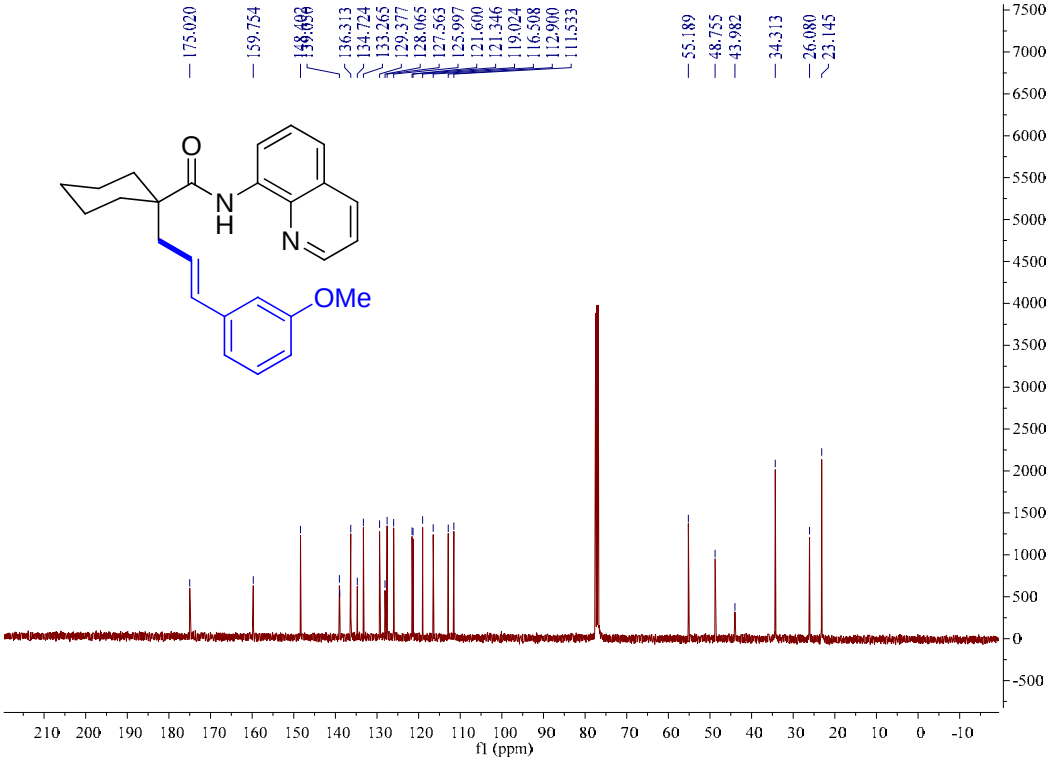
f1 (ppm)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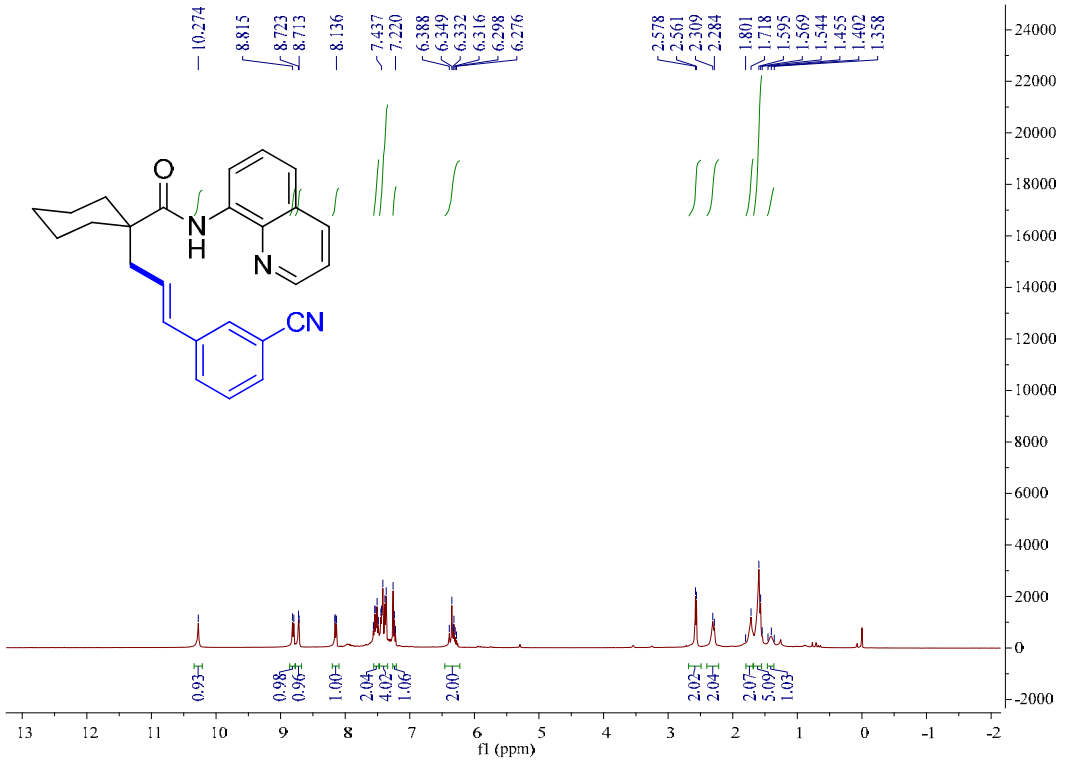
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2.309
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1.569
1.544
1.455
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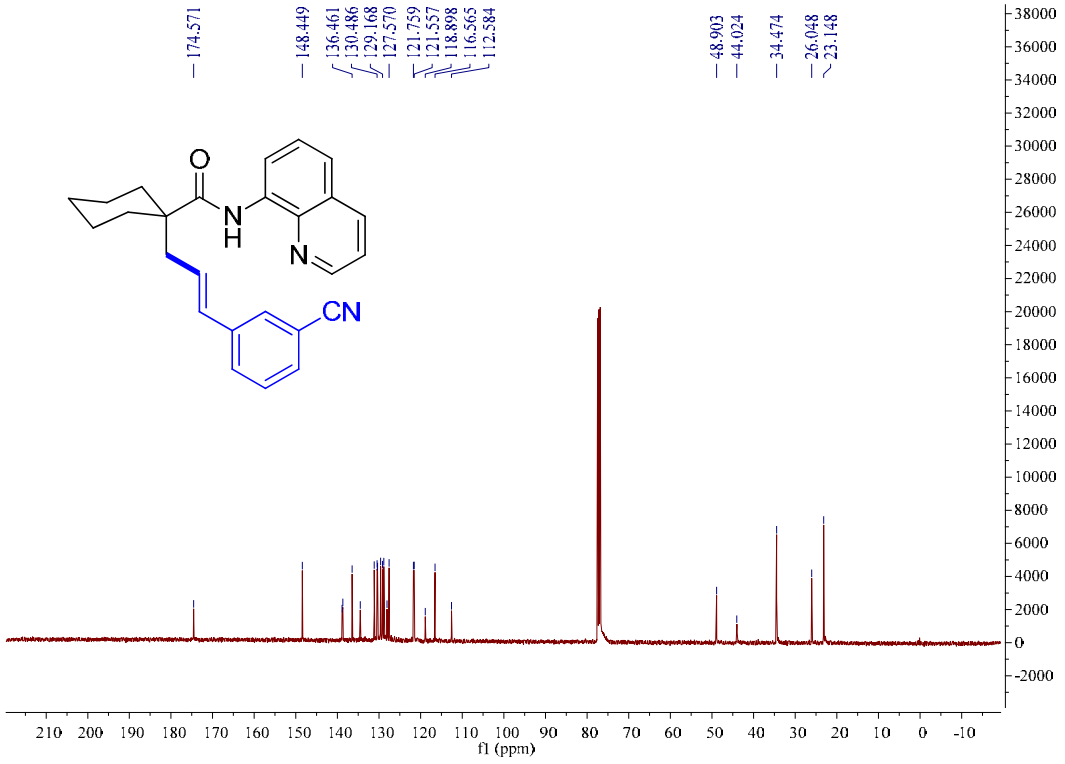
f1 (ppm)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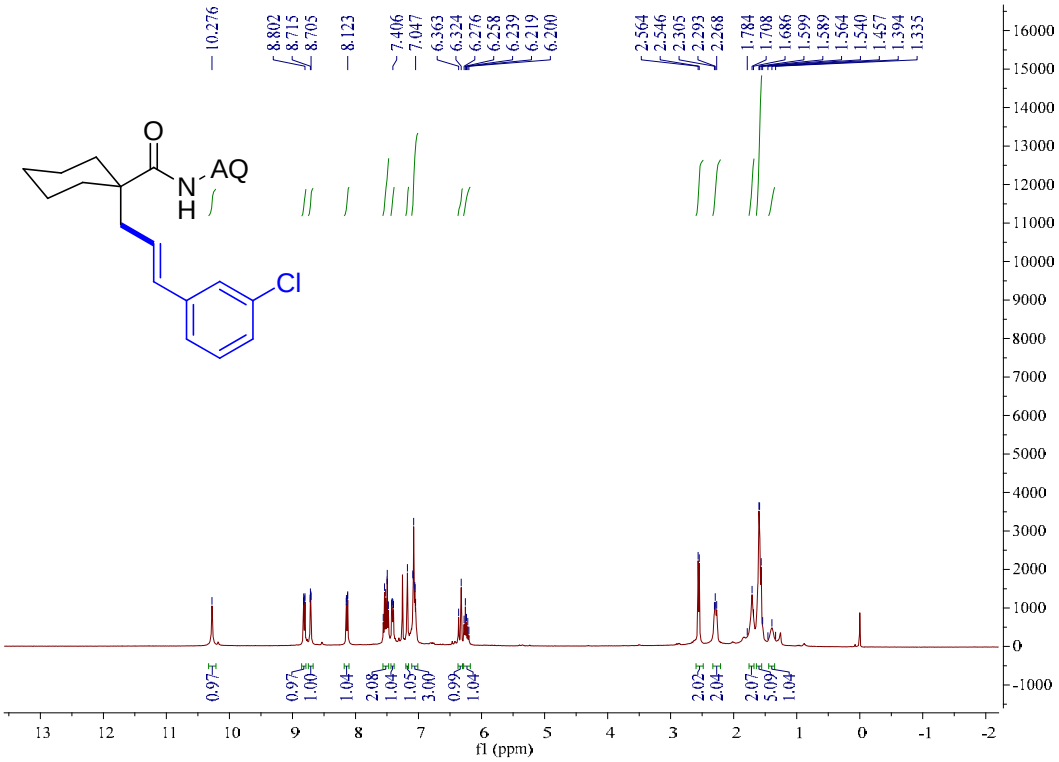
f1 (ppm)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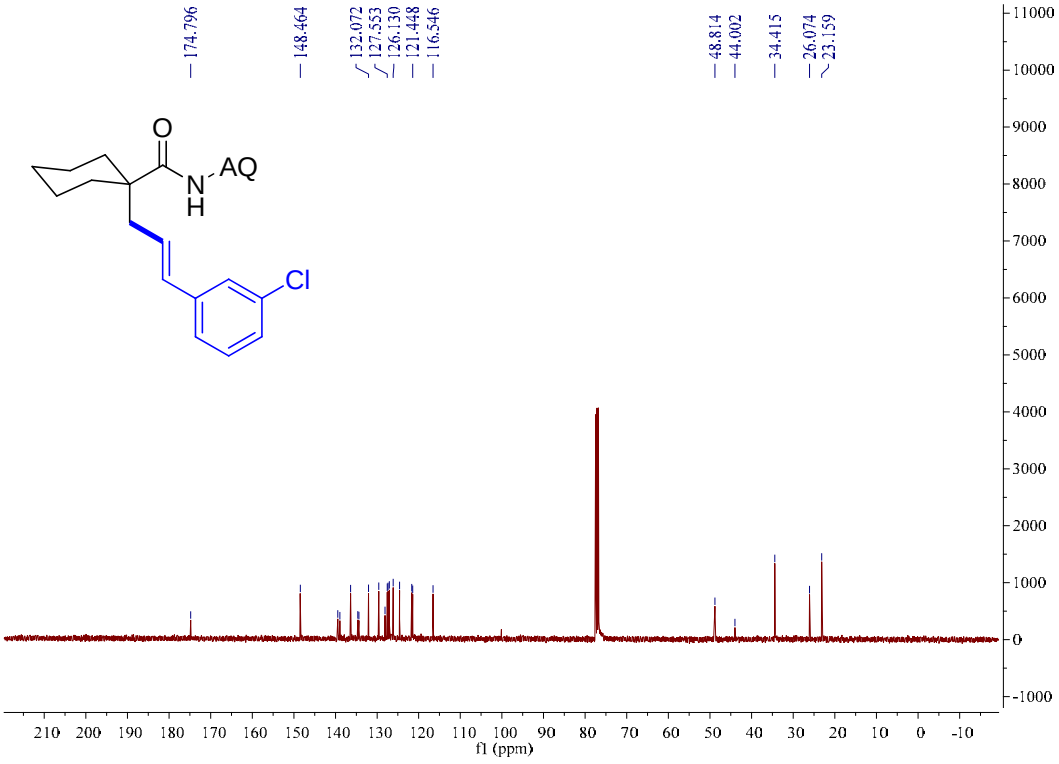
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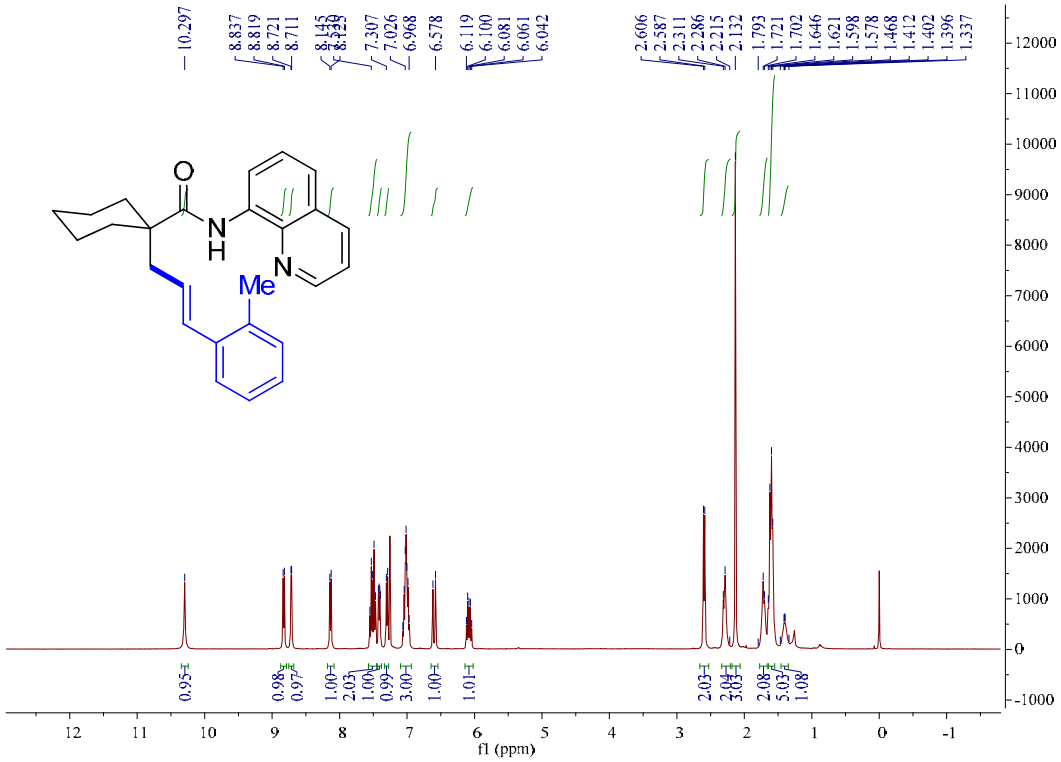
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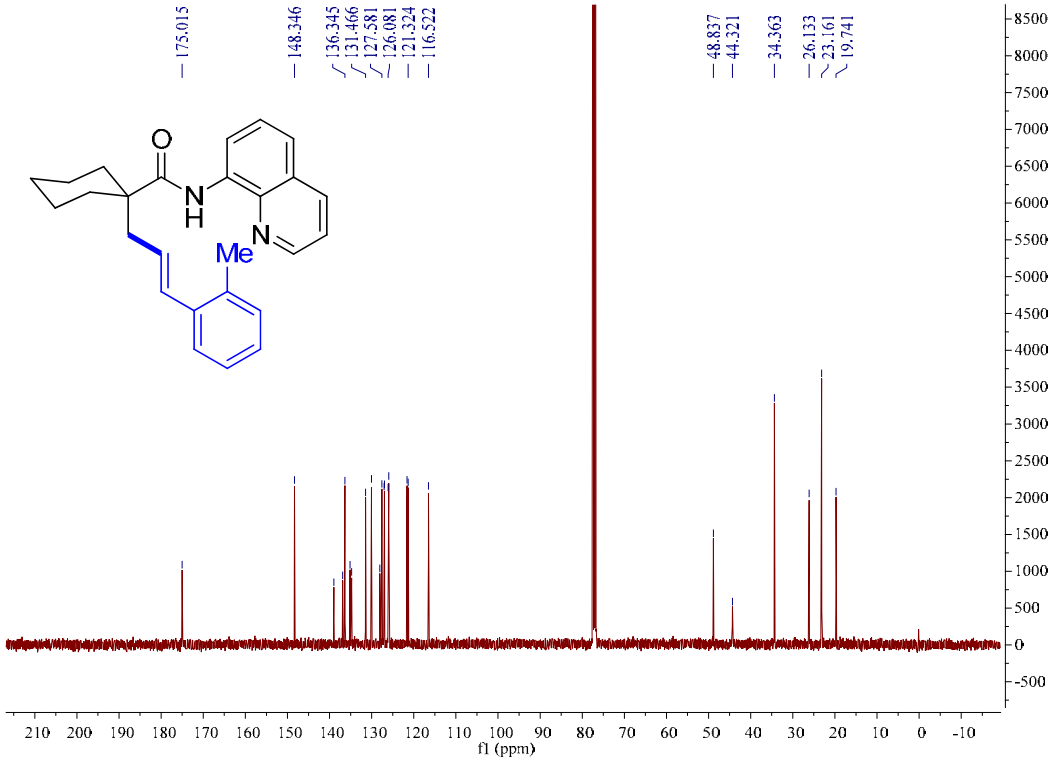
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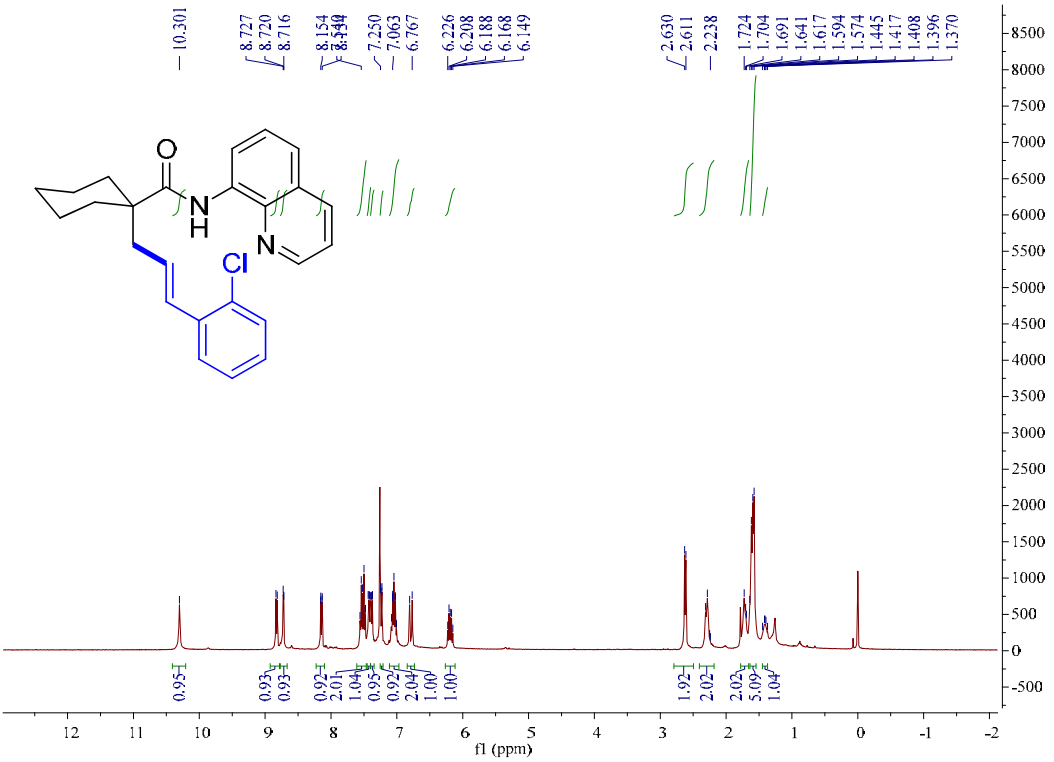
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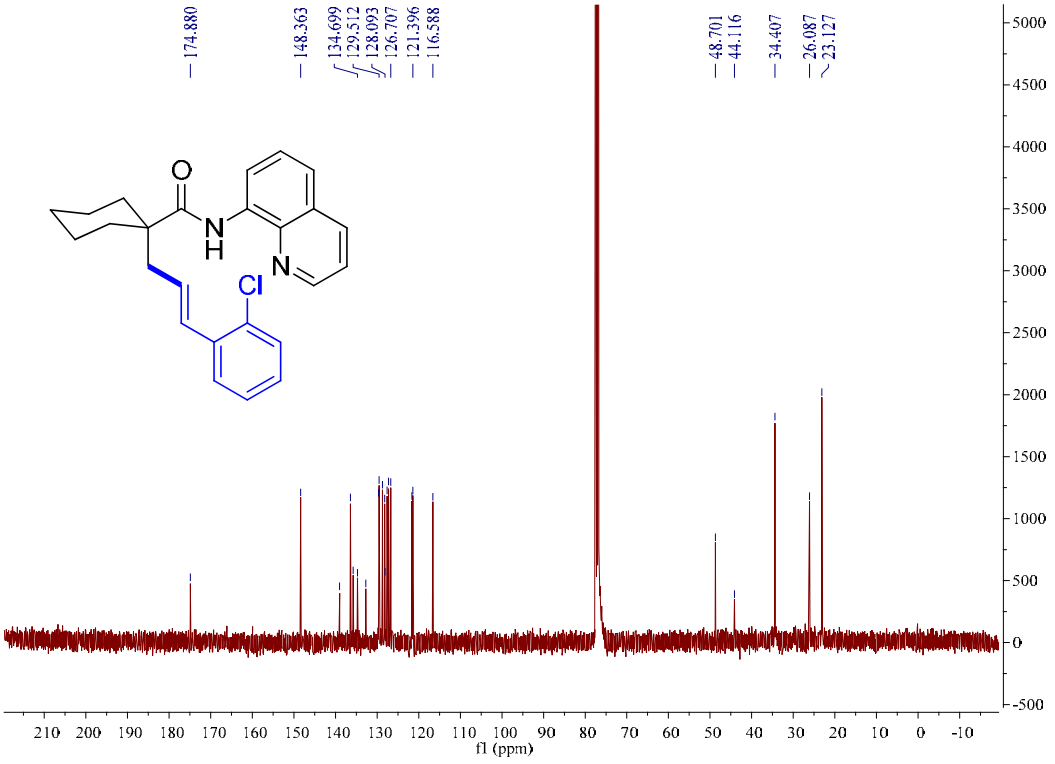
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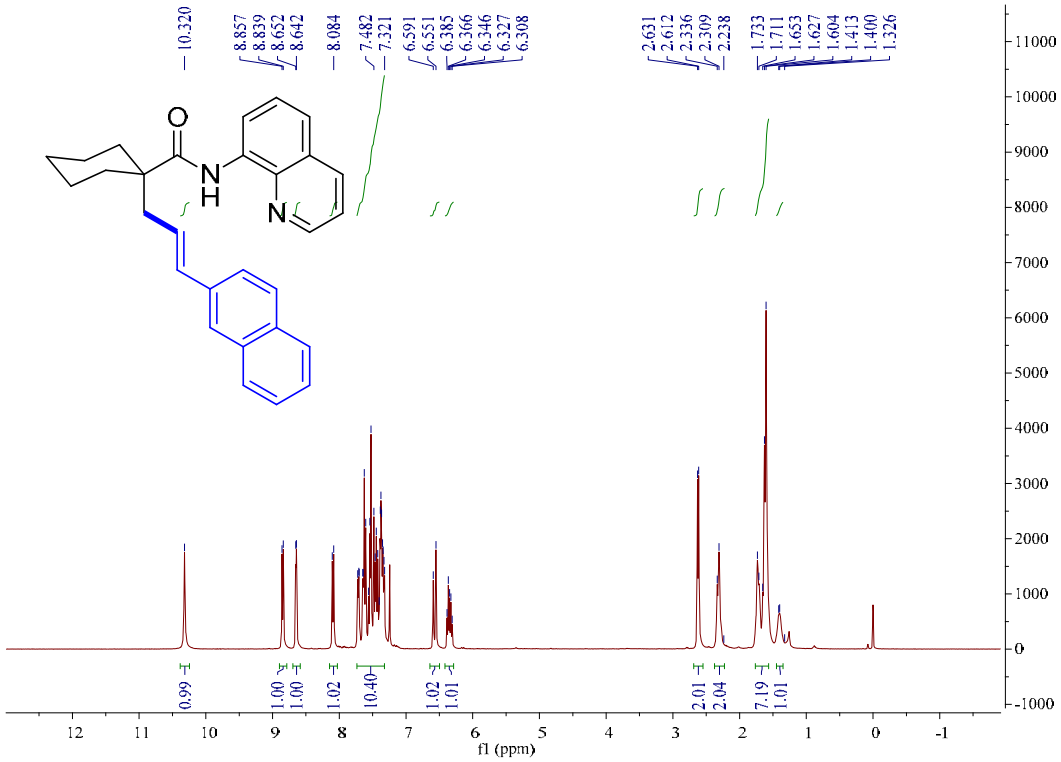
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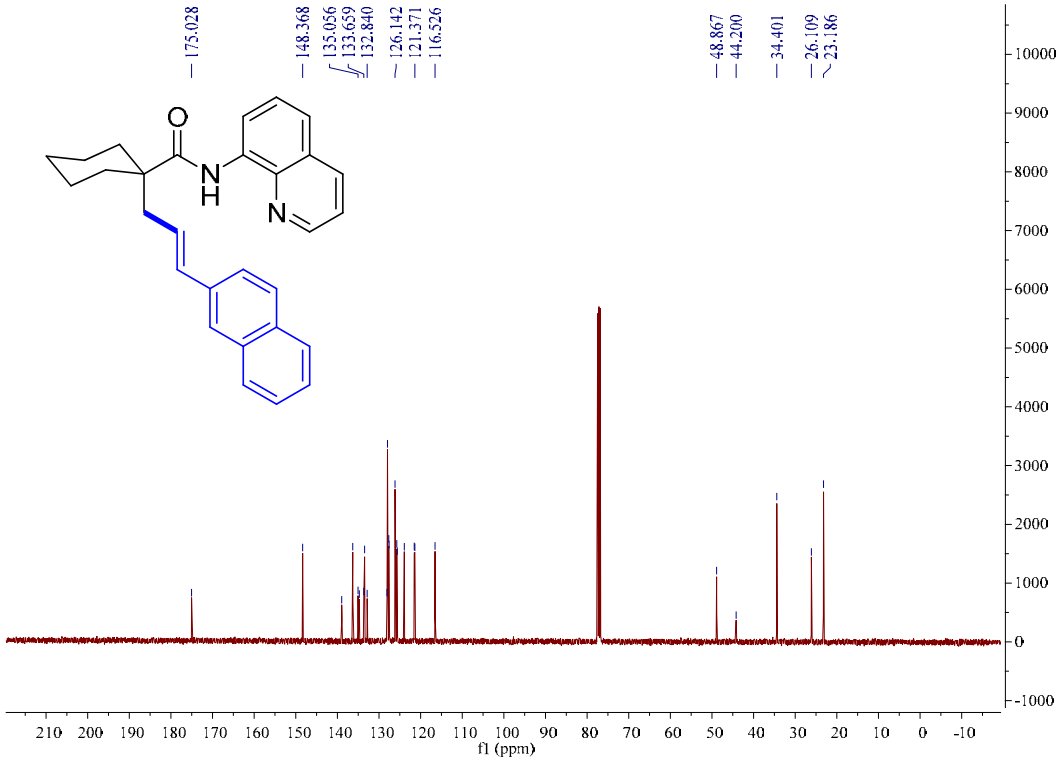
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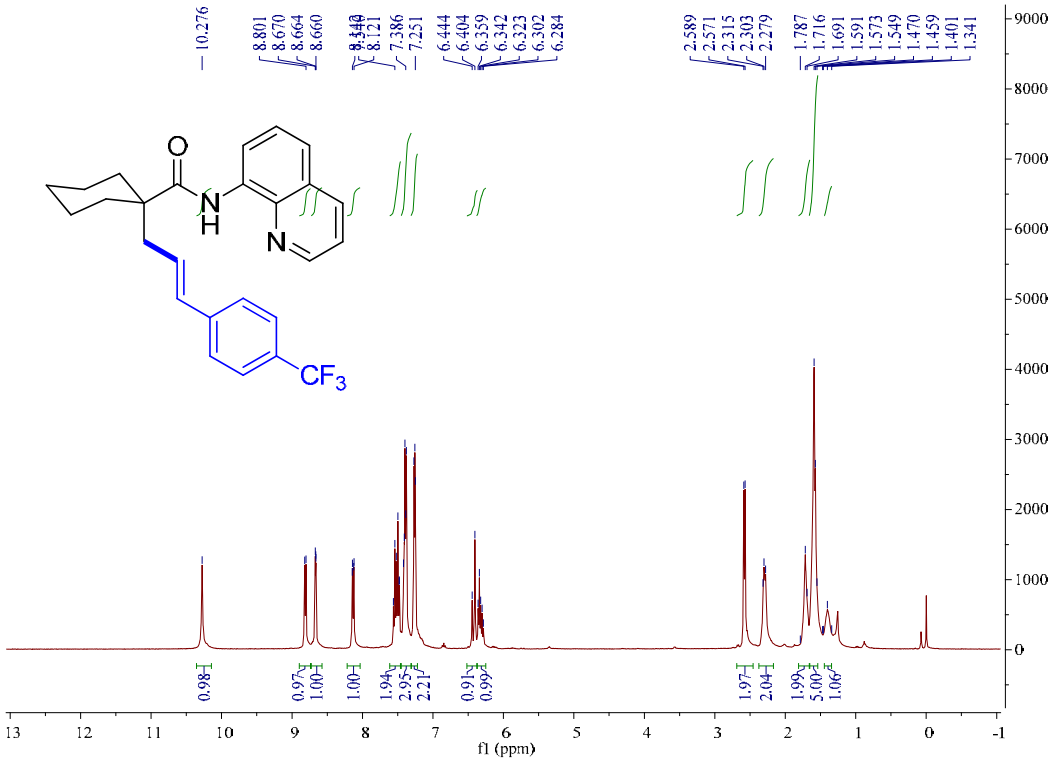
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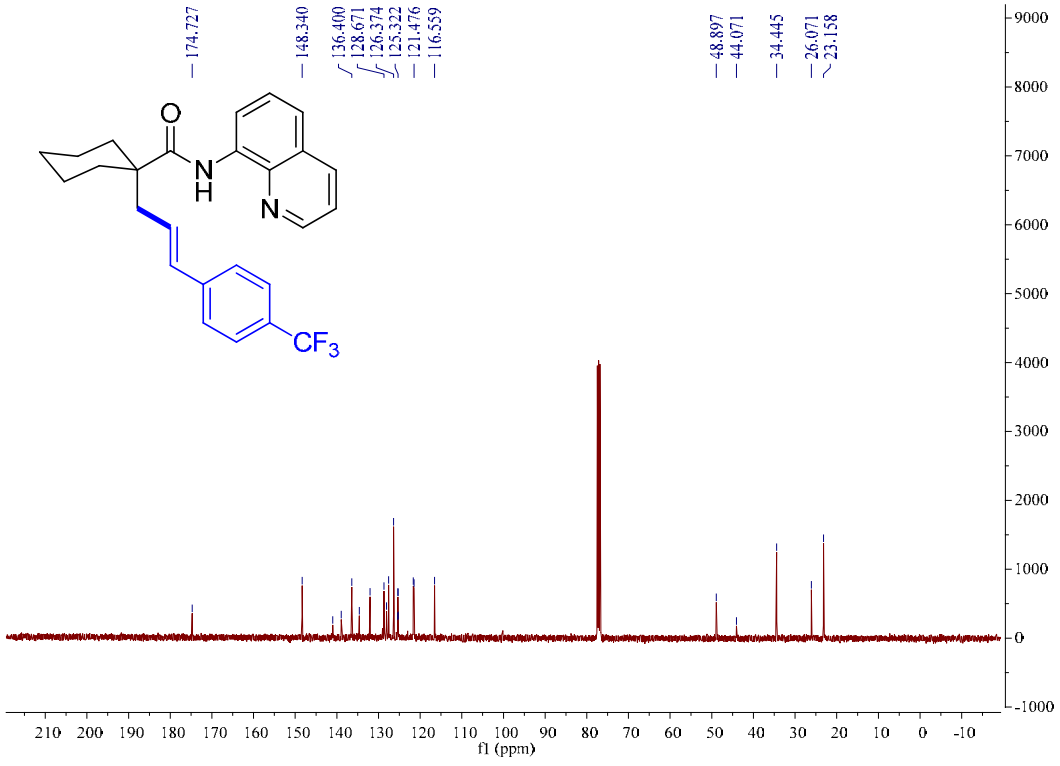
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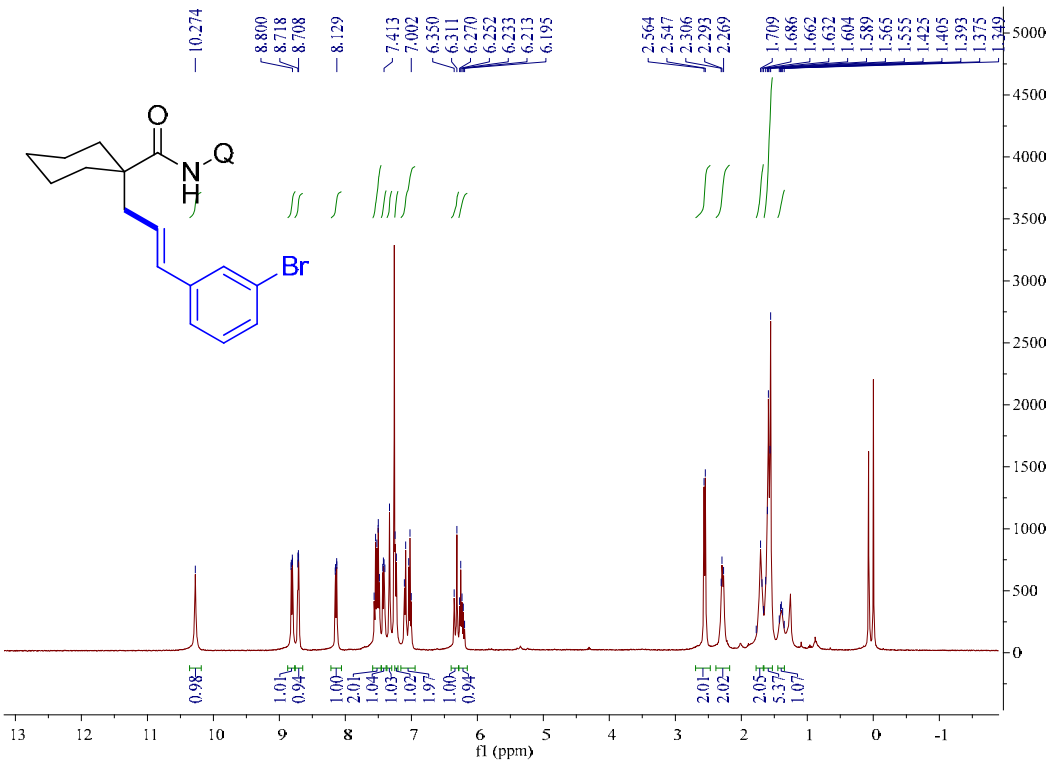
CF3
f1 (ppm)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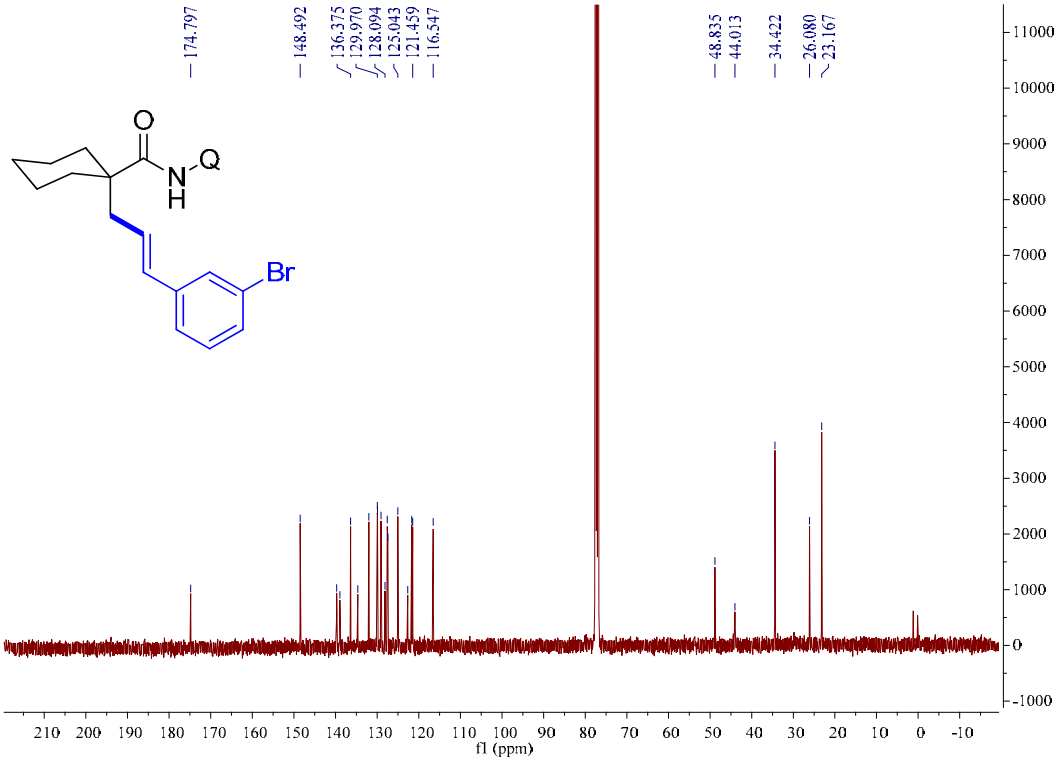
7.413
7.002
6.350
6.311
6.270
6.252
6.233
6.213
6.195
2.564
2.547
2.306
2.293
2.269
1.709
1.686
1.662
1.632
1.604
1.589
1.565
1.555
1.425
1.405
1.393
1.375
1.349
0.98
1.01
0.94
1.00
2.01
1.04
1.03
1.02
1.97
1.00
0.94
2.01
2.02
2.05
5.37
1.07
O
N
H
Q
Br
f1 (ppm)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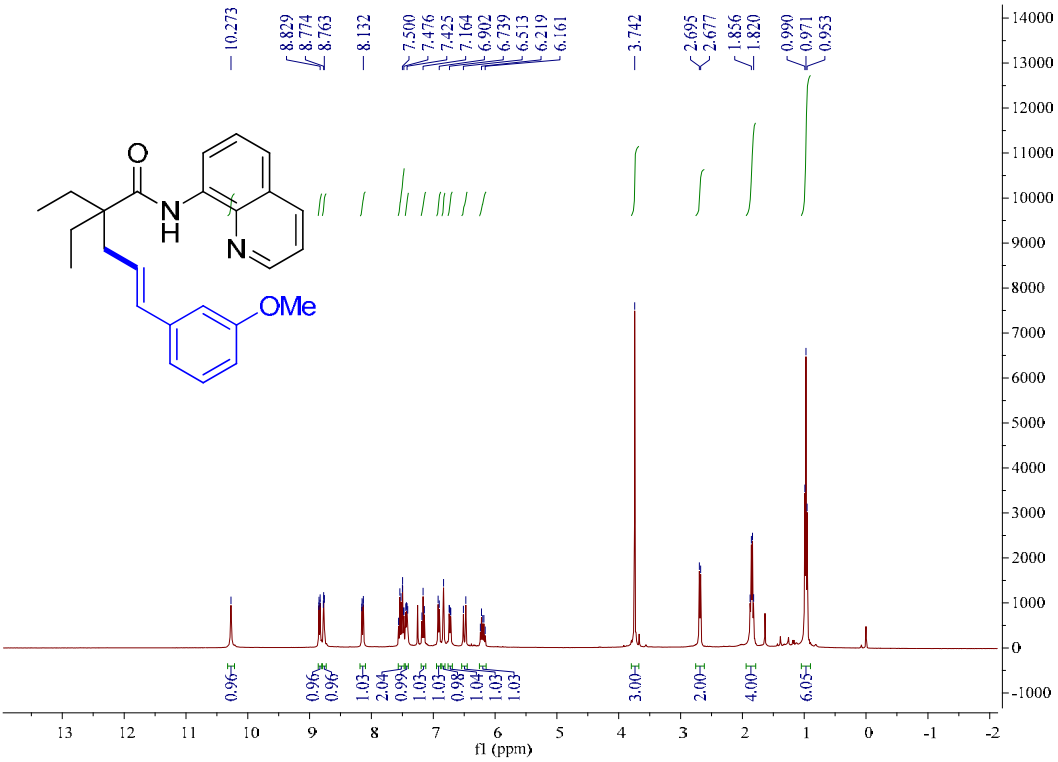
136.375
129.970
128.094
125.043
121.459
116.547
48.835
44.013
34.422
26.080
23.167
O
N
H
Q
Br
f1 (ppm)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8.774
8.763
8.132
7.500
7.476
7.425
7.164
6.902
6.739
6.513
6.219
6.161
3.742
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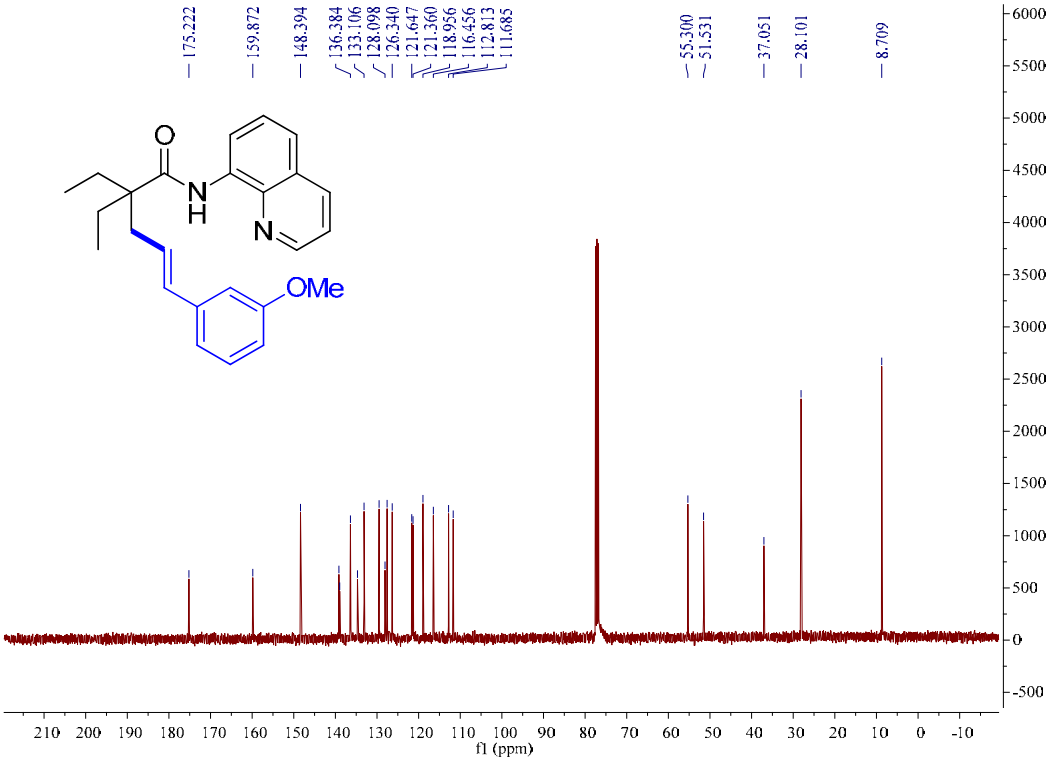
1.856
1.820
0.990
0.971
0.953
O
N
H
N
OMe
f1 (ppm)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148.394
136.384
133.106
128.098
126.340
121.647
121.360
118.956
116.456
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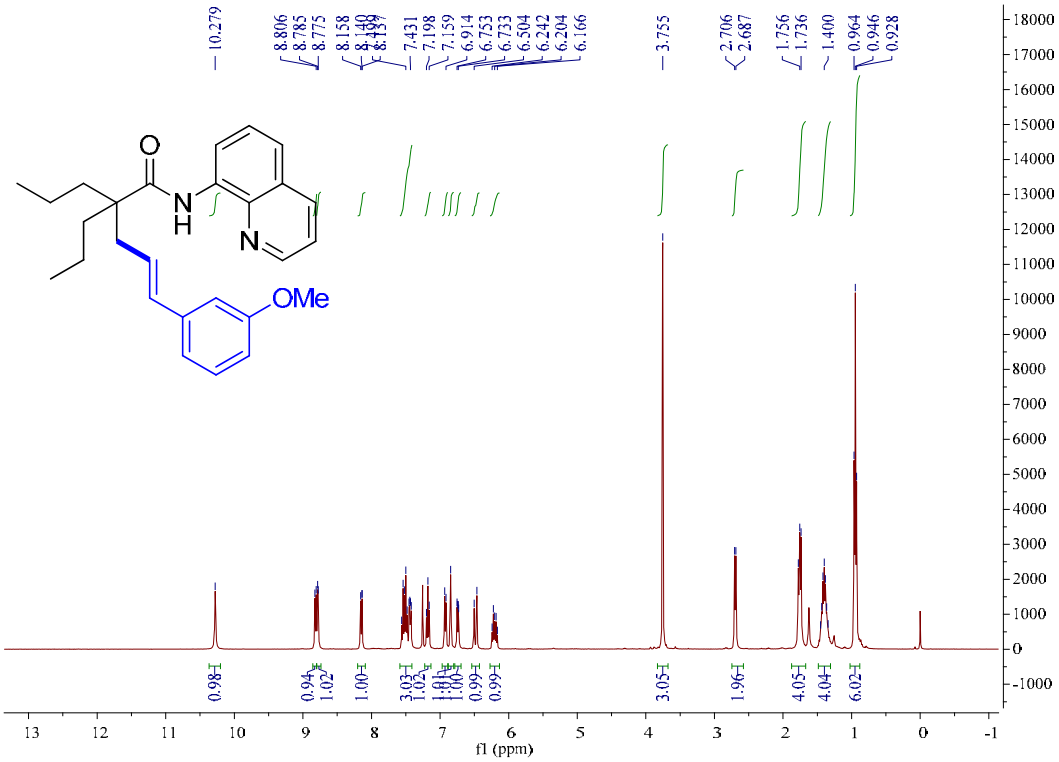
111.685
55.300
51.531
37.051
28.101
8.709
O
N
H
N
OMe
f1 (ppm)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8.785
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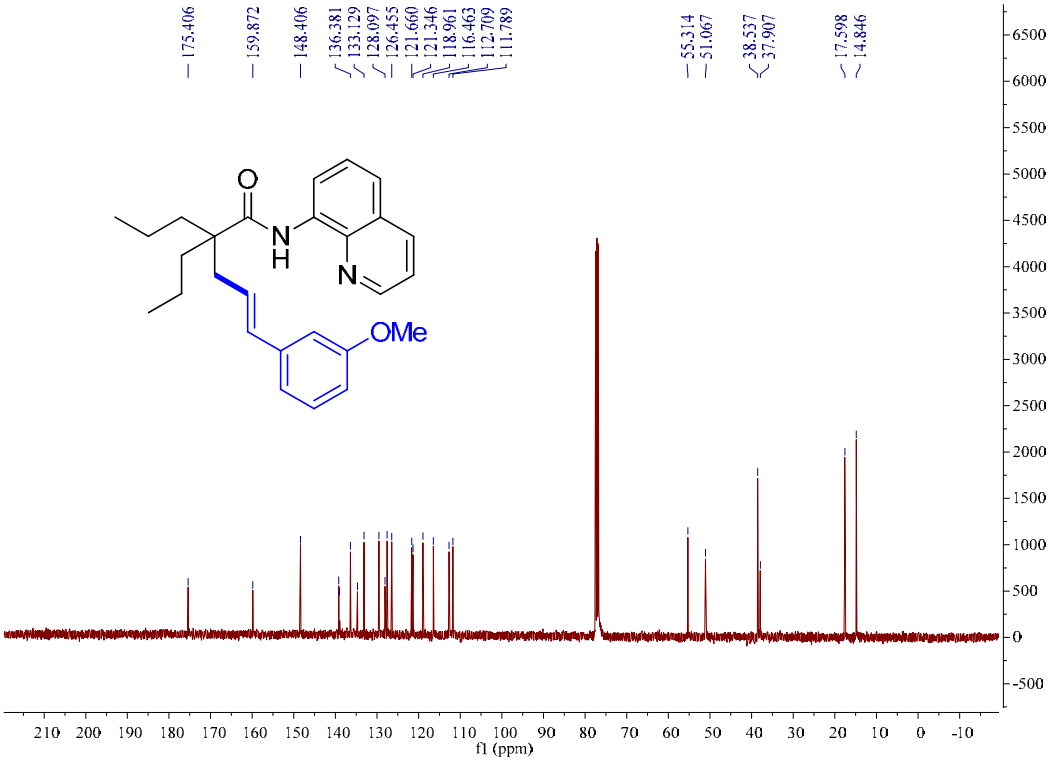
8.158
8.140
8.139
8.137
7.431
7.198
7.159
6.914
6.753
6.733
6.504
6.242
6.204
6.166
3.755
2.706
2.687
1.756
1.736
1.400
0.964
0.946
0.928
O
N
H
N
OMe
0.98
0.94
1.02
1.00
3.03
1.02
1.01
1.00
0.99
0.99
3.05
1.96
4.05
4.04
6.02
f1 (ppm)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121.660
121.346
118.961
116.463
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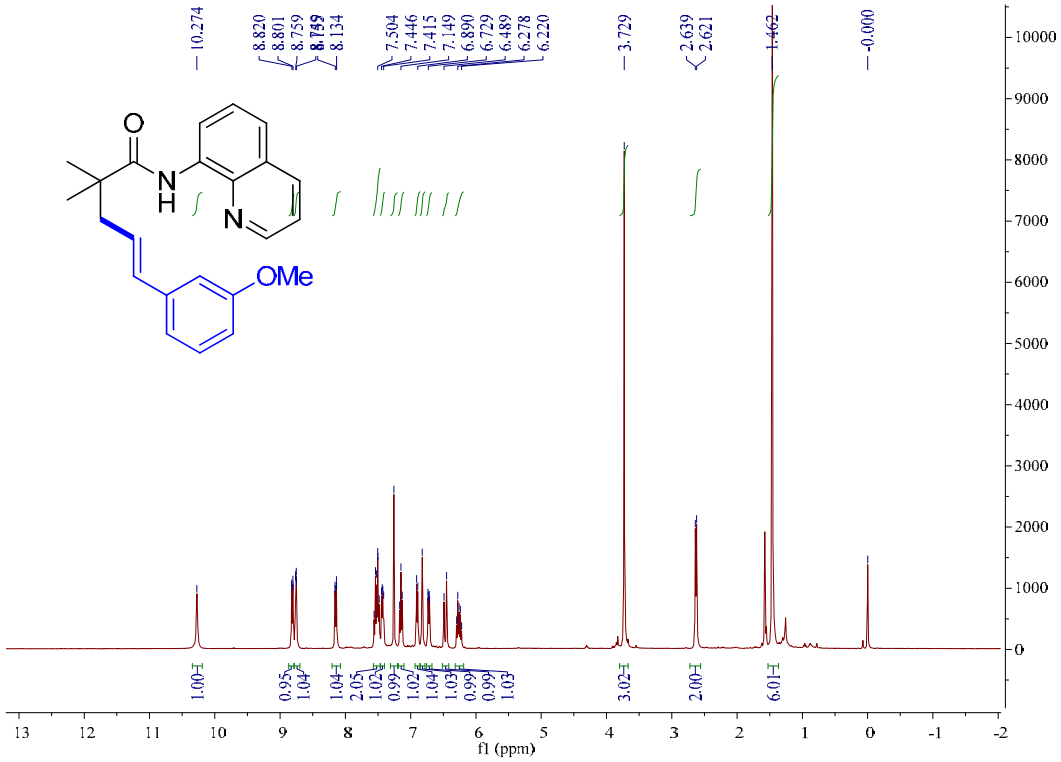
51.067
38.537
37.907
17.598
14.846
O
N
H
N
OMe
f1 (ppm)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8.134
7.504
7.446
7.415
7.149
6.890
6.729
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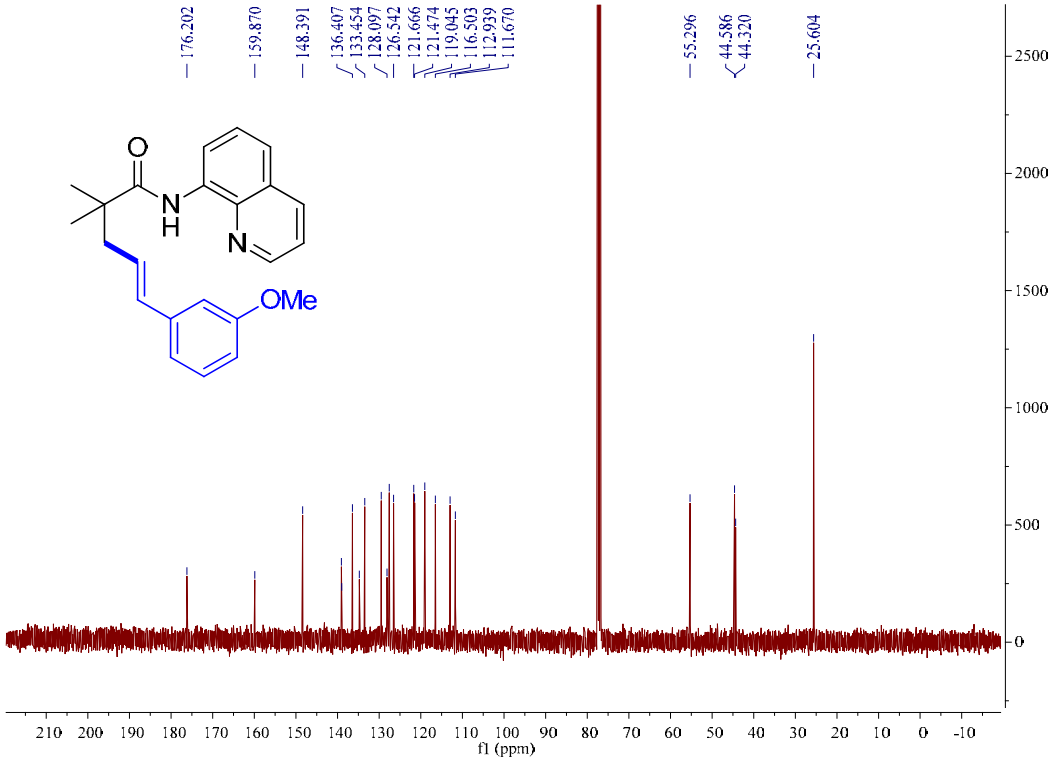
6.278
6.220
3.729
2.639
2.621
1.462
-0.000
O
N
H
N
OMe
1.00
0.95
1.04
1.04
2.05
1.02
0.99
1.02
1.04
1.03
0.99
0.99
1.03
3.02
2.00
6.01
f1 (ppm)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148.391
136.407
133.454
128.097
126.542
121.666
121.474
119.045
116.503
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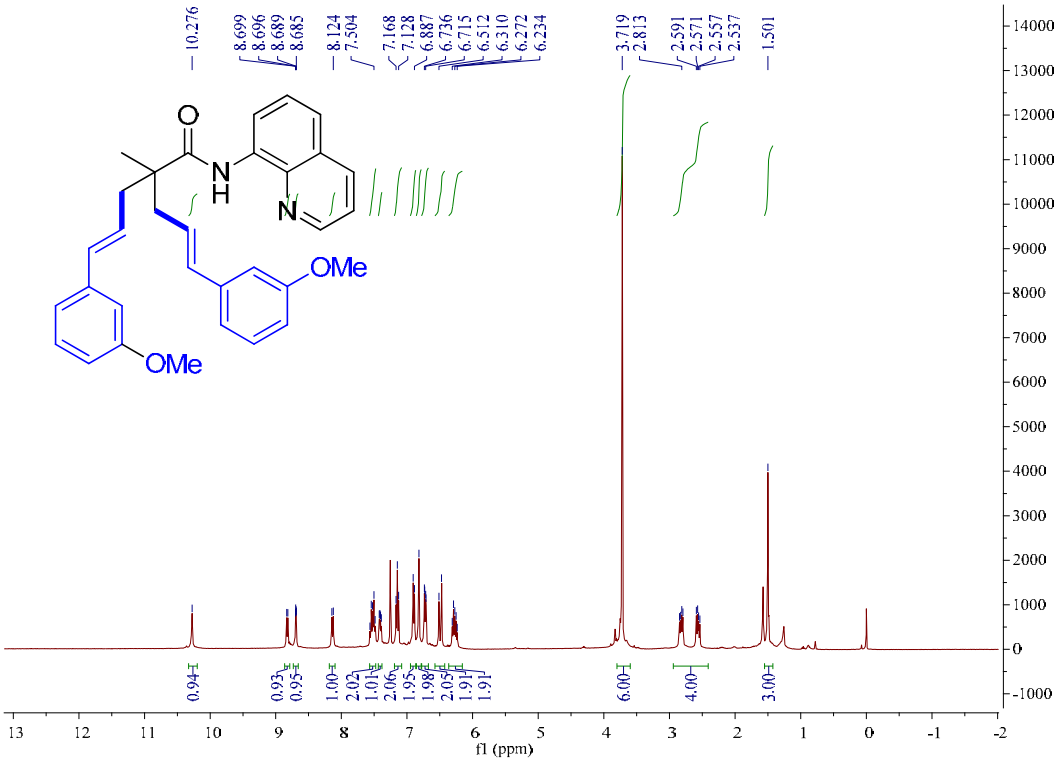
111.670
55.296
44.586
44.320
25.604
O
N
H
N
OMe
f1 (ppm)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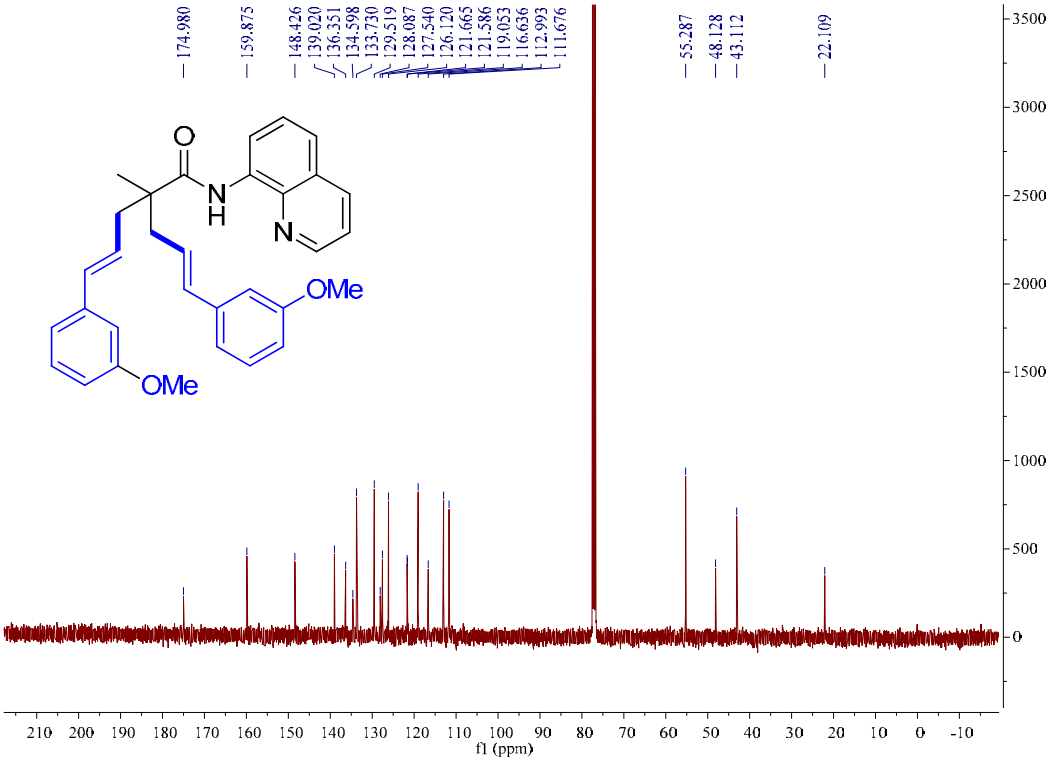
8.689
8.685
8.124
7.504
7.168
7.128
6.887
6.736
6.715
6.512
6.310
6.272
6.234
3.719
2.813
2.591
2.571
2.557
2.537
1.501
O
N
H
N
OMe
OMe
0.94
0.93
0.95
1.00
2.02
1.01
2.06
1.95
1.98
2.05
1.91
1.91
6.00
4.00
3.00
fl (ppm)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134.598
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129.519
128.087
127.540
126.120
121.665
121.586
119.053
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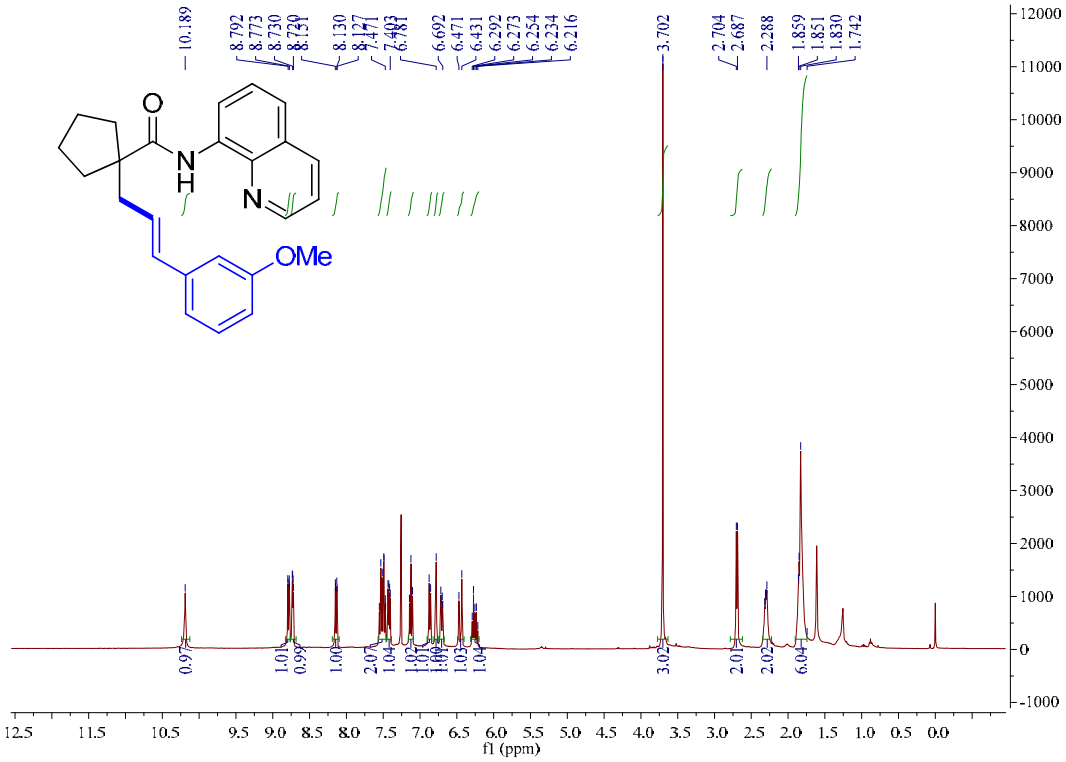
112.993
111.676
55.287
48.128
43.112
22.109
O
N
H
N
OMe
OMe
fl (ppm)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8.127
7.471
7.403
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6.471
6.431
6.292
6.273
6.254
6.234
6.216
3.702
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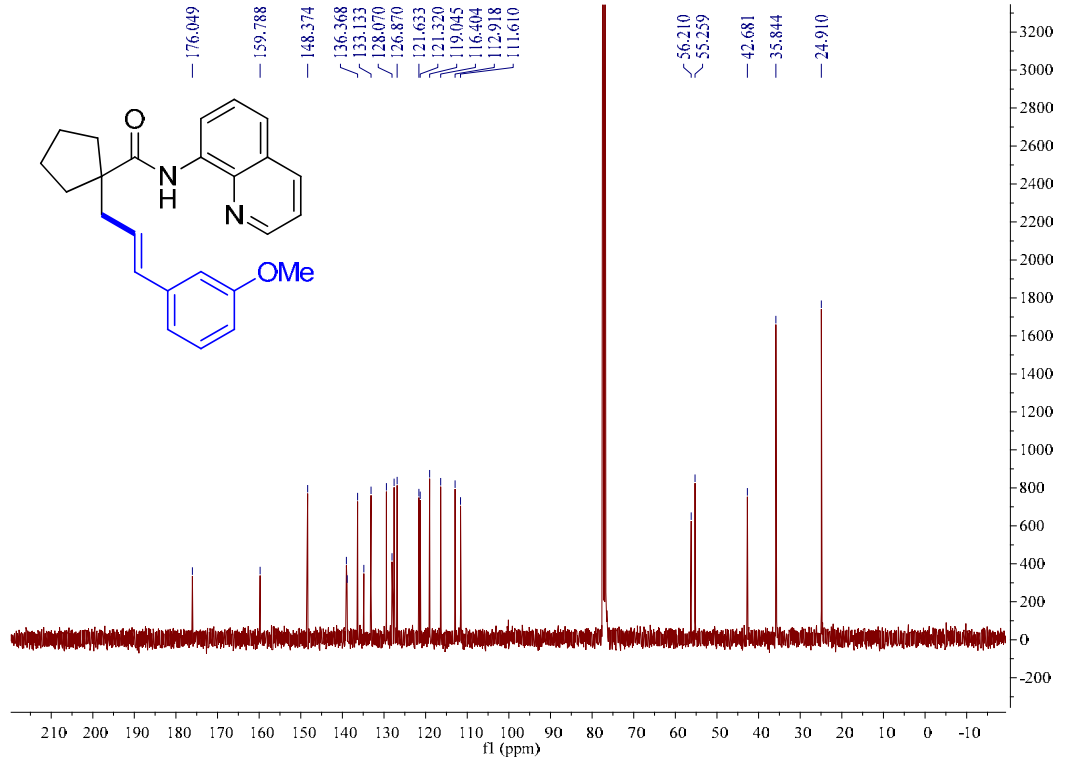
2.687
2.288
1.859
1.851
1.830
1.742
O
N
H
N
OMe
f1 (ppm)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116.404
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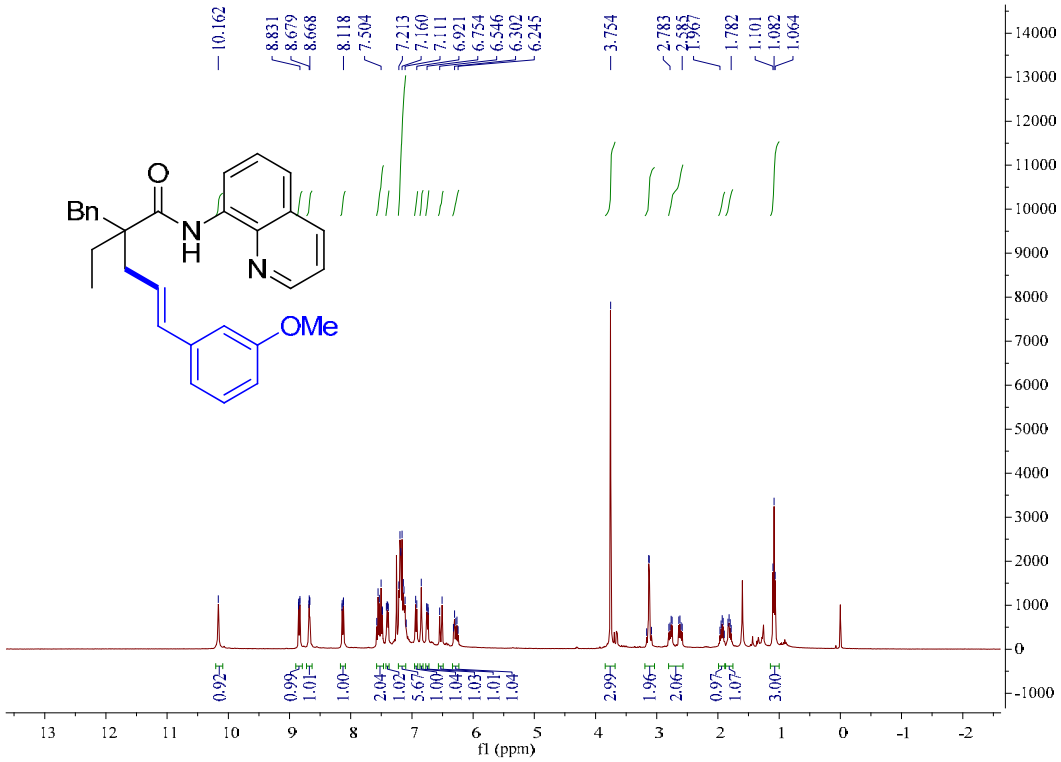
O
N
H
N
OMe
f1 (ppm)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7.213
7.160
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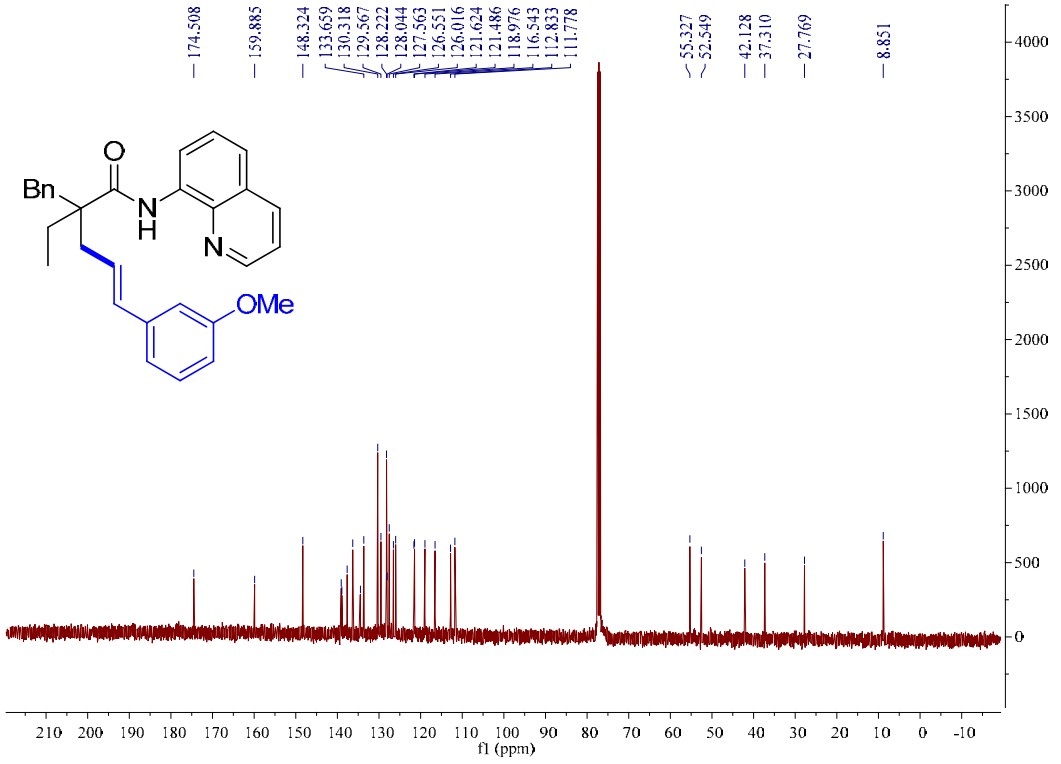
6.546
6.302
6.245
3.754
2.783
2.685
1.967
1.782
1.101
1.082
1.064
0.92
0.99
1.01
1.00
2.04
1.02
5.67
1.00
1.04
1.03
1.01
1.04
2.99
1.96
2.06
0.97
1.07
3.00
Bn
O
N
H
N
OMe
f1 (ppm)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126.551
126.016
121.624
121.486
118.976
116.543
112.833
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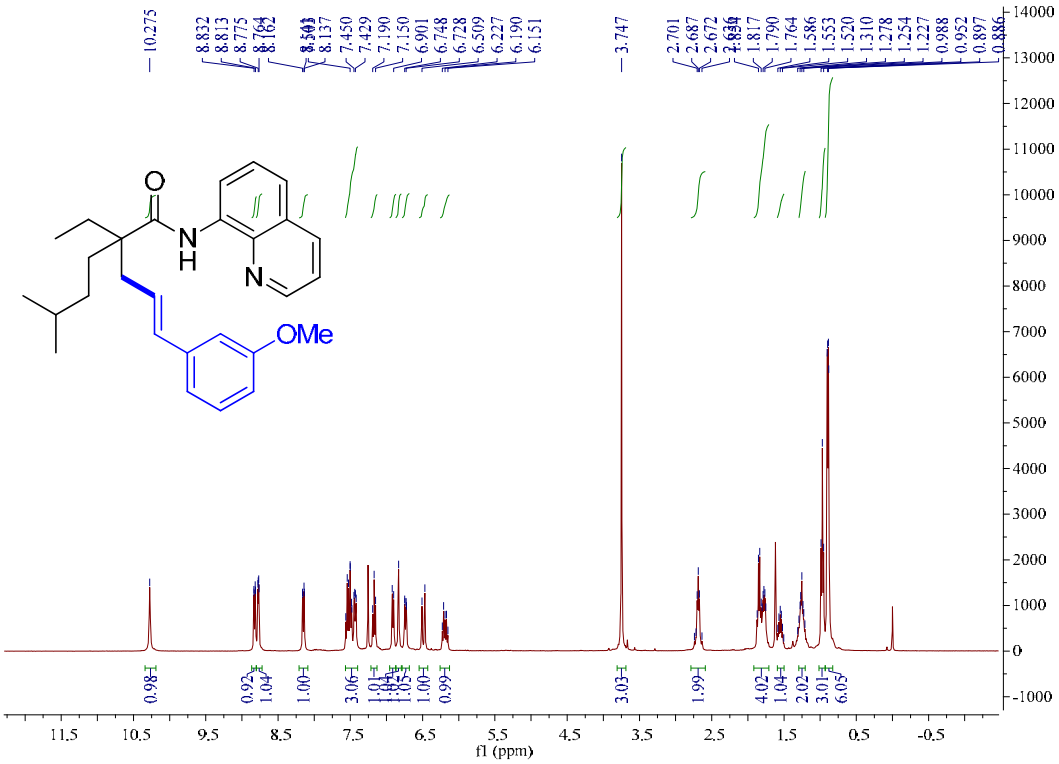
42.128
37.310
27.769
8.851
Bn
O
N
H
N
OMe
f1 (ppm)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7.450
7.429
7.190
7.150
6.901
6.748
6.728
6.509
6.227
6.190
6.151
3.747
2.701
2.687
2.672
1.817
1.790
1.764
1.586
1.553
1.520
1.310
1.278
1.254
1.227
0.988
0.952
0.897
0.886
O
N
H
N
OMe
0.98
0.92
1.04
1.00
3.06
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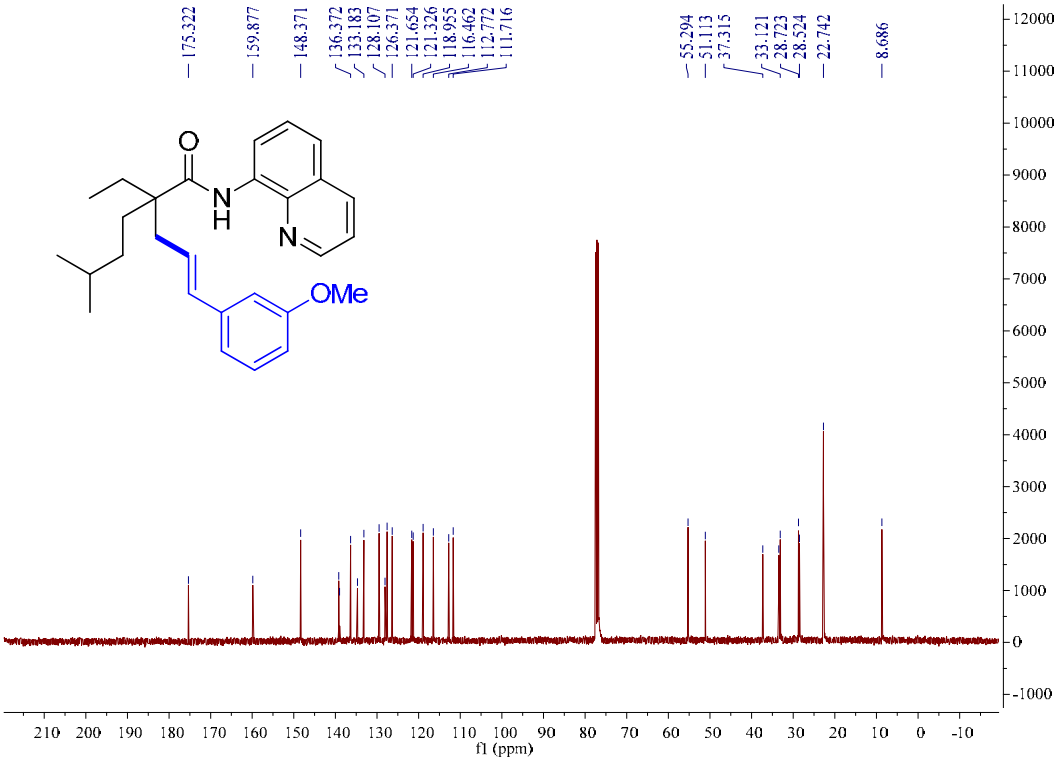
1.05
1.00
0.99
3.03
1.99
4.02
1.04
2.02
3.01
6.05
f1 (ppm)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55.294
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28.524
22.742
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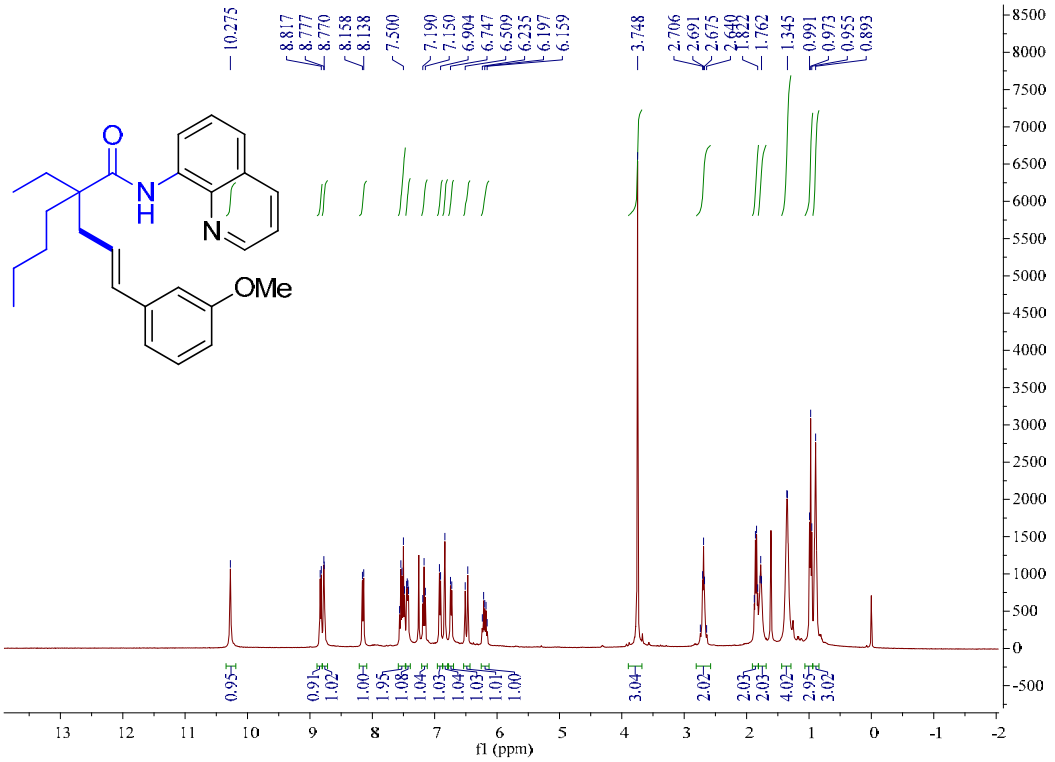
O
N
H
N
OMe
f1 (ppm)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8.770
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7.190
7.150
6.904
6.747
6.509
6.235
6.197
6.159
3.748
2.706
2.691
2.675
2.640
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O
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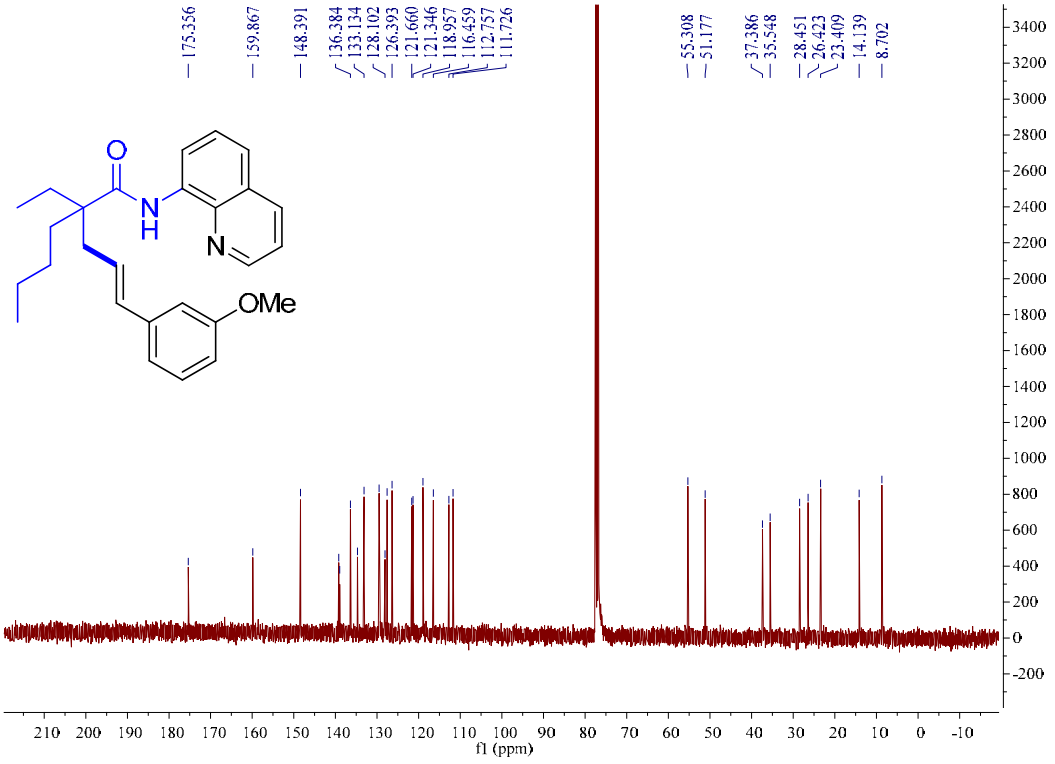
N
OMe
f1 (ppm)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55.308
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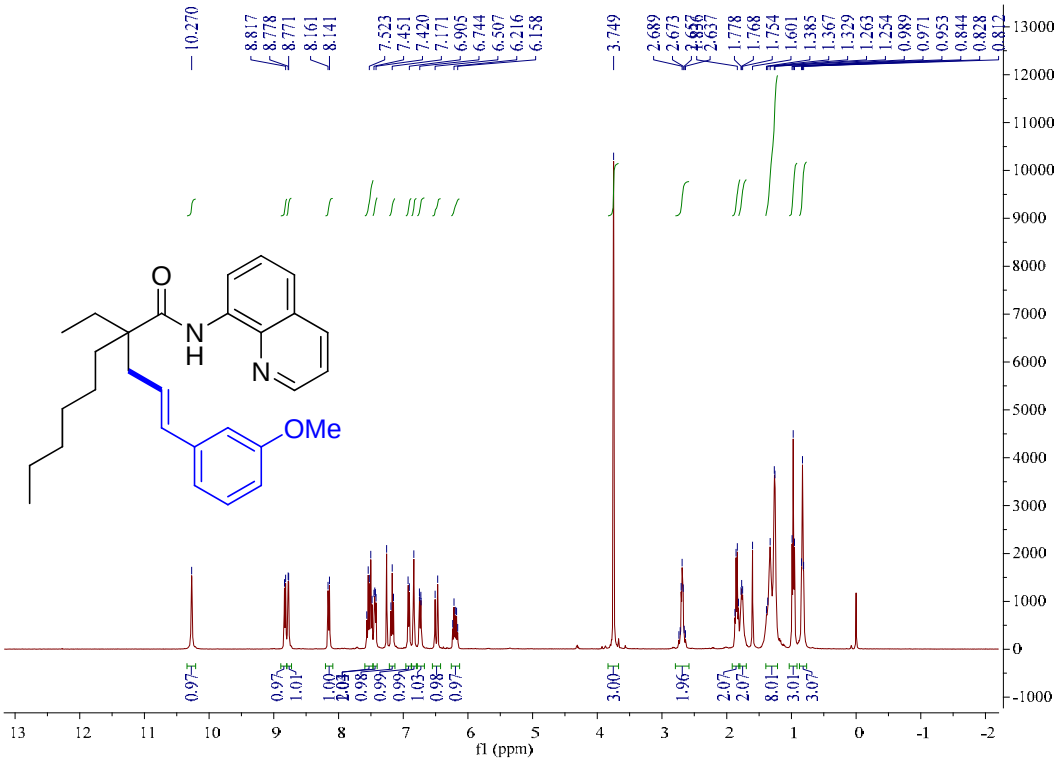
28.451
26.423
23.409
14.139
8.702
O
N
H
N
OMe
f1 (ppm)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7.451
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6.507
6.216
6.158
3.749
2.689
2.673
2.637
1.778
1.768
1.754
1.601
1.385
1.367
1.329
1.263
1.254
0.989
0.971
0.953
0.844
0.828
0.812
O
N
H
N
OMe
0.97
0.97
1.01
1.00
2.04
0.98
0.99
0.99
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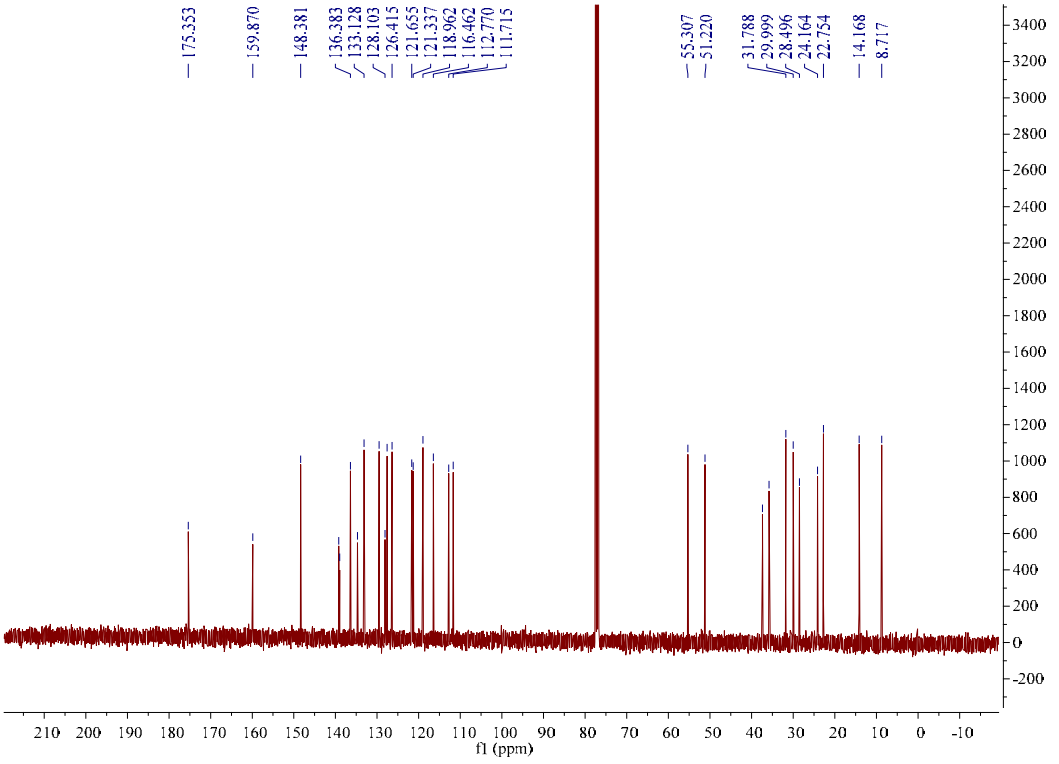
0.97
3.00
1.96
2.07
2.07
8.01
3.01
3.07
f1 (ppm)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29.999
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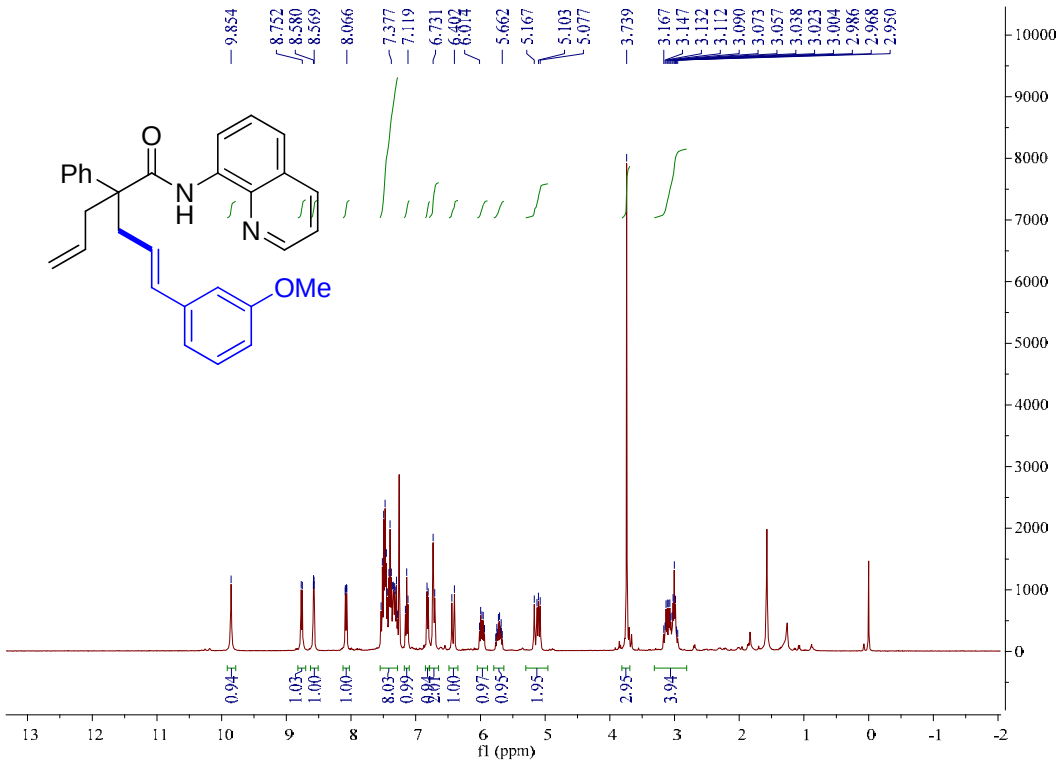
8.717
f1 (ppm)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5.077
3.739
3.167
3.147
3.132
3.112
3.090
3.073
3.057
3.038
3.023
3.004
2.986
2.968
2.950
Ph
O
N
H
N
OMe
0.94
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1.00
0.97
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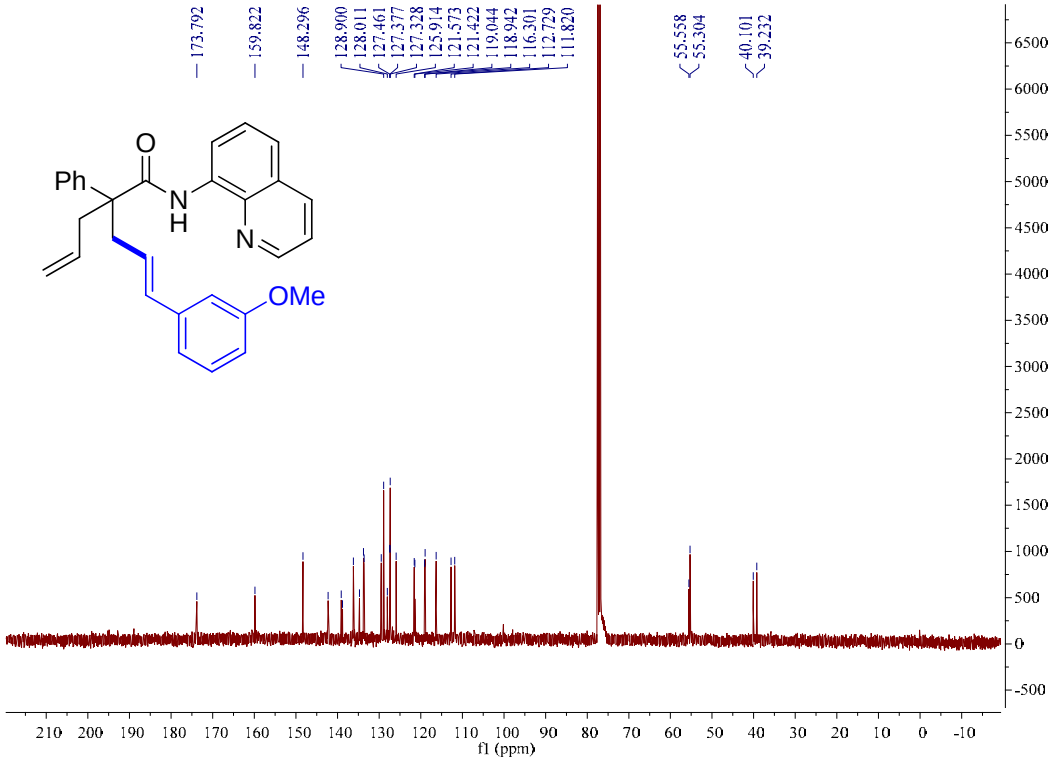
3.94
f1 (ppm)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118.942
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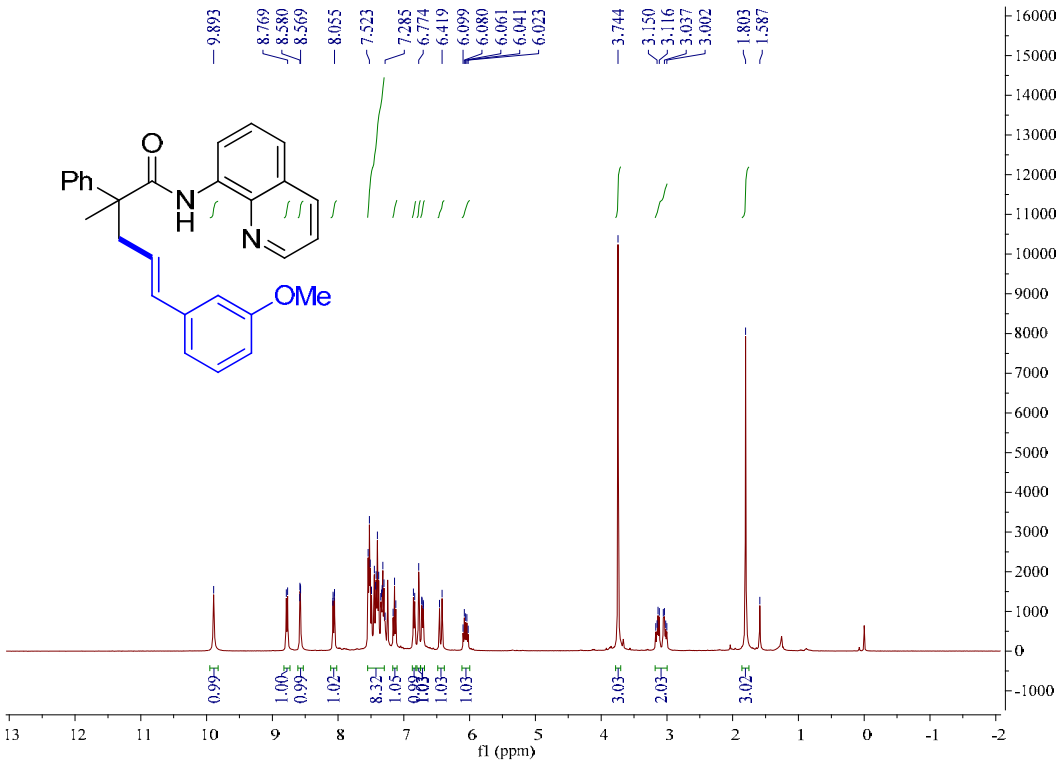
40.101
39.232
Ph
O
N
H
N
OMe
f1 (ppm)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6.041
6.023
3.744
3.150
3.116
3.037
3.002
1.803
1.587
Ph
O
N
H
N
OMe
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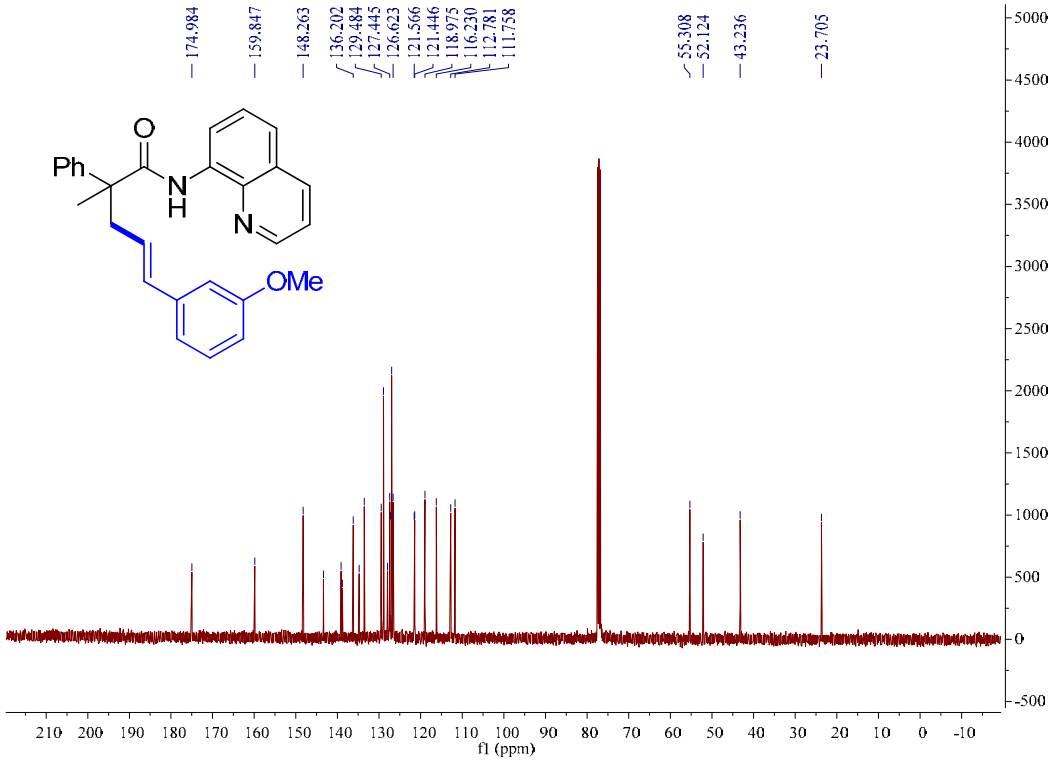
8.32
1.05
1.03
1.03
3.03
2.03
3.02
f1 (ppm)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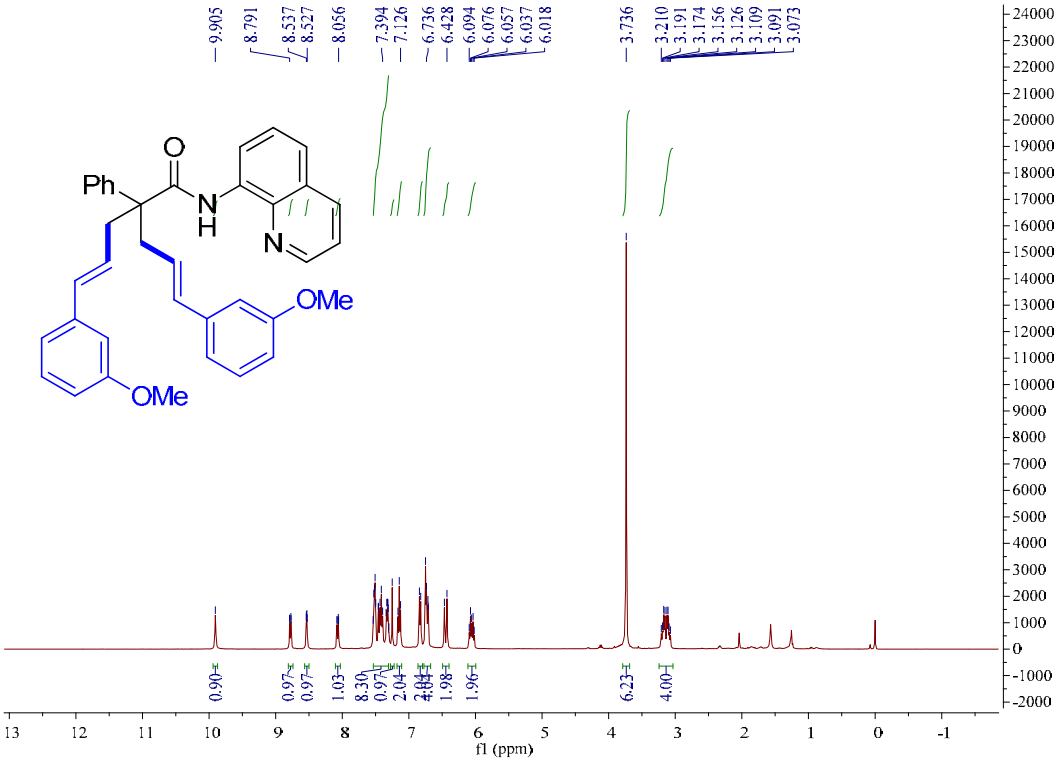
55.308
52.124
43.236
23.705
Ph
O
N
H
N
OMe
f1 (ppm)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6.057
6.037
6.018
3.736
3.210
3.191
3.174
3.156
3.126
3.109
3.091
3.073
Ph
O
N
H
N
OMe
OMe
0.90
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2.04
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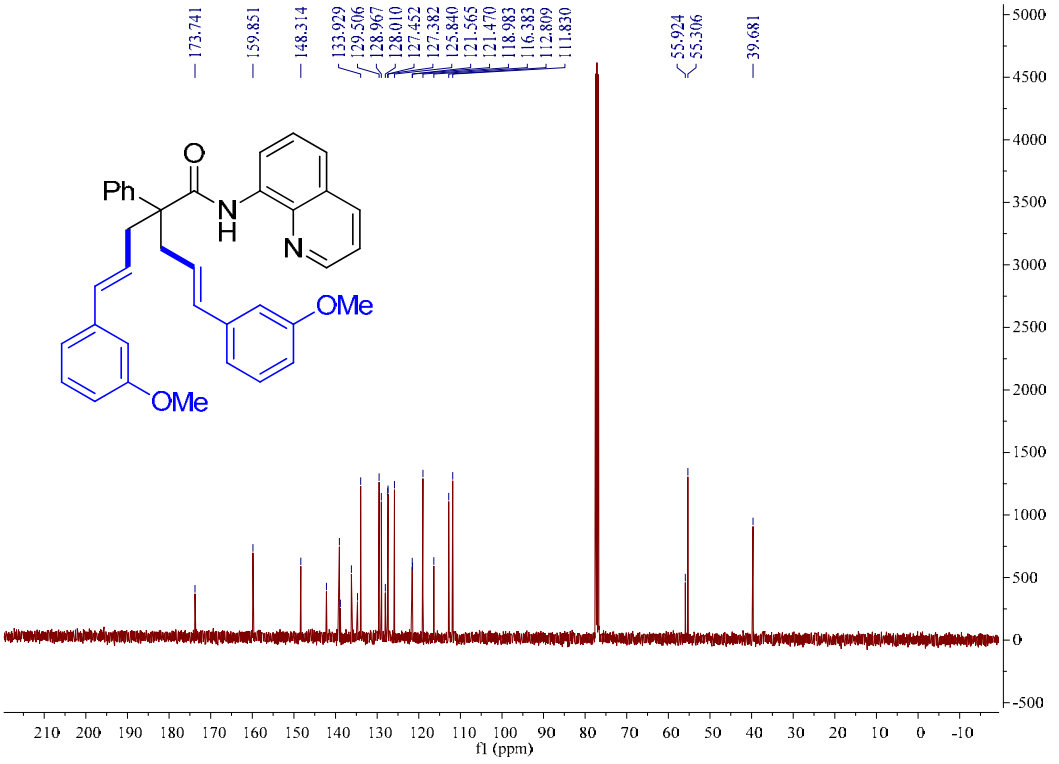
1.96
6.23
4.00
f1 (ppm)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121.470
118.983
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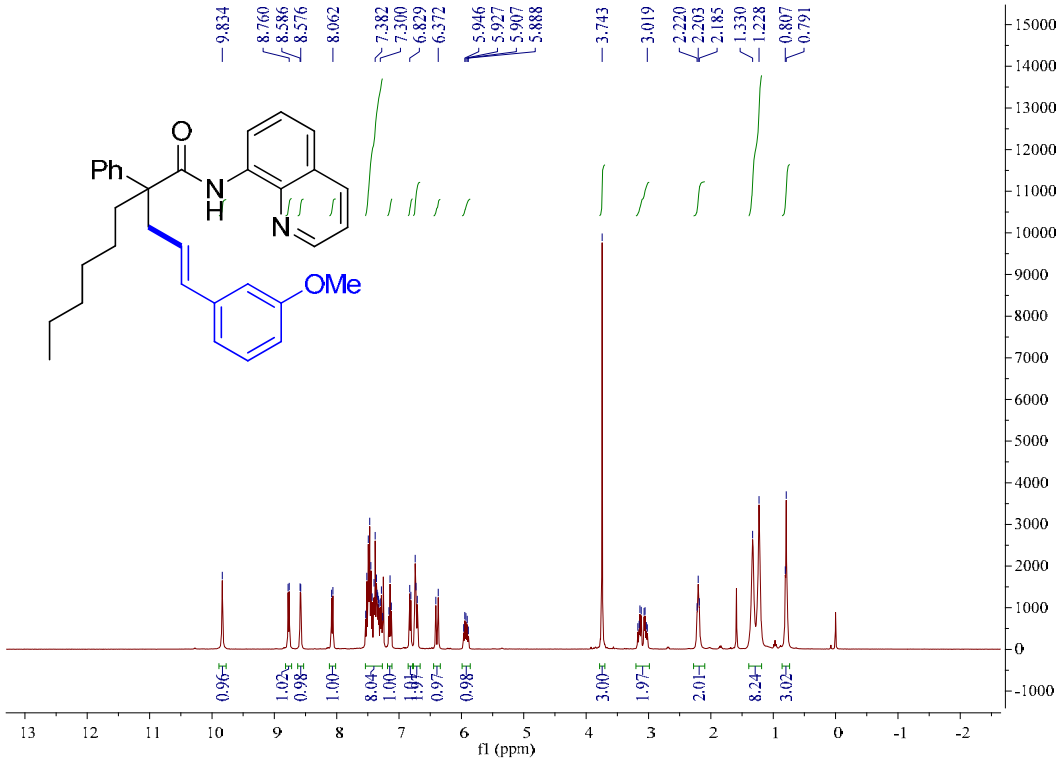
55.924
55.306
39.681
Ph
O
N
H
N
OMe
OMe
f1 (ppm)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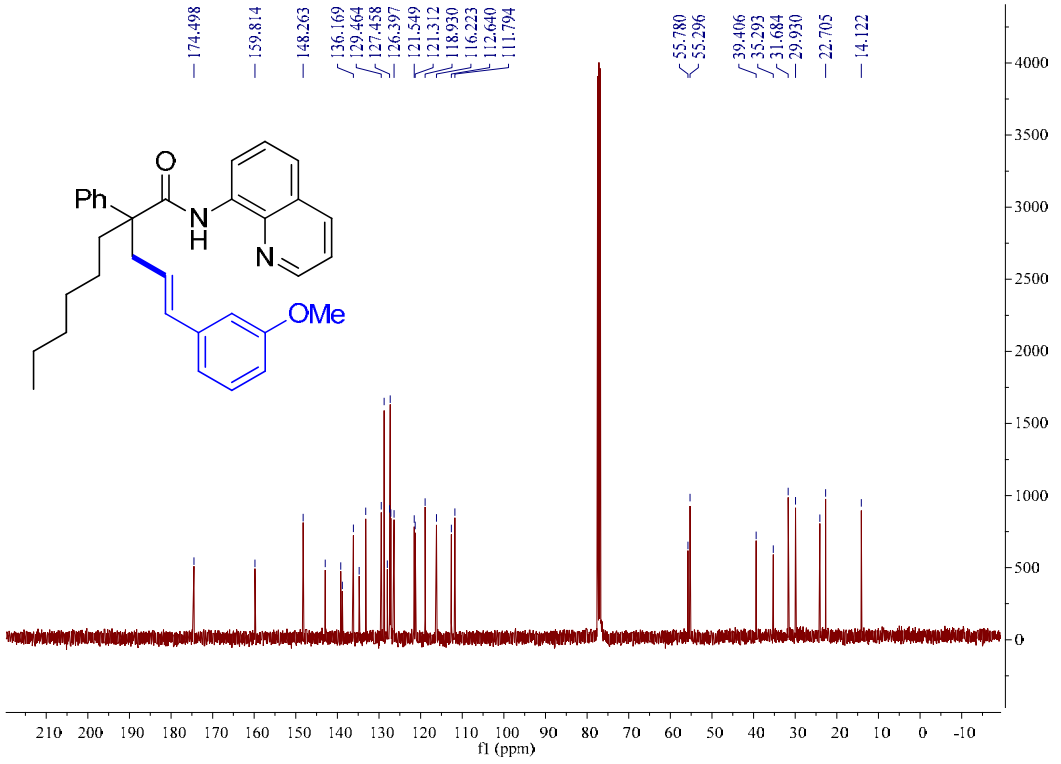
5.888
3.743
3.019
2.220
2.203
2.185
1.330
1.228
0.807
0.791
O
Ph
N
H
N
OMe
0.96
1.02
0.98
1.00
8.04
1.00
1.01
0.97
0.98
3.00
1.97
2.01
8.24
3.02
f1 (ppm)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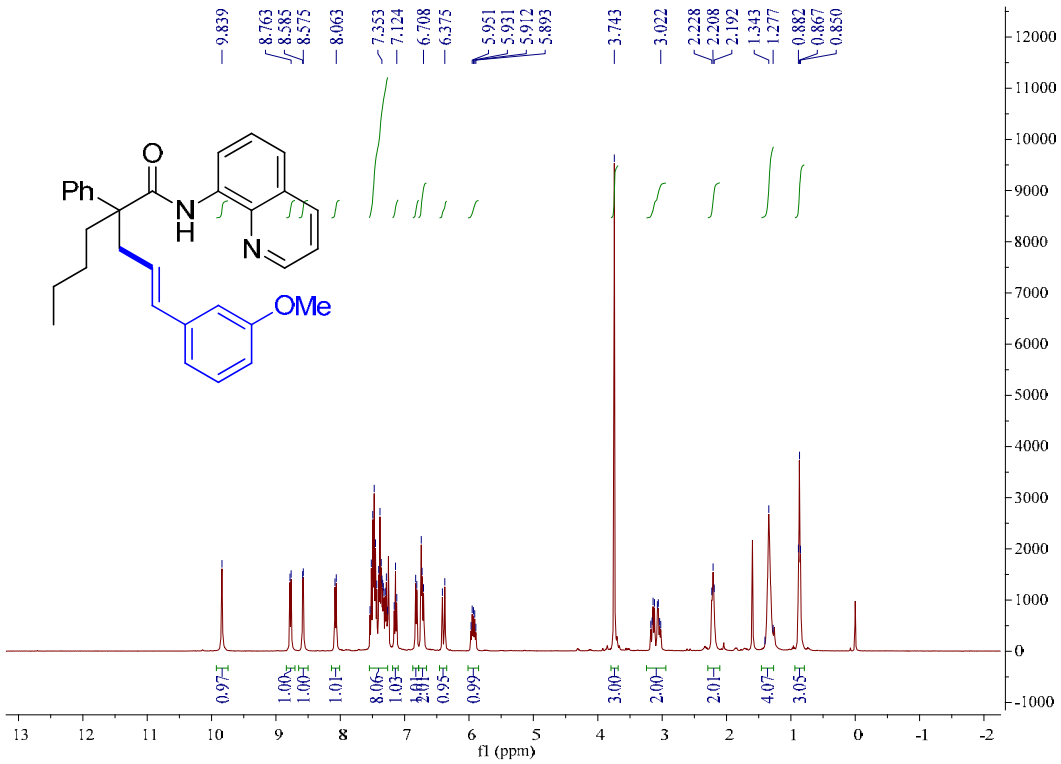
148.263
136.169
129.464
127.458
126.397
121.549
121.312
118.930
116.223
112.640
111.794
55.780
55.296
39.406
35.293
31.684
29.930
22.705
14.122
O
Ph
N
H
N
OMe
f1 (ppm)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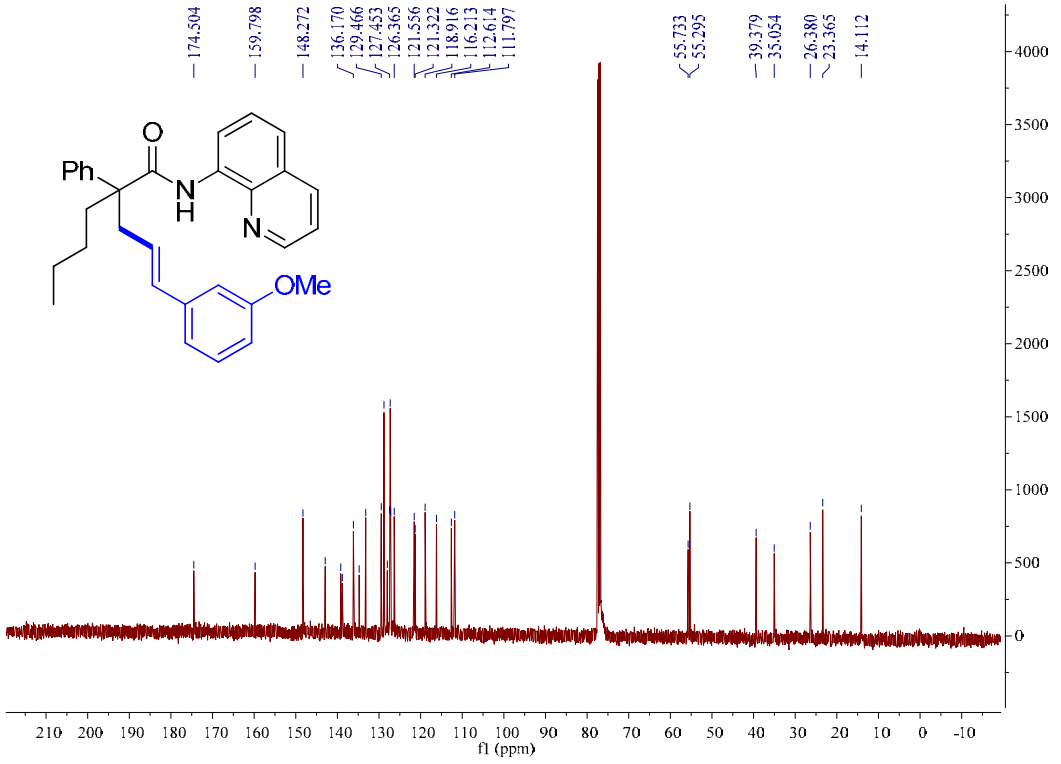
8.585
8.575
8.063
7.353
7.124
6.708
6.375
5.951
5.931
5.912
5.893
3.743
3.022
2.228
2.208
2.192
1.343
1.277
0.882
0.867
0.850
Ph
O
N
H
N
OMe
f1 (ppm)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148.272
136.170
129.466
127.453
126.365
121.556
121.322
118.916
116.213
112.614
111.797
55.733
55.295
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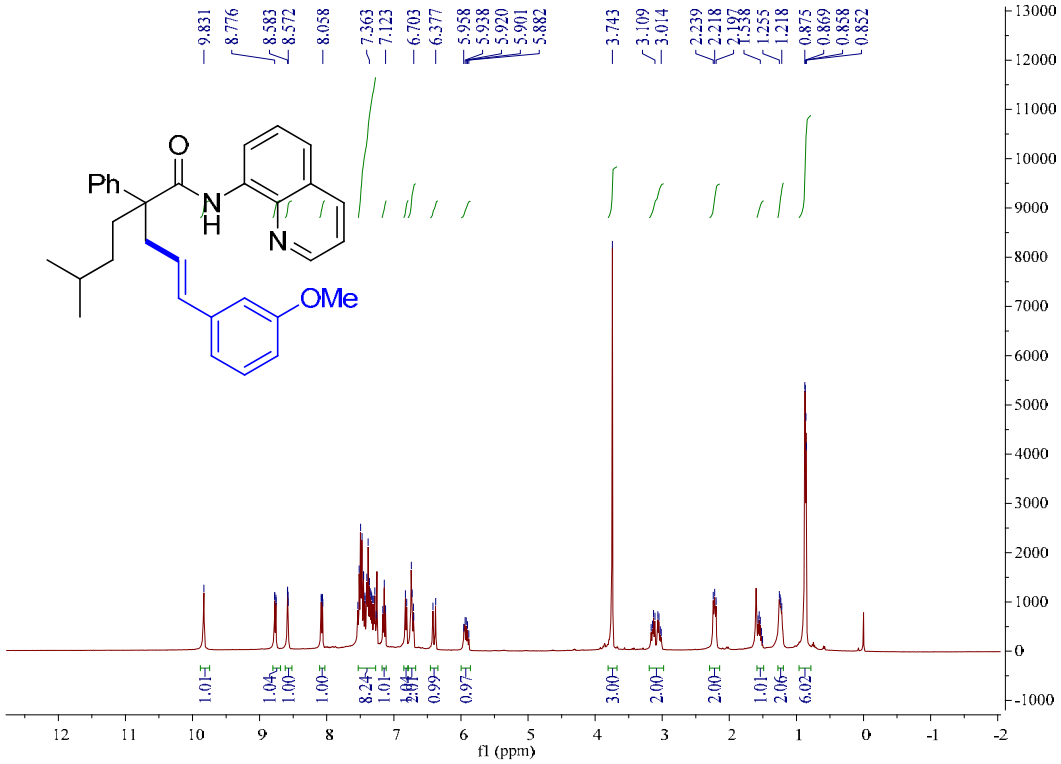
35.054
26.380
23.365
14.112
Ph
O
N
H
N
OMe
f1 (ppm)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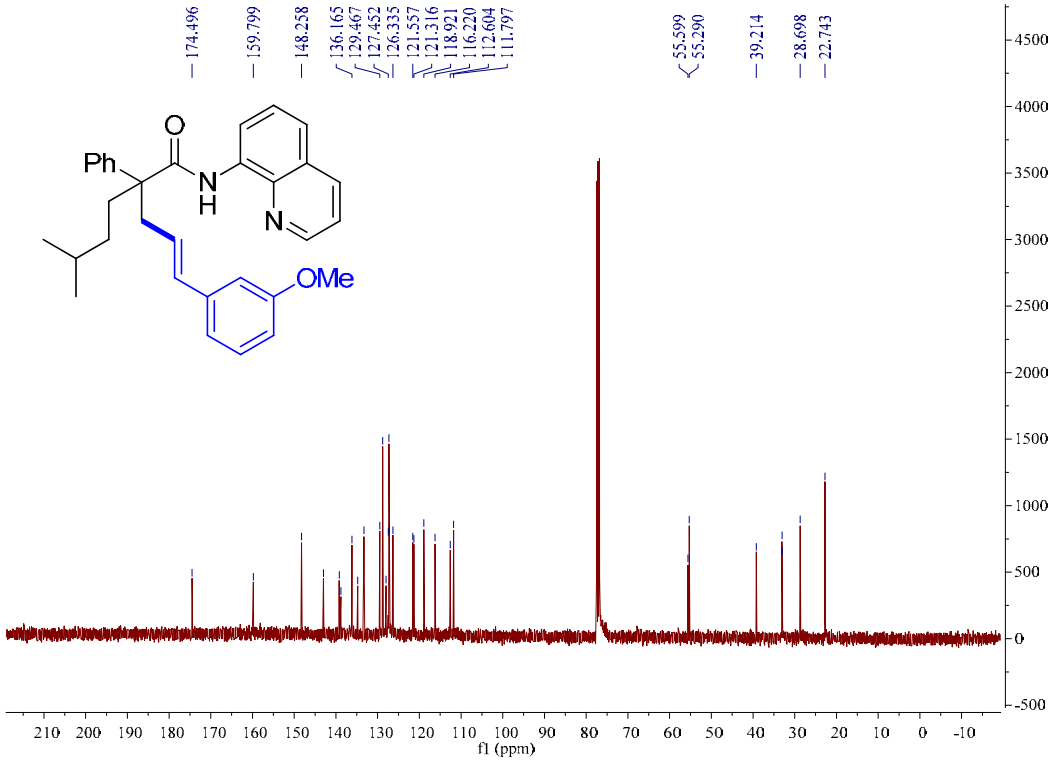
8.583
8.572
8.058
7.363
7.123
6.703
6.377
5.958
5.938
5.920
5.901
5.882
3.743
3.109
3.014
2.239
2.218
2.197
1.338
1.255
1.218
0.875
0.869
0.858
0.852
Ph
O
N
H
N
OMe
f1 (ppm)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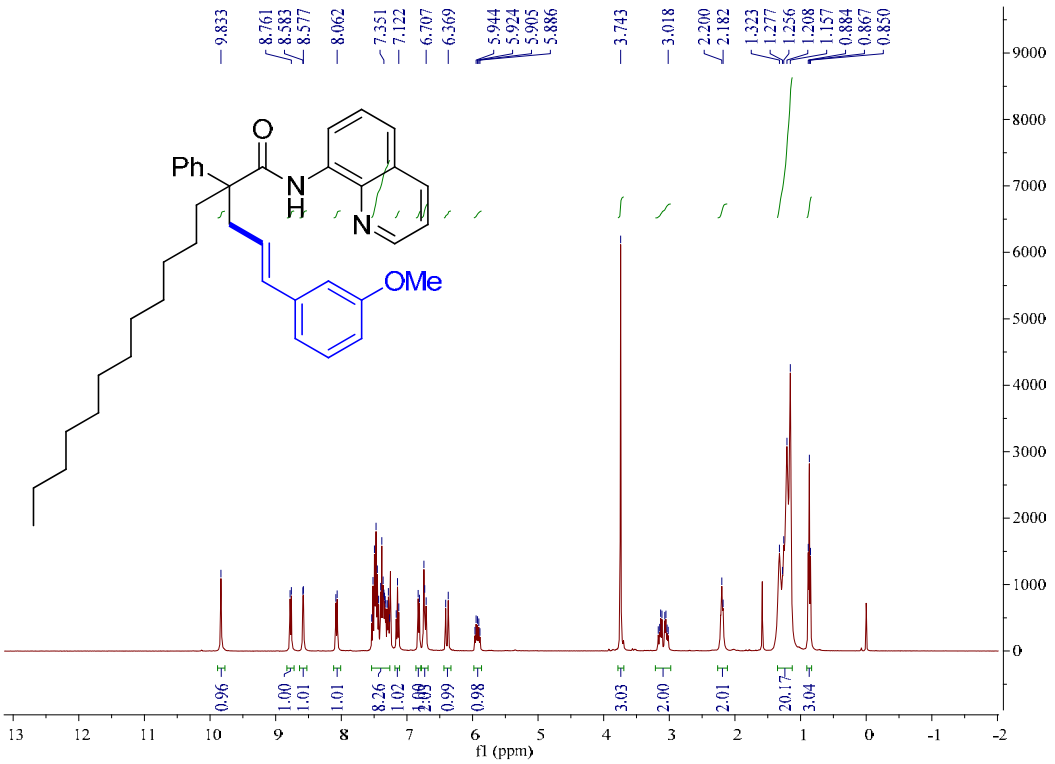
136.165
129.467
127.452
126.335
121.557
121.316
118.921
116.220
112.604
111.797
55.599
55.290
39.214
28.698
22.743
Ph
O
N
H
N
OMe
f1 (ppm)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8.577
8.062
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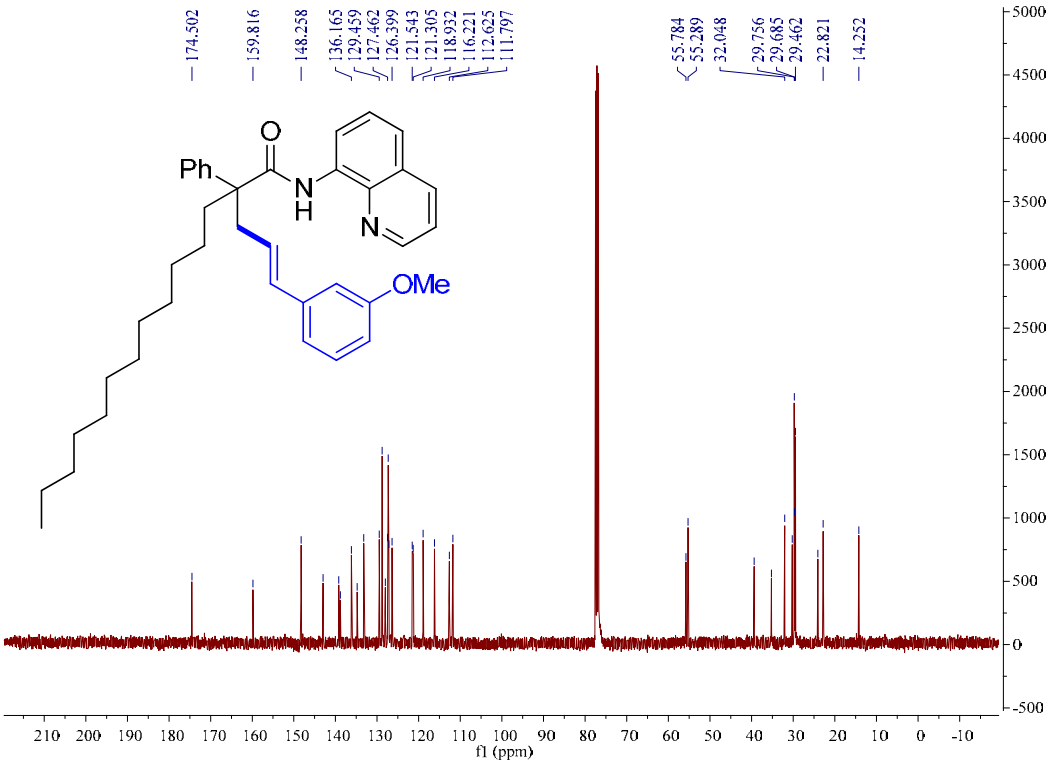
7.122
6.707
6.369
5.944
5.924
5.905
5.886
3.743
3.018
2.200
2.182
1.323
1.277
1.256
1.208
1.157
0.884
0.867
0.850
O
Ph
N
H
N
OMe
0.96
1.00
1.01
1.01
8.26
1.02
0.99
0.98
3.03
2.00
2.01
20.17
3.04
f1 (ppm)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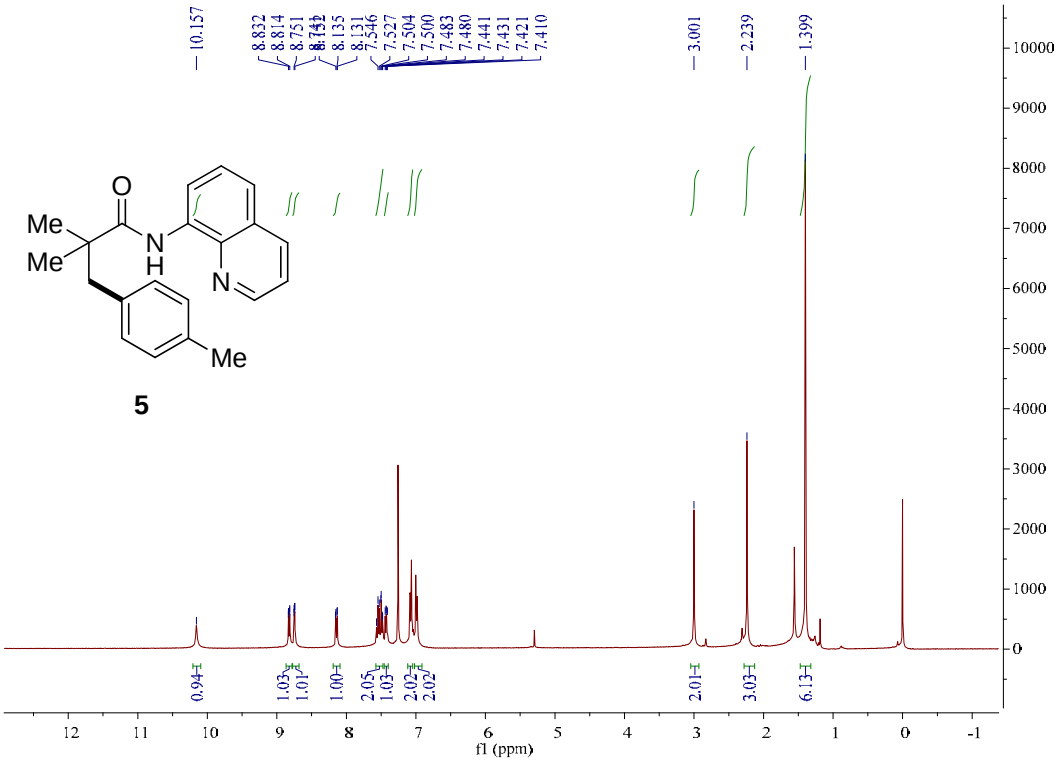
159.816
148.258
136.165
129.459
127.462
126.399
121.543
121.305
118.932
116.221
112.625
111.797
55.784
55.289
32.048
29.756
29.685
29.462
22.821
14.252
O
Ph
N
H
N
OMe
f1 (ppm)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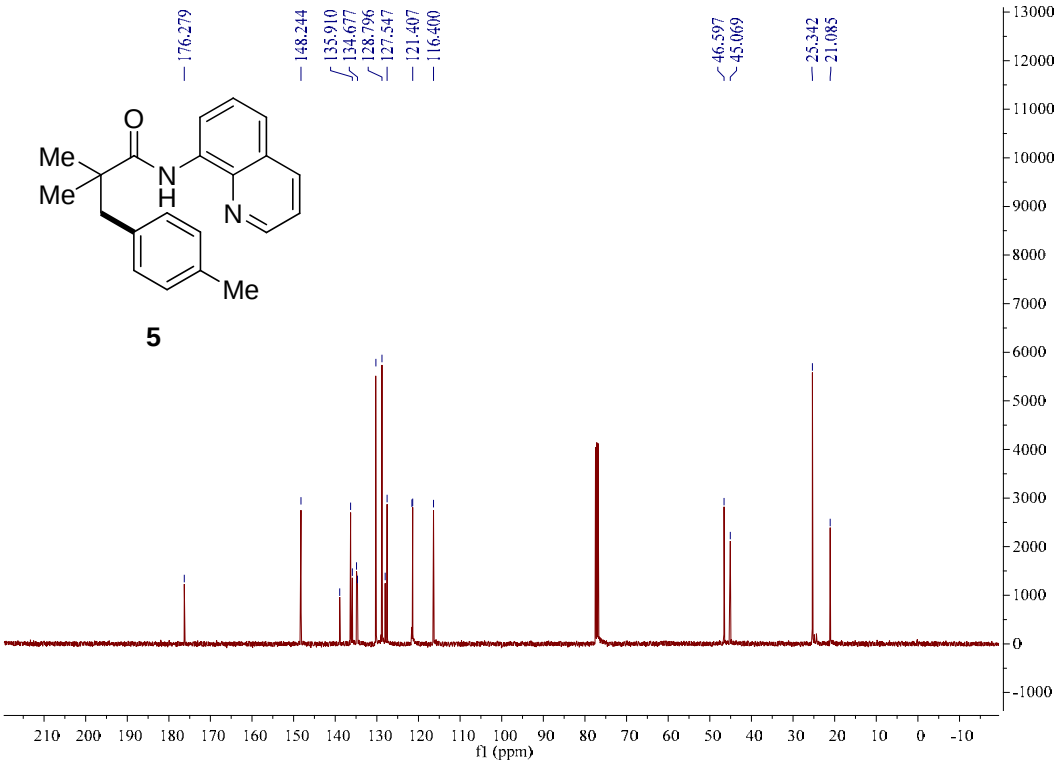
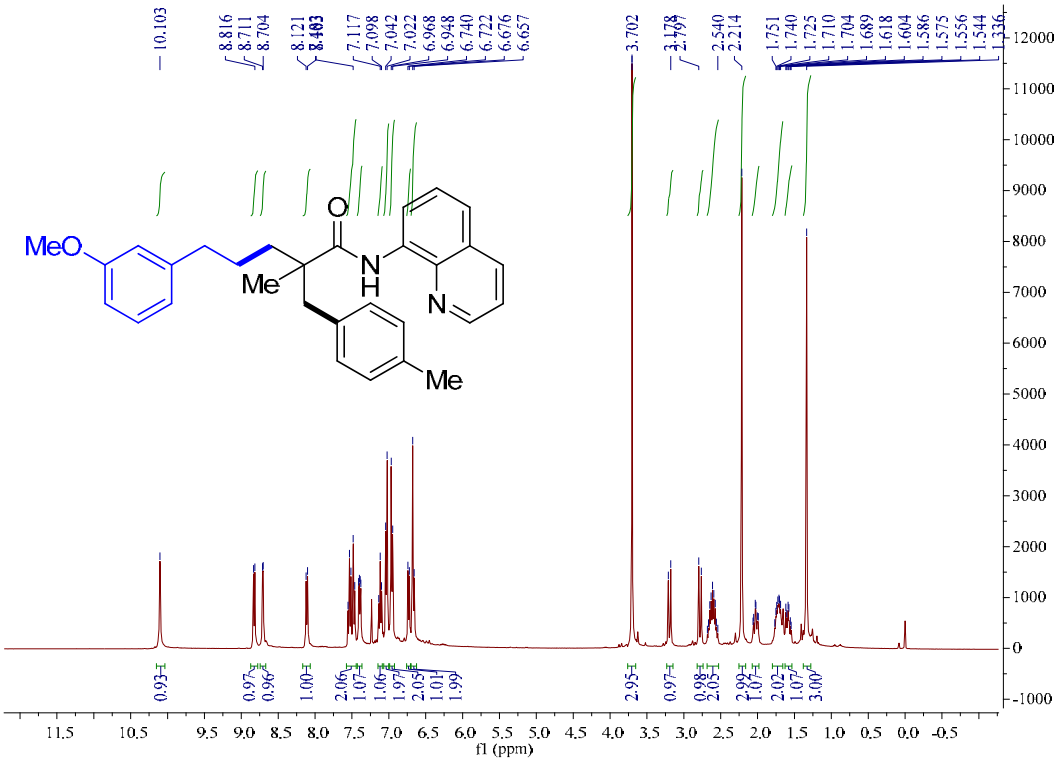
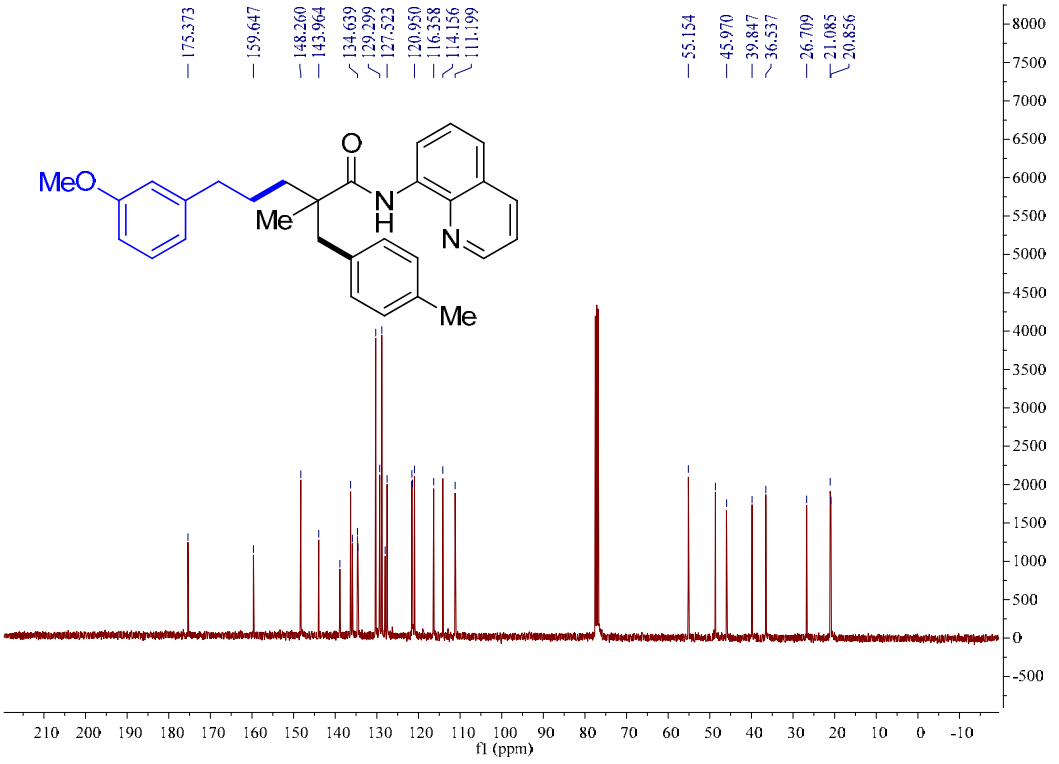
8.832
8.814
8.751
8.135
8.131
7.546
7.527
7.504
7.500
7.483
7.480
7.441
7.431
7.421
7.410
3.001
2.239
1.399
Me
Me
O
N
H
N
Me
0.94
1.03
1.01
1.00
2.05
1.03
2.02
2.02
2.01
3.03
6.13
f1 (ppm)

5


176.279
148.244
135.910
134.677
128.796
127.547
121.407
116.400
46.597
45.069
25.342
21.085
Me
Me
O
N
H
N
Me
f1 (ppm)

5


10.103
8.816
8.711
8.704
8.121
7.117
7.098
7.042
7.022
6.968
6.948
6.740
6.722
6.676
6.657
3.702
3.178
2.797
2.540
2.214
1.751
1.740
1.725
1.710
1.704
1.689
1.618
1.604
1.586
1.575
1.556
1.544
1.336
MeO
O
N
H
Me
N
Me
0.93
0.97
0.96
1.00
2.06
1.07
1.06
1.97
2.05
1.01
1.99
2.95
0.97
0.98
2.05
2.99
1.07
2.02
1.07
3.00
f1 (ppm)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127.523
120.950
116.358
114.156
111.199
55.154
45.970
39.847
36.537
26.709
21.085
20.856
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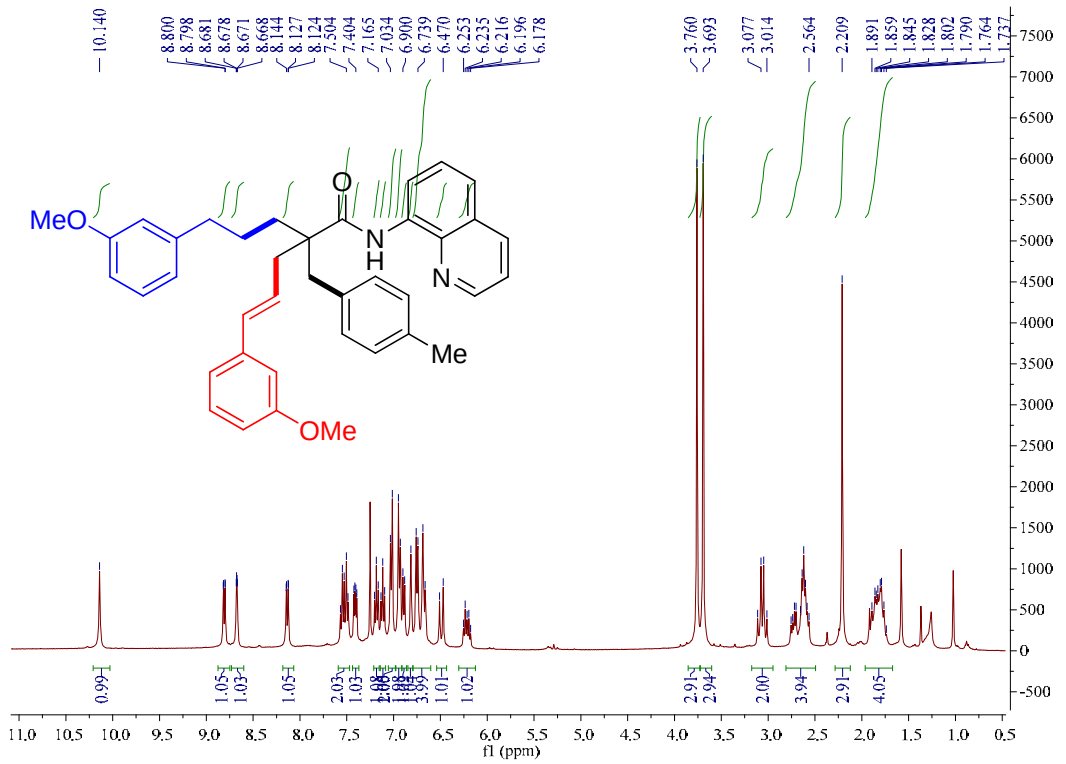
O
N
H
Me
N
Me
f1 (ppm)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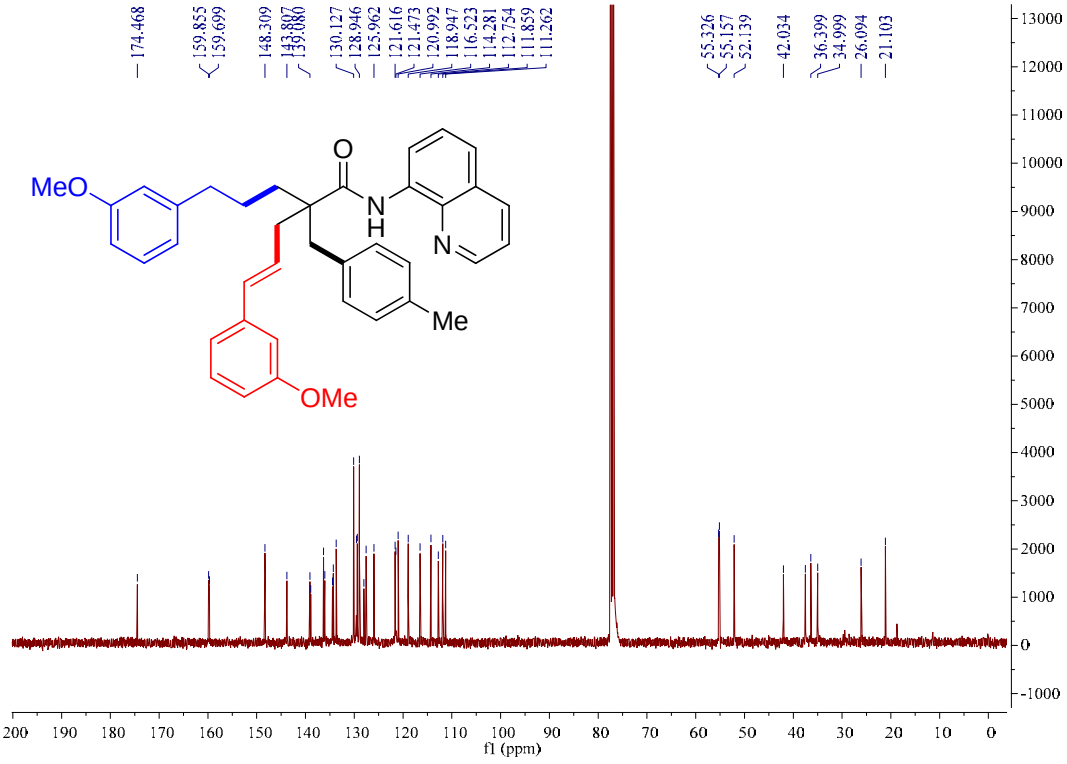
8.671
8.668
8.144
8.127
8.124
7.504
7.404
7.165
7.034
6.900
6.739
6.470
6.253
6.235
6.216
6.196
6.178
3.760
3.693
3.077
3.014
2.564
2.209
1.891
1.859
1.845
1.828
1.802
1.790
1.764
1.737
MeO
O
N
H
N
Me
OMe
0.99
1.05
1.03
1.05
2.03
1.03
3.99
1.01
1.02
2.91
2.94
2.00
3.94
2.91
4.05
f1 (ppm)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159.699
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128.946
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121.616
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118.947
116.523
114.281
112.754
111.859
111.262
55.326
55.157
52.139
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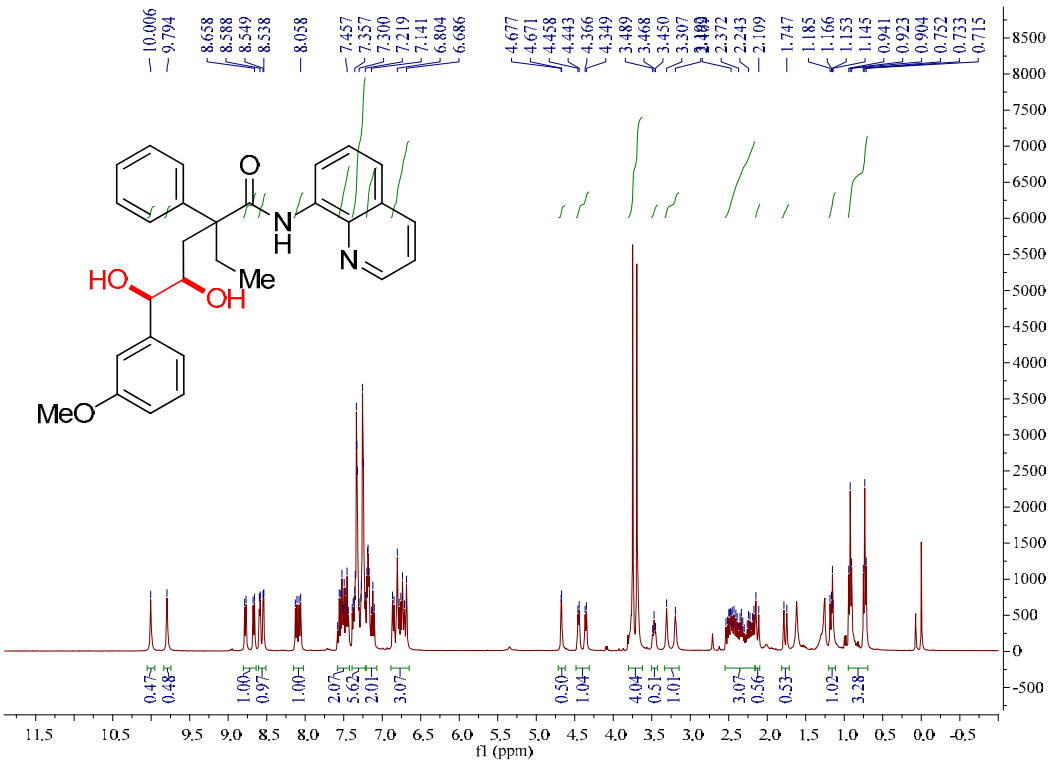
36.399
34.999
26.094
21.103
MeO
O
N
H
N
Me
OMe
f1 (ppm)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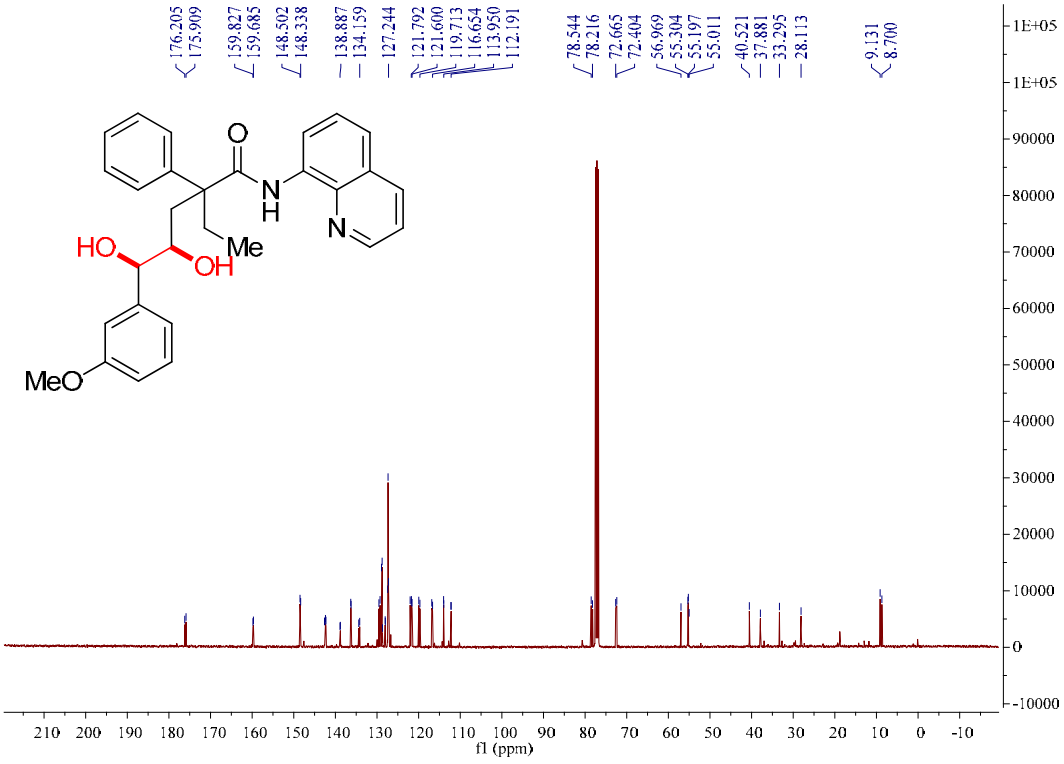
8.549
8.538
8.058
7.457
7.357
7.300
7.219
7.141
6.804
6.686
4.677
4.671
4.458
4.443
4.366
4.349
3.489
3.468
3.450
3.307
2.372
2.243
2.109
1.747
1.185
1.166
1.153
1.145
0.941
0.923
0.904
0.752
0.733
0.715
O
N
H
N
HO
OH
Me
MeO
0.47
0.48
1.00
0.97
1.00
2.07
5.62
2.01
3.07
0.50
1.04
4.04
0.51
1.01
3.07
0.56
0.53
1.02
3.28
f1 (ppm)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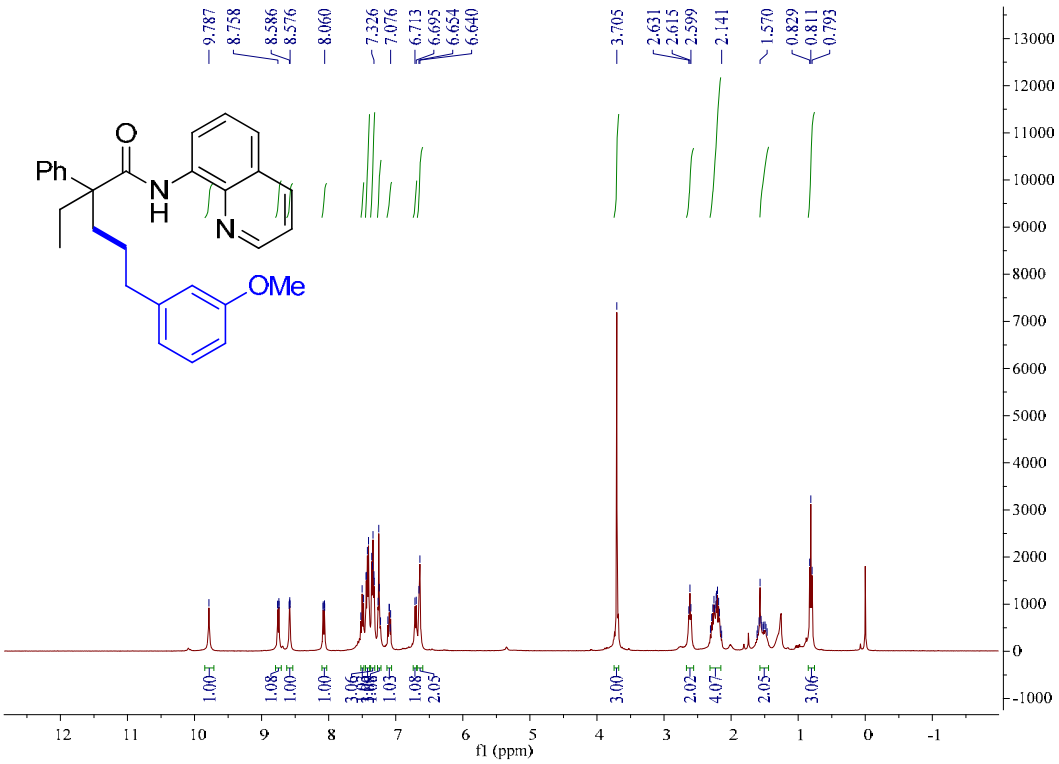
175.909
159.827
159.685
148.502
148.338
138.887
134.159
127.244
121.792
121.600
119.713
116.654
113.950
112.191
78.544
78.216
72.665
72.404
56.969
55.304
55.197
55.011
40.521
37.881
33.295
28.113
9.131
8.700
O
N
H
N
HO
OH
Me
MeO
f1 (ppm)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8.576
8.060
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7.076
6.713
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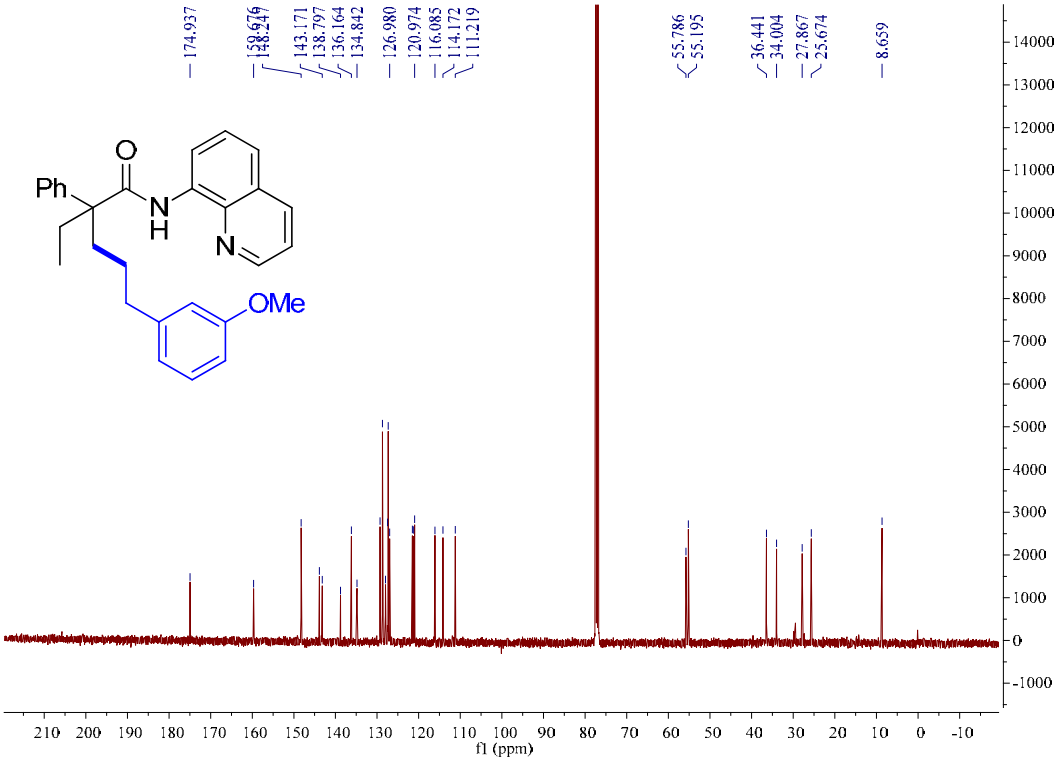
6.654
6.640
3.705
2.631
2.615
2.599
2.141
1.570
0.829
0.811
0.793
Ph
O
N
H
N
OMe
1.00
1.08
1.00
1.00
3.06
1.03
1.08
2.05
3.00
2.02
4.07
2.05
3.06
f1 (ppm)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136.164
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126.980
120.974
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114.172
111.219
55.786
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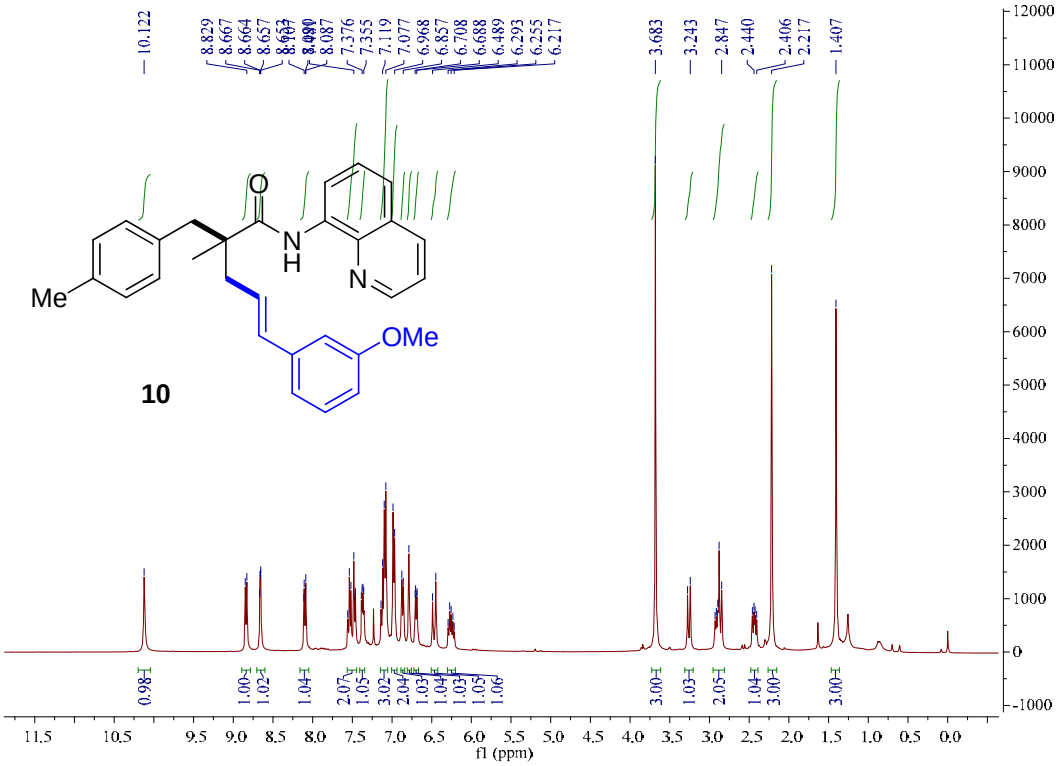
36.441
34.004
27.867
25.674
8.659
Ph
O
N
H
N
OMe
f1 (ppm)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8.087
7.376
7.355
7.119
7.077
6.968
6.857
6.708
6.688
6.489
6.293
6.255
6.217
3.683
3.243
2.847
2.440
2.406
2.217
1.407
Me
O
N
H
N
OMe
10
0.98
1.00
1.02
1.04
2.07
1.05
3.02
2.04
1.03
1.04
1.03
1.06
3.00
1.03
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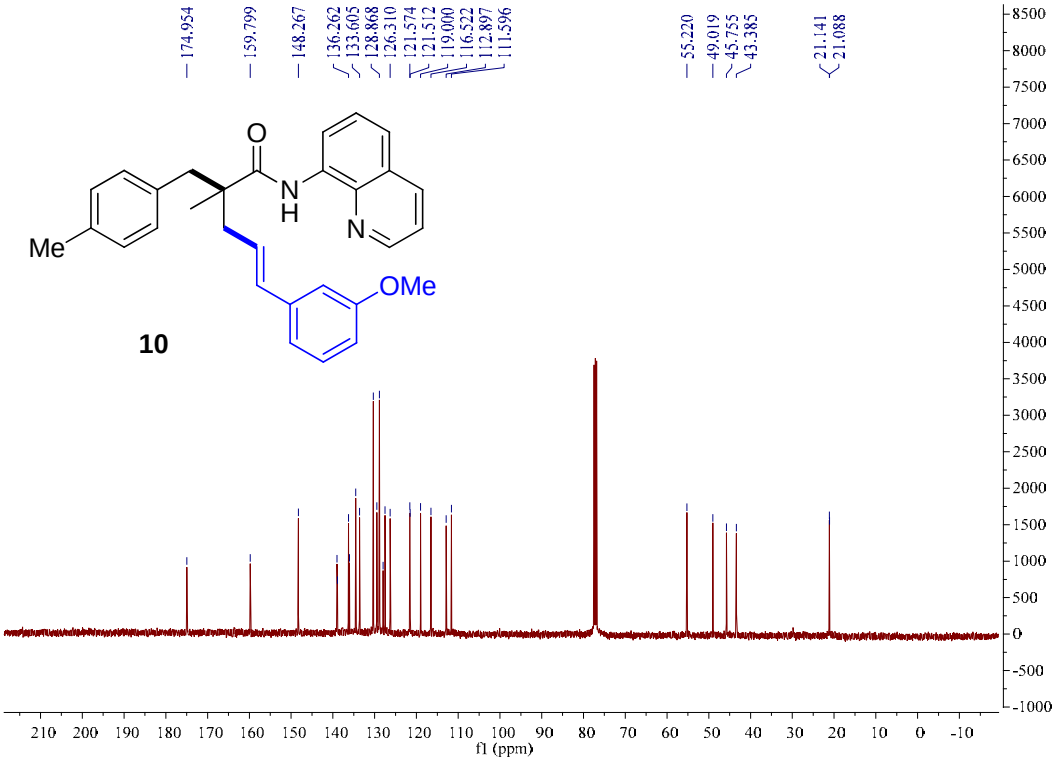
1.04
3.00
3.00
f1 (ppm)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148.267
136.262
133.605
128.868
126.310
121.574
121.512
119.000
116.522
112.897
111.596
55.220
49.019
45.755
43.385
21.141
21.088
Me
O
N
H
N
OMe
10
f1 (ppm)