Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Supporting Information

for

Highly selective and additive-free $Pd(OAc)_2$/CPP catalyzed hydroaminocarbonylation of alkynes

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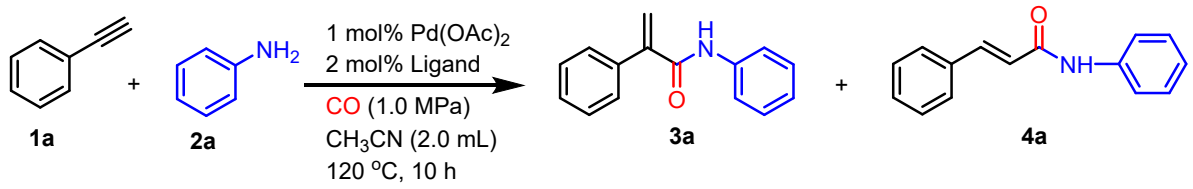
S1. General Information: Marterials and Methods

All commercial reagents were ordered from commercial suppliers, unless otherwise stated, commercial reagents were used without purification.

NMR spectra, including ^{1}H NMR (400 MHz), ^{13}C NMR (100 MHz) and ^{31}P NMR (162 MHz), were recorded on the Bruker AVENCE III HD-400 spectrometer. Chemical shifts δ (ppm) are given relative to solvent: references for $CDCl_3$ were 7.26 ppm (^{1}H NMR) and 77.16 ppm (^{13}C NMR), for CD_3CN were 1.94 ppm (^{1}H NMR) and 117.34 ppm (^{13}C NMR), for DMSO-d_6 were 2.50 ppm (^{1}H NMR) and 39.52 ppm (^{13}C NMR). Signals were assigned as s (singlet), d (doublet), t (triplet), dd (doublet of doublet), m (multiplet) and br. s (broad singlet). All measurements were carried out at room temperature unless otherwise stated. GC analysis was performed with Agilent 7890B (KB-1, 30 m × 0.32 mm × 0.25 μm) and AT (C- 2000, 3 m ×3 mm). GC-Mass analysis was performed with SHIMADZU GCMS-QP2020 (SH-Rtx- 35MS, 30 m ×0.25 mm × 0.25 μm). High resolution mass spectra (HRMS) were measured on SHIMADZU LCMS-IT-TOF (ESI) mass spectrometer, and the corresponding molecular ion, such as $[M]^+$, $[M+H]^+$, were given in m/z units. Column chromatography was carried out using silica gel (200-300 mesh) eluating with petroleum ether/ethyl acetate.

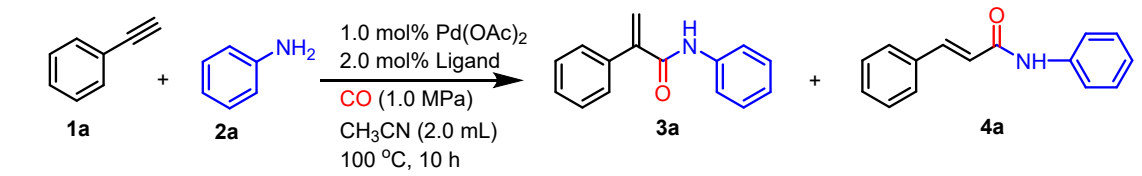
S2. General Procedure for the synthesis of products

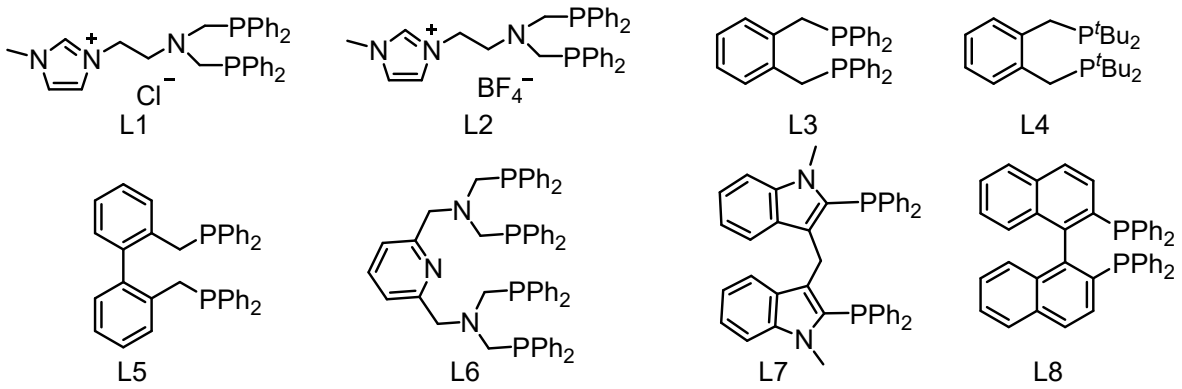


Under nitrogen protection, a mixture of alkyne (1.0 mmol), amine (1.25 mmol), $Pd(OAc)_2$ (1.0 mol%), **CPP** (2.0 mol%), an oven-dried stirring bar and CH_3CN (2.0 mL) was added to a stainless-steel autoclave. The autoclave was flushed three times with CO and then pressurized to appointed pressure of CO. The reaction was heated under specified temperature for 10 hours. Then, the stainless-steel autoclave was cooled to room temperature and slowly depressurized. The reaction solution was analyzed by GC to determine the conversion and selectivity use n-dodecane as internal standard. Finally, the solvent was removed under vacuum and the obtained residue was purified by flash column chromatography on a silica gel (eluted with ethyl acetate/petroleum ether = 1/10 ~ 1/0) to furnish the desired *α,β*-unsaturated amides products.

S3. Optimization of reaction conditions

S3.1. The effect of ligand

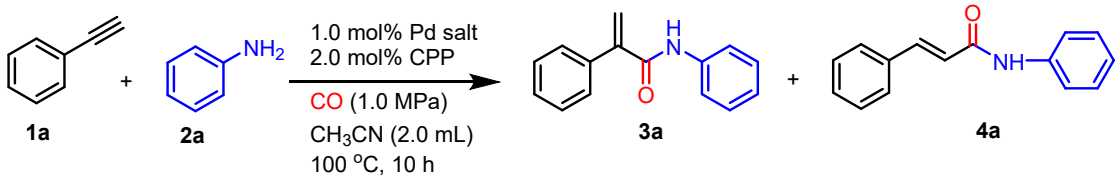




Entry	Ligand	Conversion (%)	Yield 3a (%)	b:l
1	**L1**	**78**	**78**	**>99:1**
2	L2	49	48	99:1
3	L3	55	49	90:10
4	L4	52	33	78:22
5	L5	37	21	88:12
6	L6	60	55	93:7
7	L7	48	45	92:8
8	L8	70	68	98:2

Table S1. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol,), $Pd(OAc)_2$ (1.0 mol%), Ligand (1.0 mol% or 2.0 mol%), CO (1.0 MPa), CH_3CN (2.0 mL), 100 °C, 10 h; the ratio of products and yields were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

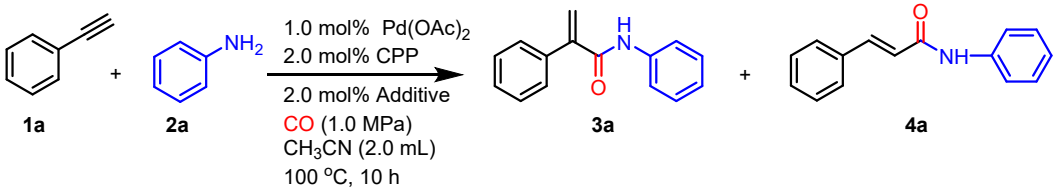
S3.2. The effect of Palladium precursor



Entry	Pd salt	Conversion (%)	Yield 3a (%)	b:l
1	**$Pd(OAc)_2$**	**78**	**78**	**>99:1**
2	$PdCl_2(CH_3CN)_2$	4	3	86:14
3	$Pd(PPh_3)_4$	22	17	79:21
4	$PdCl_2$	7	6	86:14
5	$Pd(TFA)_2$	3	2	71:29

Table S2. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol), Pd salt (1.0 mol%), **CPP** (2.0 mol%), CO (1.0 MPa), CH_3CN (2.0 mL), 100 °C, 10 h; the ratio of products and yields were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

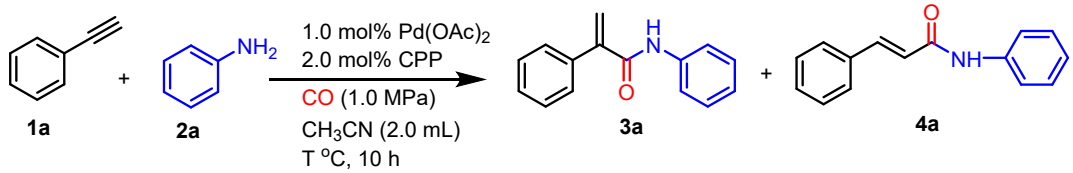
S3.3. The effect of additive



Entry	Additive	Conversion (%)	Yield 3 (%)	b:l
1	$Al(OTf)_3$	Trace		
2	$PTSA{\cdot}H_2O$	NR		
3	**-**	**78**	**78**	**>99:1**
4	Cs_2CO_3	42	28	2:1
5	KO^tBu	96	81	84:16
6	NaO^tBu	87	84	93:7
7	KOH	42	40	97:3

Table S3. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol), $Pd(OAc)_2$ (1.0 mol%), **CPP** (2.0 mol%), additive (2.0 mol%), CO (1.0 MPa), CH_3CN (2.0 mL), 100 °C, 10 h; the ratio of products and yield were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

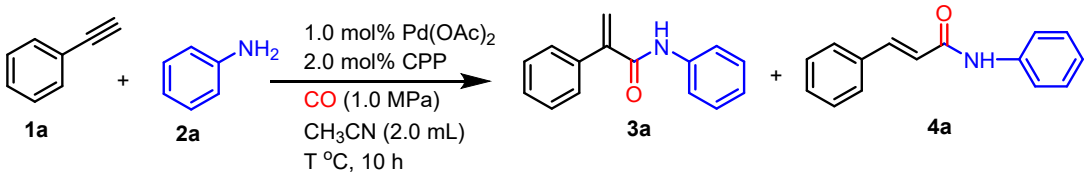
S3.4. The effect of CO pressure



Entry	CO (MPa)	Conversion (%)	Yield 3a (%)	b:l
1	0.5	44	43	>99:1
2	**1**	**78**	**78**	**>99:1**
3	2	55	54	>99:1

Table S4. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol), $Pd(OAc)_2$ (1.0 mol%), **CPP** (2.0 mol%), CO, CH_3CN (2.0 mL), 100 °C, 10 h; the ratio of products and yield were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

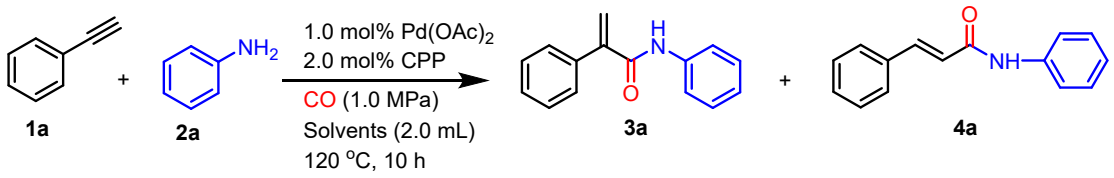
S3.5. The effect of reaction temperature



Entry	T (°C)	Conversion (%)	Yield 3a (%)	b:l
1	60	10	8	87:13
2	80	29	28	>99:1
3	100	78	77	>99:1
4	**120**	**91**	**91**	**>99:1**

Table S5. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol), $Pd(OAc)_2$ (1.0 mol%), **CPP** (2.0 mol%), CO (1.0 MPa), CH_3CN (2.0 mL), T °C, 10 h; the ratio of products and yield were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

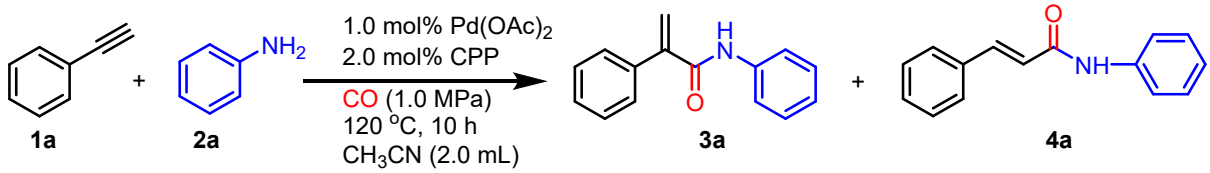
S3.6. The effect of solvents



Entry	Solvent	Conversion (%)	Yield 3a (%)	b:l
1	THF	45	44	>99:1
2	**CH_3CN**	**91**	**91**	**>99:1**
3	Toluene	82	82	99:1
4	NMP	4	4	87:13

Table S6. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol), $Pd(OAc)_2$ (1.0 mol%), **CPP** (2.0 mol%), CO (1.0 MPa), solvents (2.0 mL), 120 ℃, 10 h; the ratio of products and yield were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

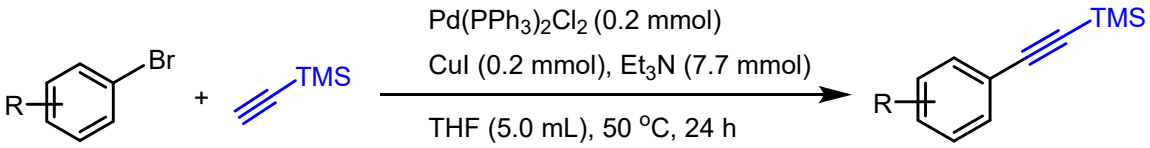
S3.7. Optimal reaction conditions



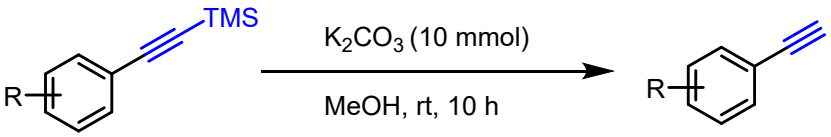
Conversion (%)	Yield 3a (%)	b:l
91	91	>99:1

Table S7. Reaction conditions: Phenylacetylene (1.0 mmol), aniline (1.25 mmol), $Pd(OAc)_2$ (1.0 mol%), **CPP** (2.0 mol%), CO (1.0 MPa), CH_3CN (2.0 mL), 120 ℃, 10 h; the ratio of products and yield were determined by GC analysis with n-dodecane as the internal standard. b:l = **3a**:**4a**.

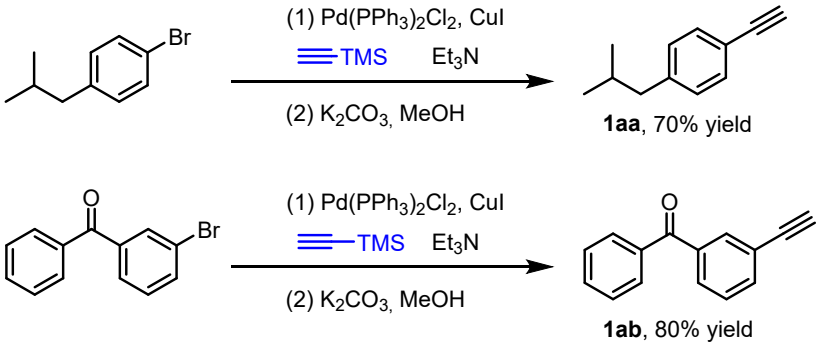
S4. General Procedure for the synthesis of substrates



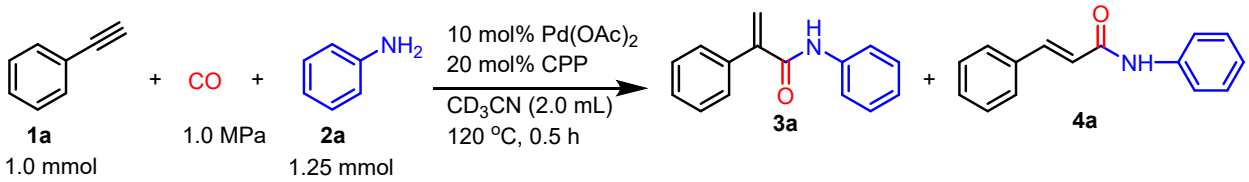
Reactions were set up in a nitrogen-filled glove box. To round-bottom flask with magnetic stirring bar were added $Pd(PPh_3)_2Cl_2$ (0.2 mmol), CuI (0.2mmol), aryl bromides (5.0 mmol), THF (5.0 mL) and Et_3N (7.7 mmol). Then the flask was sealed with a rubber plug, removed from glovebox and stirred at 0 °C 15 min. Trimethylsilylacetylene (10 mmol) was slowly added to the reaction mixture and the color of the reactants gradually darkened. Then, the flask was transferred to oil bath and the mixture was reacted for 24 h at 50 °C. After the reaction was completed, the reaction mixture was cooled to room temperature and dissolved in ethyl acetate, which was then washed with water/ brine sequentially. The organic phase was dried with anhydrous Na_2SO_4 and concentrated *via* vacuum to get the crude products[1]. Finally, the crude products were purified by a short fast column to get the chromatography1-Aryl-2-trimethylphenylacetyl derivatives.



1-Aryl-2-trimethylphenylacetyl derivative (1.0 equiv.) was added to a mixture of potassium carbonate (2 equiv.) and anhydrous MeOH. Then, the reaction was stirred at room temperature for 10 hours under the protection of nitrogen and the reaction process was observed by TLC or GC-MS, When the reaction finished, the reaction mixture was quenched by saturated NH_4Cl. The MeOH were evaporated under reduced pressure and the residue was dissolved in ethyl acetate, which was washed with water/ brine sequentially and concentrated *via* vacuum to get crude products. Then, the crude products were purified by a short fast column chromatography to obtain the terminal alkyne substrates.

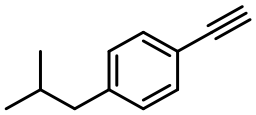


S5. Procedure for the NMR studies on the crude reaction mixture



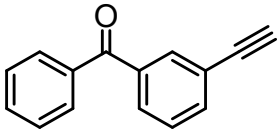
Given the low concentration of Palladium active species, the catalyst amount was increased by a factor of 10 in NMR experiments. The specific experimental steps are as follows: under nitrogen protection, $Pd(OAc)_2$ (10 mol%), **CPP** (20 mol%), Phenylacetylene (1.0 mmol), amine (1.25 mmol), an oven-dried stirring bar and CD_3CN (2.0 mL) was added to a stainless-steel autoclave. The reaction was heated at 120 ℃ under CO (1.0 MPa) for 0.5 hours. Then, the stainless-steel autoclave was cooled to room temperature and slowly depressurized. The reaction solution was analyzed by NMR immediately to analyze active species.

S6. NMR spectra of drug-derived substrates



Ethynyl-4-isobutyl benzene 1aa[1]

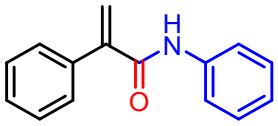
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 8.2 Hz, 2H), 7.11 (d, *J* = 8.2 Hz, 2H), 3.04 (s, 1H), 2.48 (d, *J* = 7.2 Hz, 2H), 1.93 – 1.80 (m, 1H), 0.90 (d, *J* = 6.6 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 142.8, 131.9, 129.1, 119.3, 83.9, 77.4, 45.3, 30.2, 22.3.



(3-ethynylphenyl) (phenyl)methanone 1ab[2]

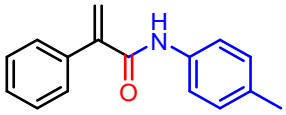
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (t, *J* = 1.7 Hz, 1H), 7.79 (ddd, *J* = 7.7, 3.7, 2.0 Hz, 3H), 7.69 (d, *J* = 7.7 Hz, 1H), 7.60 (s, 1H), 7.52 – 7.39 (m, 3H), 3.12 (s, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 195.77, 137.85, 137.12, 135.71, 133.55, 132.74, 130.09 (d, *J* = 9.5 Hz), 128.45 (d, *J* = 2.6 Hz), 122.47, 82.63, 78.34, 29.71.

S7. Structural characterization of products



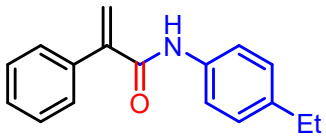
N,2-diphenylacrylamide (3aa)[3]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.27 (s, 1H), 7.72 (d, J = 7.7 Hz, 2H), 7.51 – 7.47 (m, 2H), 7.41 – 7.30 (m, 5H), 7.10 – 7.06 (m, 1H), 5.94 (s, 1H), 5.72 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.8, 145.7, 139.5, 136.8, 129.6 – 128.2 (m), 127.4, 124.2, 120.4, 118.1.



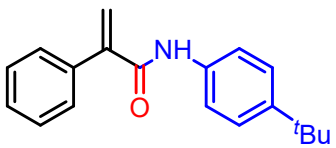
2-Phenyl-N-(p-tolyl) acrylamide (3ab)[4]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.17 (s, 1H), 7.61 (d, J = 8.3 Hz, 2H), 7.54 – 7.46 (m, 2H), 7.44 – 7.33 (m, 3H), 7.14 (d, J = 8.3 Hz, 2H), 5.93 (s, 1H), 5.72 (s, 1H), 2.28 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 145.8, 136.9 (d, J = 16.7 Hz), 133.0, 129.5, 128.9, 128.7, 128.4 – 127.9 (m), 127.3, 120.4, 117.9, 21.0.



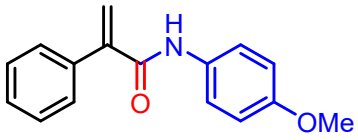
N-(4-ethylphenyl)-2-phenylacrylamide (3ac)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.18 (s, 1H), 7.62 (d, J = 8.4 Hz, 2H), 7.53 – 7.44 (m, 2H), 7.44 – 7.29 (m, 3H), 7.16 (d, J = 8.5 Hz, 2H), 5.92 (s, 1H), 5.71 (s, 1H), 2.57 (q, J = 7.6 Hz, 2H), 1.16 (t, J = 7.6 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.6, 139.6, 137.2, 136.8, 128.9, 128.7, 128.3, 127.3, 120.5, 117.9, 28.1, 16.2. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{17}H_{17}NO$: 252.1383; Found: 252.1387.



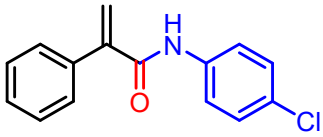
N-(4-(tert-butyl) phenyl)-2-phenylacrylamide (3ad)[5]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.18 (s, 1H), 7.63 (d, J = 8.6 Hz, 2H), 7.53 – 7.46 (m, 2H), 7.43 – 7.26 (m, 5H), 5.92 (s, 1H), 5.71 (s, 1H), 1.27 (s, 10H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.6, 146.5, 145.8, 136.90 (d, J = 9.6 Hz), 128.9, 128.7, 127.3, 125.7, 120.2, 118.0, 34.5, 31.7.



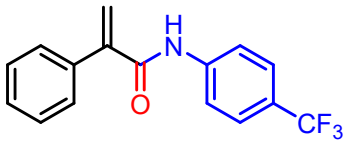
(4-methoxyphenyl)-2-phenylacrylamide (3ae)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.11 (s, 1H), 7.62 (d, J = 9.0 Hz, 2H), 7.51 – 7.45 (m, 2H), 7.42 – 7.29 (m, 3H), 6.90 (d, J = 9.0 Hz, 2H), 5.90 (s, 1H), 5.71 (s, 1H), 3.73 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.4, 156.0, 145.8, 136.9, 132.6, 128.9, 128.7, 127.3, 122.0, 117.9, 114.2, 55.7.



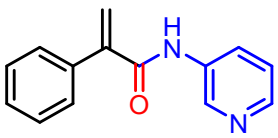
N-(4-chlorophenyl)-2-phenylacrylamide (3af)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.40 (s, 1H), 7.79 – 7.71 (m, 2H), 7.54 – 7.45 (m, 2H), 7.43 – 7.28 (m, 5H), 5.96 (s, 1H), 5.75 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.9, 145.5, 138.5, 136.6, 128.99 (d, J = 6.8 Hz), 128.8, 127.7, 127.3, 121.9, 118.5.



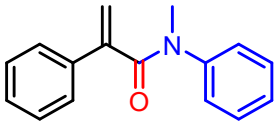
2-Phenyl-N-(4-(trifluoromethyl) phenyl) acrylamide (3ag)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.64 (s, 1H), 7.95 (d, J = 8.5 Hz, 2H), 7.71 (d, J = 8.5 Hz, 2H), 7.58 – 7.47 (m, 2H), 7.45 – 7.25 (m, 3H), 6.00 (s, 1H), 5.80 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.1, 144.1, 139.4, 138.0, 131.6, 130.1, 129.7(d, J = 31.2 Hz),129.1, 125.3 (q, J = 3.9 Hz), 124.6 (d, J = 273.4 Hz), 124.3, 120.9, 120.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{16}H_{12}NOF_3$: 292.0944; Found: 292.0935.



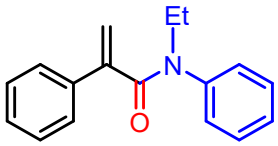
2-Phenyl-N-(pyridin-3-yl) acrylamide (3ah)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.48 (s, 1H), 8.88 (d, J = 2.2 Hz, 1H), 8.31 (dd, J = 4.7, 1.4 Hz, 1H), 8.16 (ddd, J = 8.3, 2.2, 1.5 Hz, 1H), 7.54 – 7.48 (m, 2H), 7.46 – 7.35 (m, 4H), 6.00 (s, 1H), 5.82 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.2, 160.6, 145.3, 145.0, 142.0, 136.6, 136.2, 129.0, 128.8, 127.40, 127.36, 124.0, 119.0. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{14}H_{12}NO$: 225.1022; Found: 225.1027.



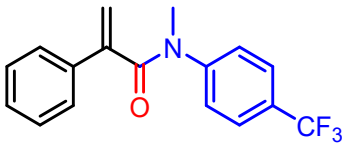
N-Methyl-N,2-diphenylacrylamide (3ai)[4]

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.93 – 6.69 (m, 10H), 5.61 (br, 1H), 5.22 (br, 1H), 3.29 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 169.8, 145.0, 144.1, 136.6, 135.2, 129.3, 129.0, 128.6, 128.0, 127.7, 127.2, 126.2, 37.5.



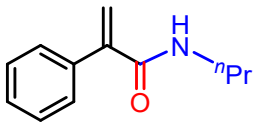
N-(2-phenylacryloyl) isonicotinamide (3aj)

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.32 – 6.96 (m, 10H), 5.56 (s,1H), 5.22 (s, 1H), 3.94 – 3.71 (m, 2H), 1.07 (d, J = 5.8 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 169.3, 145.2, 142.4, 130.1, 129.3, 128.9, 128.7, 128.5, 128.4, 128.1, 128.0, 127.5, 127.3, 126.2, 117.0, 44.1, 13.3. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{17}H_{17}NO$: 252.1383; Found: 252.1385.



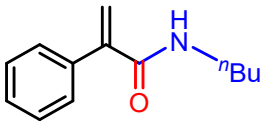
N-methyl-2-phenyl-N-(4-(trifluoromethyl) phenyl)acrylamide (3ak)

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.63 (d, J = 8.3 Hz, 2H), 7.42 (d, J = 7.7 Hz, 2H), 7.43 – 7.22 (m, 5H), 5.74 (s, 1H), 5.36 (s, 1H), 3.35 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ169.2, 147.6, 144.8, 136.2, 129.3, 129.0, 128.8, 128.4, 128.2 (q, J = 35.80 Hz), 127.2, 126.35 (q, J = 3.8 Hz), 124.4 (q, J = 273.1 Hz), 37.5. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{17}H_{14}F_3NO$: 306.1100; Found: 306.1099.



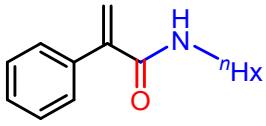
2-Phenyl-N-propylacrylamide (3al)[3]

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.15 (s, 1H), 7.56 – 7.07 (m, 5H), 5.70 (s, 1H), 5.54 (s, 1H), 3.11 (dd, J = 13.0, 6.9 Hz, 2H), 1.47 (dd, J = 14.3, 7.3 Hz, 2H), 0.85 (t, J = 7.4 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.7, 146.0, 137.2, 128.8, 128.5, 127.4, 117.4, 41.1, 22.8, 11.9.



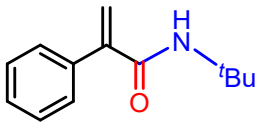
N-Butyl-2-phenylacrylamide (3am)

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.16 (t, J = 5.1 Hz, 1H), 7.78 – 7.19 (m, 5H), 5.72 (s, 1H), 5.55 (s, 1H), 3.16 (dd, J = 12.9, 7.0 Hz, 2H), 1.51 – 1.39 (m, 2H), 1.30 (dd, J = 15.0, 7.4 Hz, 2H), 0.89 (t, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.7, 146.0, 137.2, 128.8, 128.5, 127.4, 117.4, 38.9, 31.6, 20.1, 14.2. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{17}H_{17}NO$: 204.1383; Found: 294.1381.



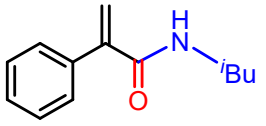
N-Exyl-2-phenylacrylamide (3an)

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.17 (s, 1H), 7.43 – 7.29 (m, 5H), 5.74 (s, 1H), 5.56 (s, 1H), 3.22 – 3.11 (m, 2H), 1.54 – 1.43 (m, 2H), 1.33 – 1.24 (m, 6H), 0.88 (t, J = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168, 146.0, 137.2, 128.7, 128.5, 127.4, 117.3, 39.2, 31.4, 29.4, 26.6, 22.6, 14.4. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{15}H_{21}NO$: 232.1896; Found: 232.1899.



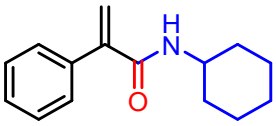
N-(tert-butyl)-2-phenylacrylamide (3ao)[7]

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.67 (s, 1H), 7.54 – 7.18 (m, 5H), 5.69 (s, 1H), 5.44 (s, 1H), 1.33 (s, 9H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.9, 146.4, 137.3, 128.8, 128.4, 127.1, 116.2, 51.1, 28.9.



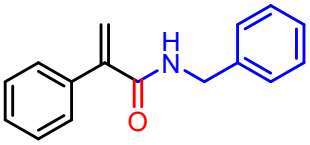
N-Isobutyl-2-phenylacrylamide (3ap)

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.17 (s, 1H), 7.63 – 6.94 (m, 5H), 5.73 (s, 1H), 5.56 (s, 1H), 3.00 (dd, J = 6.8, 6.2 Hz, 2H), 1.80 (dt, J = 13.5, 6.8 Hz, 1H), 0.87 (d, J = 6.7 Hz, 7H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.8, 146.0, 137.2, 128.8, 128.5, 127.4, 117.3, 46.8, 28.6, 20.7. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{17}H_{17}NO$: 204.1383; Found: 204.1381.



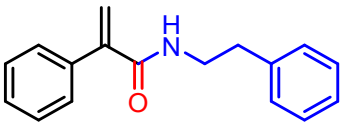
N-Cyclohexyl-2-phenylacrylamide (3aq)[3]

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.03 (d, J = 7.9 Hz, 1H), 7.65 – 7.06 (m, 5H), 5.72 (s, 1H), 5.49 (s, 1H), 3.83 – 3.50 (m, 1H), 1.69 (ddd, J = 52.5, 42.4, 10.7 Hz, 6H), 1.41 – 1.18 (m, 4H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.1, 145.9, 137.2, 128.8, 128.5, 127.2, 116.7, 48.4, 32.7, 25.7, 25.3.



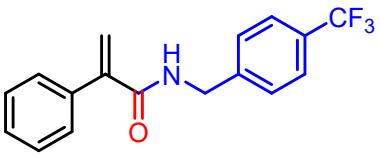
N-Benzyl-2-phenylacrylamide (3ar)[3]

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.76 (t, J = 5.8 Hz, 1H), 7.88 – 6.83 (m, 10H), 5.79 (s, 1H), 5.68 (s, 1H), 4.40 (d, J = 6.1 Hz, 2H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.7, 145.6, 140.1, 137.2, 128.78 (d, J = 1.3 Hz), 128.6, 127.6, 127.5, 127.2, 118.2, 42.8.



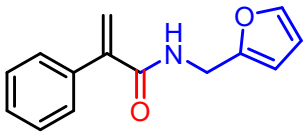
N-Phenethyl-2-phenylacrylamide (3as)[3]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.27 (s, 1H), 7.72 (d, J = 7.7 Hz, 2H), 7.51 – 7.47 (m, 2H), 7.41 – 7.30 (m, 5H), 7.10 – 7.06 (m, 1H), 5.94 (s, 1H), 5.72 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.6, 145.9, 139.9, 137.1, 129.2, 129.0, 128.74 (d, J = 3.8 Hz), 128.5, 127.5, 126.5, 117.6, 40.8, 35.4.



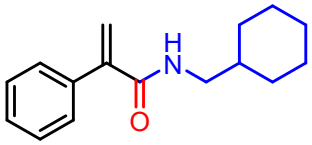
2-phenyl-N-(4-(trifluoromethyl) benzyl) acrylamide (3at)

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.86 (t, J = 6.0 Hz, 1H), 7.72 (d, J = 8.1 Hz, 2H), 7.54 (d, J = 8.0 Hz, 2H), 7.48 – 7.42 (m, 2H), 7.42 – 7.31 (m, 5H), 5.82 (s, 1H), 5.74 (s, 1H), 4.49 (d, J = 6.0 Hz, 2H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ168.8, 145.5, 145.0, 137.1, 128.8, 128.6, 128.3, 128.0 (q, J = 32.0 Hz), 127.6, 125.2 (q, J = 3.9 Hz), 124.8 (q, J = 273.10 Hz), 118.6, 42.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{17}H_{14}F_3NO$: 306.1100; Found: 306.1117.



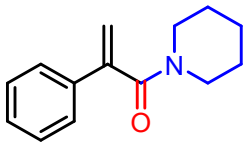
N-(furan-2-ylmethyl)-2-phenylacrylamide (3au)

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.69 (t, J = 5.9 Hz, 1H), 7.59 (dd, J = 1.9, 0.9 Hz, 1H), 7.53 – 7.17 (m, 5H), 6.41 (dd, J = 3.2, 1.9 Hz, 1H), 6.28 (dd, J = 3.2, 0.9 Hz, 1H), 5.78 (s, 1H), 5.65 (s, 1H), 4.41 (dd, J = 5.8, 0.9 Hz, 2H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.7, 152.8, 145.4, 142.5, 137.1, 128.8, 128.6, 127.5, 118.2, 111.0, 107.1, 36.3. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{14}H_{14}NO_2$: 228.1019; Found: 228.1018.



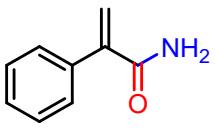
N-(cyclohexylmethyl)-2-phenylacrylamide (3av)

^{1}H NMR (400 MHz, DMSO-d_6) δ 8.15 (s, 1H), 7.68 – 7.12 (m, 5H), 5.73 (s, 1H), 5.56 (s, 1H), 3.02 (t, *J* = 6.4 Hz, 2H), 1.77 – 1.40 (m, 6H), 1.28 – 1.07 (m, 3H), 1.07 – 0.78 (m, 2H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.8, 146.0, 137.3, 128.8, 128.5, 127.4, 117.4, 45.5, 37.9, 31.0, 26.6, 25.9. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{16}H_{22}NO$: 244.1696; Found: 244.1693.



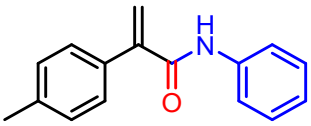
2-Phenyl-1-(piperidin-1-yl) prop-2-en-1-one (3aw)

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.62 – 7.25 (m, 5H), 5.78 (s, 1H), 5.23 (s, 1H), 3.58 – 3.52 (m, 2H), 3.28 – 3.21 (m, 2H), 1.54 (ddd, *J* = 15.5, 9.3, 2.9 Hz, 4H), 1.34 – 1.25 (m, 2H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.3, 145.0, 136.0, 129.3, 129.0, 128.4, 125.9, 113.4, 47.7, 42.0, 26.4, 25.7, 24.4. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{14}H_{17}NO$: 216.1383; Found: 216.1385.



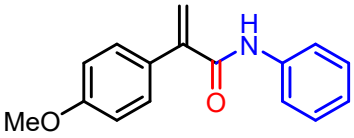
2-Phenylacrylamide (3ax)[8]

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.59 – 7.19 (m, 1H), 5.73 (s, 1H), 5.68 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 170.5, 145.6, 137.4, 132.0 – 125.3 (m), 118.3 (s).



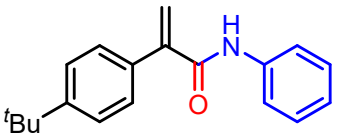
N-phenyl-2-(p-tolyl) acrylamide (3ba)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.22 (s, 1H), 7.72 (d, J = 7.7 Hz, 2H), 7.44 – 7.26 (m, 4H), 7.19 (d, J = 7.9 Hz, 2H), 7.10 – 7.03 (m, 1H), 5.88 (s, 1H), 5.65 (s, 1H), 2.31 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.0, 145.6, 139.6, 138.2, 133.9, 129.5, 129.1, 127.2, 124.1, 120.4, 117.0, 21.2.



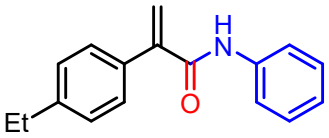
2-(4-methoxyphenyl)-N-phenylacrylamide (3ca)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.20 (s, 1H), 7.71 (d, J = 7.7 Hz, 2H), 7.51 – 7.39 (m, 2H), 7.38 – 7.24 (m, 2H), 7.16 – 7.02 (m, 1H), 7.01 – 6.83 (m, 2H), 5.82 (s, 1H), 5.59 (s, 1H), 3.76 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.1, 159.8, 145.2, 139.6, 129.1, 128.6, 124.1, 120.4, 116.0, 114.3, 55.6.



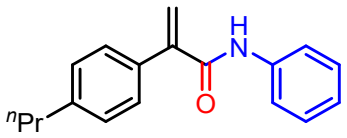
2-(4-(tert-butyl) phenyl)-N-phenylacrylamide (3da)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.22 (s, 1H), 7.73 (d, J = 7.8 Hz, 2H), 7.40 (dd, J = 9.4, 0.9 Hz, 4H), 7.32 (t, J = 7.9 Hz, 2H), 7.08 (t, J = 7.4 Hz, 1H), 5.88 (s, 1H), 5.68 (s, 1H), 1.28 (s, 10H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.9, 151.2, 145.6, 139.6, 134.0, 129.1, 127.1, 125.7, 124.1, 120.4, 117.4, 117.3, 34.8, 31.5. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{19}H_{21}NO$: 280.1696; Found: 280.1698.



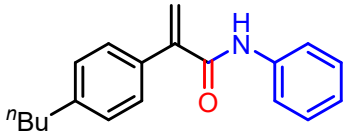
2-(4-ethylphenyl)-N-phenylacrylamide (3ea)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.24 (s, 1H), 7.74 (d, J = 7.7 Hz, 2H), 7.47 – 7.39 (m, 2H), 7.34 (dd, J = 10.8, 5.1 Hz, 2H), 7.24 (d, J = 8.3 Hz, 2H), 7.12 – 7.04 (m, 1H), 5.90 (s, 1H), 5.68 (s, 1H), 2.62 (q, J = 7.6 Hz, 2H), 1.19 (t, J = 7.6 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.0, 145.7, 144.5, 139.6, 134.2, 129.1, 128.3, 127.3, 124.1, 120.4, 117.2, 28.4, 16.0.



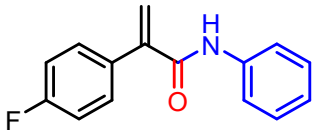
N-phenyl-2-(4-propylphenyl) acrylamide (3fa)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.23 (s, 1H), 7.90 – 7.62 (m, 2H), 7.44 – 7.29 (m, 4H), 7.24 – 7.16 (m, 2H), 7.11 – 7.06 (m, 1H), 5.89 (s, 1H), 5.66 (s, 1H), 2.58 (t, J = 7.7 Hz, 2H), 1.55 (ddt, J = 8.9, 7.6, 3.5 Hz, 2H), 1.30 (q, J = 7.4 Hz, 2H), 0.89 (t, J = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.0, 145.7, 142.9, 139.7, 134.2, 129.1, 128.94, 128.90, 127.2, 124.1, 120.4, 117.1, 37.4, 24.5, 14.1.



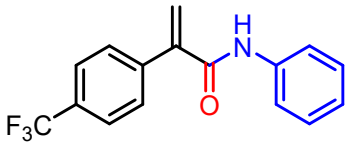
2-(4-butylphenyl)-N-phenylacrylamide (3ga)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.23 (s, 1H), 7.90 – 7.62 (m, 2H), 7.44 – 7.29 (m, 4H), 7.24 – 7.16 (m, 2H), 7.11 – 7.06 (m, 1H), 5.89 (s, 1H), 5.66 (s, 1H), 2.58 (t, J = 7.7 Hz, 2H), 1.55 (ddt, J = 8.9, 7.6, 3.5 Hz, 2H), 1.30 (q, J = 7.4 Hz, 2H), 0.89 (t, J = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.0, 145.7, 143.6, 139.6, 134.1, 129.1, 128.9, 127.2, 124.1, 120.4, 117.1, 35.0, 33.5, 22.2, 14.2. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{19}H_{21}NO$: 280.1696; Found: 280.1697.



2-(4-fluorophenyl)-N-phenylacrylamide (3ha)[6]

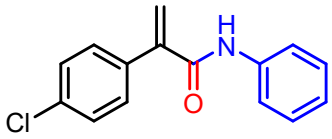
^{1}H NMR (400 MHz, DMSO-d_6) δ 10.27 (s, 1H), 7.79 – 7.69 (m, 2H), 7.57 – 7.52 (m, 2H), 7.37 – 7.29 (m, 2H), 7.26 – 7.19 (m, 2H), 7.12 – 7.04 (m, 1H), 5.94 (s, 1H), 5.77 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.6, 162.53 (d, J = 245.4 Hz), 144.6, 139.5, 133.30 (d, J = 3.3 Hz), 129.56 (d, J = 8.3 Hz), 129.1, 124.2, 120.5, 118.5, 115.76 (d, J = 21.6 Hz).



N-Phenyl-2-(4-(trifluoromethyl) phenyl) acrylamide (3ia)

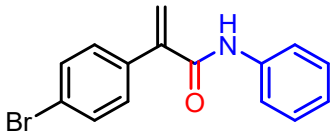
^{1}H NMR (400 MHz, DMSO-d_6) δ 10.34 (s, 1H), 7.77 – 7.69 (m, 6H), 7.34 (dd, J = 8.5, 7.4 Hz, 2H), 7.15 – 7.06 (m, 1H), 6.11 (s, 1H), 5.94 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.1, 144.4, 141.0,

139.4, 128.5 (q, J = 31.7 Hz), 125.8 (q, J = 3.9 Hz), 125.0 (q, J = 173.2 Hz), 124.3, 121.0, 120.5, 119.6, 112.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{16}H_{12}F_3NO$: 292.0944; Found: 292.0941.



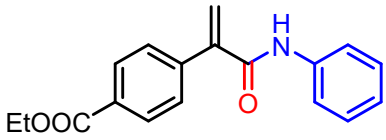
2-(4-chlorophenyl)-N-phenylacrylamide (3ja)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.29 (s, 1H), 7.81 – 7.64 (m, 2H), 7.55 – 7.50 (m, 2H), 7.47 – 7.42 (m, 2H), 7.34 (dd, J = 8.5, 7.3 Hz, 2H), 7.13 – 7.02 (m, 1H), 5.99 (s, 1H), 5.81 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.3, 144.5, 139.4, 136.0, 132.5, 131.9, 130.0, 129.5, 129.3, 129.1, 124.2, 122.0, 120.5, 119.2.



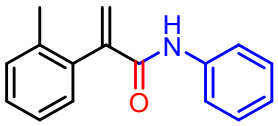
2-(4-bromophenyl)-N-phenylacrylamide (3ka)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.29 (s, 1H), 7.78 – 7.68 (m, 2H), 7.62 – 7.55 (m, 2H), 7.50 – 7.41 (m, 2H), 7.33 (dd, J = 8.5, 7.3 Hz, 2H), 7.15 – 6.99 (m, 1H), 5.99 (s, 1H), 5.81 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.3, 144.5, 139.4, 136.0, 132.5, 131.7, 130.1, 129.6, 129.3, 129.1, 124.2, 122.0, 120.5, 119.2. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{15}H_{12}BrNO$: 392.0175; Found: 392.0166.



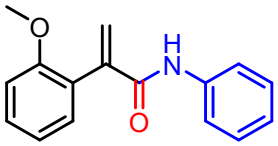
Ethyl 4-(3-oxo-3-(phenylamino) prop-1-en-2-yl) benzoate (3la)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.34 (s, 1H), 8.06 – 7.91 (m, 2H), 7.87 – 7.53 (m, 4H), 7.48 – 7.27 (m, 2H), 7.23 – 7.01 (m, 1H), 6.11 (s, 1H), 5.90 (s, 1H), 4.33 (q, J = 7.1 Hz, 2H), 1.33 (t, J = 7.1 Hz, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.2, 165.9, 144.8, 141.3, 139.4, 129.9, 129.8, 129.1, 127.7, 124.2, 120.4, 61.3, 14.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{18}H_{17}NO_3$:296.1281; Found: 296.1281.



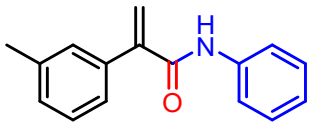
N-Phenyl-2-(o-tolyl) acrylamide (3ma)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.07 (s, 1H), 7.71 (d, J = 7.6 Hz, 2H), 7.32 (t, J = 7.9 Hz, 3H), 7.23 (tt, J = 15.2, 5.1 Hz, 4H), 7.08 (t, J = 7.4 Hz, 1H), 6.10 (s, 1H), 5.67 (s, 1H), 2.23 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.0, 146.6, 139.6, 138.4, 136.0, 130.28 (d, J = 13.5 Hz), 129.0, 128.5, 126.3, 124.1, 122.8, 120.6, 20.1.



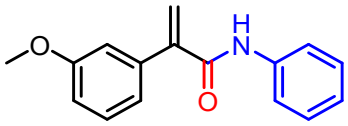
2-(2-methoxyphenyl)-N-phenylacrylamide (3na)

^{1}H NMR (400 MHz, DMSO-d_6) δ 9.93 (s, 1H), 7.70 (d, J = 7.6 Hz, 2H), 7.41 – 7.23 (m, 4H), 7.14 – 6.89 (m, 3H), 5.84 (s, 1H), 5.71 (s, 1H), 3.67 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.5, 157.1, 144.7, 140.0, 130.8, 130.3, 129.0, 127.8, 123.7, 121.1, 121.0, 120.4, 112.0, 56.2. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{16}H_{15}NO_2$:254.1176; Found: 254.1179.



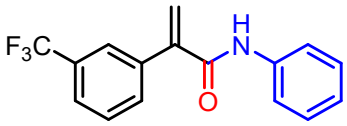
N-phenyl-2-(m-tolyl) acrylamide (3oa)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.24 (s, 1H), 7.86 – 7.67 (m, 2H), 7.36 – 7.25 (m, 5H), 7.20 – 7.13 (m, 1H), 7.12 – 7.05 (m, 1H), 5.91 (s, 1H), 5.71 (s, 1H), 2.32 (s, 3H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.9, 145.9, 139.6, 138.0, 136.8, 129.4, 129.1, 128.8, 127.8, 124.5, 124.1, 120.4, 117.9, 21.5. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{16}H_{15}NO$:238.1226; Found: 238.1228.



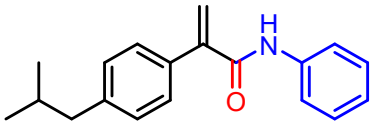
2-(3-methoxyphenyl)-N-phenylacrylamide (3pa)[6]

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.36 (s, 1H), 7.88 – 7.77 (m, 2H), 7.77 – 7.70 (m, 4H), 7.65 (t, J = 7.7 Hz, 1H), 7.35 (dd, J = 8.5, 7.4 Hz, 2H), 7.14 – 7.04 (m, 1H), 6.14 (s, 1H), 5.95 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.7, 159.8, 145.6, 139.5, 138.2, 130.0, 129.1, 124.1, 120.4, 119.8, 118.5, 114.2, 113.0, 55.6.



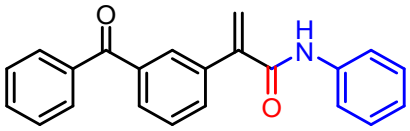
N-phenyl-2-(3-(trifluoromethyl) phenyl) acrylamide (3qa)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.36 (s, 1H), 7.88 – 7.77 (m, 2H), 7.77 – 7.70 (m, 4H), 7.65 (t, J = 7.7 Hz, 1H), 7.35 (dd, J = 8.5, 7.4 Hz, 2H), 7.14 – 7.04 (m, 1H), 6.14 (s, 1H), 5.95 (s, 1H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.1, 144.0, 139.4, 138.0, 131.6, 130.0, 129.7 (q, J = 31.7 Hz), 129.1, 125.3 (q, J = 3.9 Hz), 124.3, 124.0 (q, J = 273.4 Hz), 121.0, 120.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{16}H_{12}F_3NO$:292.0944; Found: 292.0935.



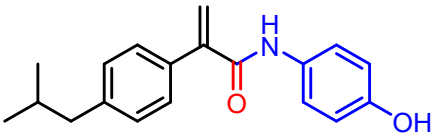
2-(4-isobutylphenyl)-N-phenylacrylamide (3ra)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.24 (s, 1H), 7.73 (d, J = 8.0 Hz, 2H), 7.44 – 7.38 (m, 2H), 7.33 (t, J = 7.9 Hz, 2H), 7.17 (d, J = 8.1 Hz, 2H), 7.11 – 7.03 (m, 1H), 5.90 (s, 1H), 5.66 (s, 1H), 2.45 (d, J = 7.2 Hz, 2H), 1.83 (dp, J = 13.4, 6.6 Hz, 1H), 0.87 (d, J = 6.6 Hz, 6H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 168.0, 145.7, 141.9, 139.6, 134.2, 129.5, 129.1, 127.0, 124.1, 120.4, 117.0, 44.74, 30.1, 22.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{19}H_{21}NO$:280.1696; Found: 280.1698.



2-(3-benzoylphenyl)-N-phenylacrylamide (3sa)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.33 (s, 1H), 7.89 – 7.82 (m, 2H), 7.81 – 7.49 (m, 9H), 7.42 – 7.30 (m, 2H), 7.20 – 7.03 (m, 1H), 6.06 (s, 1H), 5.90 (s, 1H).**^{13}C NMR** (100 MHz, DMSO-d_6) δ 196.0, 167.3, 144.8, 139.4, 137.7, 137.27 (d, J = 4.2 Hz), 133.3, 131.6, 130.2, 130.0, 129.3, 129.09 (d, J = 7.0 Hz), 128.5, 124.2, 120.5, 120.1. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{22}H_{17}NO_2$:328.1332; Found: 328.1329.



N-(4-hydroxyphenyl)-2-(4-isobutylphenyl) acrylamide (3ta)

^{1}H NMR (400 MHz, DMSO-d_6) δ 9.99 (s, 1H), 9.24 (s, 1H), 7.50 (d, J = 8.9 Hz, 2H), 7.40 (d, J = 8.2 Hz, 2H), 7.16 (d, J = 8.1 Hz, 2H), 6.73 (d, J = 8.9 Hz, 1H), 5.85 (s, 1H), 5.61 (s, 1H), 2.45 (d, J = 7.1 Hz, 2H), 1.82 (dq, J = 13.5, 6.8 Hz, 1H), 0.86 (d, J = 6.6 Hz, 6H). **^{13}C NMR** (100 MHz, DMSO-d_6) δ 167.4, 154.1, 145.8, 141.8, 134.3, 131.2, 129.5, 127.0, 122.1, 116.6, 115.4, 44.7, 30.1, 22.6. HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{19}H_{21}NO_2$:296.1645; Found: 296.1648.

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8 D. Wang, W. Guo, Q. Zhou, L. Liu, Y. Lu and Y. Liu, *ChemCatChem*, 2018, **10**, 4264–4268.

S8. The NMR spectra relevant to elucidating CPP coordination behavior

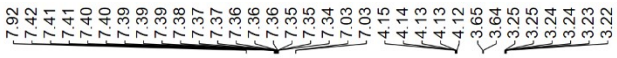


Figure 2. (1), a

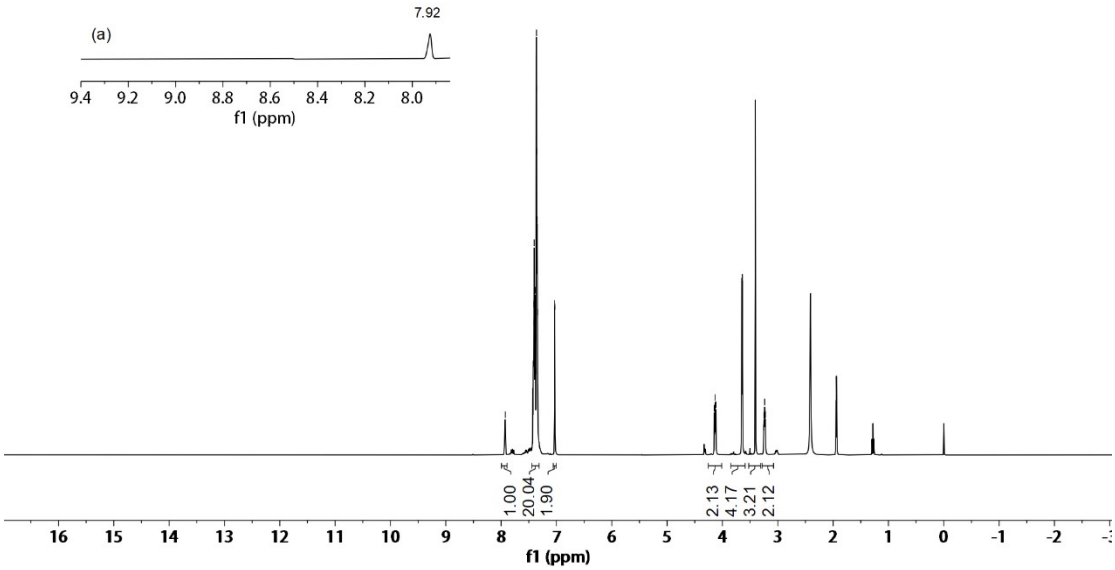


Figure 2. (1), a

Figure 2. (1), b

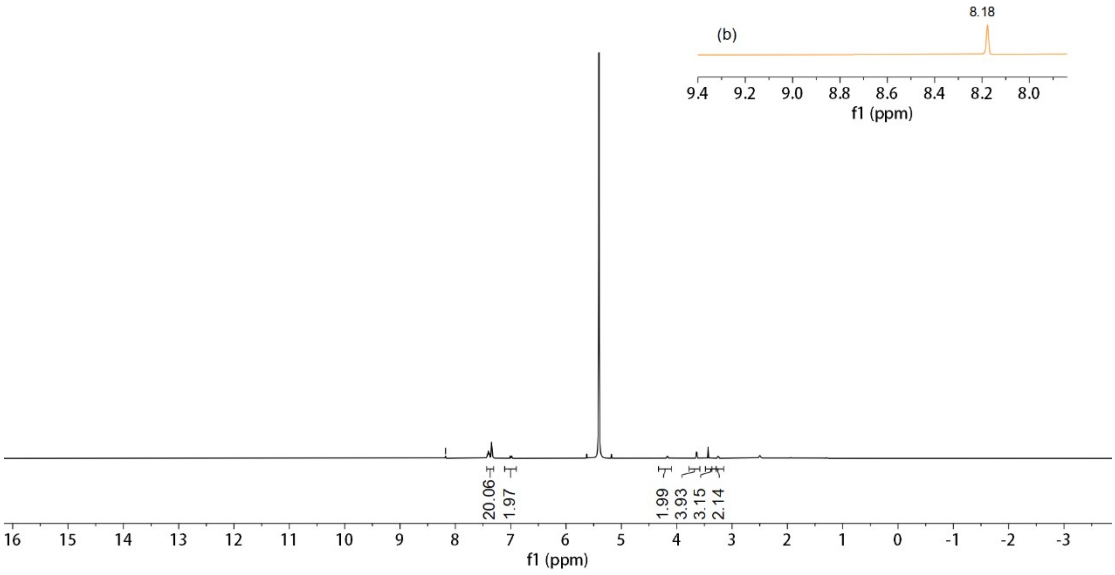


Figure 2. (1), b

Figure 2. (1), c

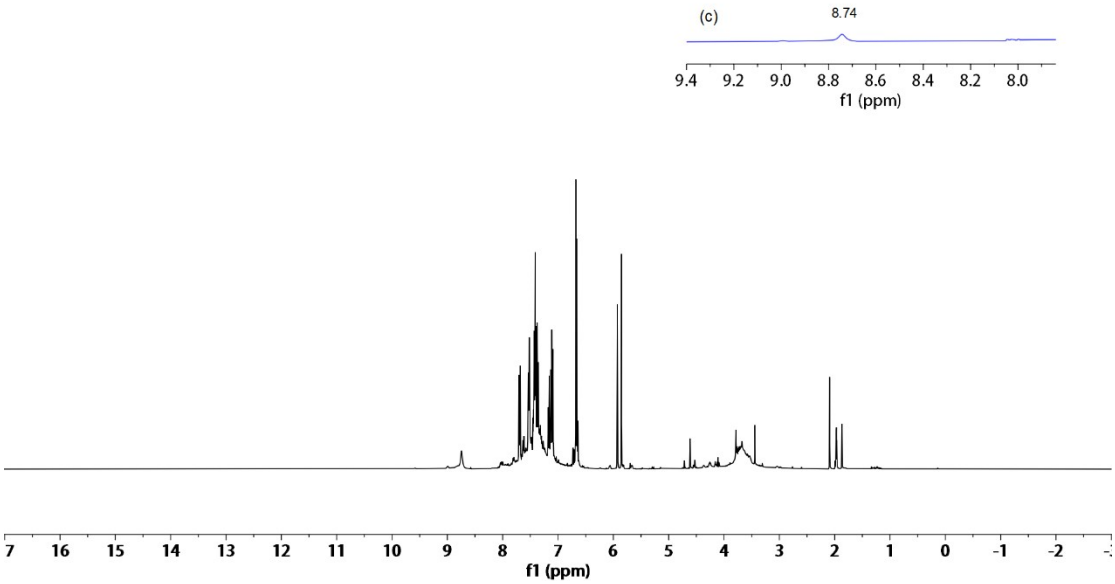
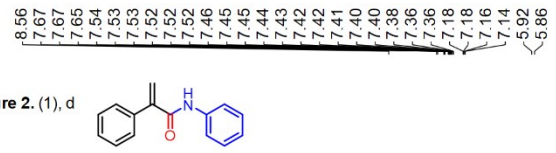
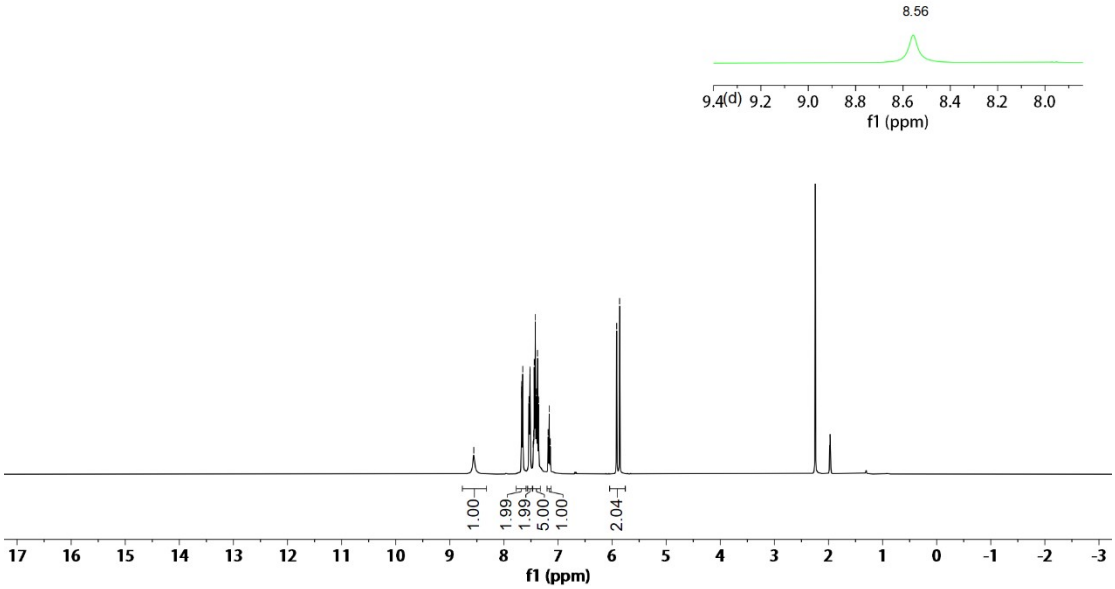


Figure 2. (1), c

Figure 2. (1), d





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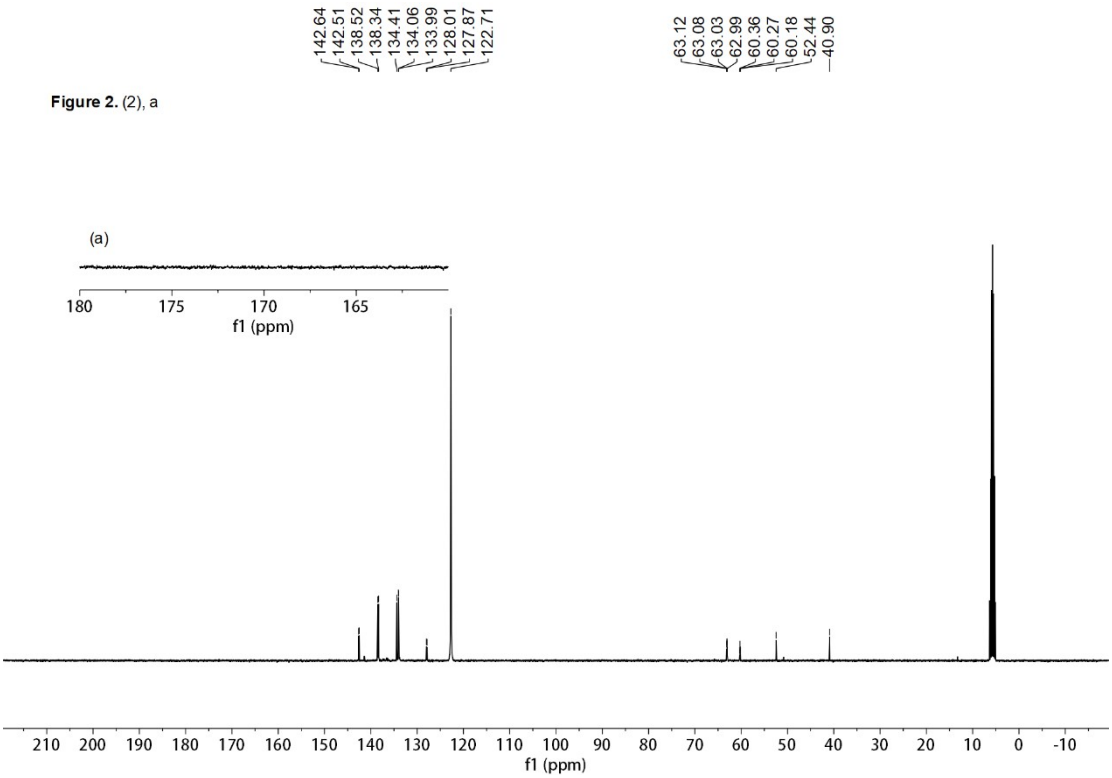


Figure 2. (2), a

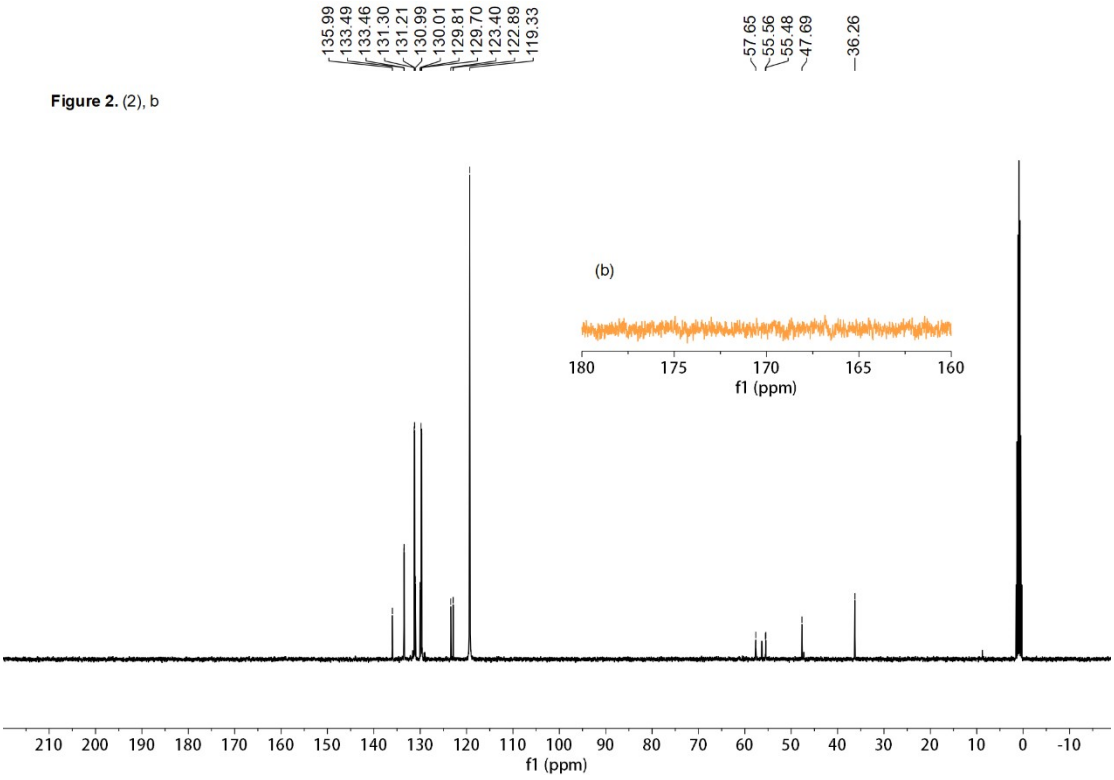


Figure 2. (2), b

Figure 2. (2), c

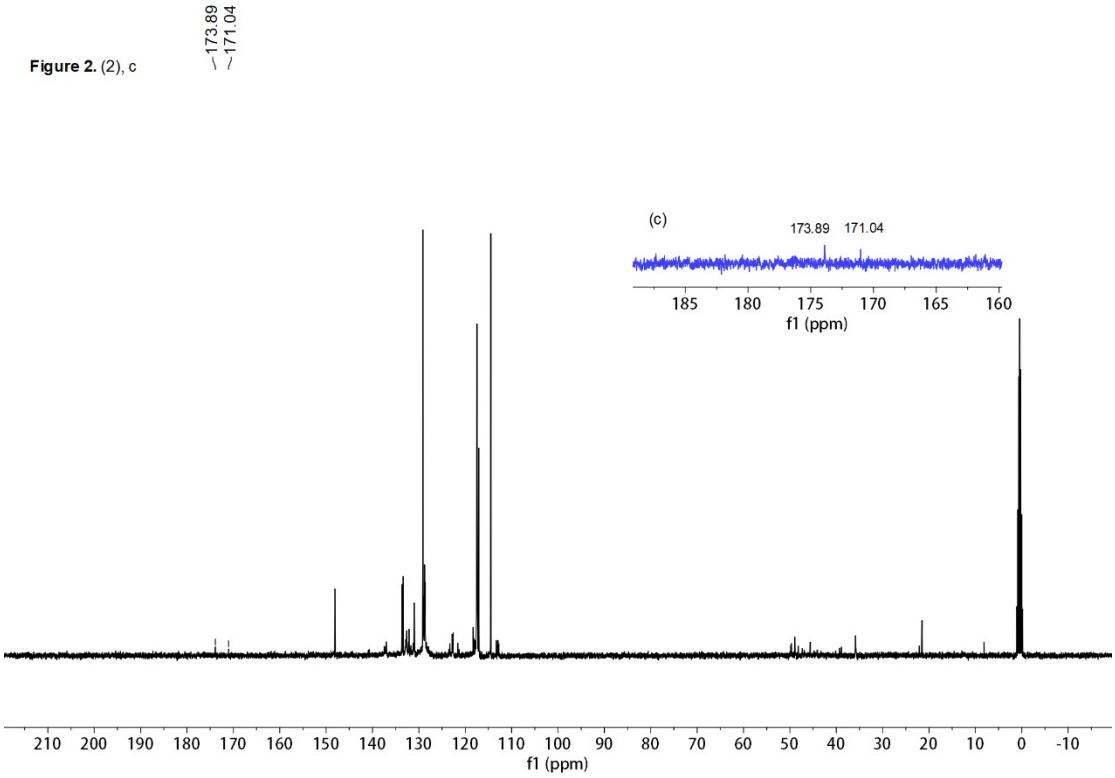


Figure 2. (2), c

Figure 2. (2), d

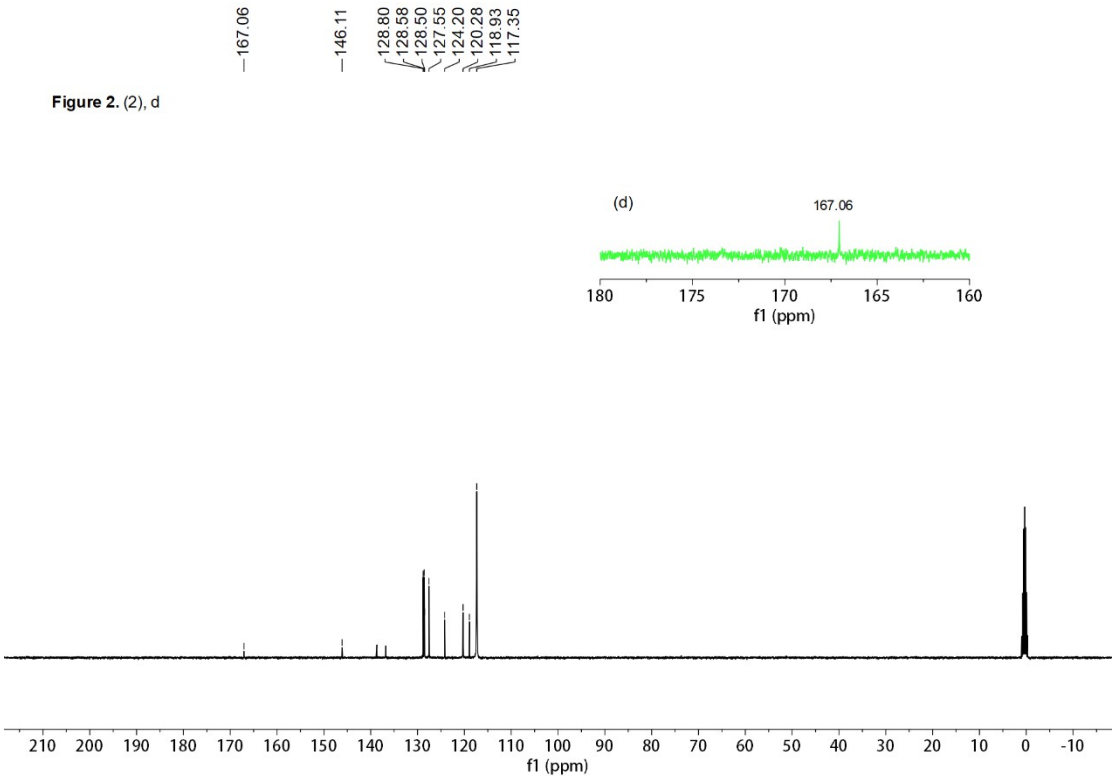


Figure 2. (2), d

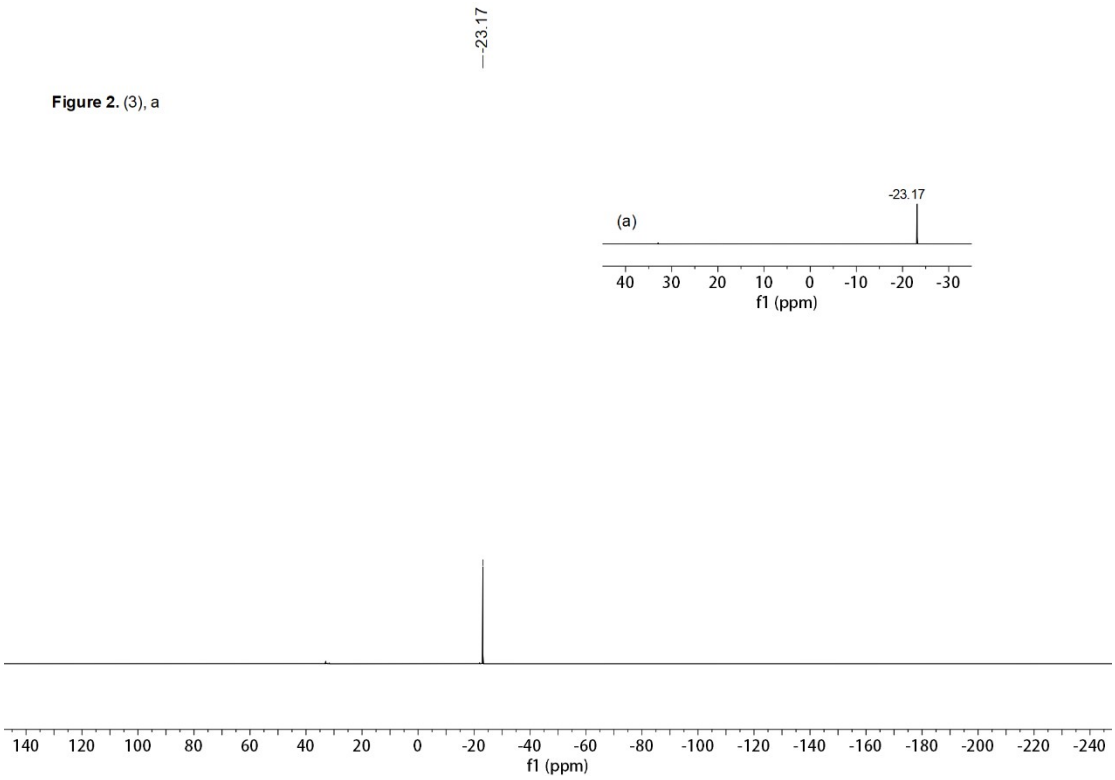


Figure 2. (3), a

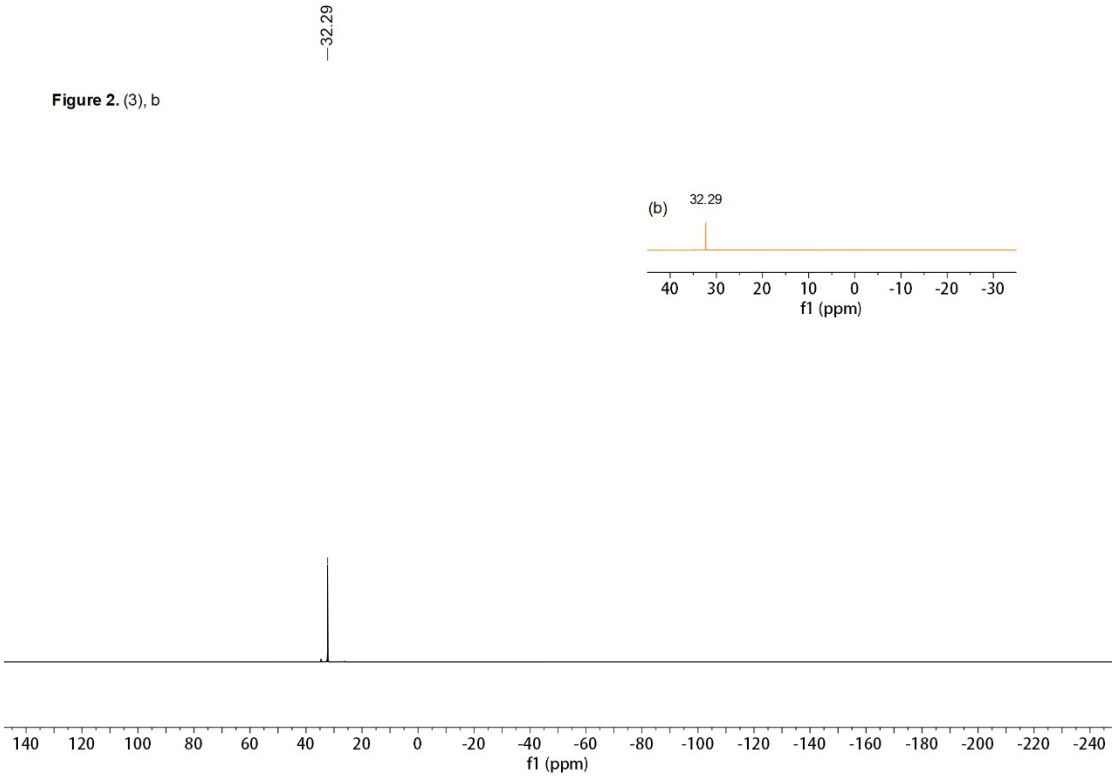


Figure 2. (3), b

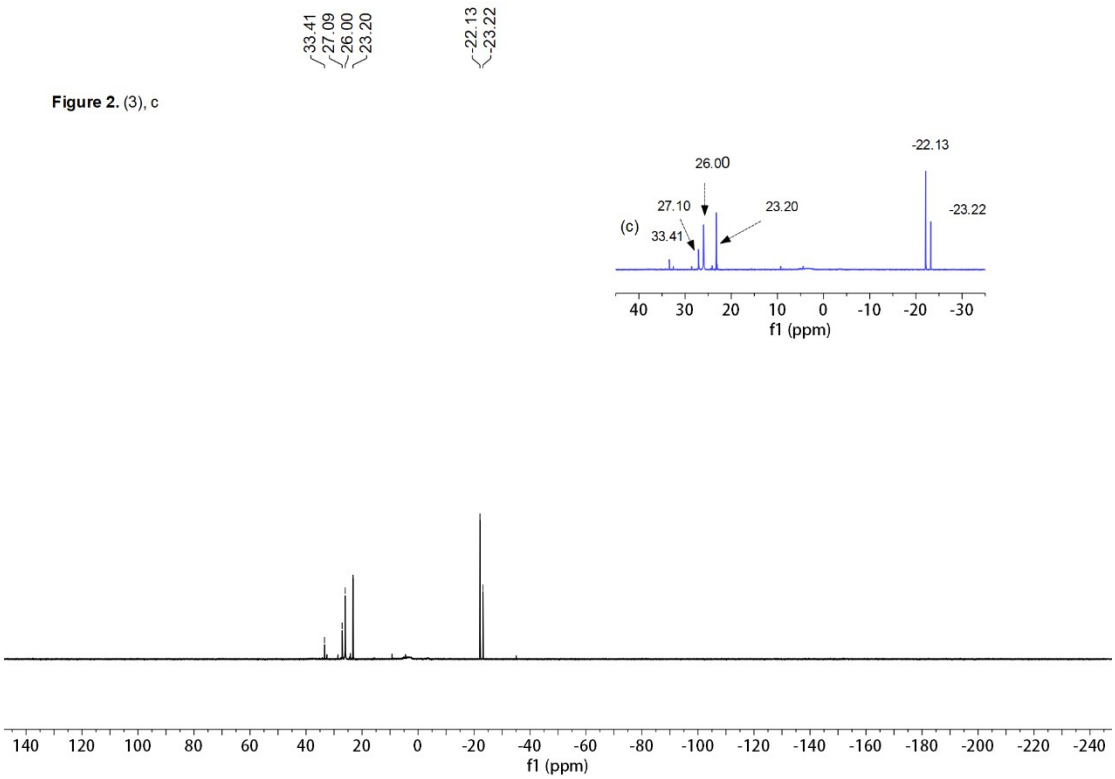
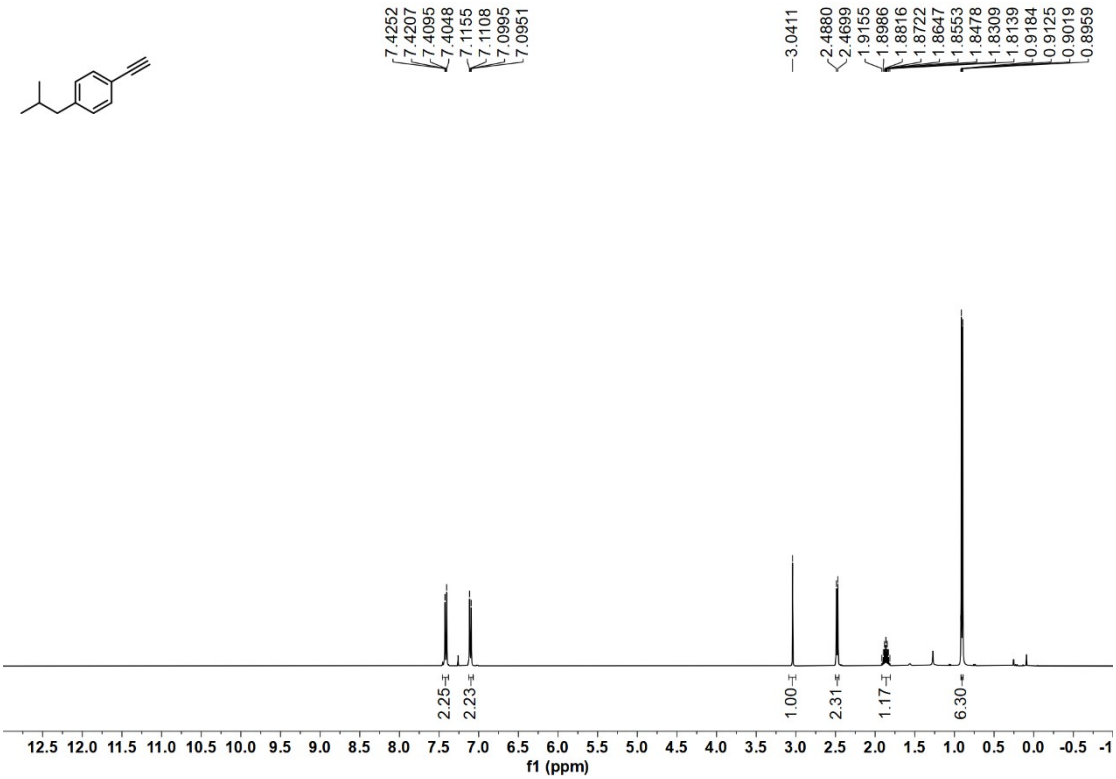
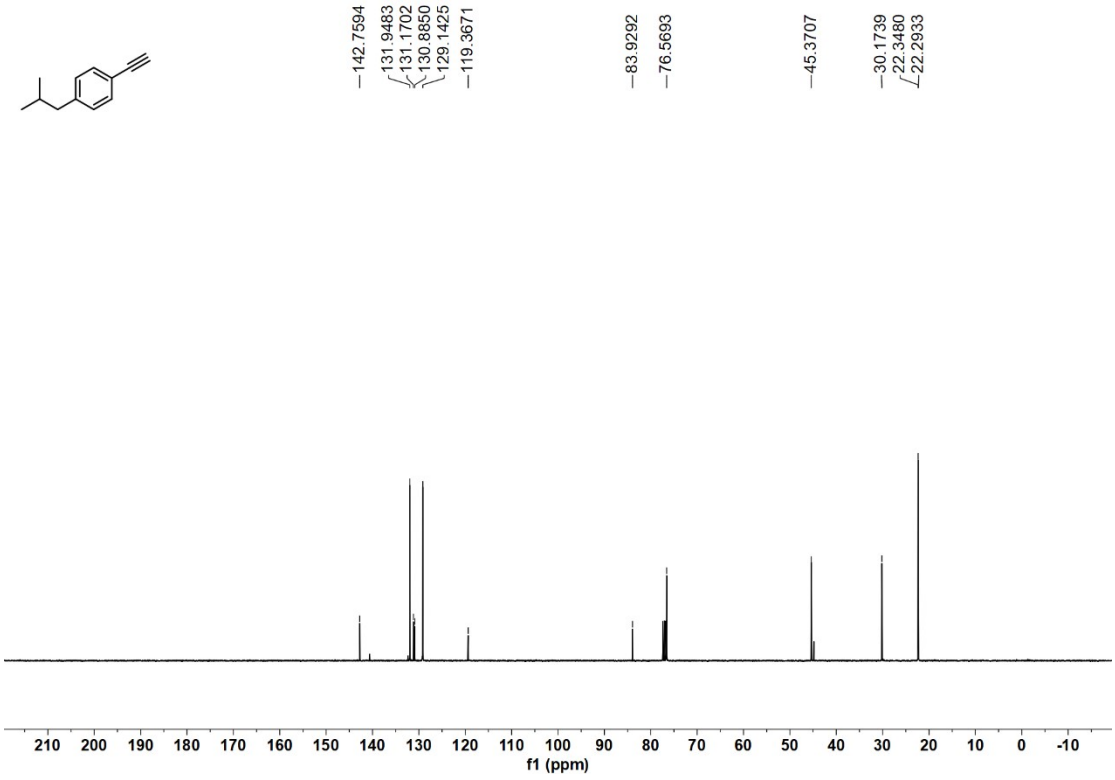

33.41
27.09
26.00
23.20
-22.13
-23.22
Figure 2. (3), c
26.00
-22.13
27.10
23.20
-23.22
(c)
33.41
40 30 20 10 0 -10 -20 -30
f1 (ppm)
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240
f1 (ppm)

Figure 2. (3), c

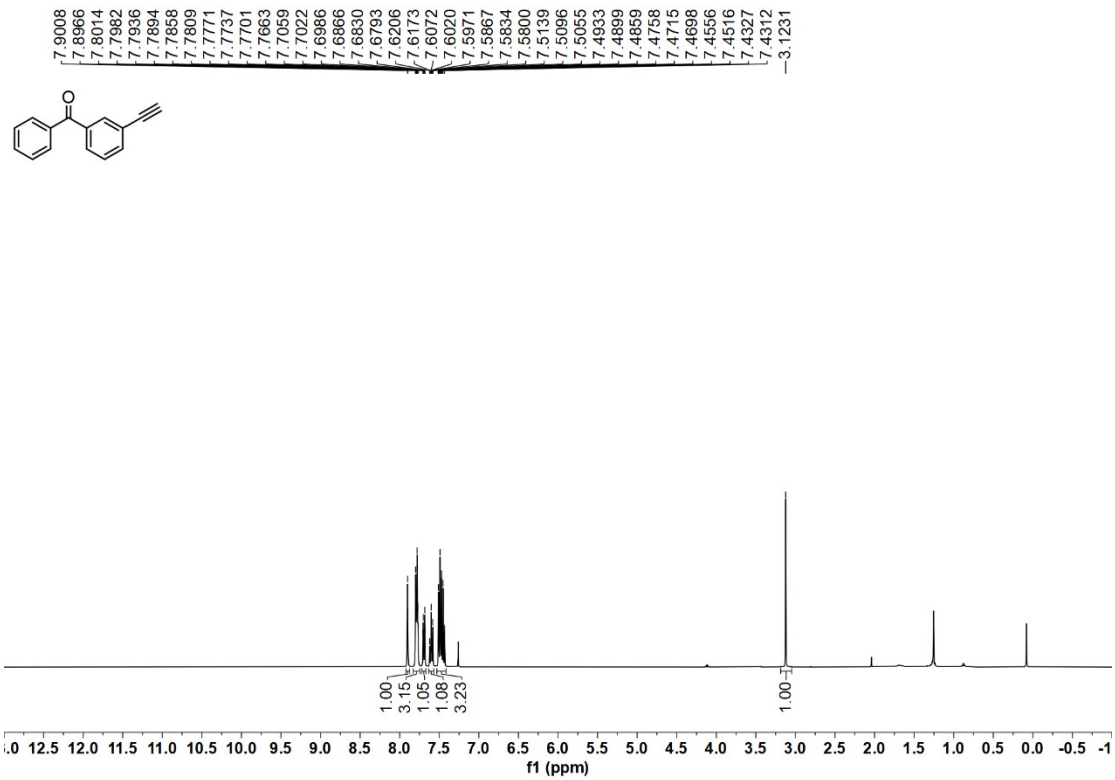
S9. NMR spectra of substrates and products



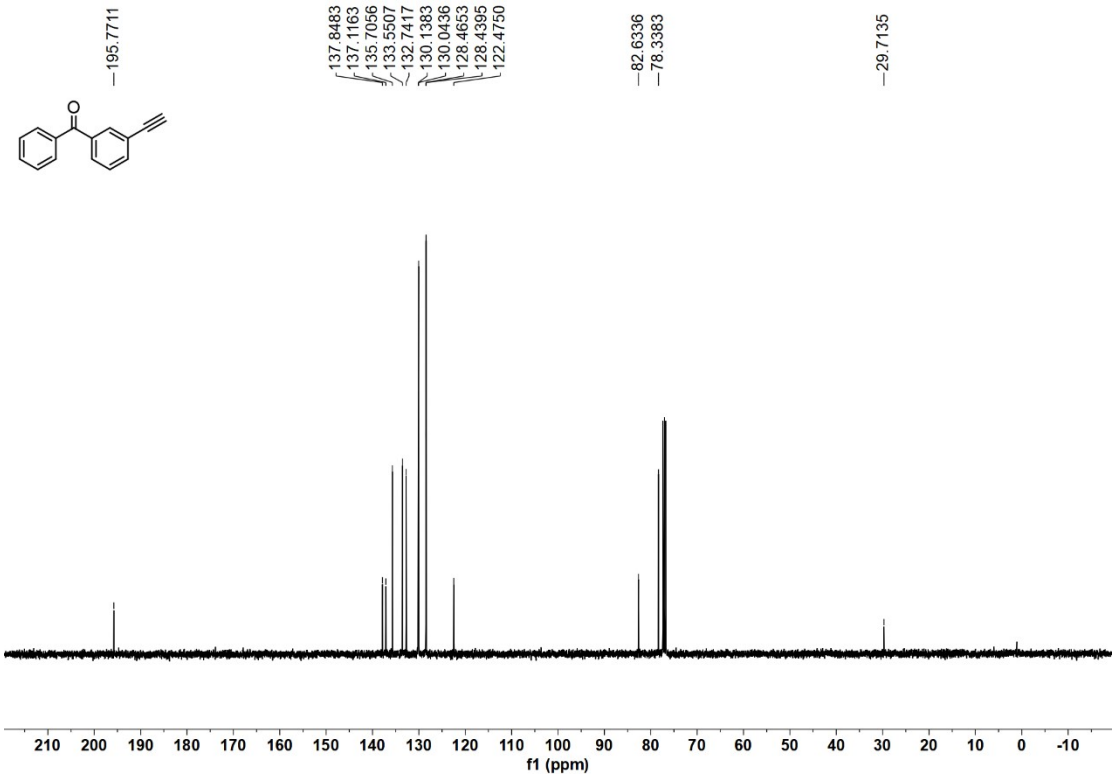
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of 1aa



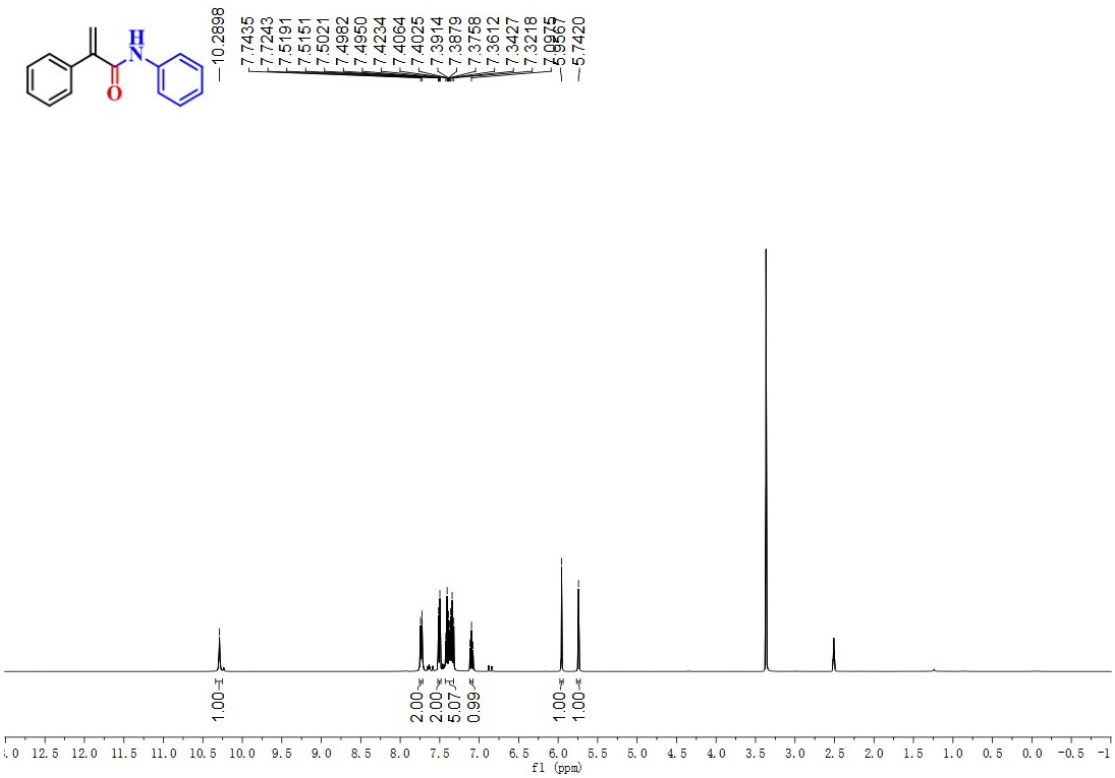
^{13}C NMR (100 MHz, $CDCl_3$) spectrum of 1aa



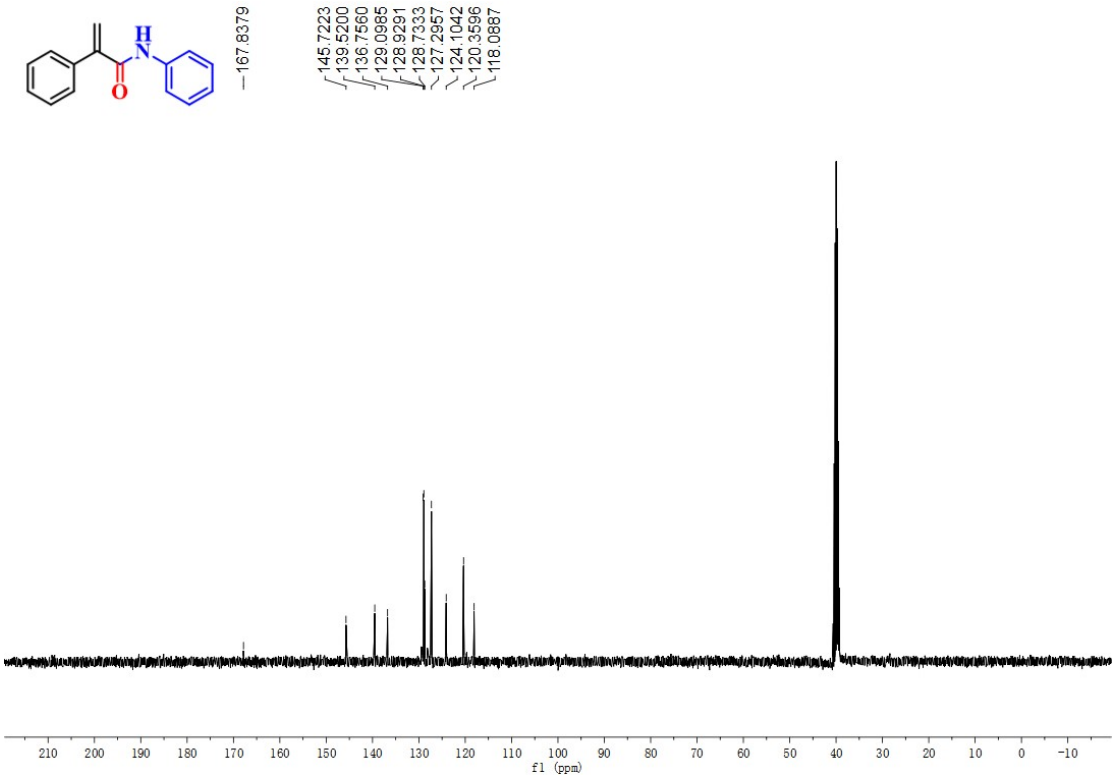
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of 1ab



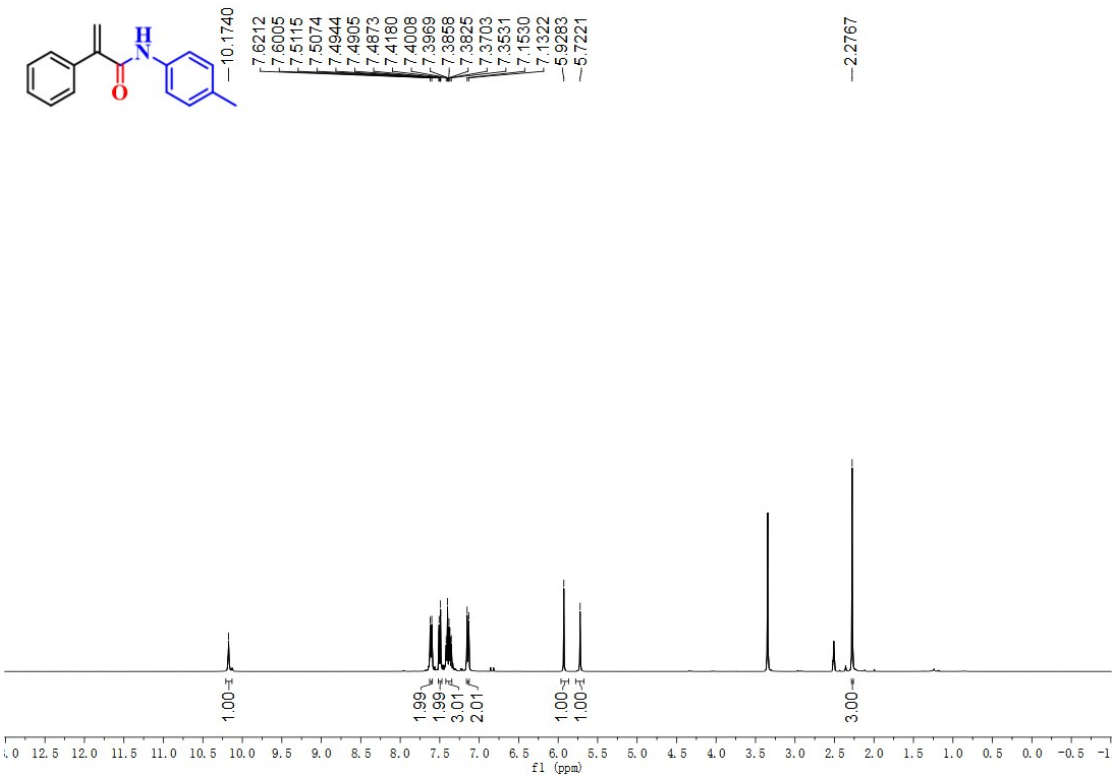
^{13}C NMR (100 MHz, $CDCl_3$) spectrum of 1ab



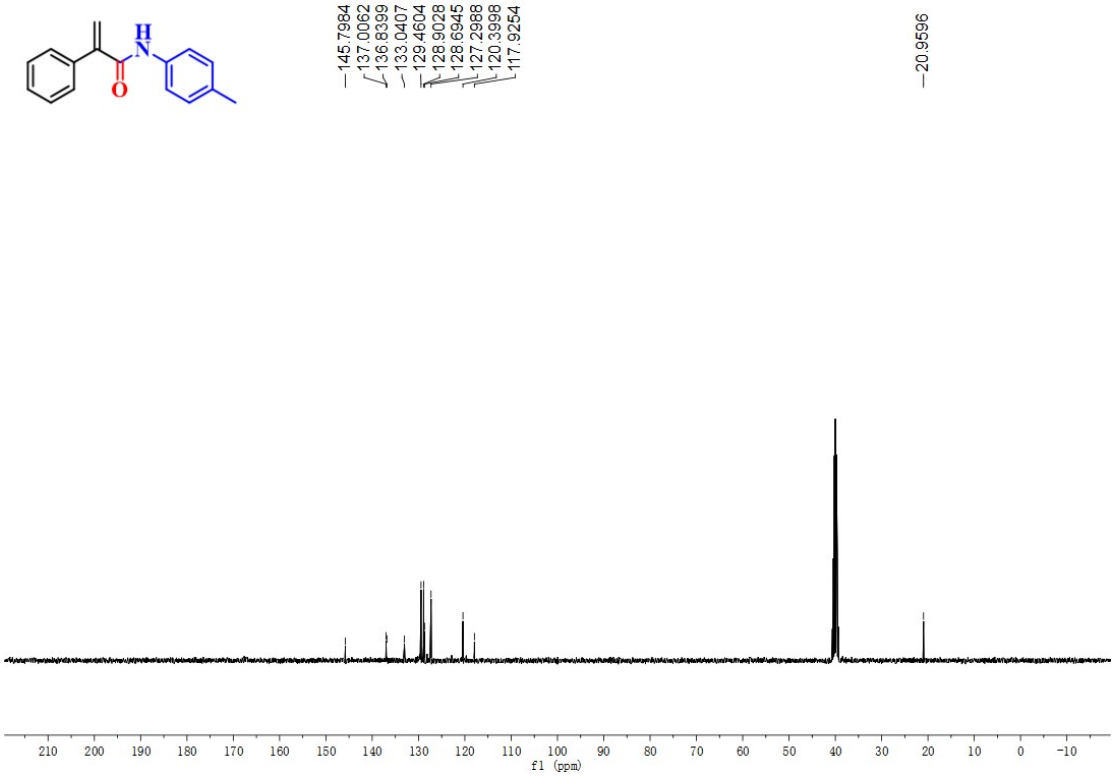
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3aa



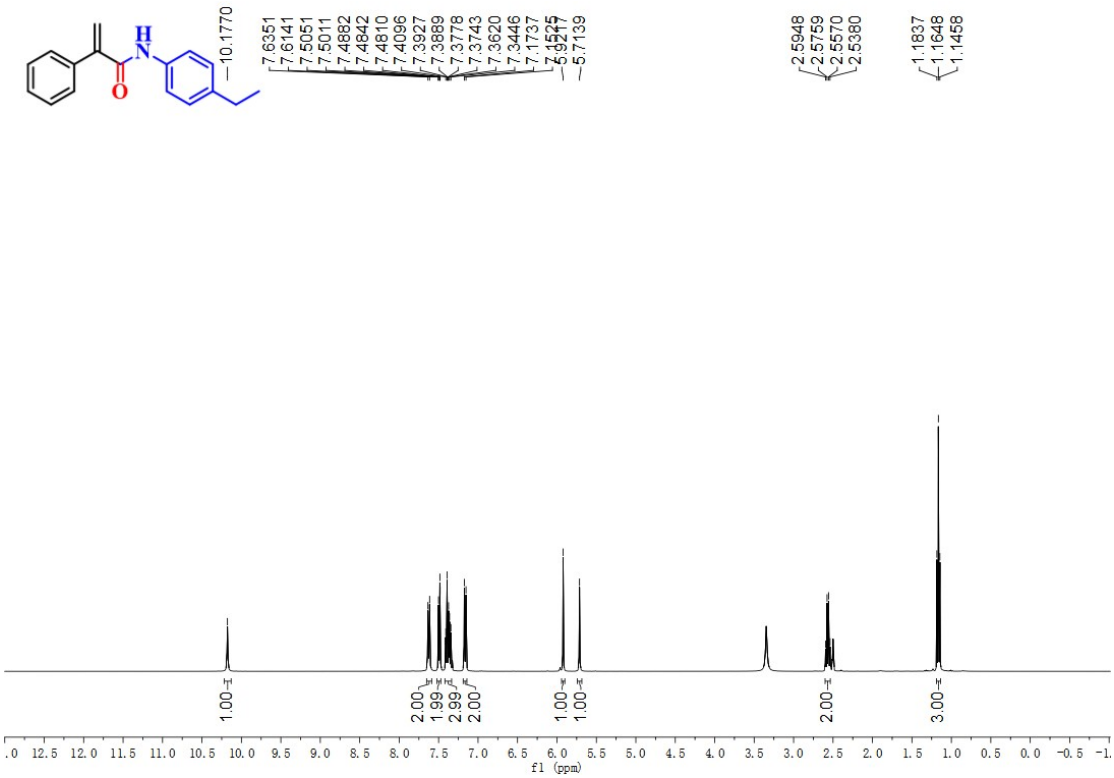
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3aa



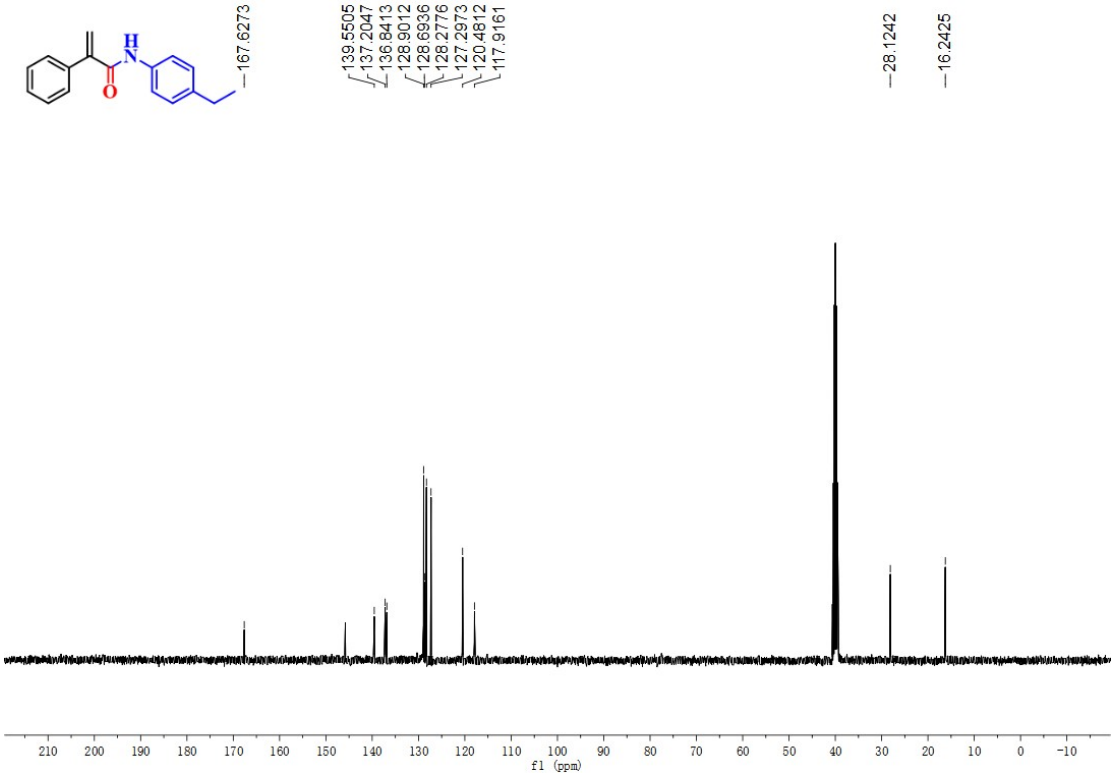
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ab



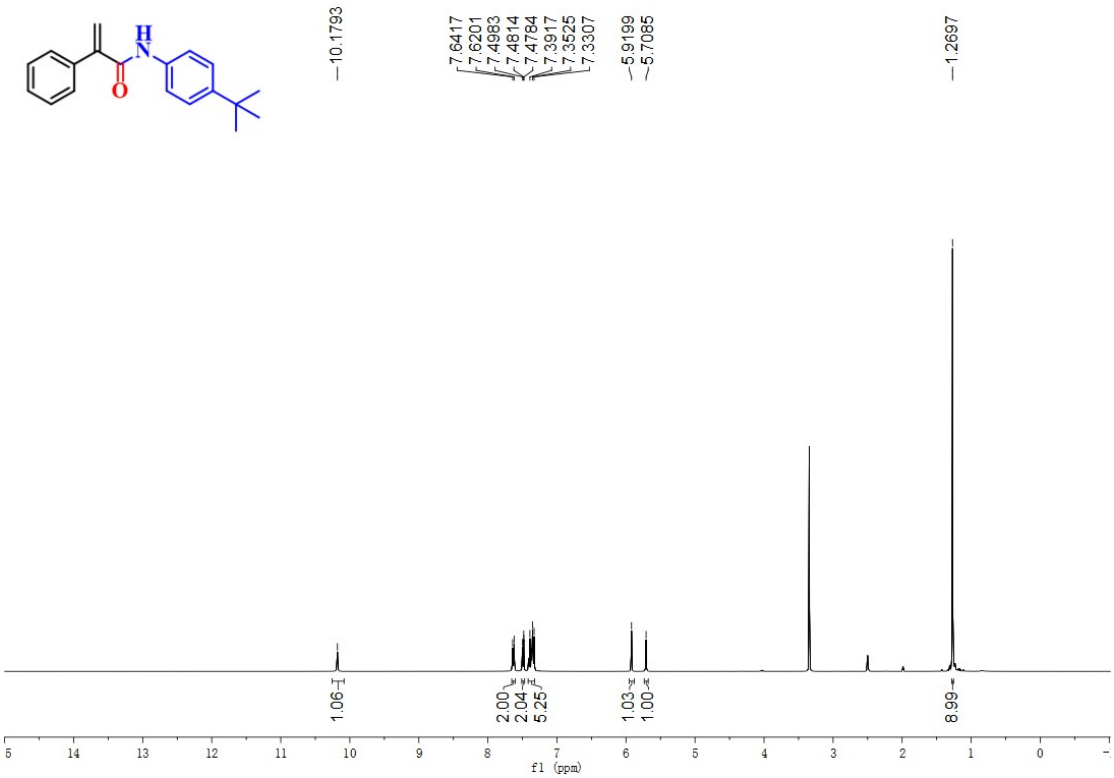
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ab



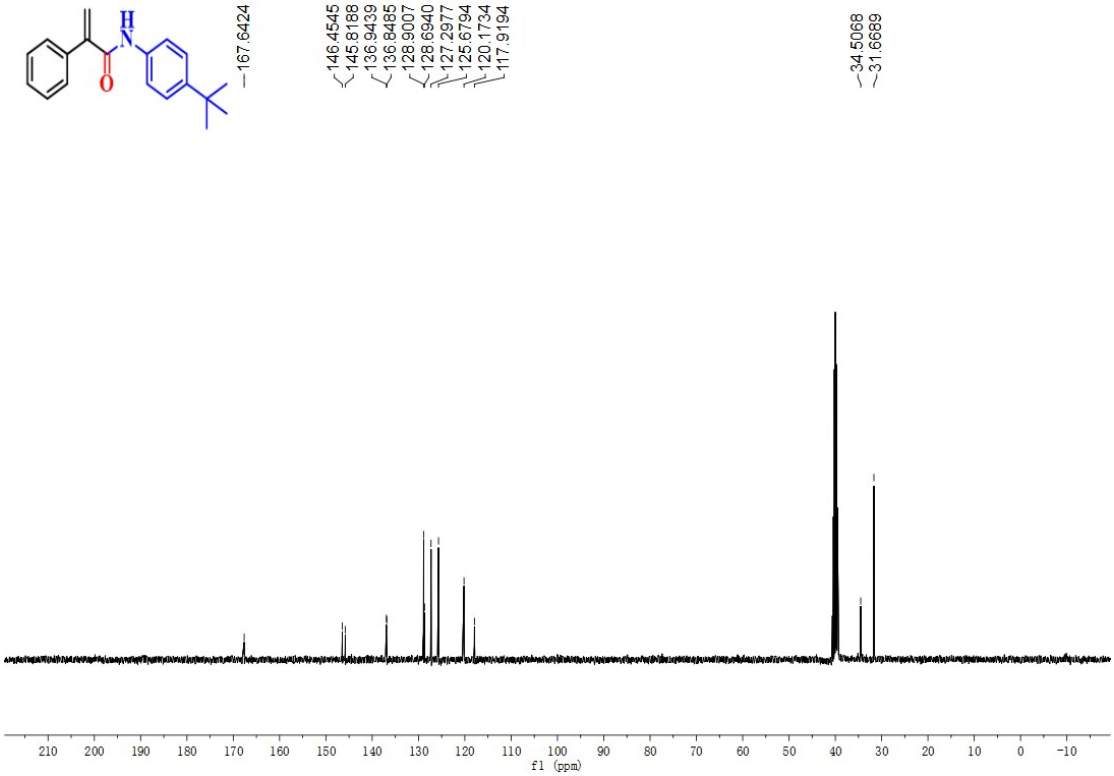
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ac



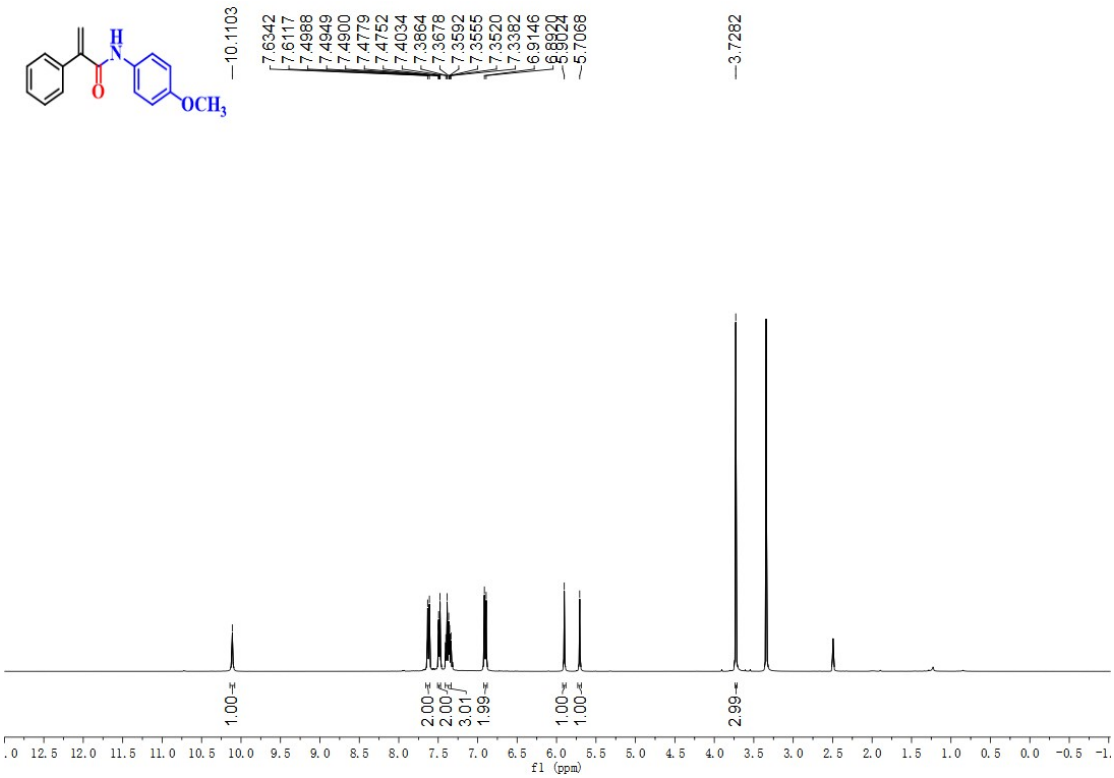
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ac



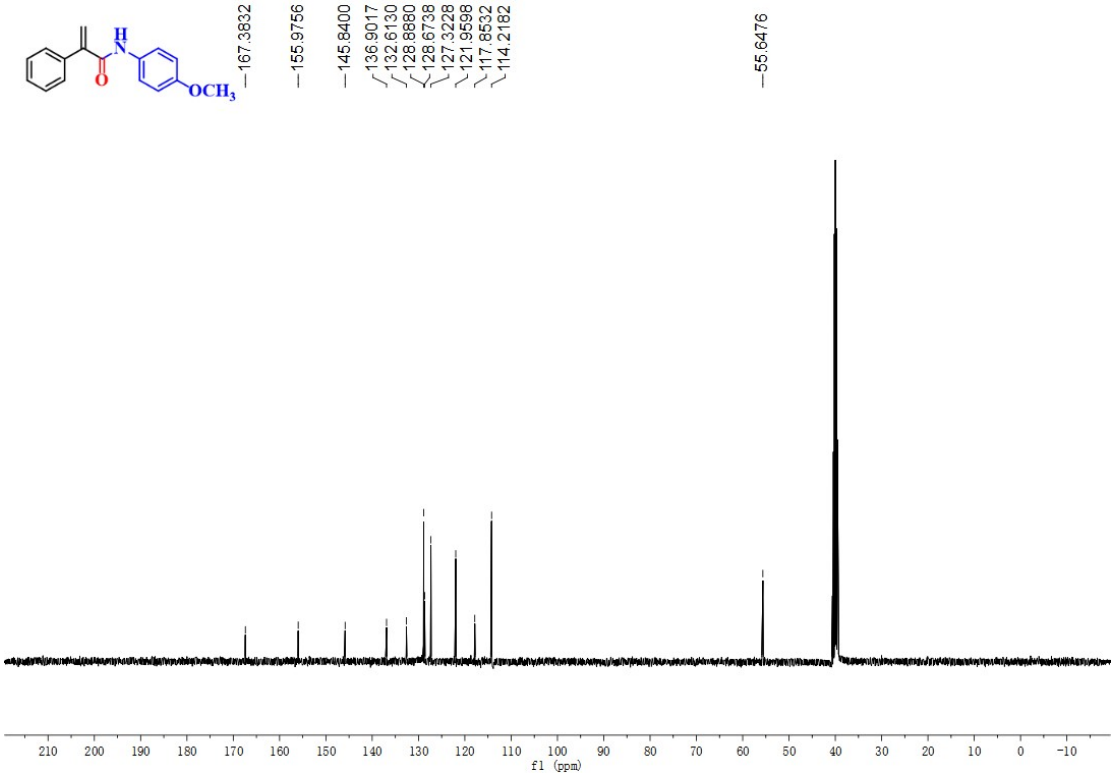
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ad



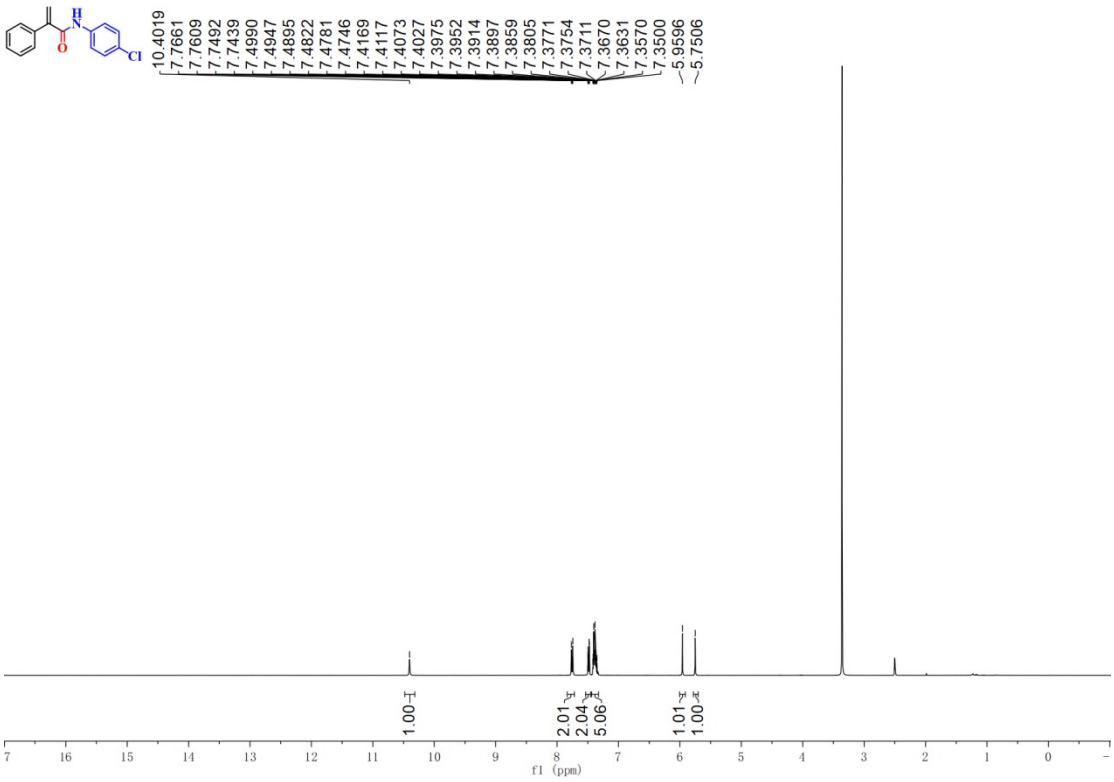
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ad



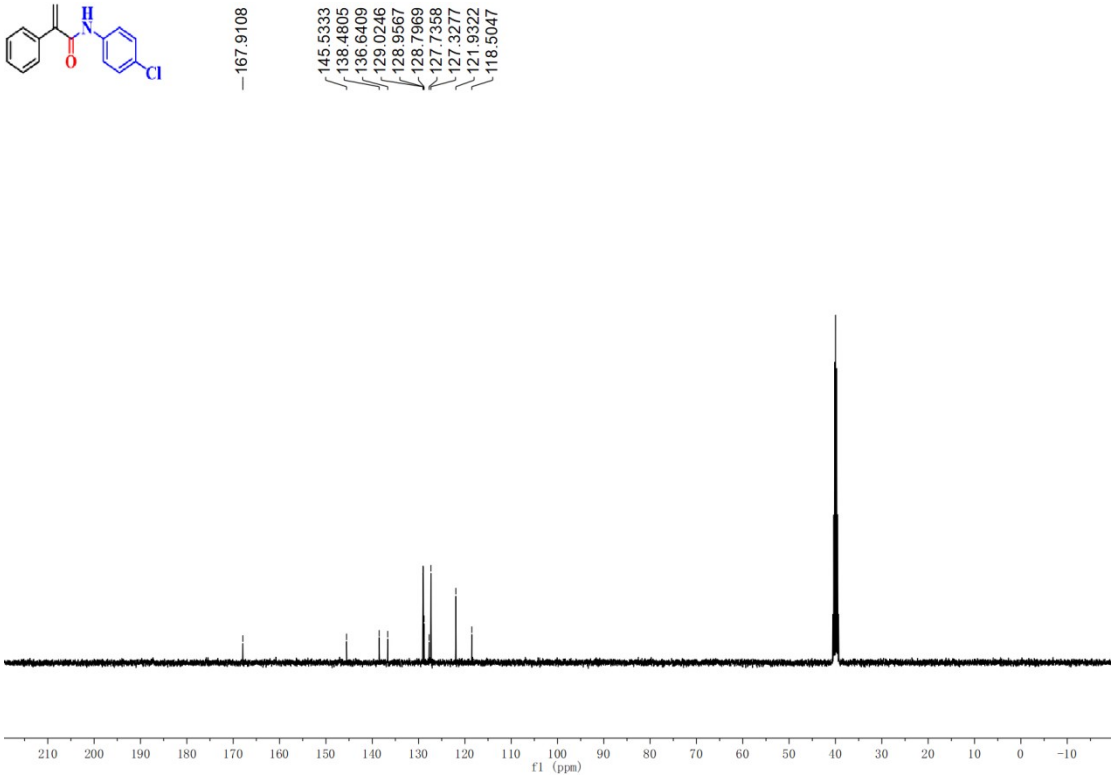
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ae



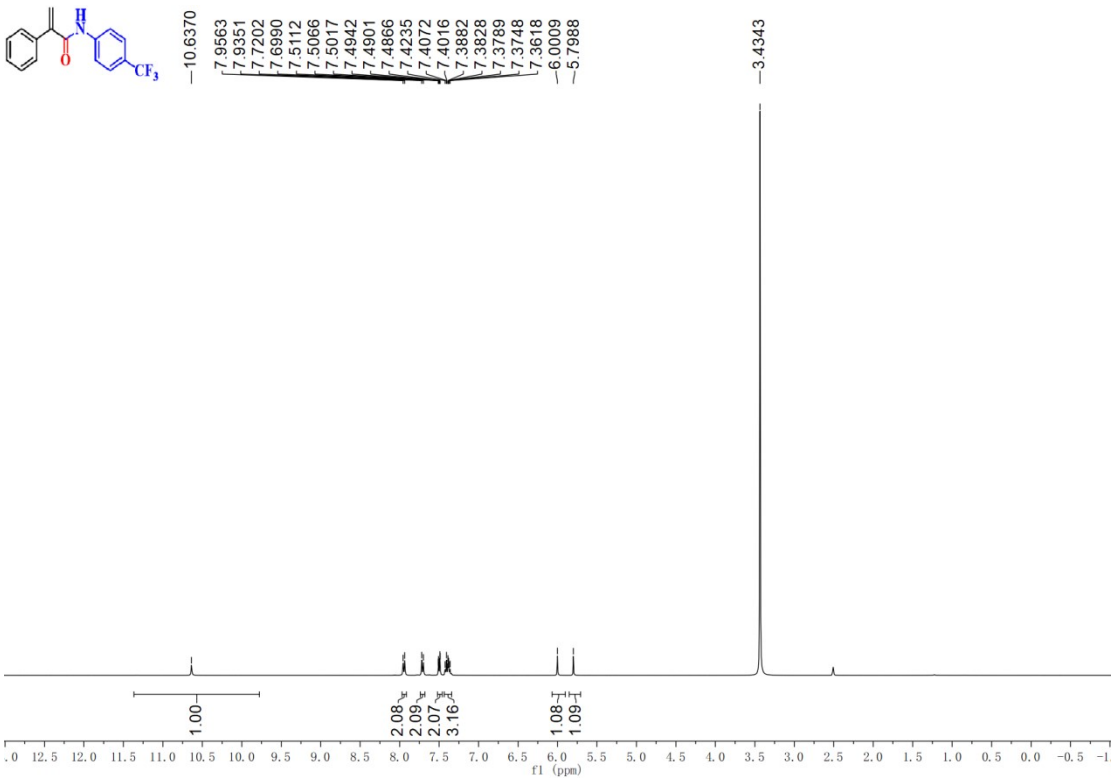
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ae



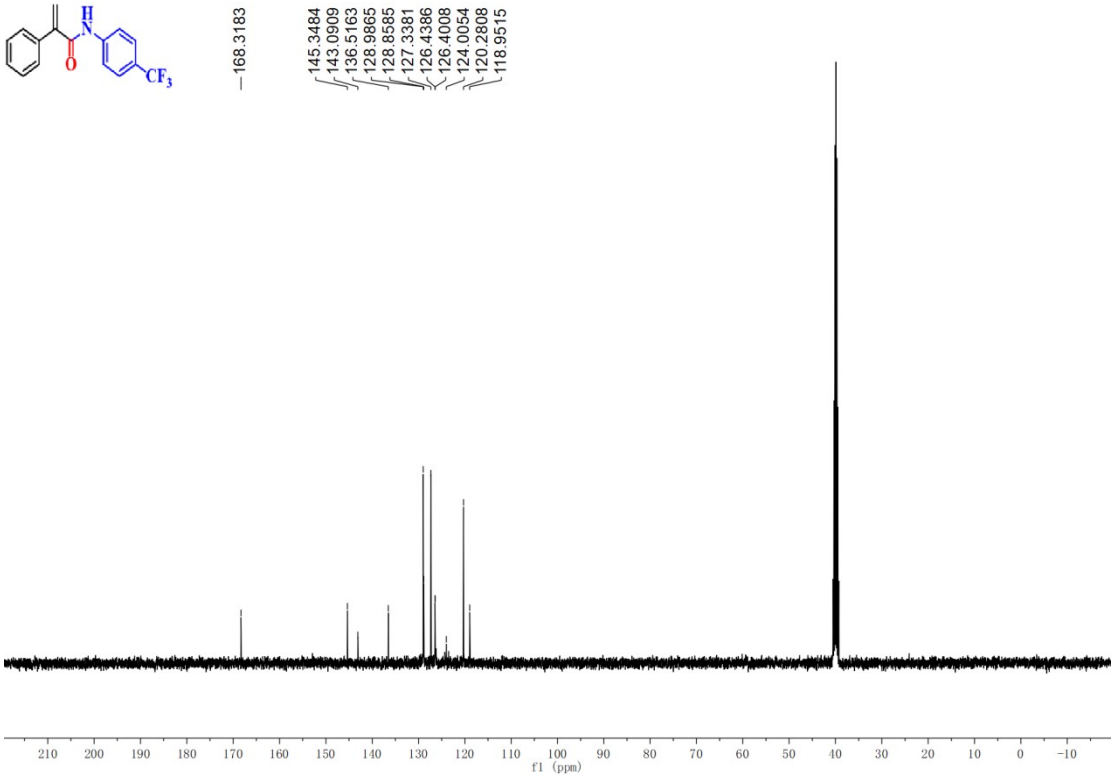
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3af



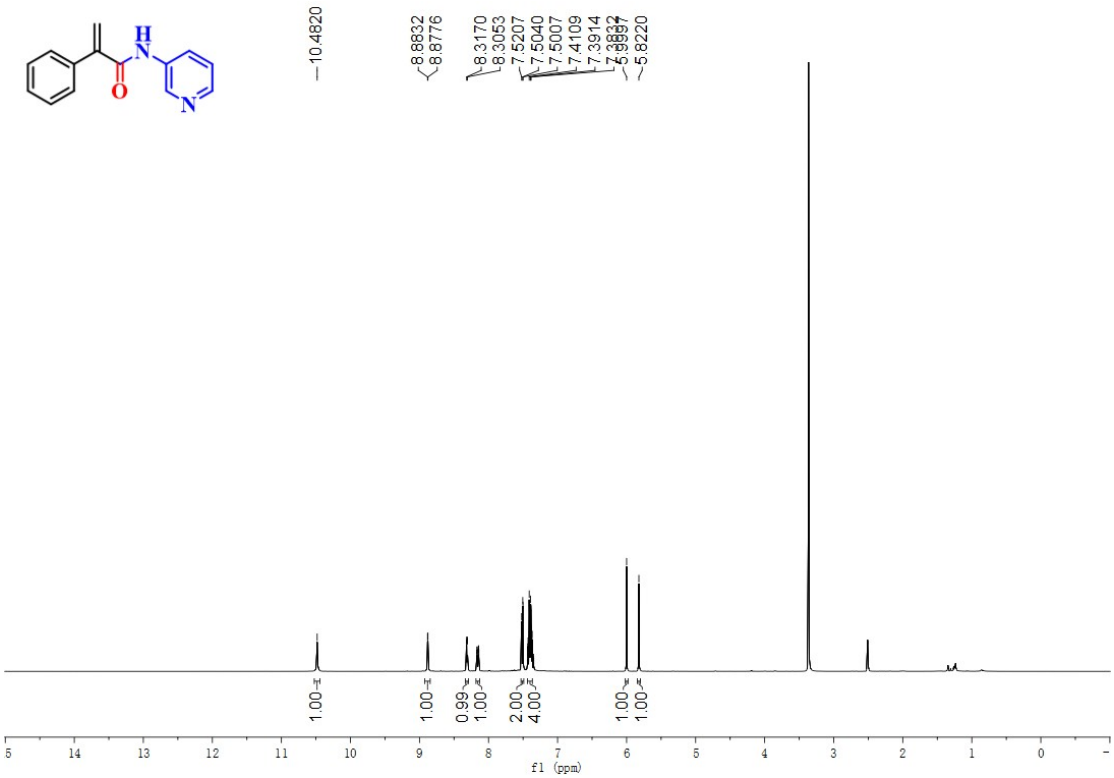
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3af



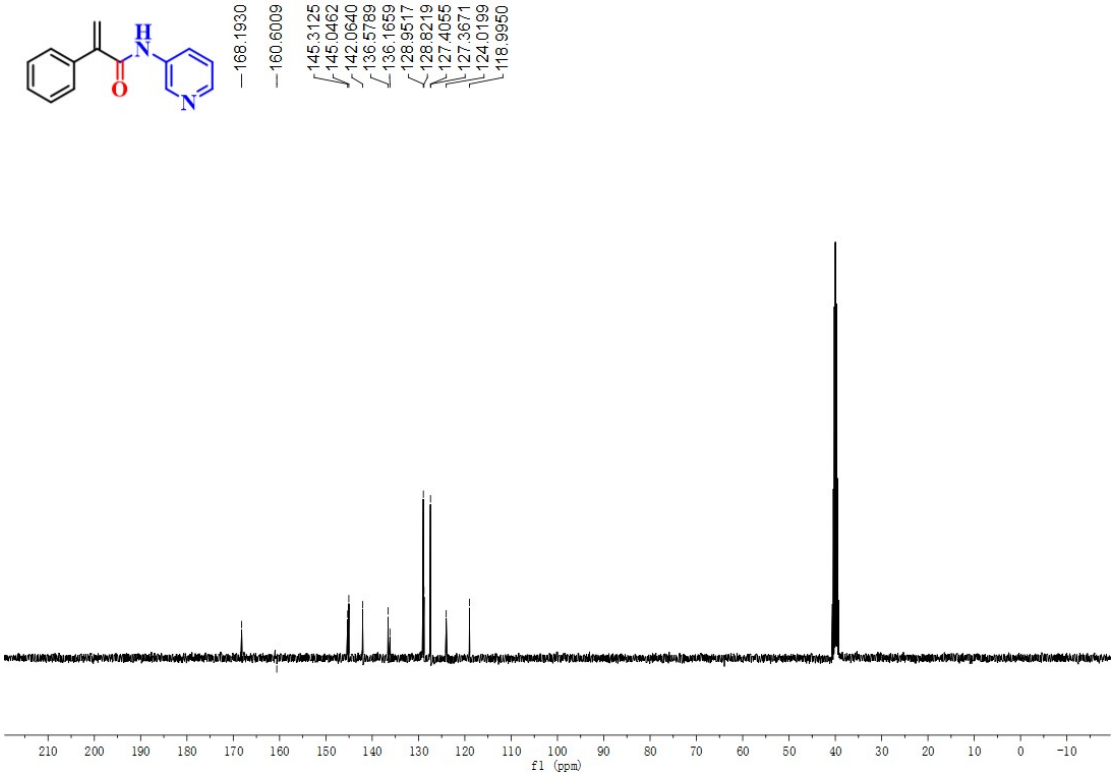
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ag



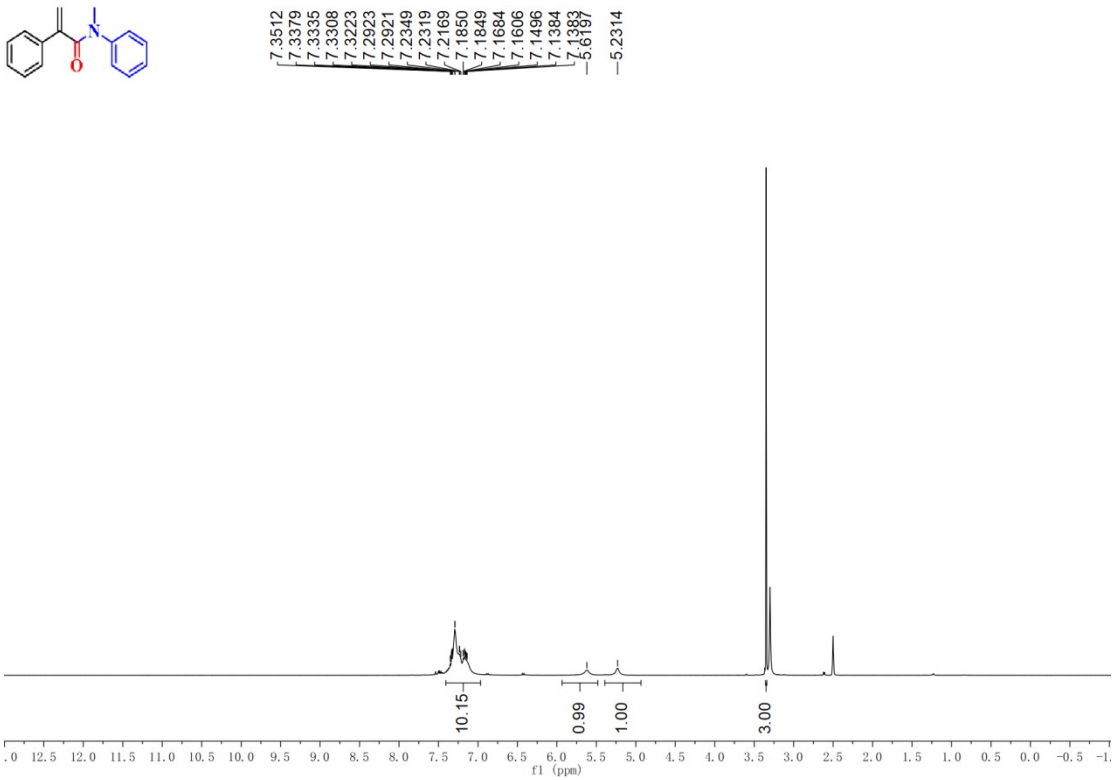
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ag



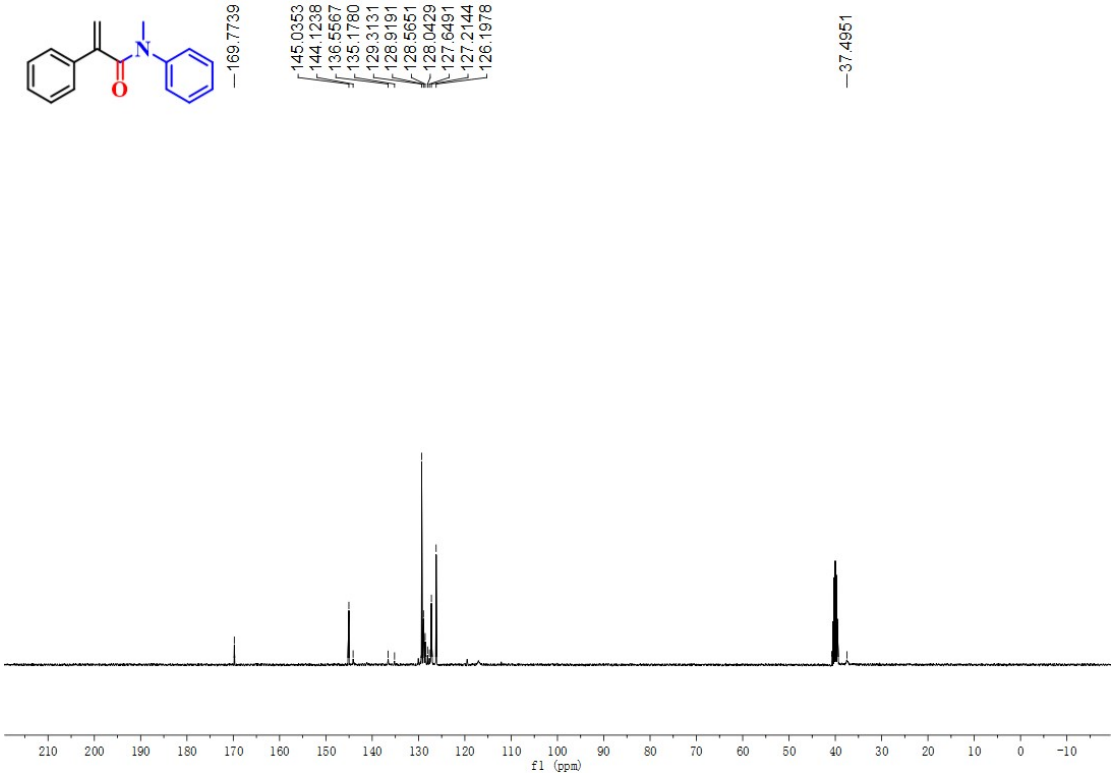
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ah



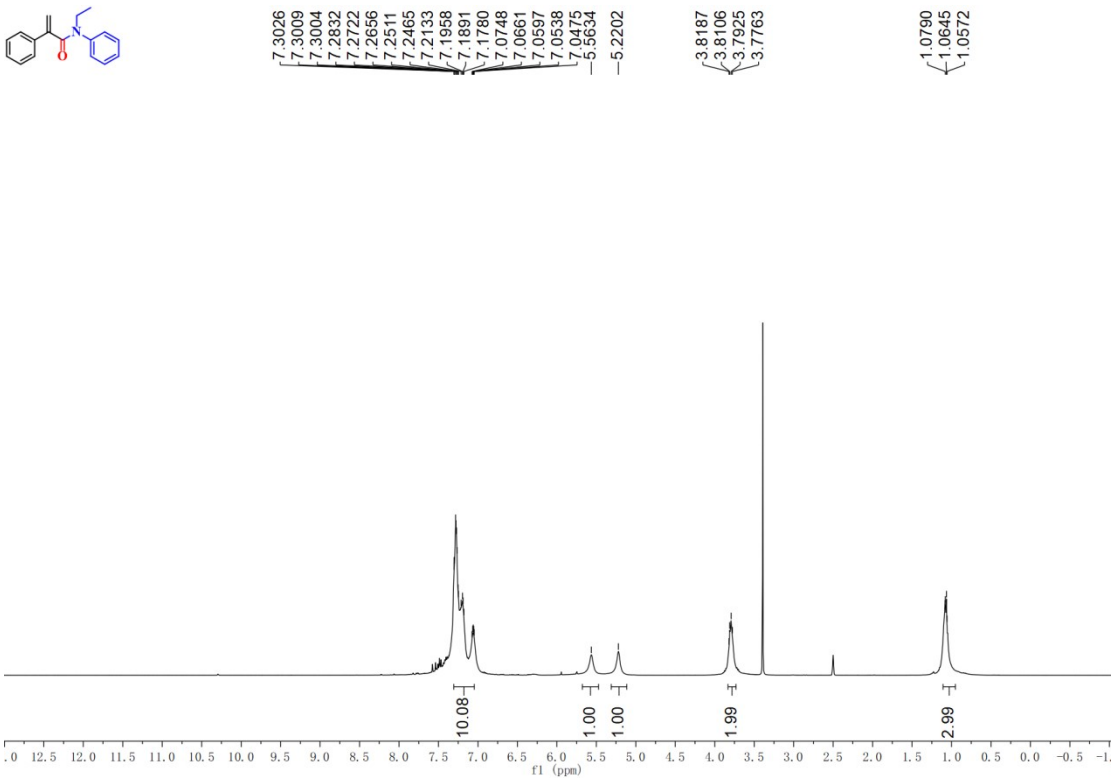
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ah



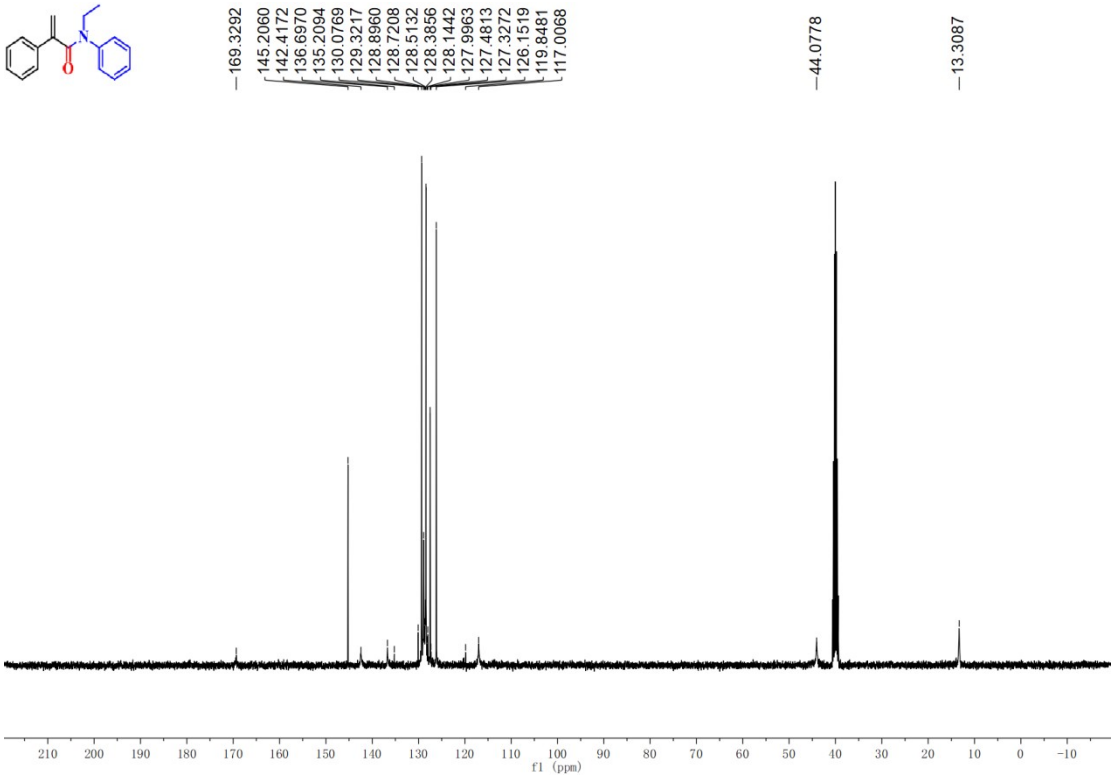
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ai



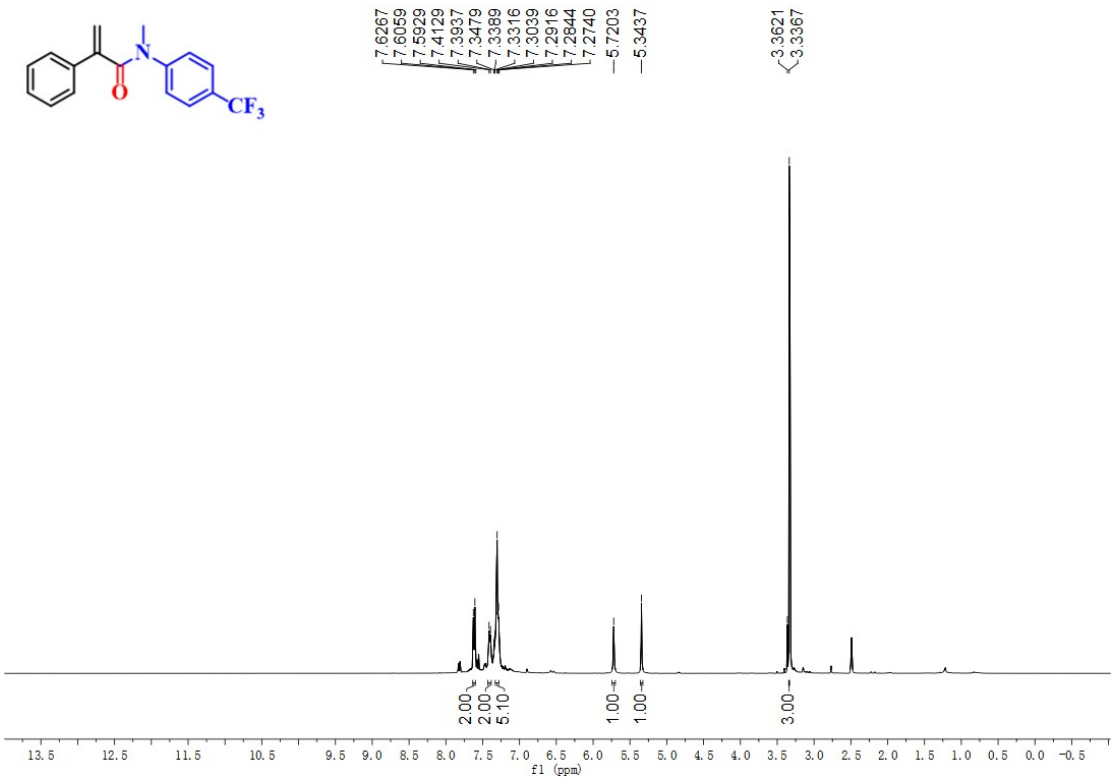
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ai



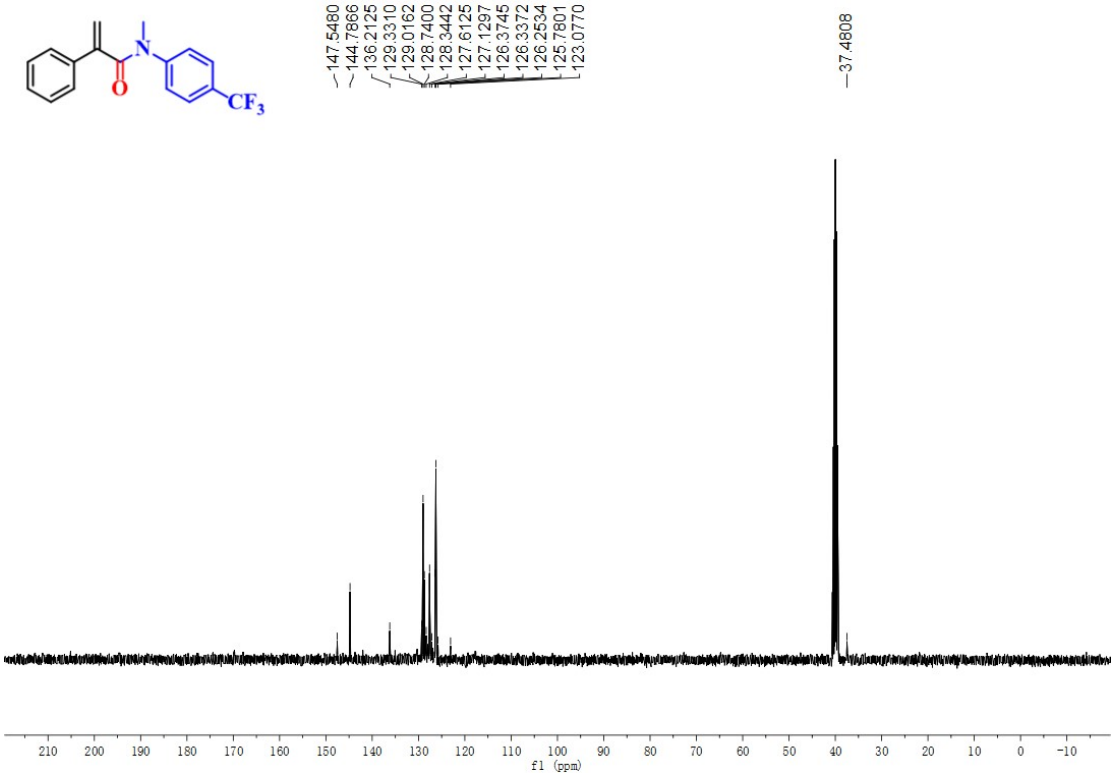
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3aj



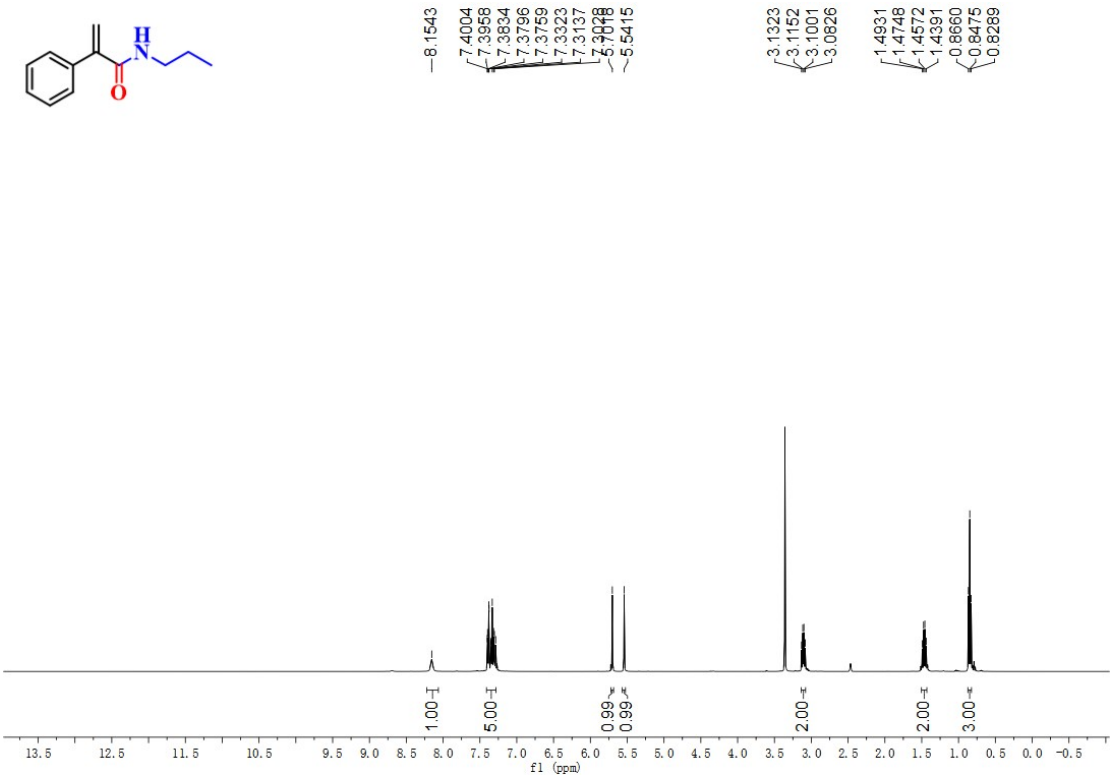
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3aj



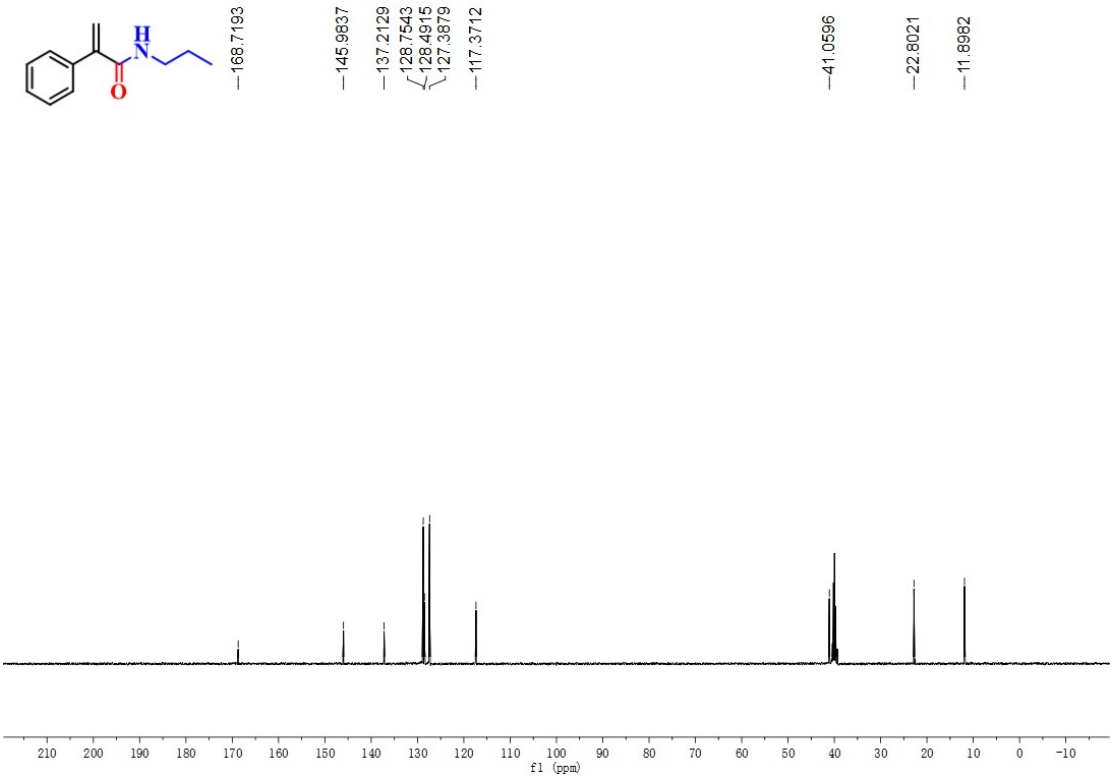
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ak



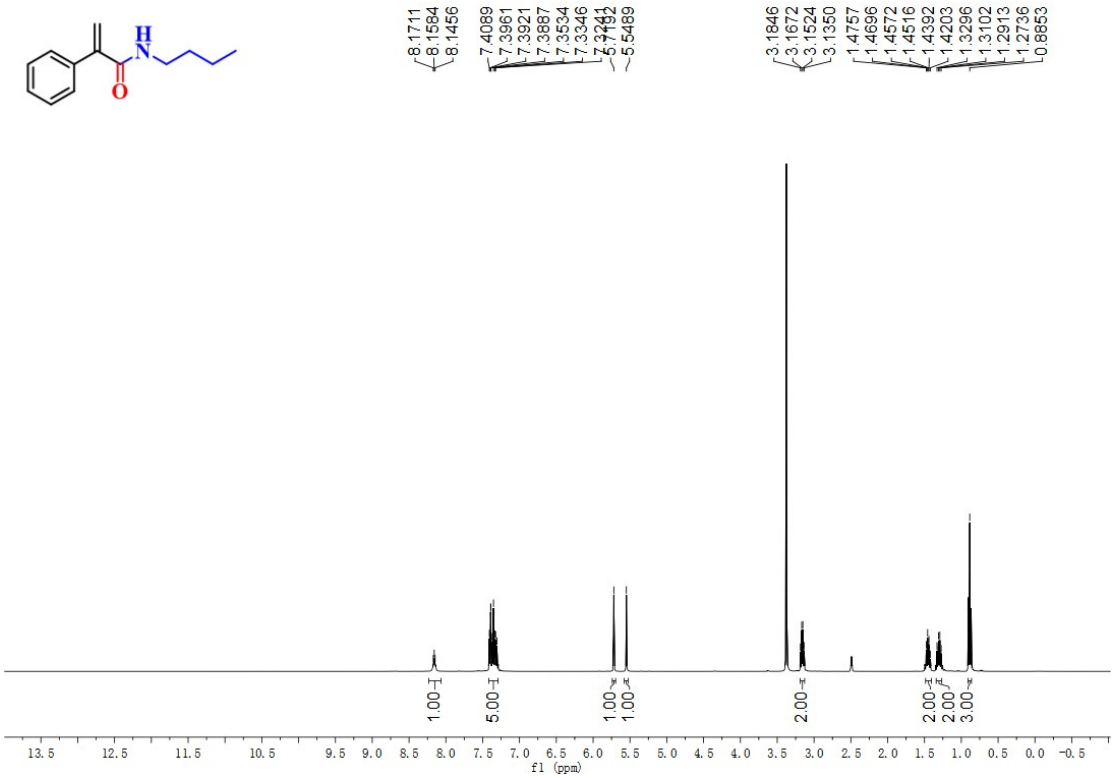
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ak



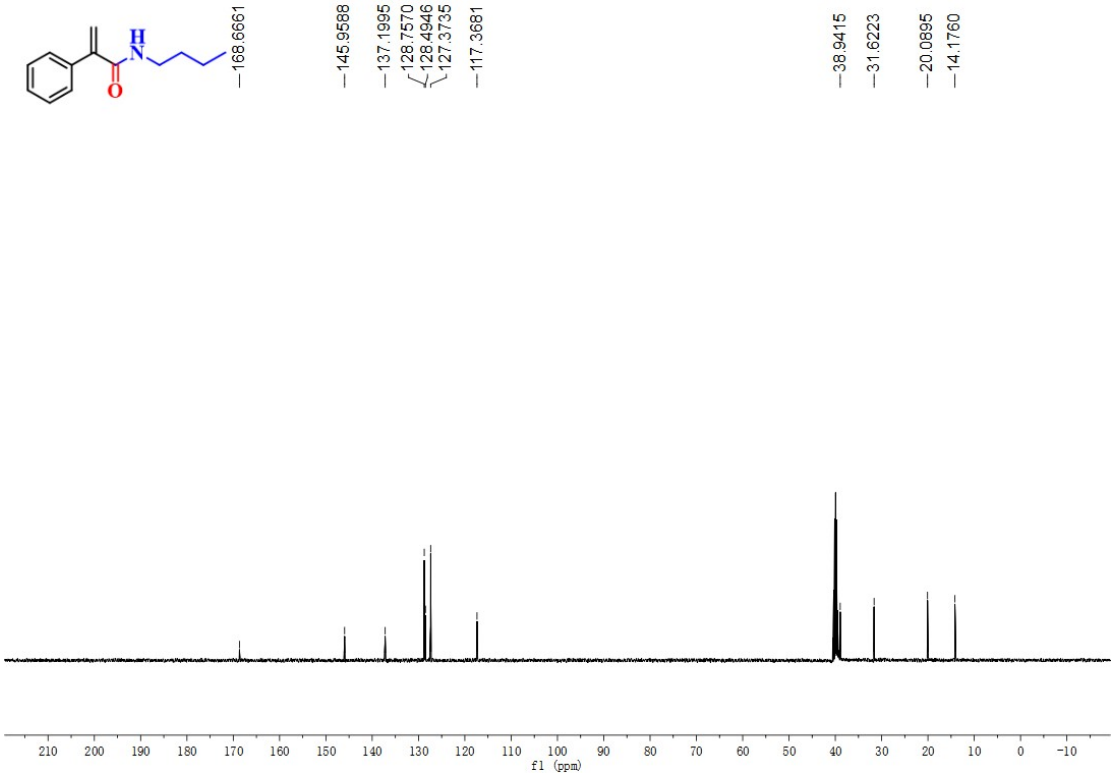
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3al



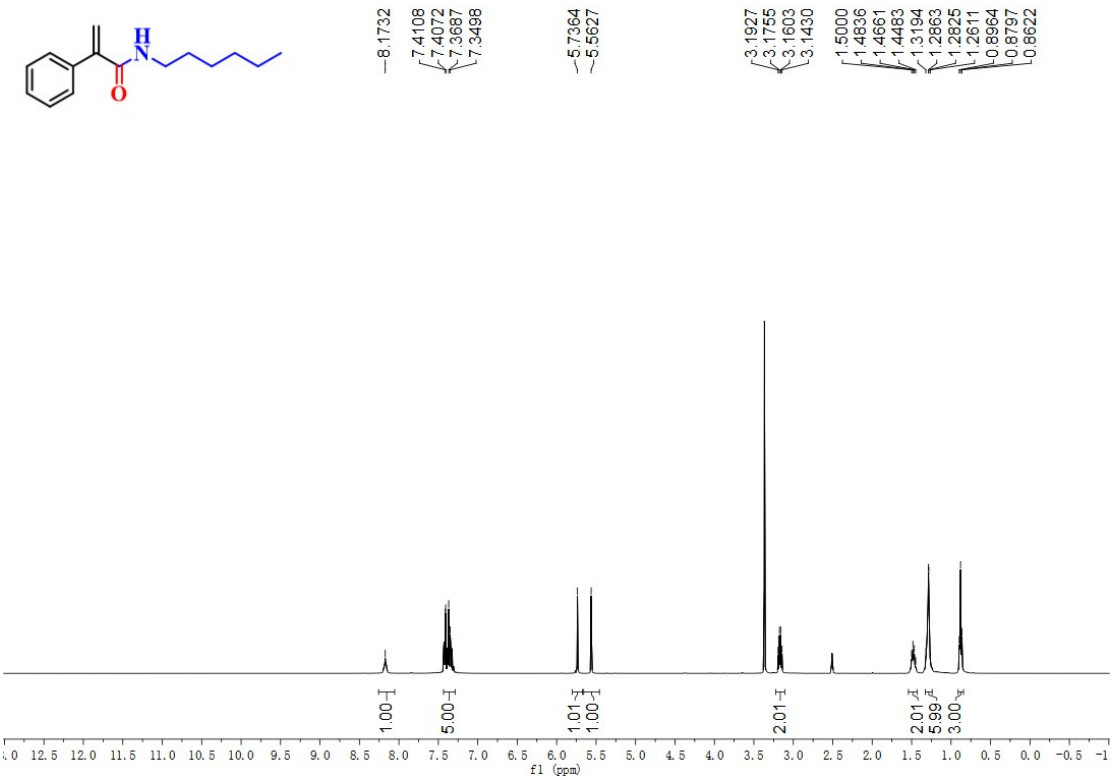
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3al



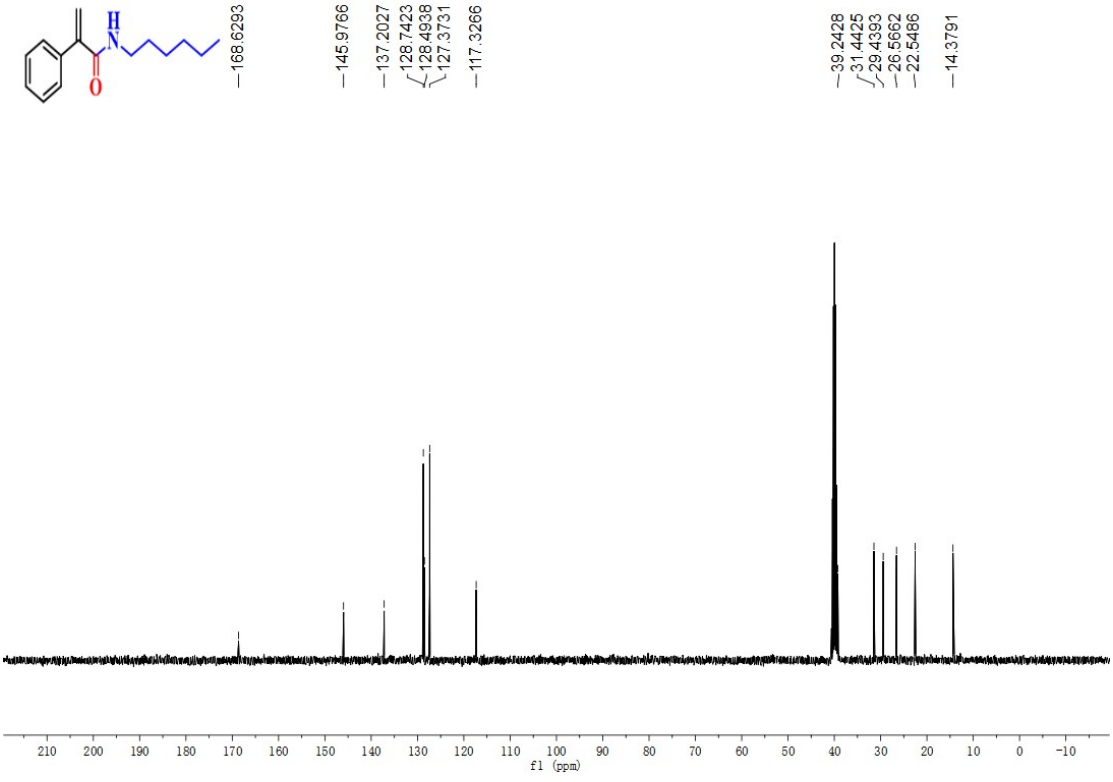
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3am



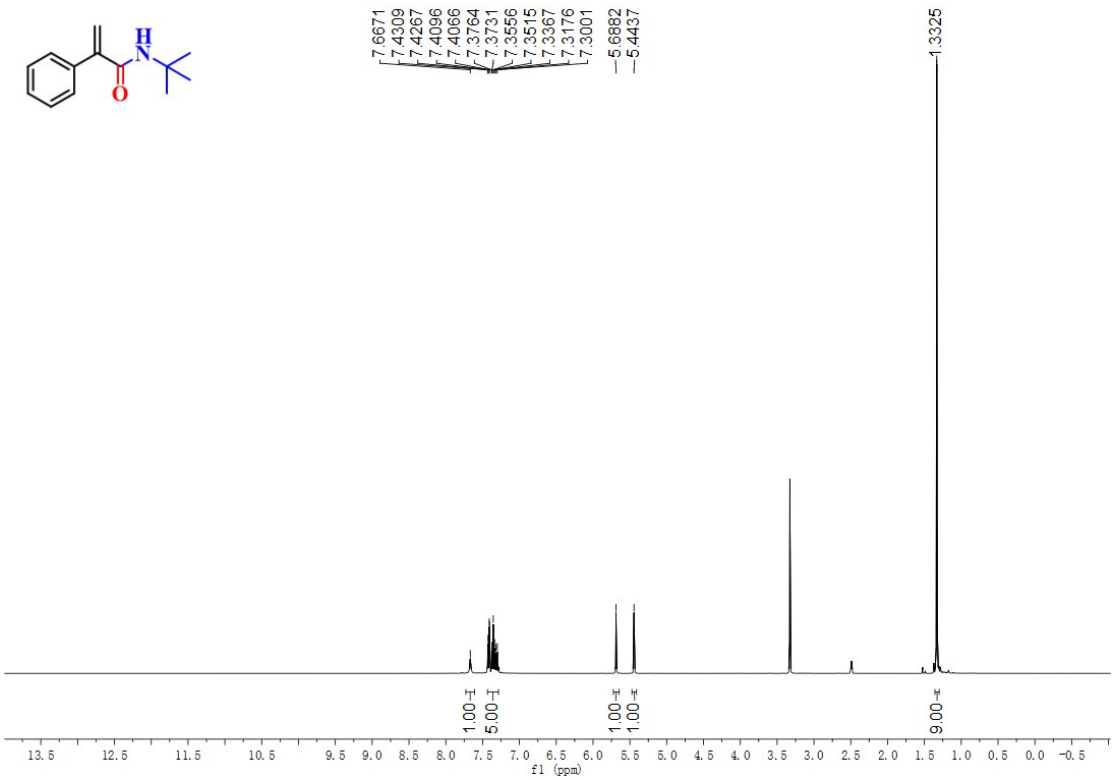
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3am



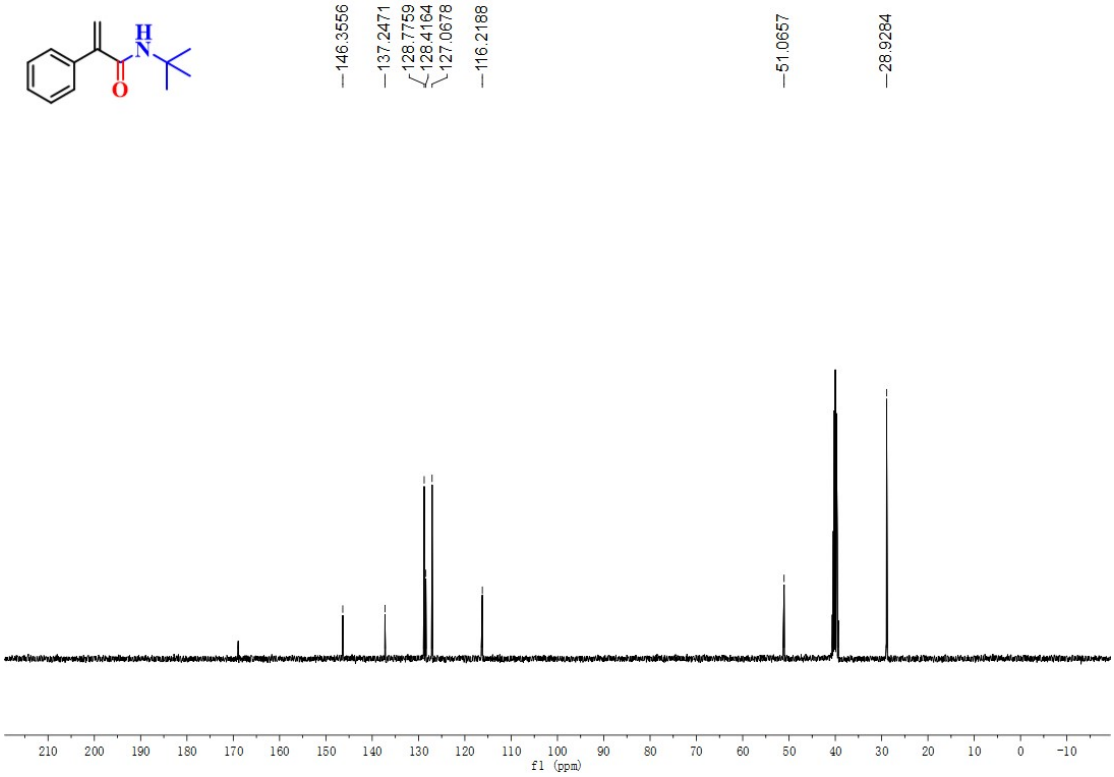
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3an



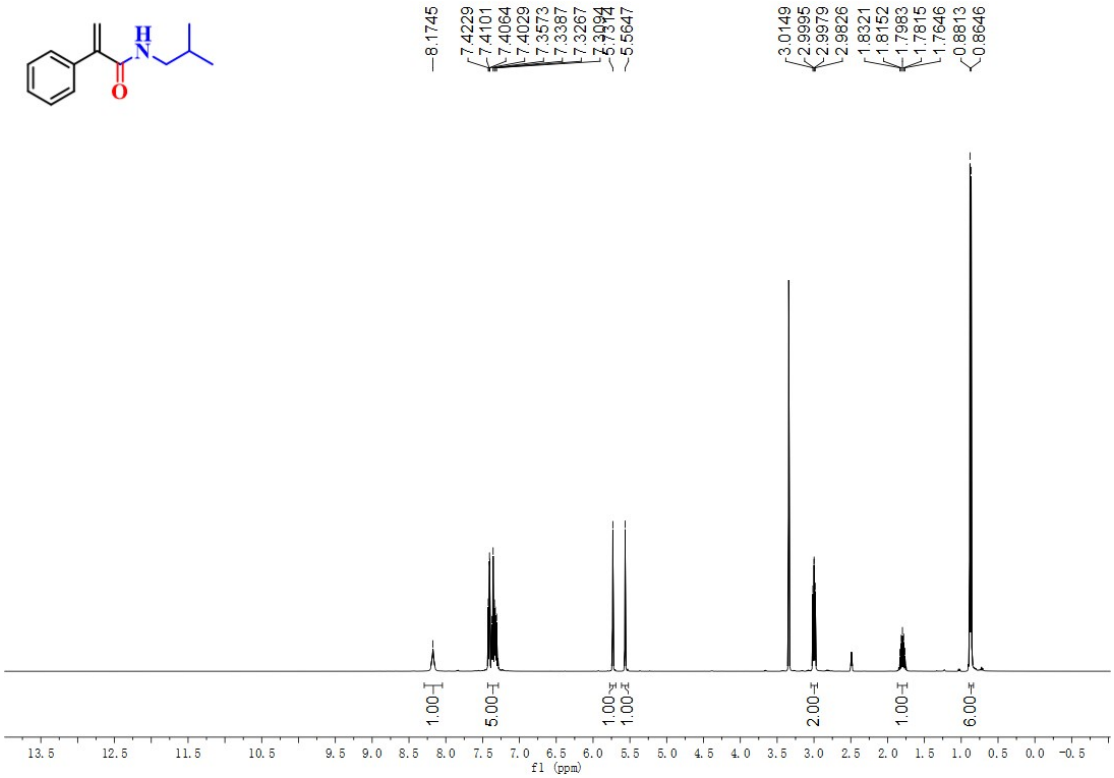
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3an



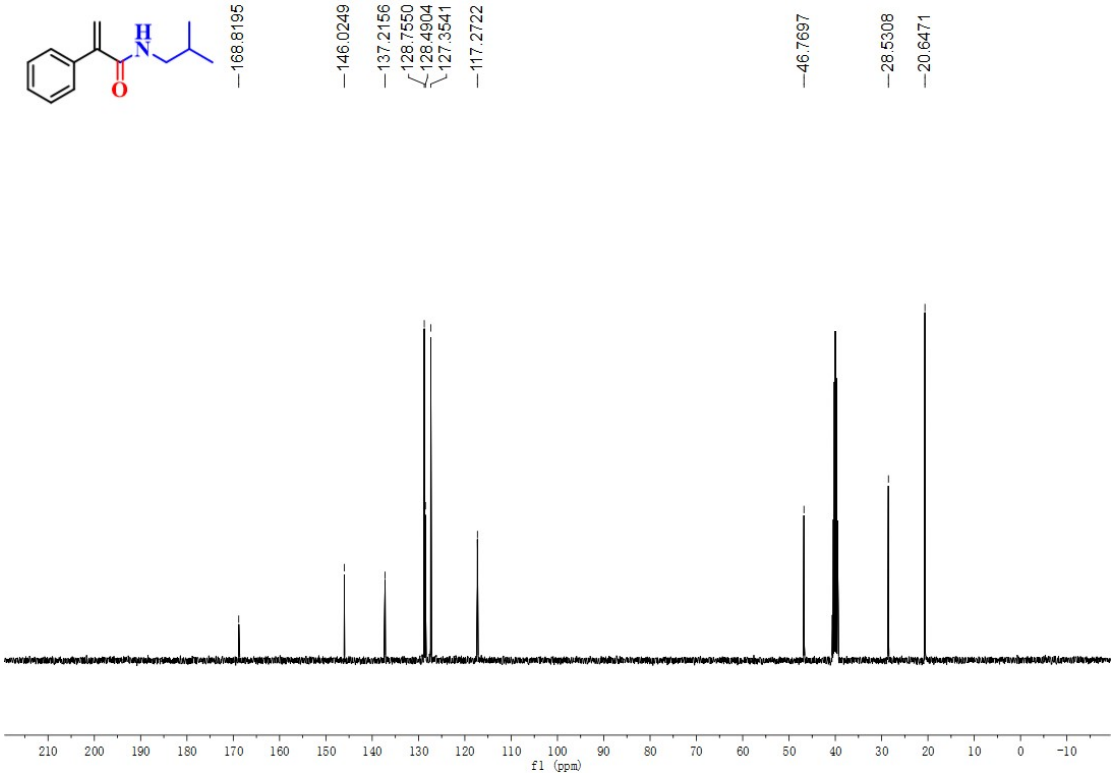
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ao



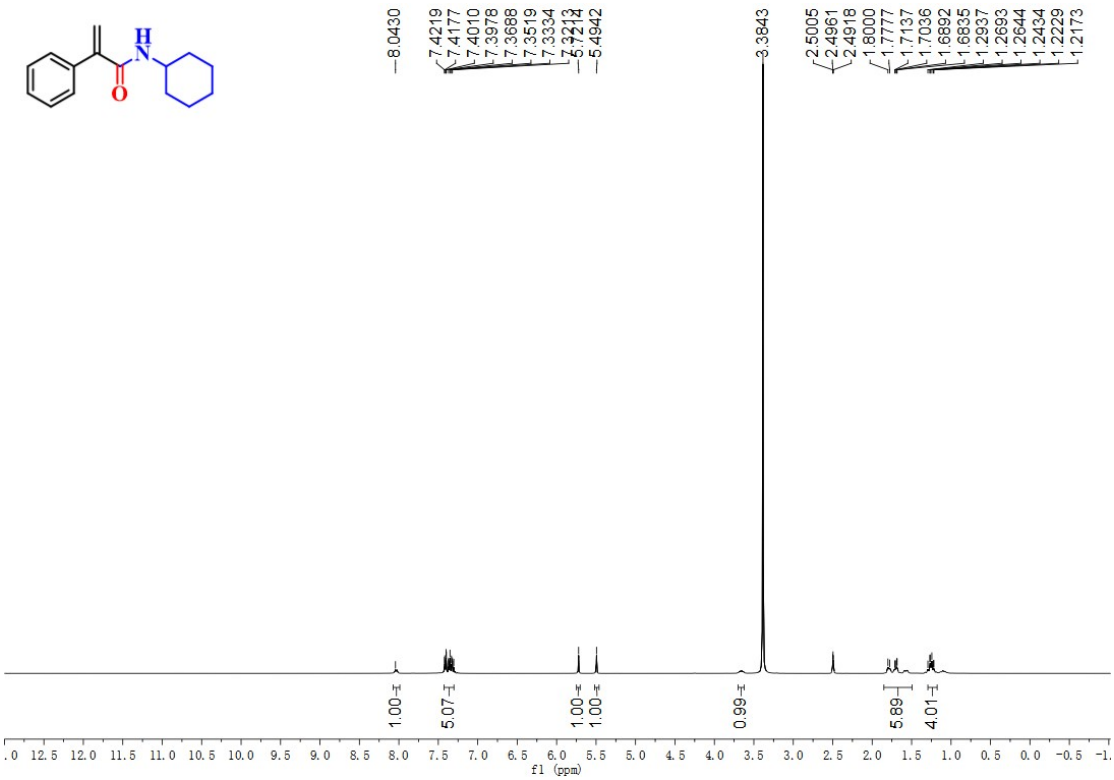
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ao



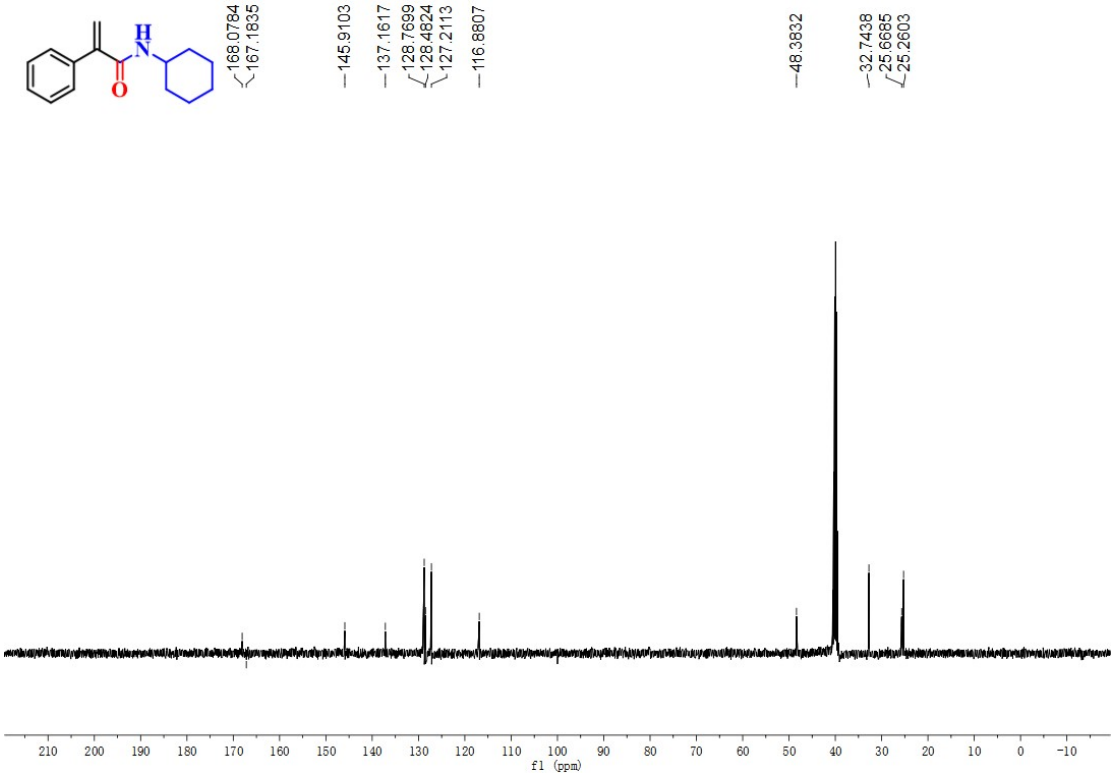
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ap



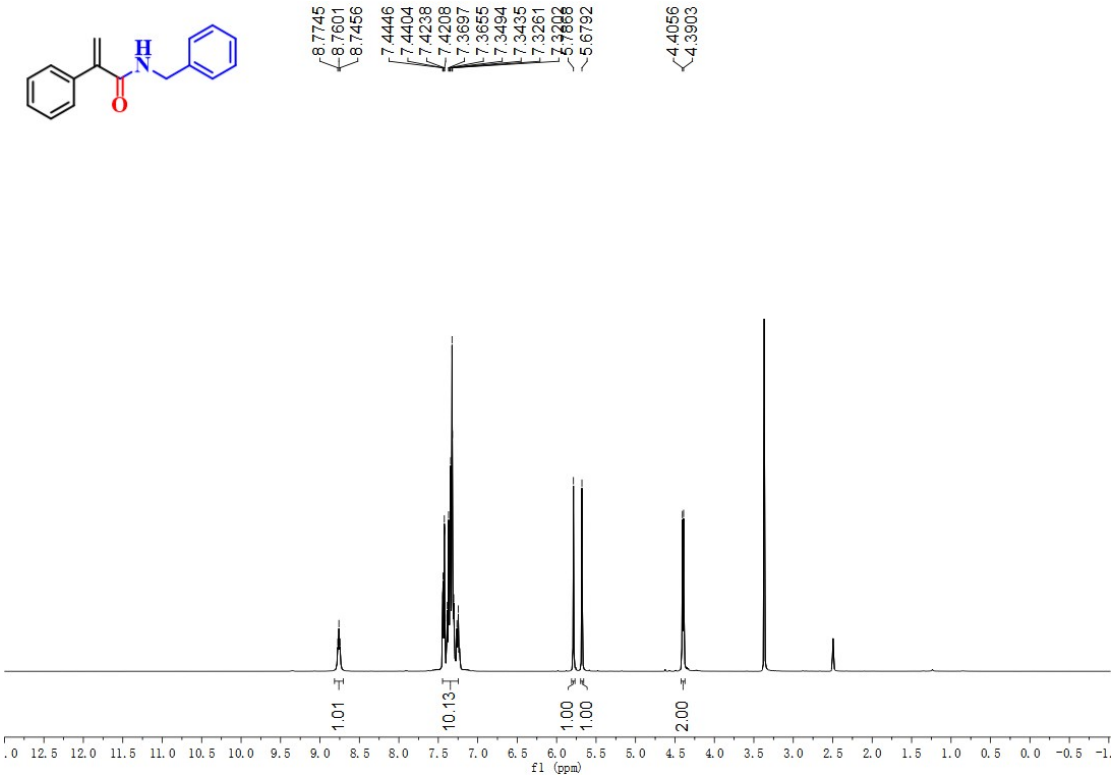
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ap



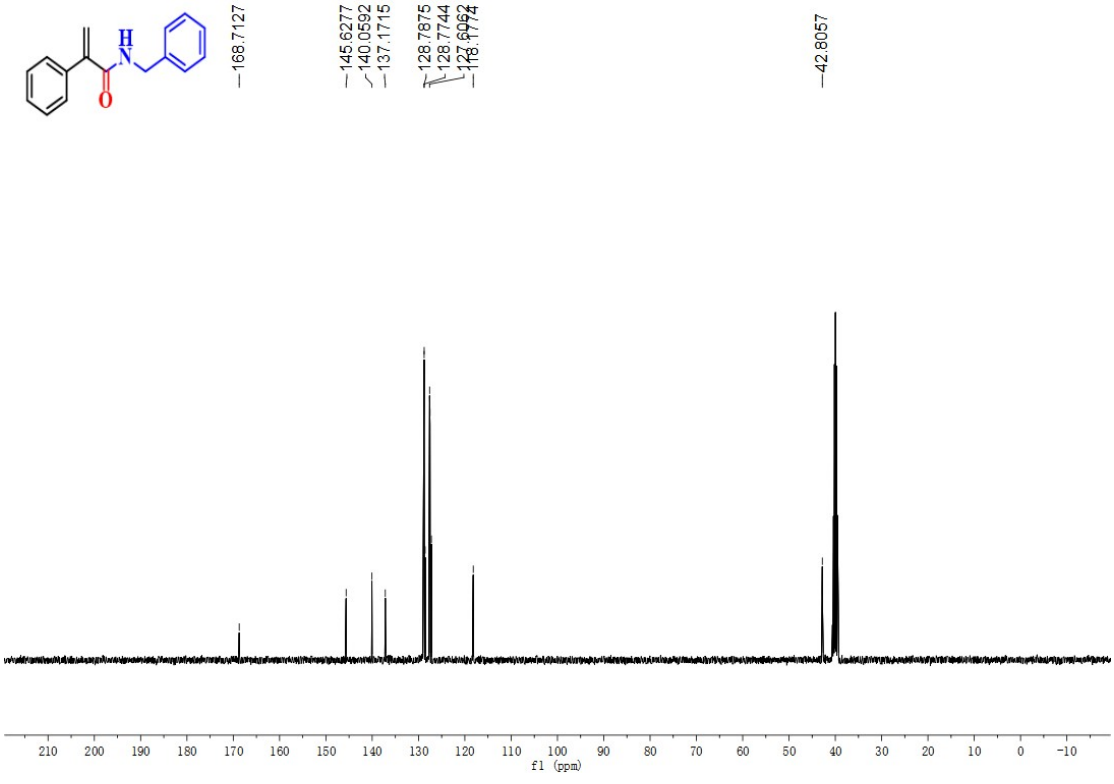
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3aq



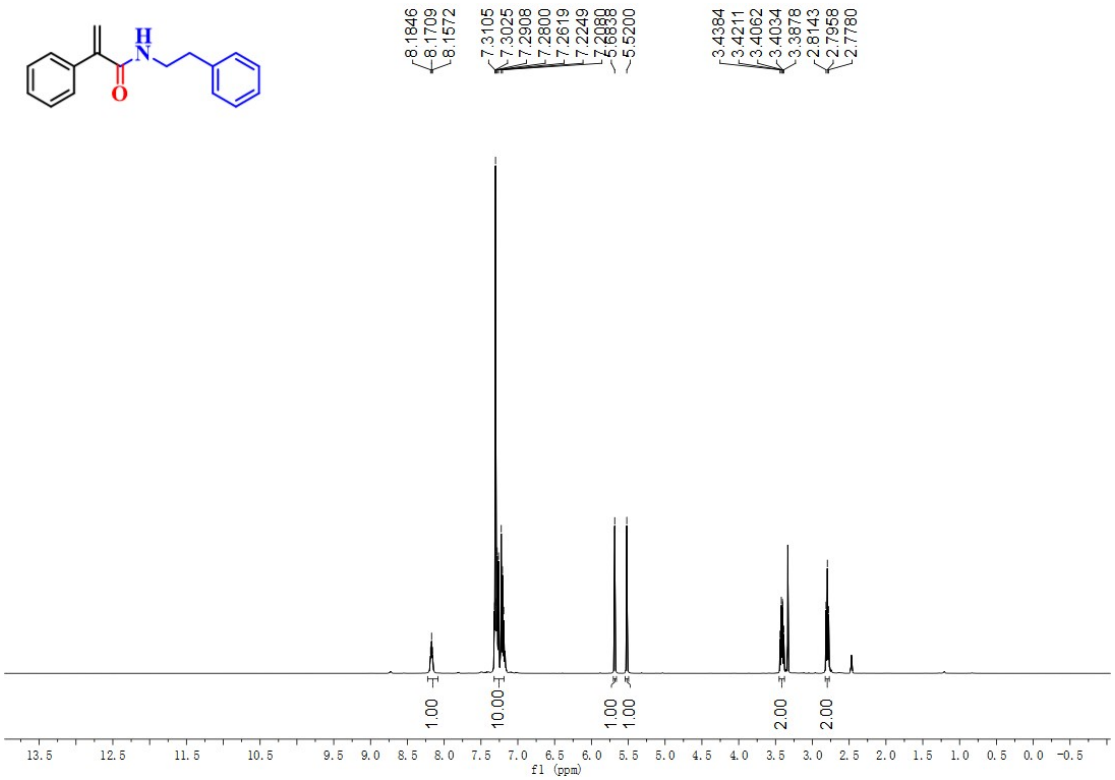
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3aq



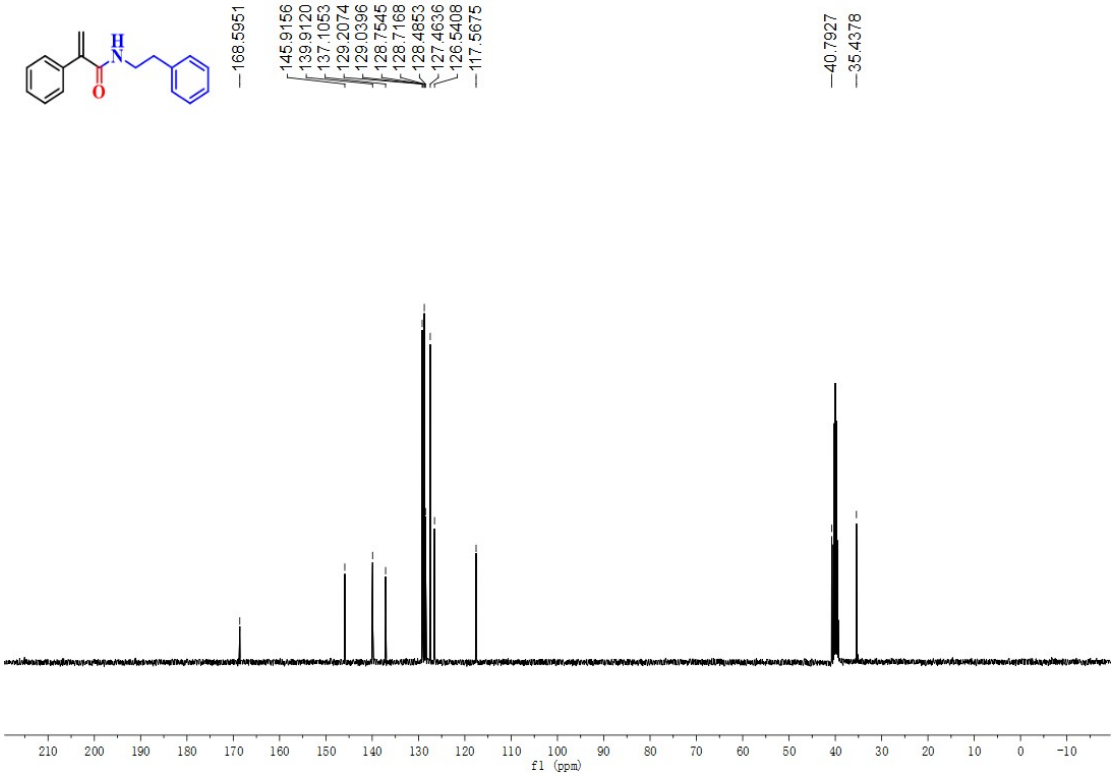
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ar



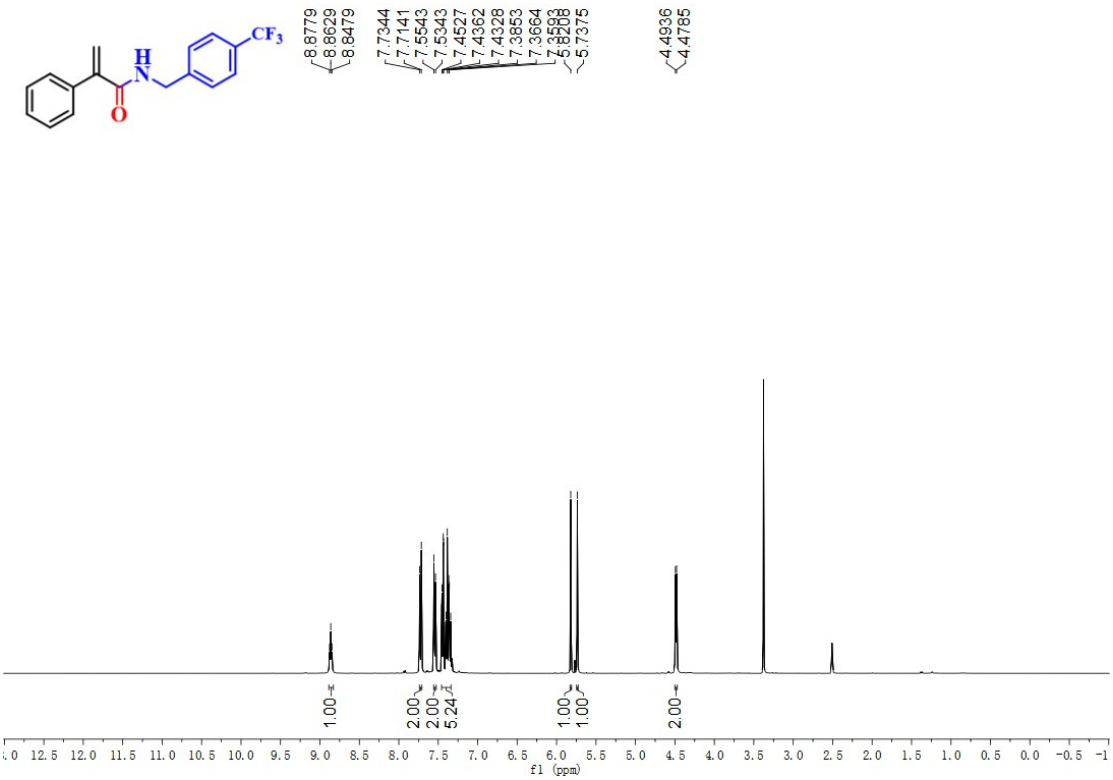
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ar



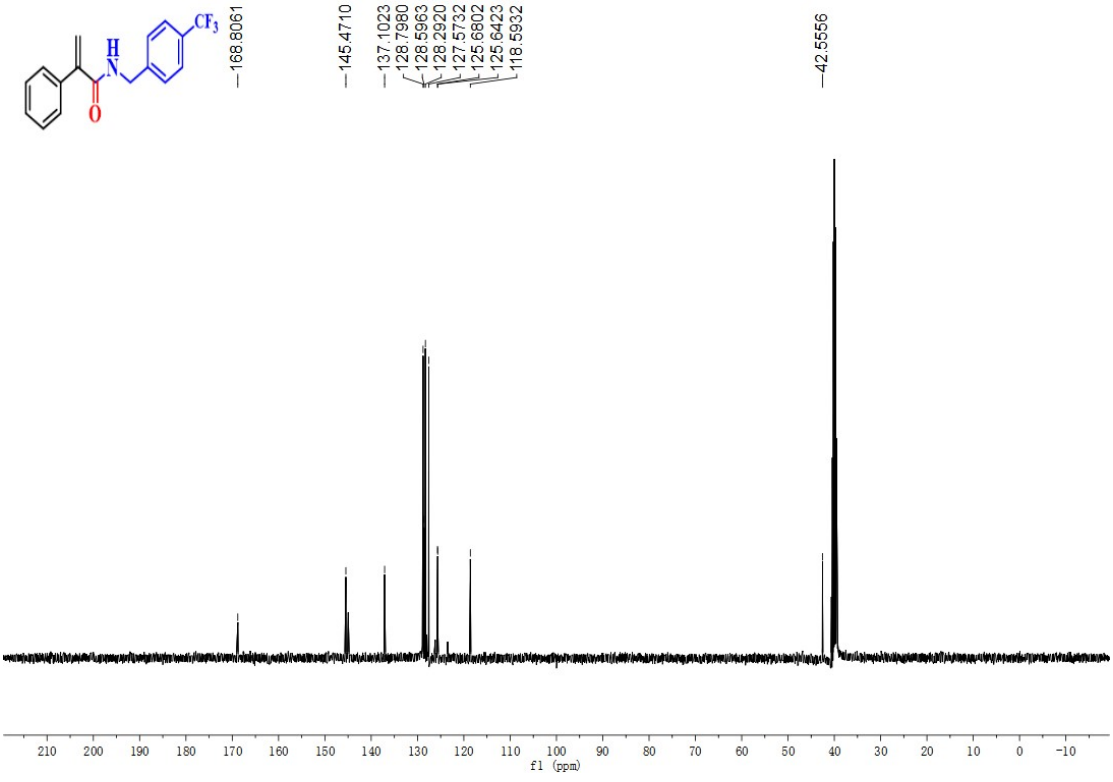
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3as



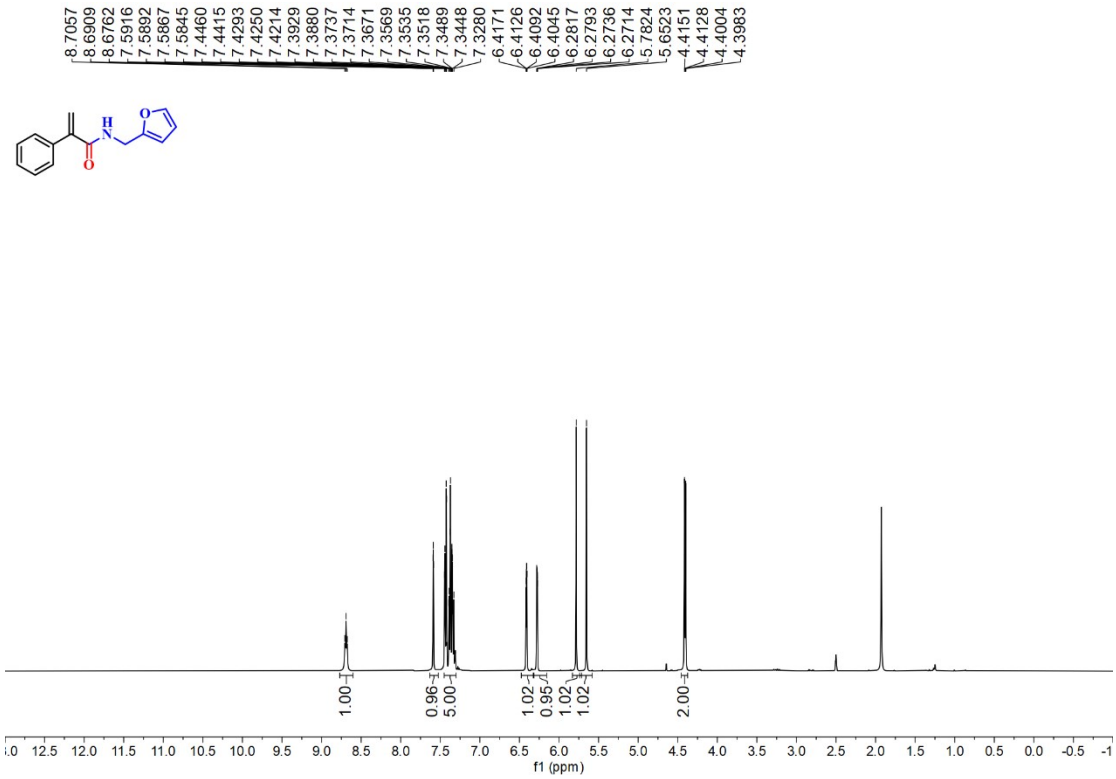
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3as



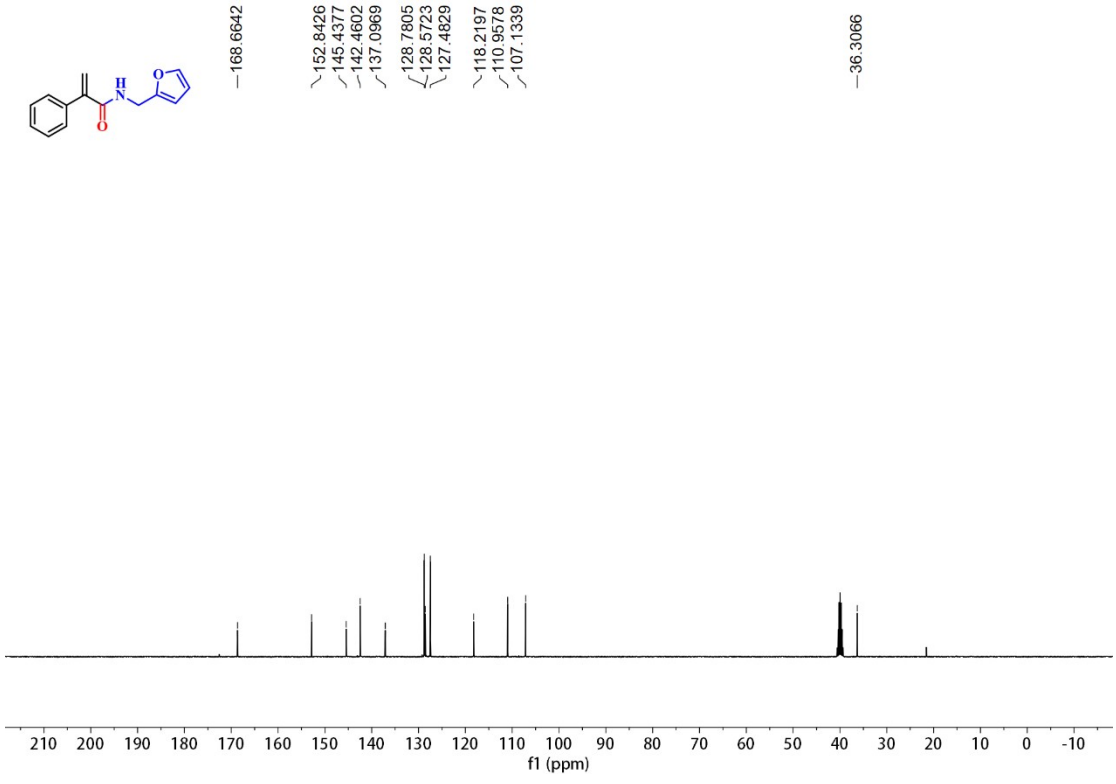
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3at



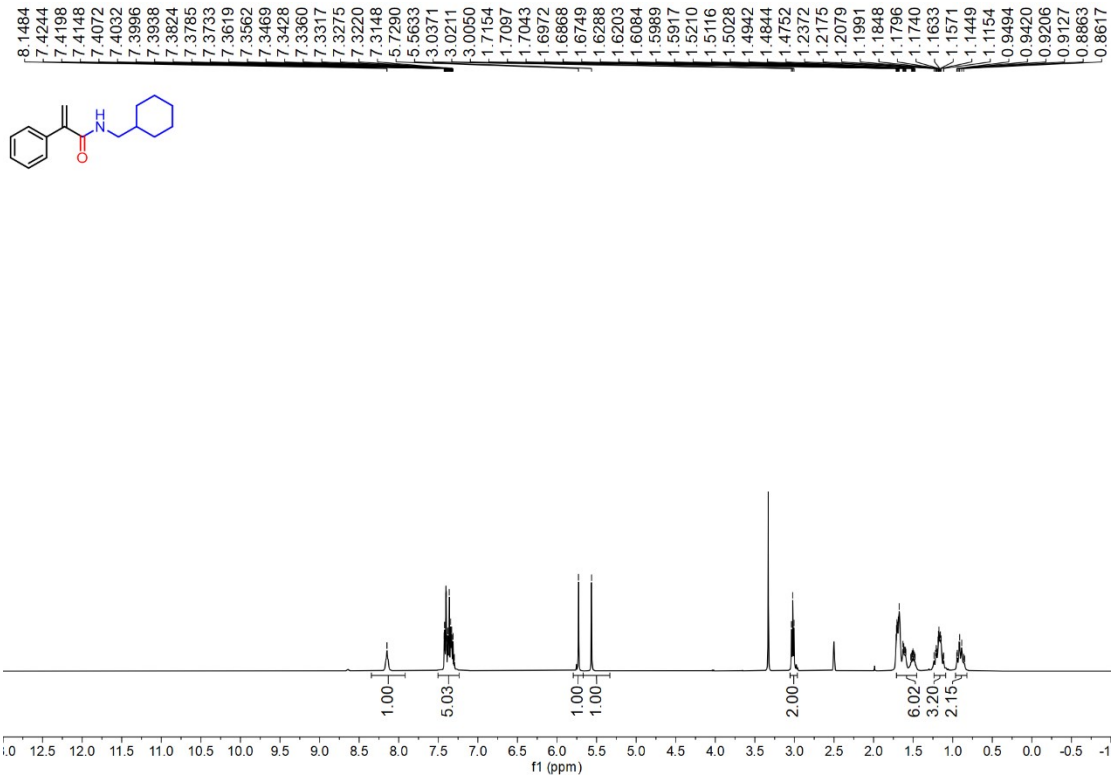
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3at



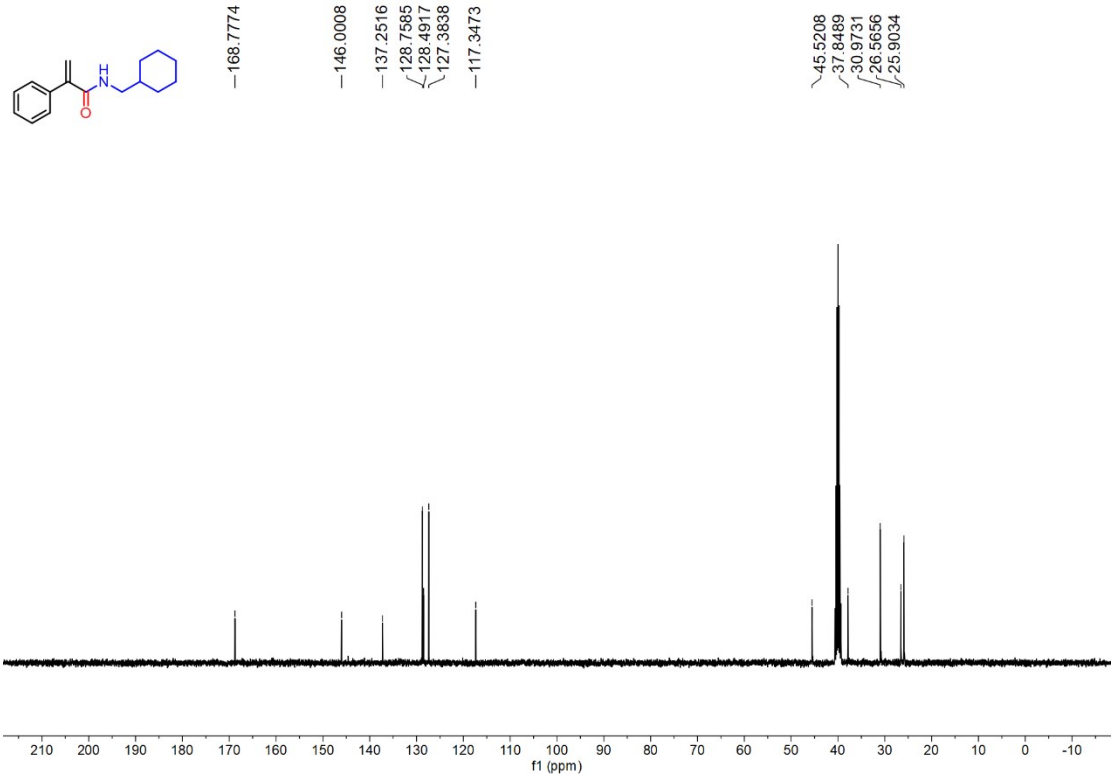
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3au



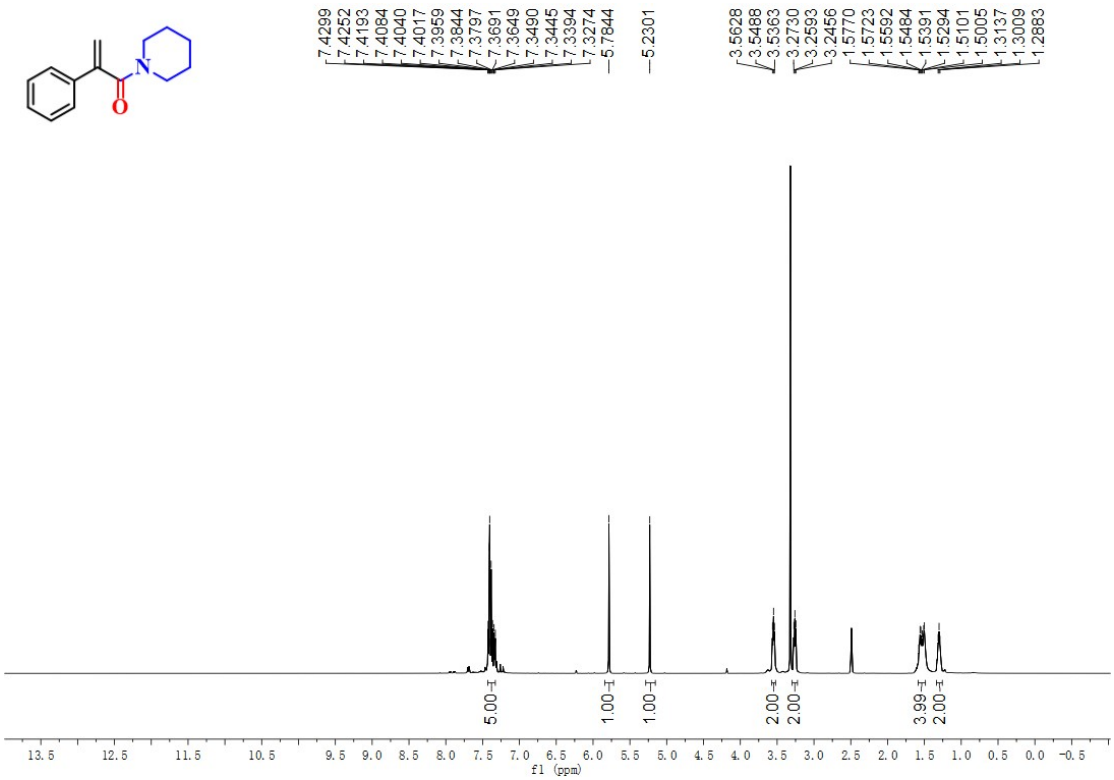
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3au



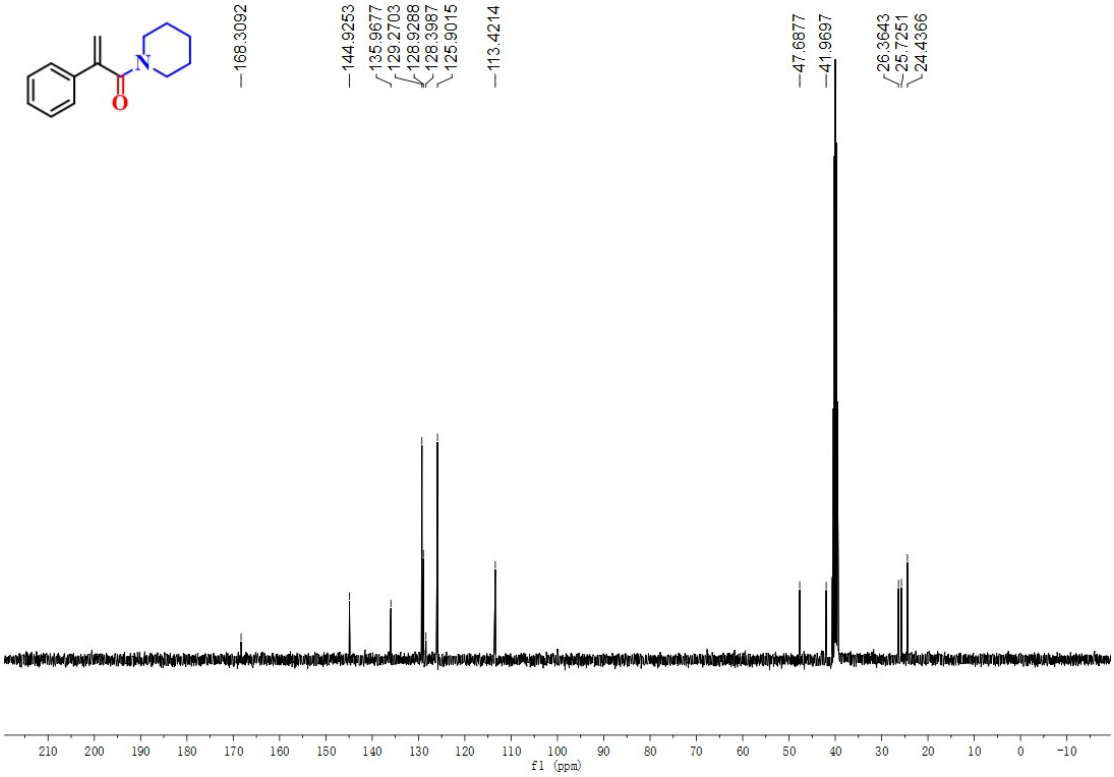
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3av



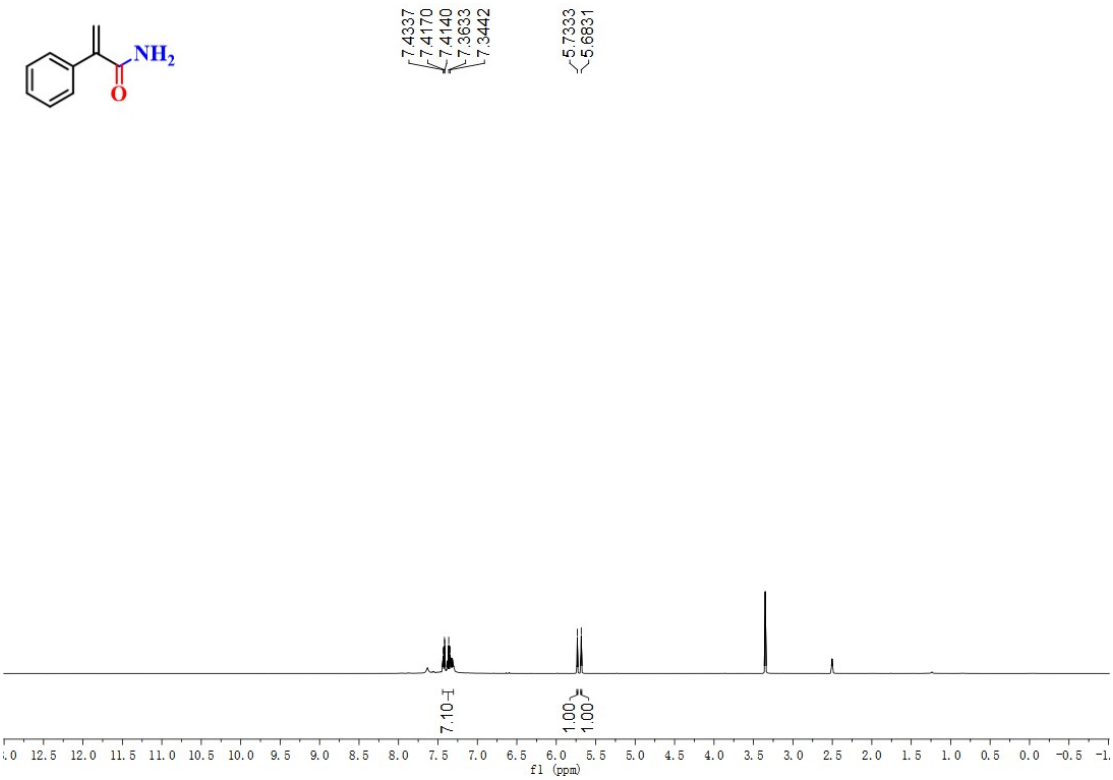
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3av



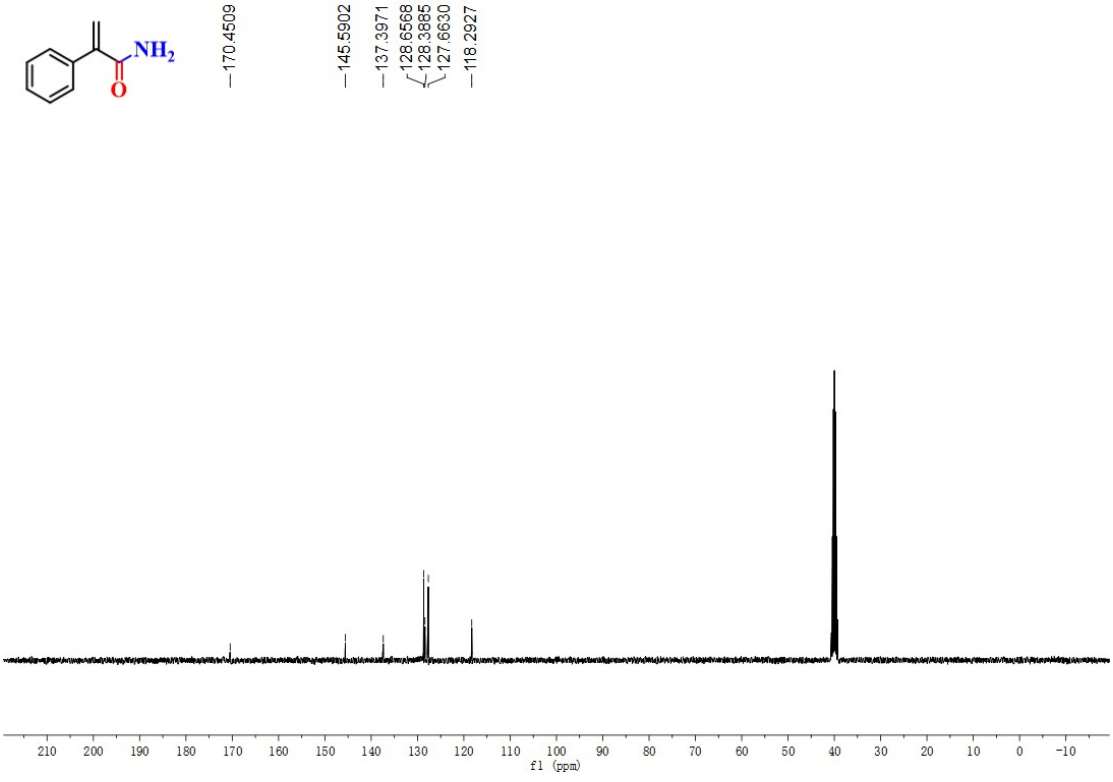
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3aw



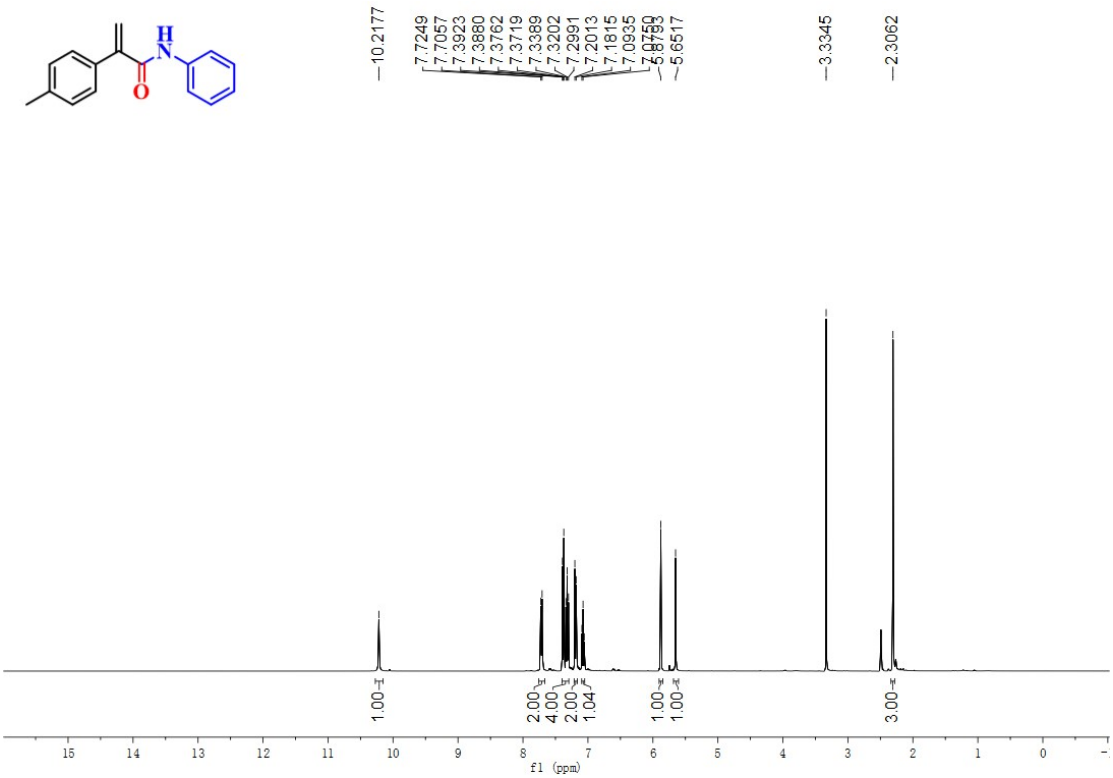
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3aw



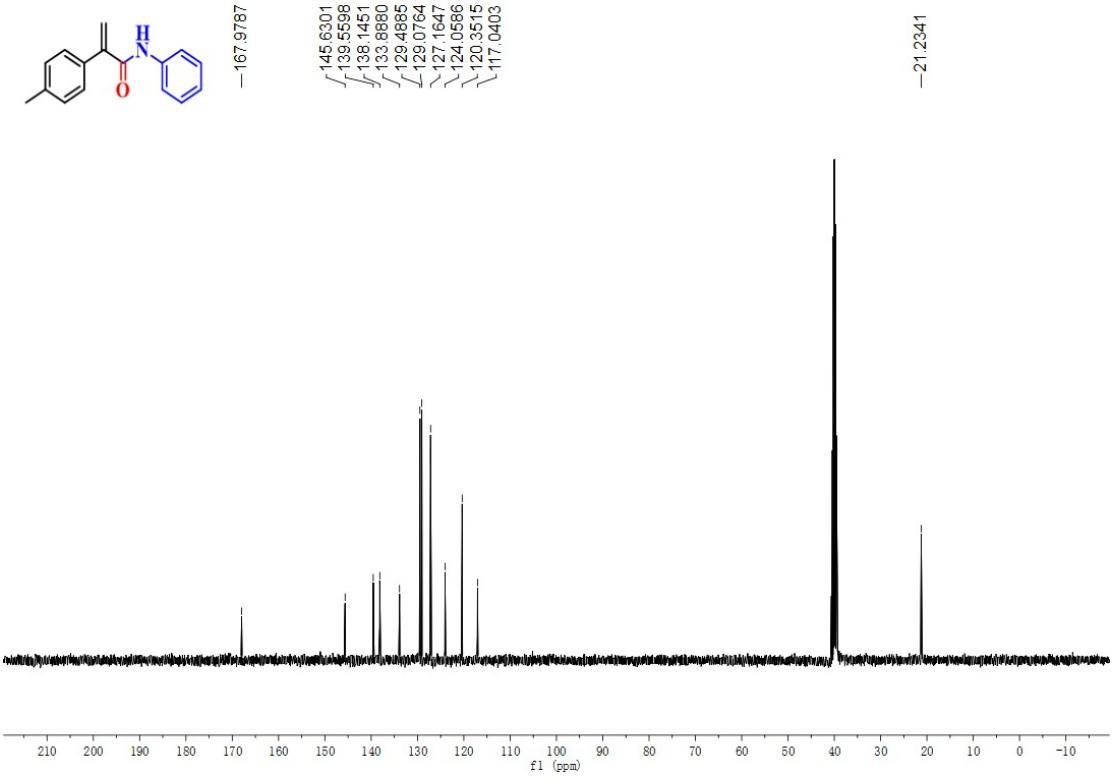
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ax



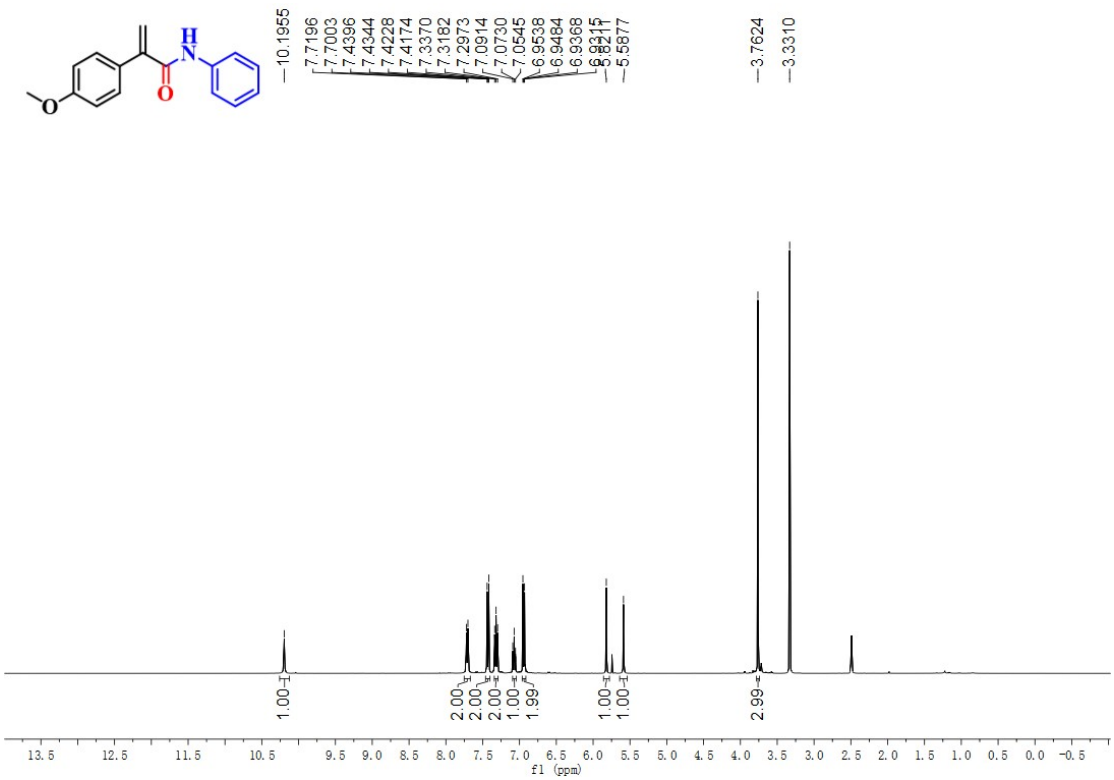
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ax



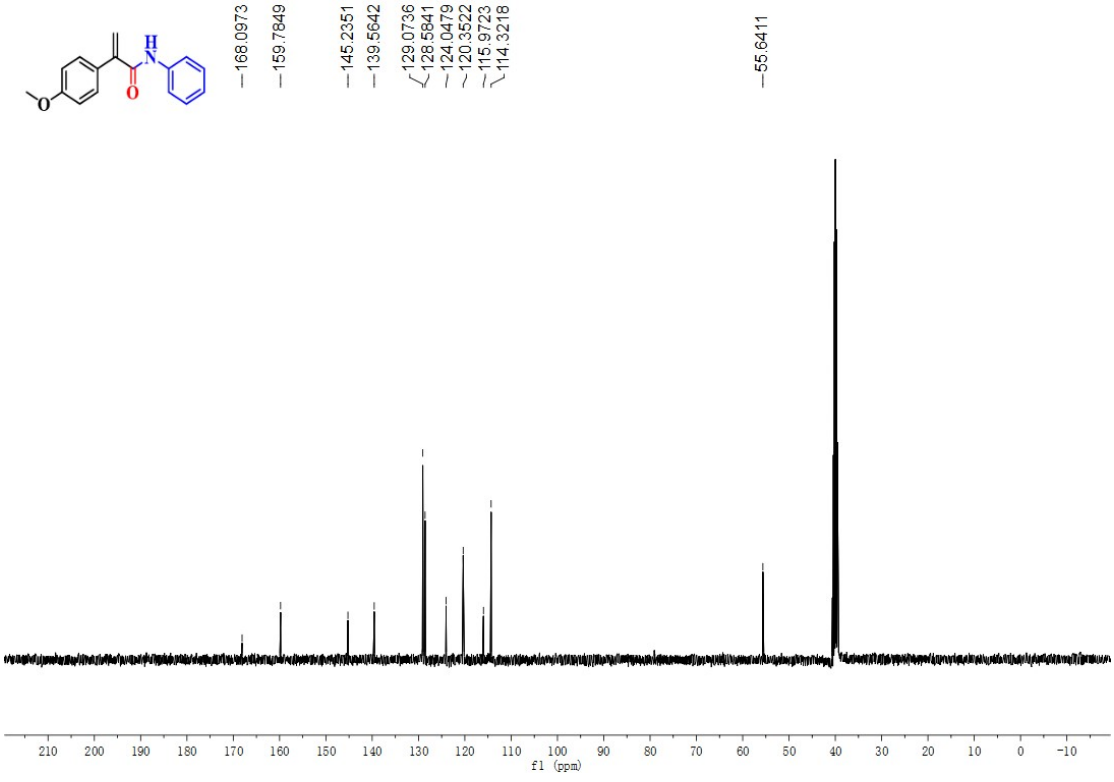
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ba



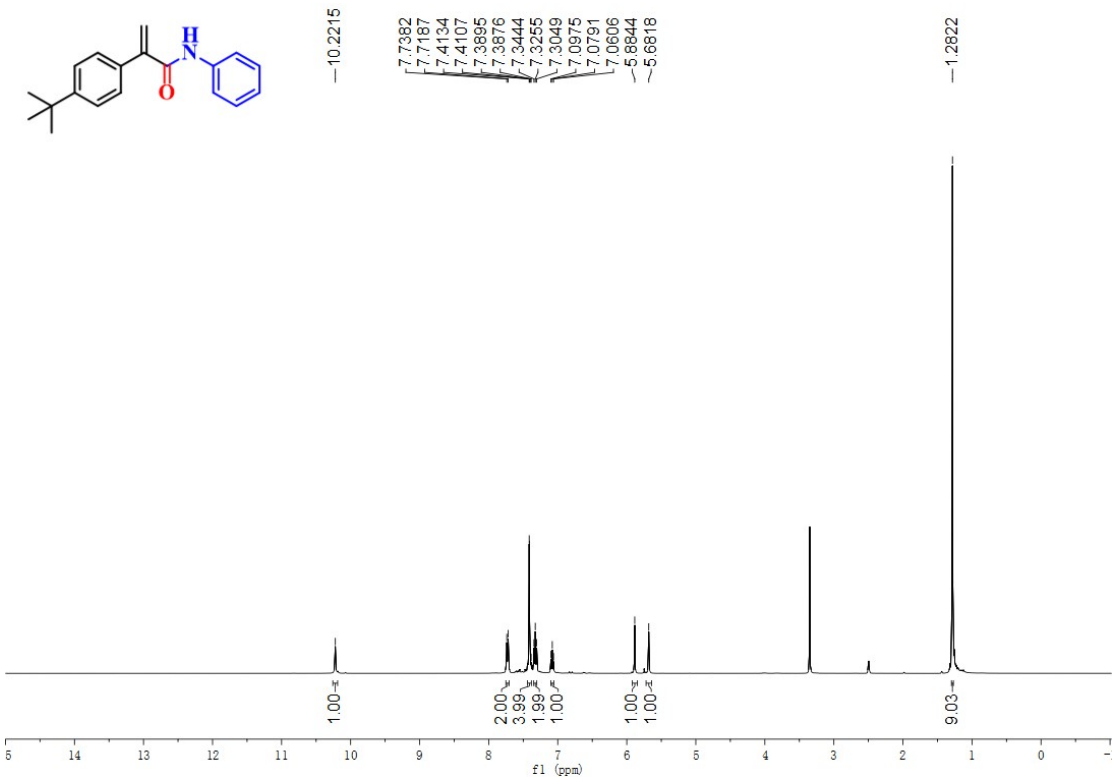
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ba



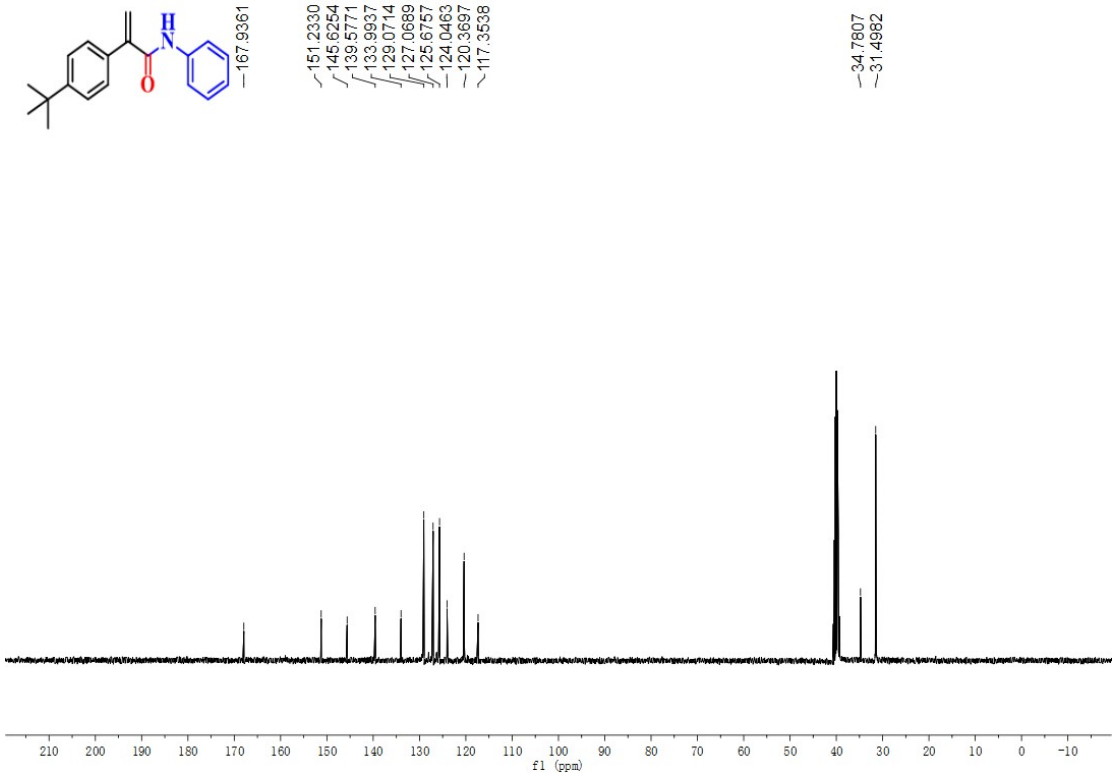
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ca



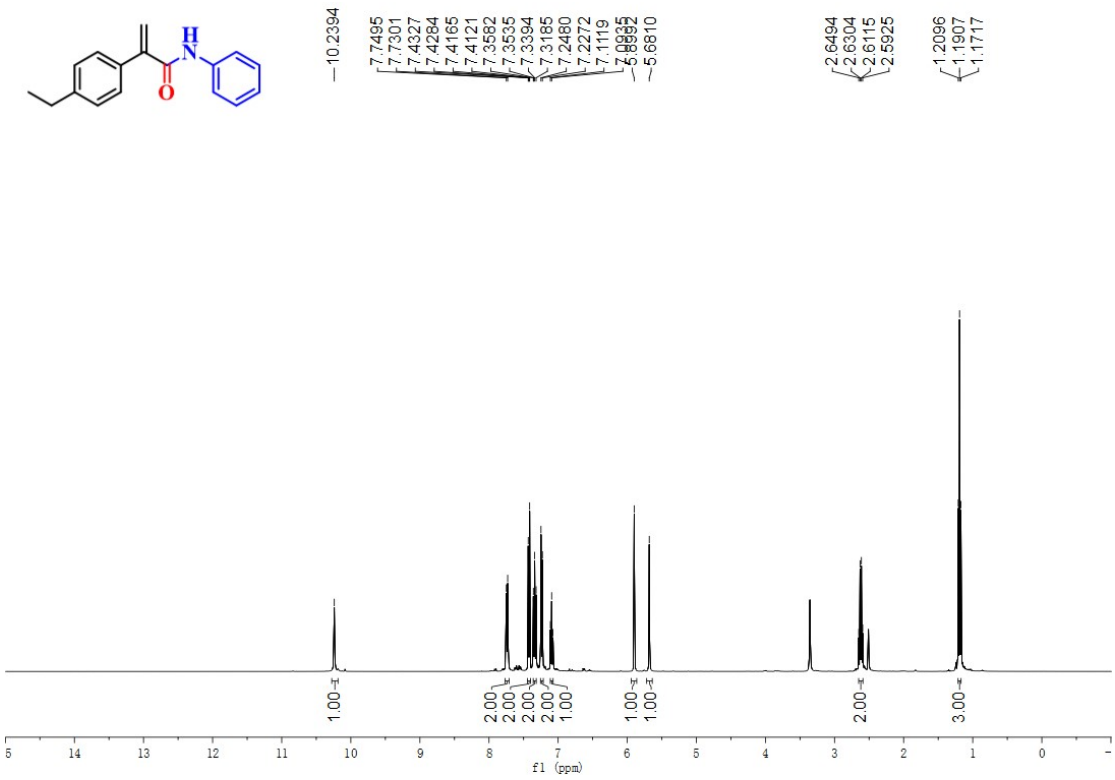
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ca



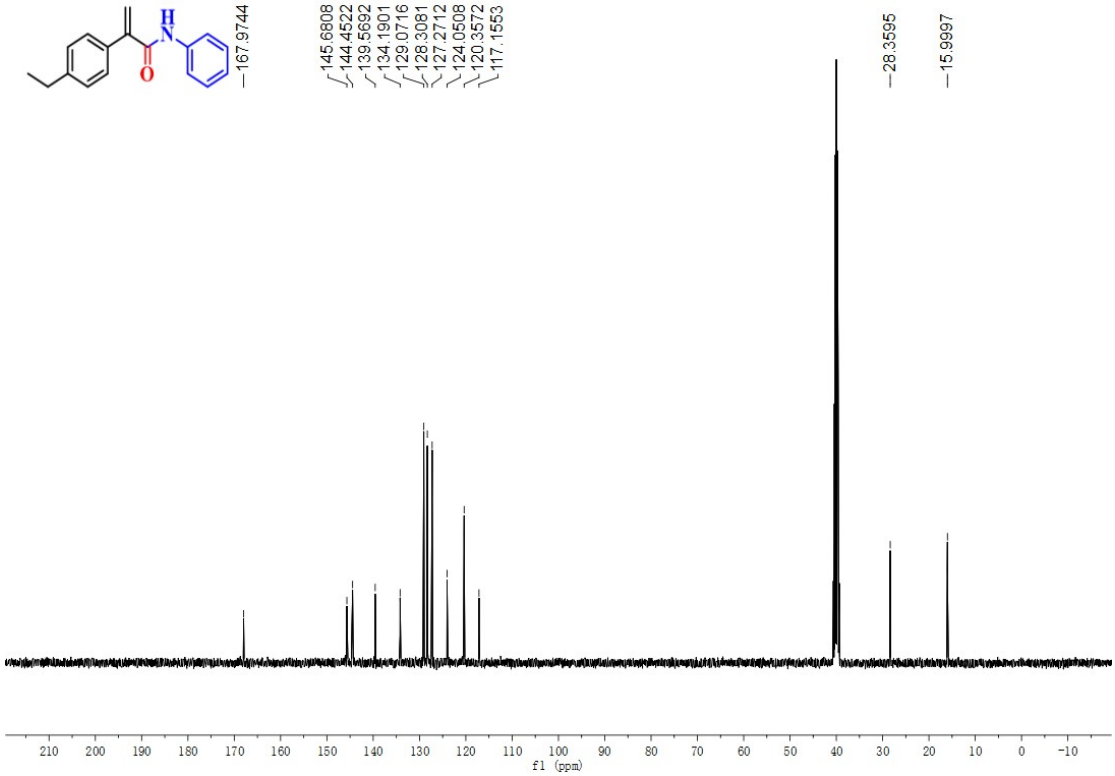
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3da



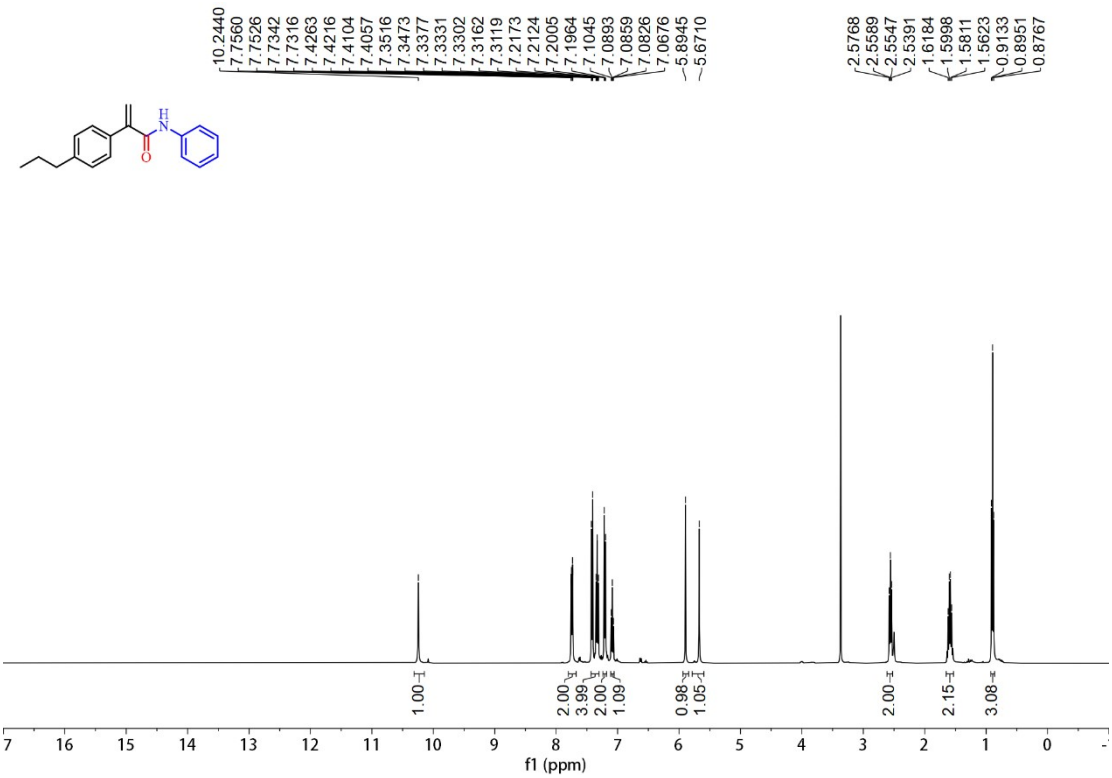
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3da



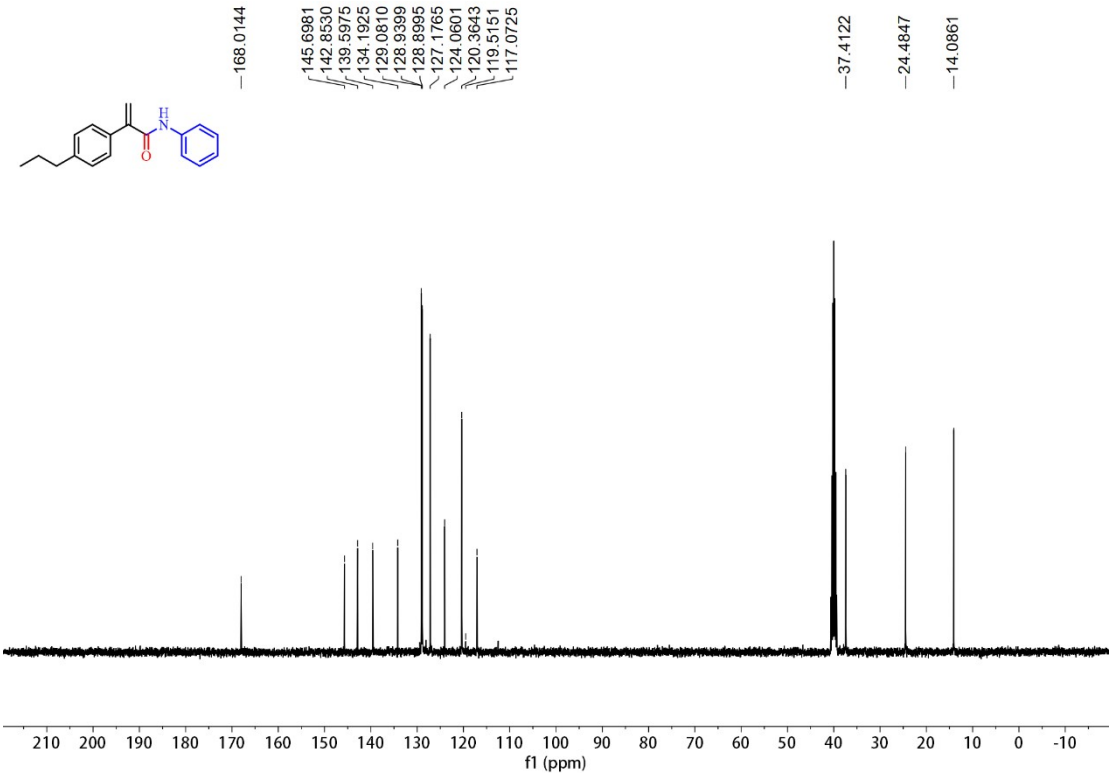
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ea



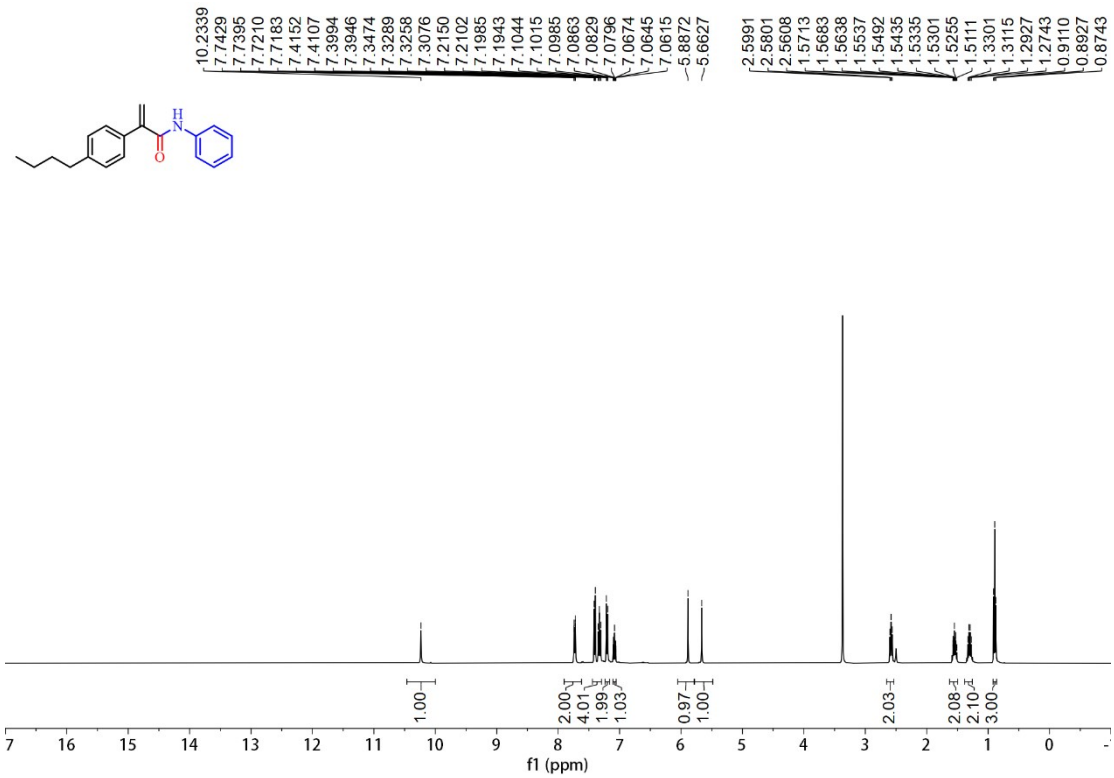
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ea



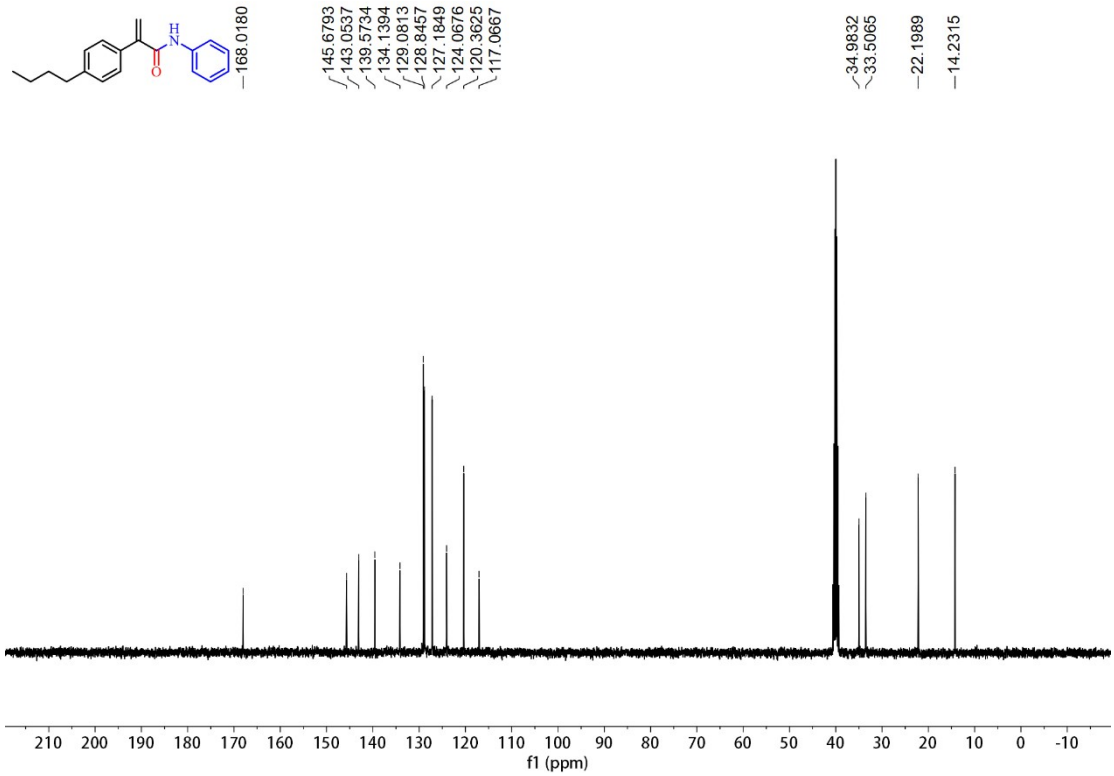
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3fa



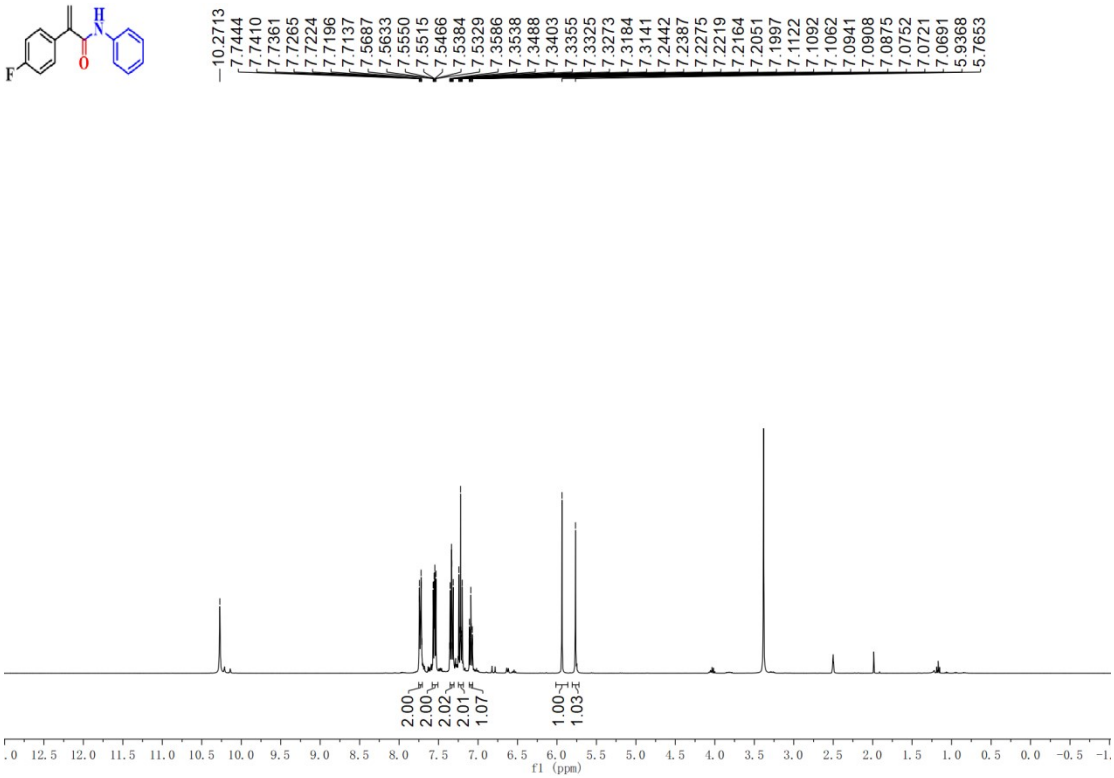
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3fa



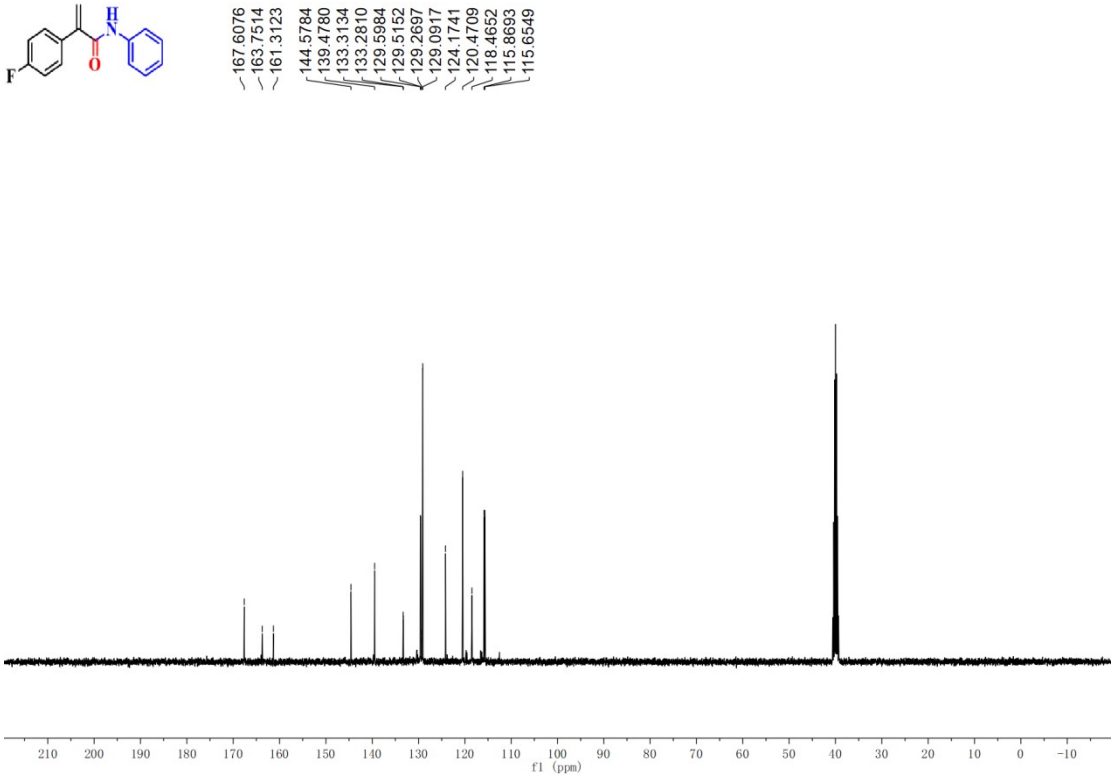
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ga



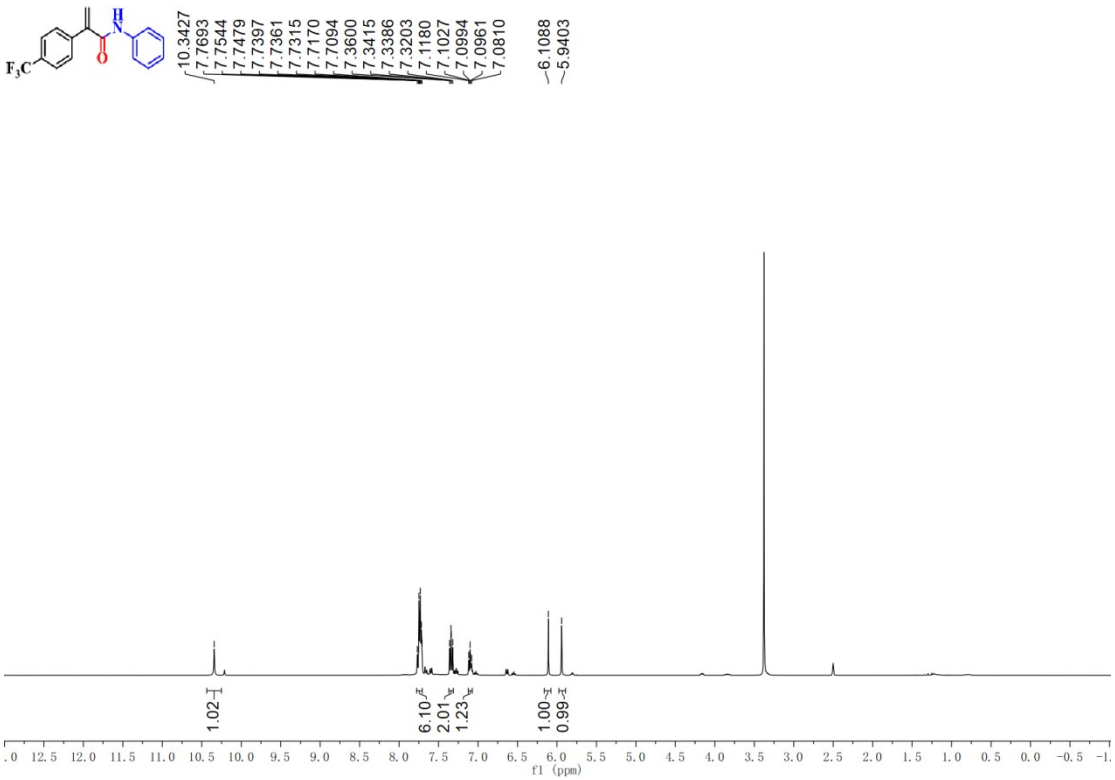
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ga



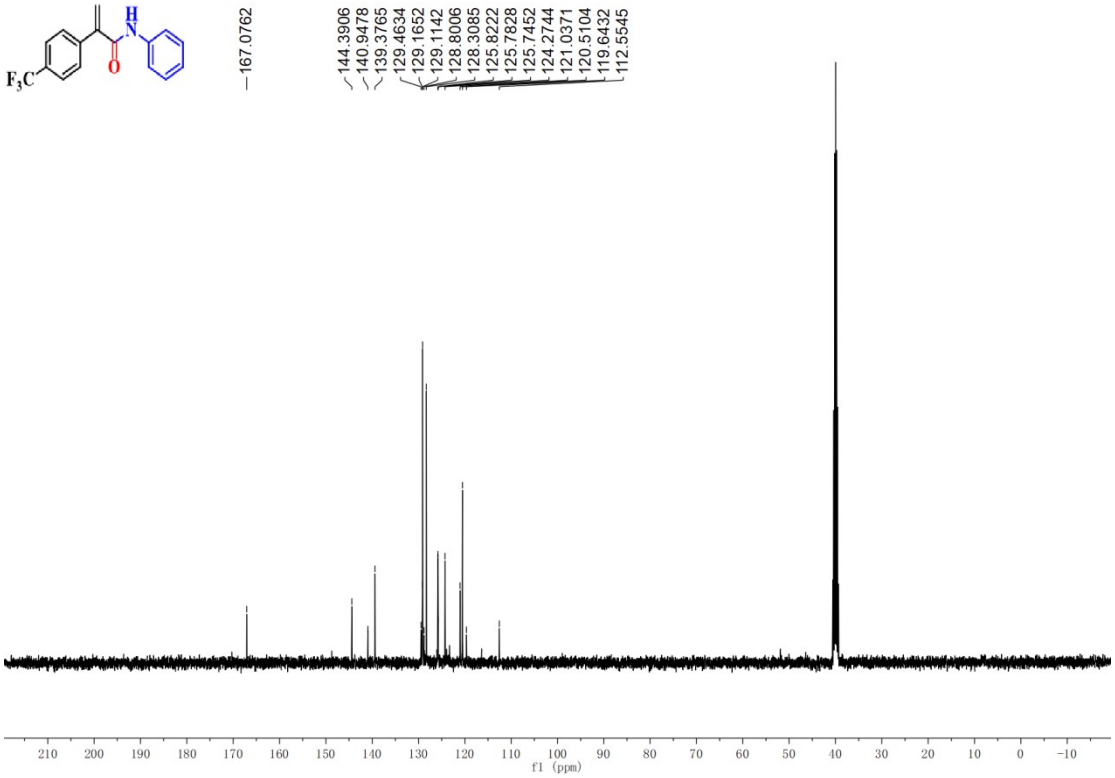
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ha



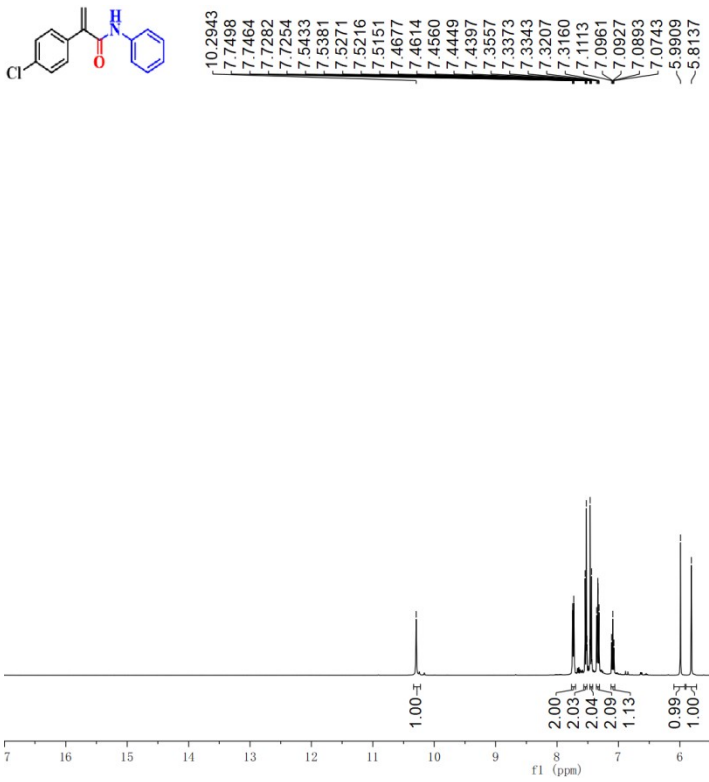
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ha



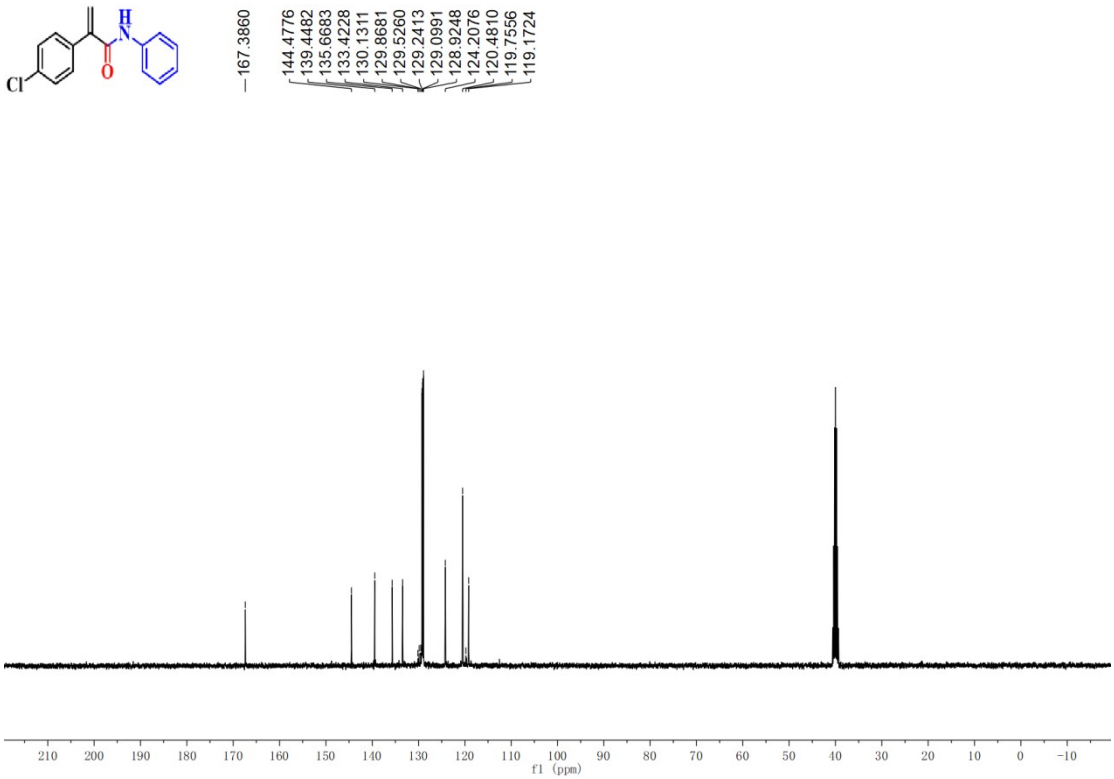
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ia



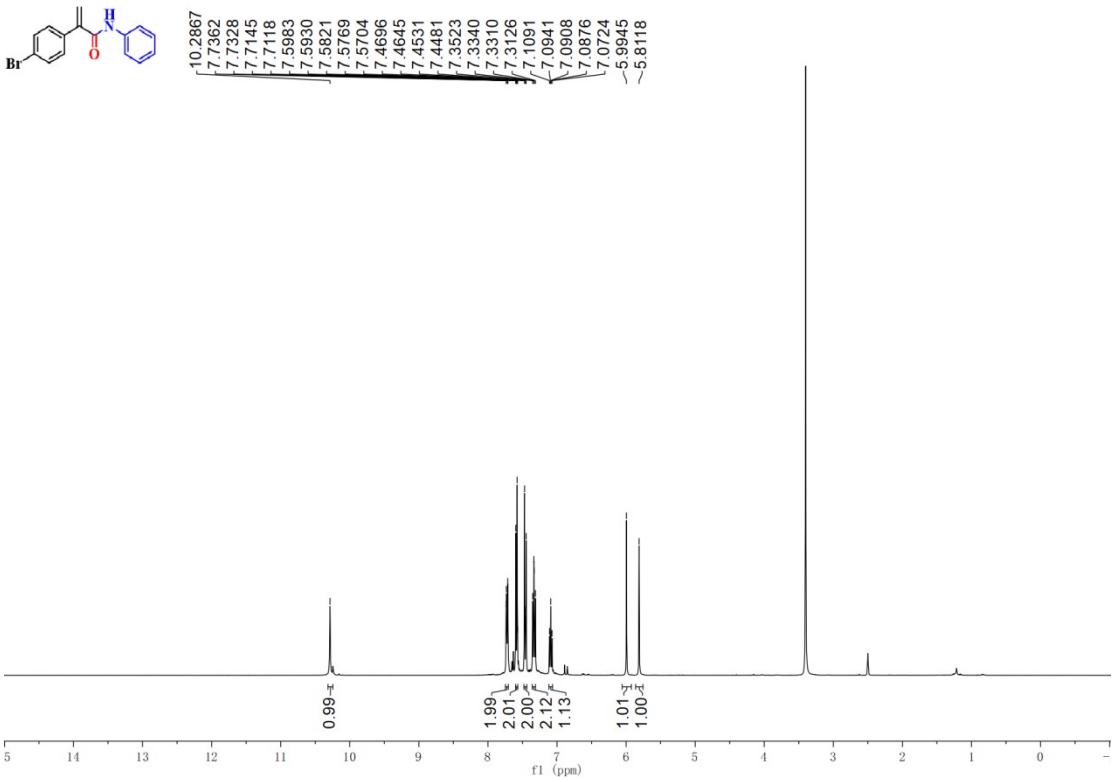
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ia



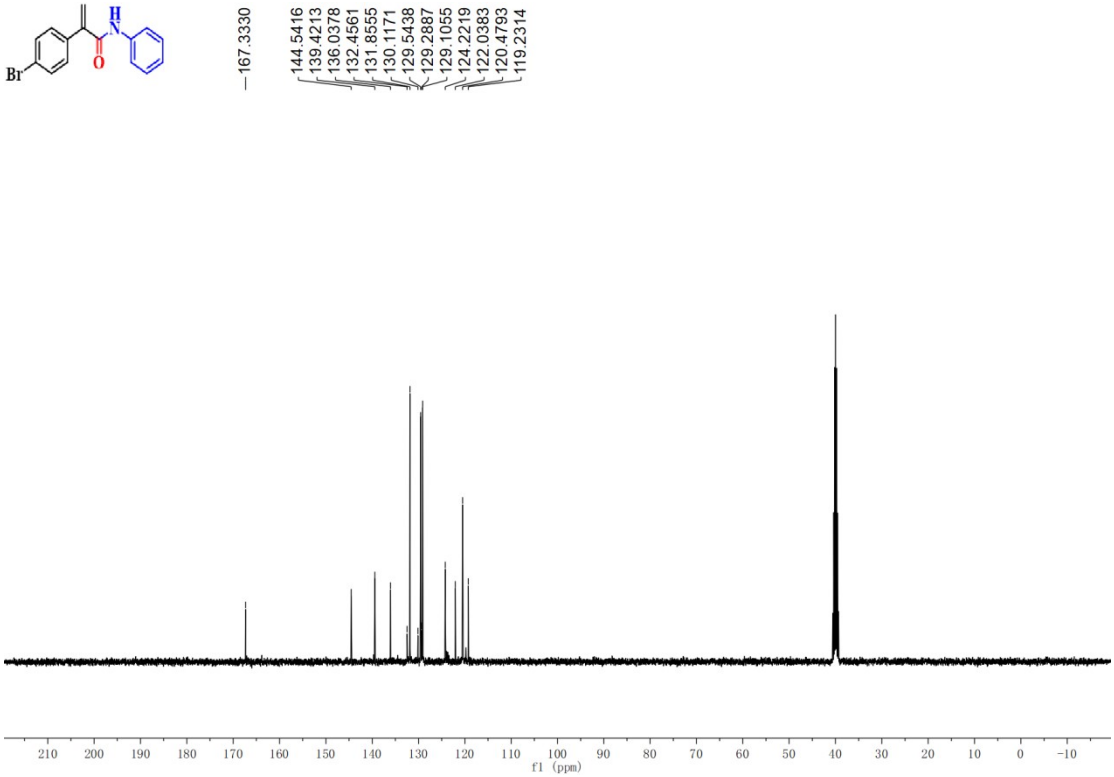
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ja



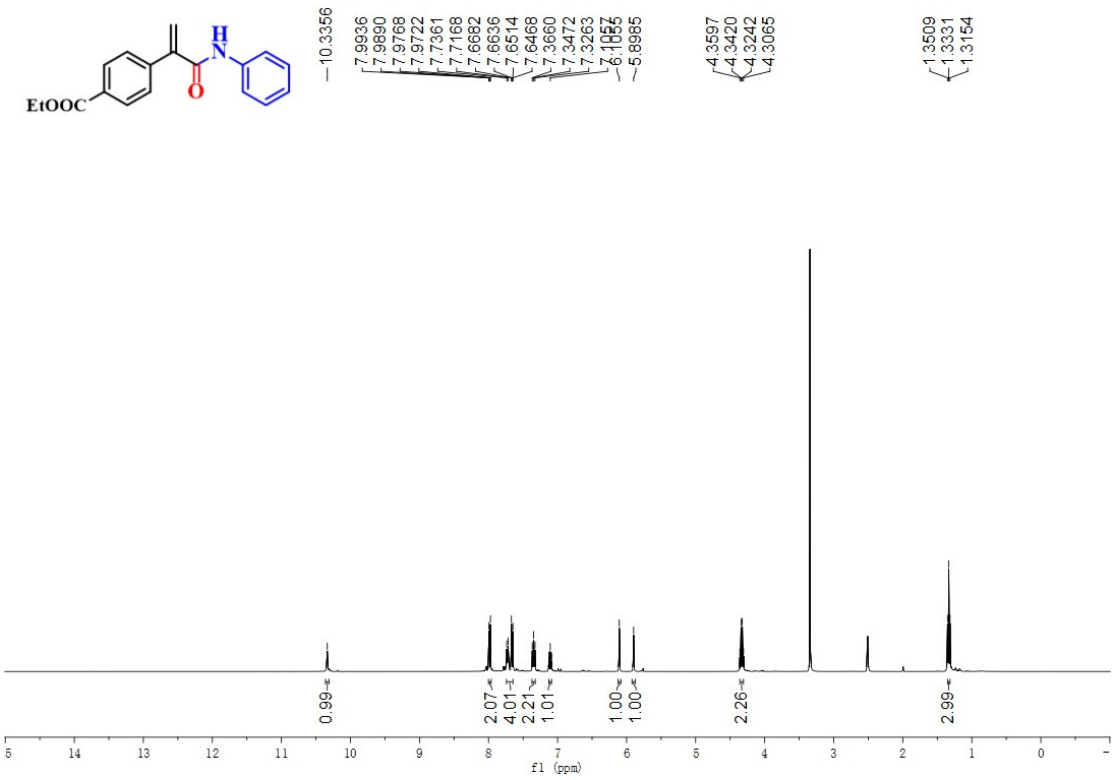
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ja



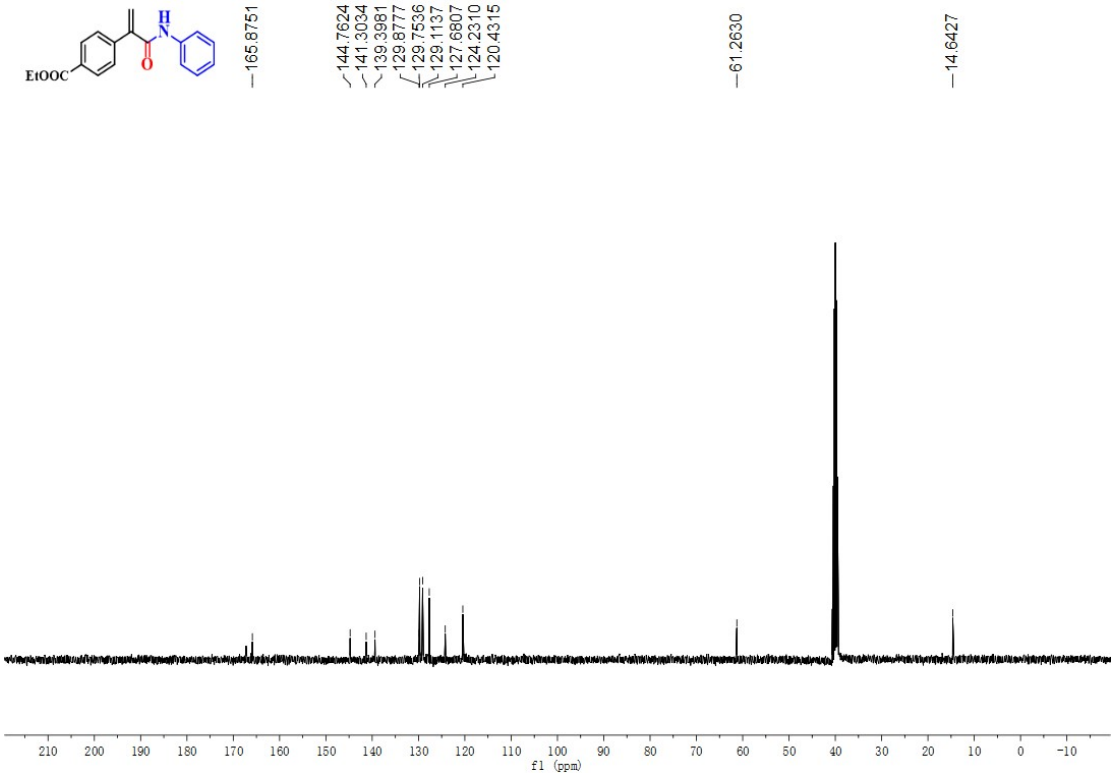
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ka



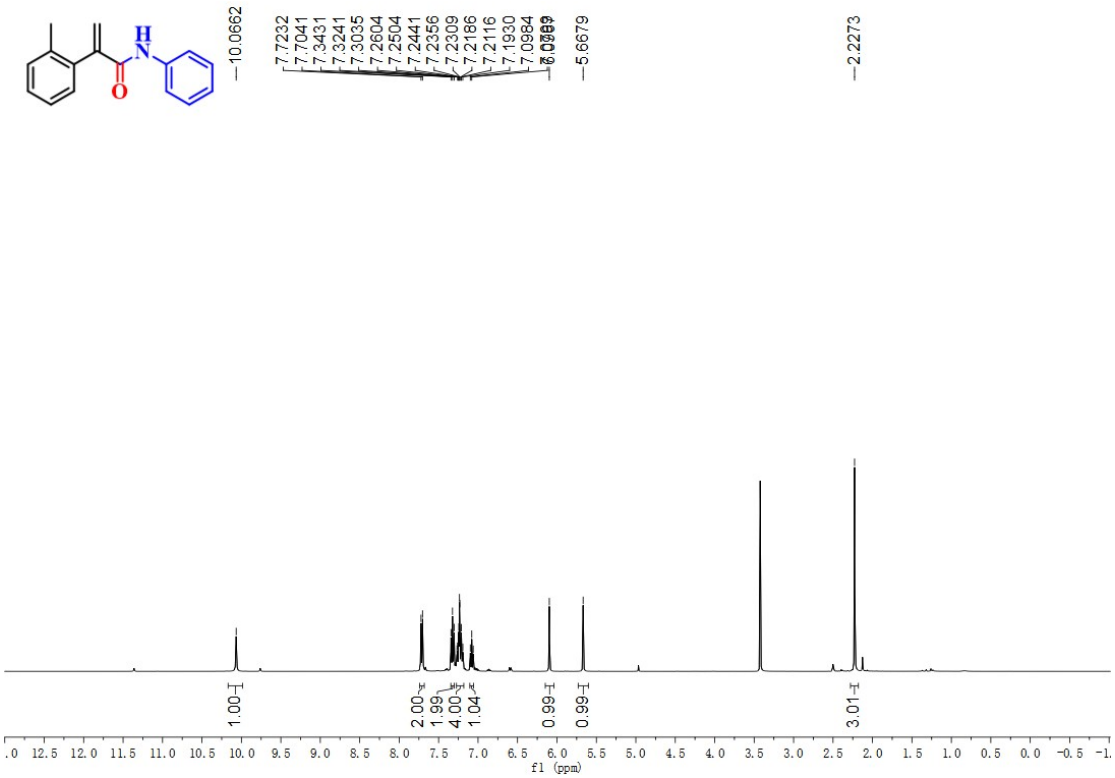
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ka



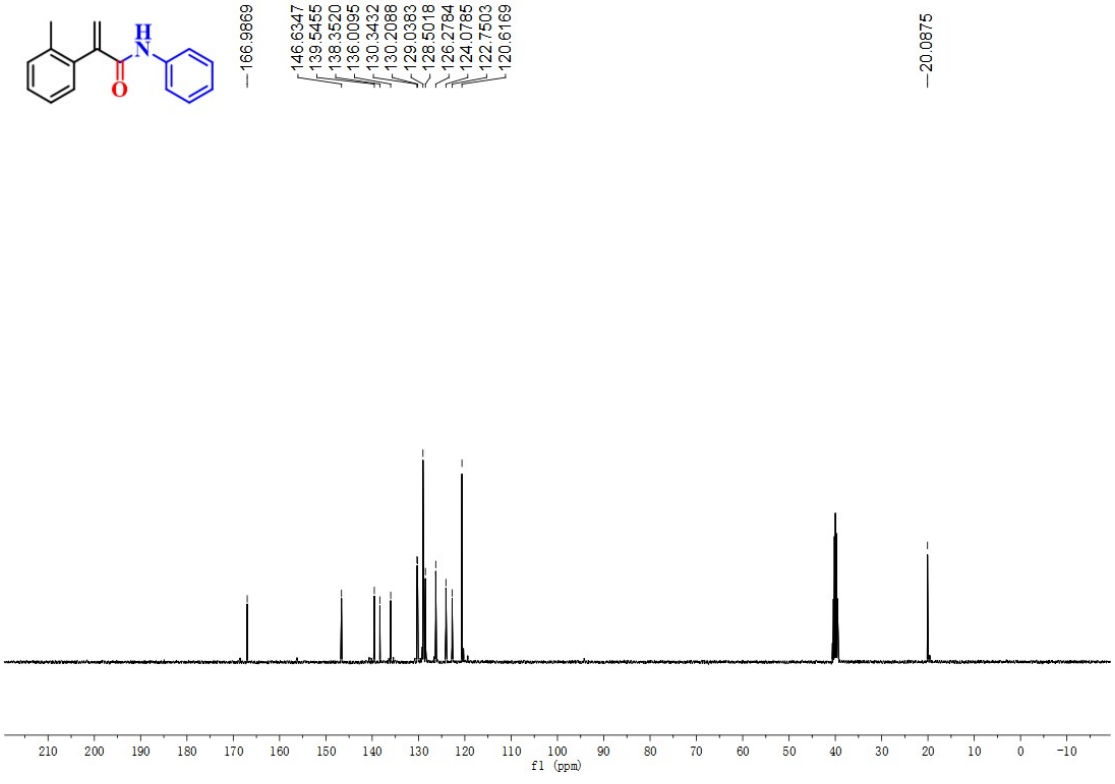
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3la



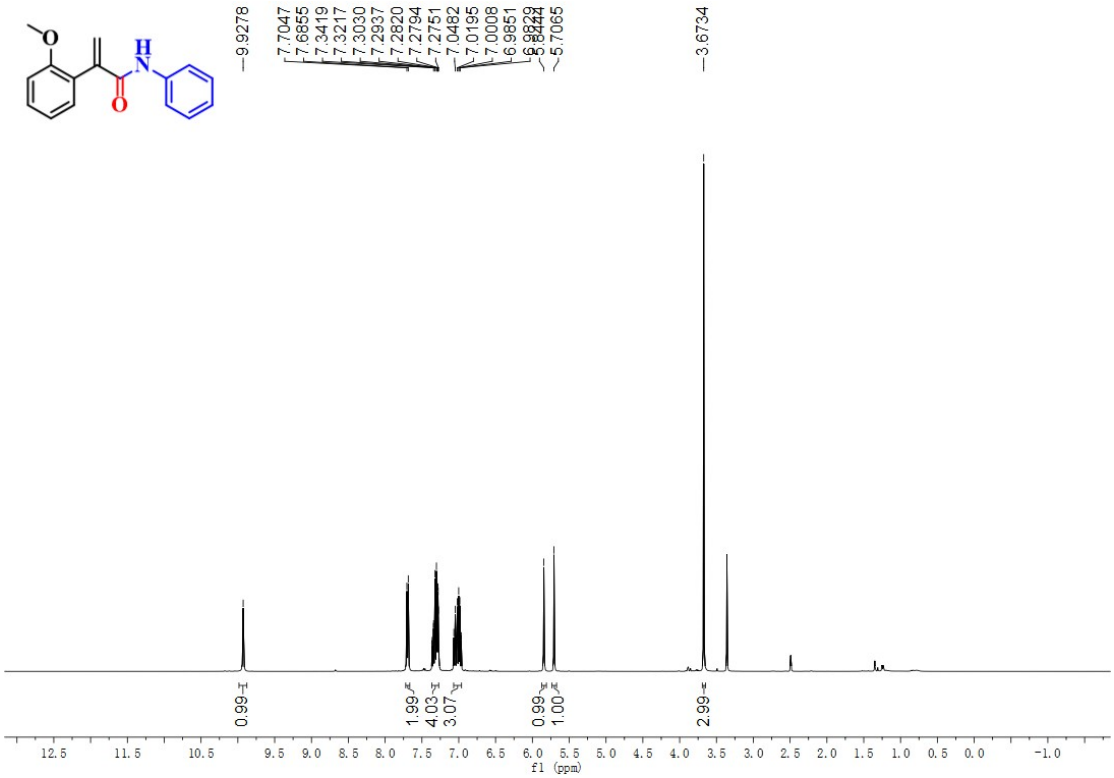
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3la



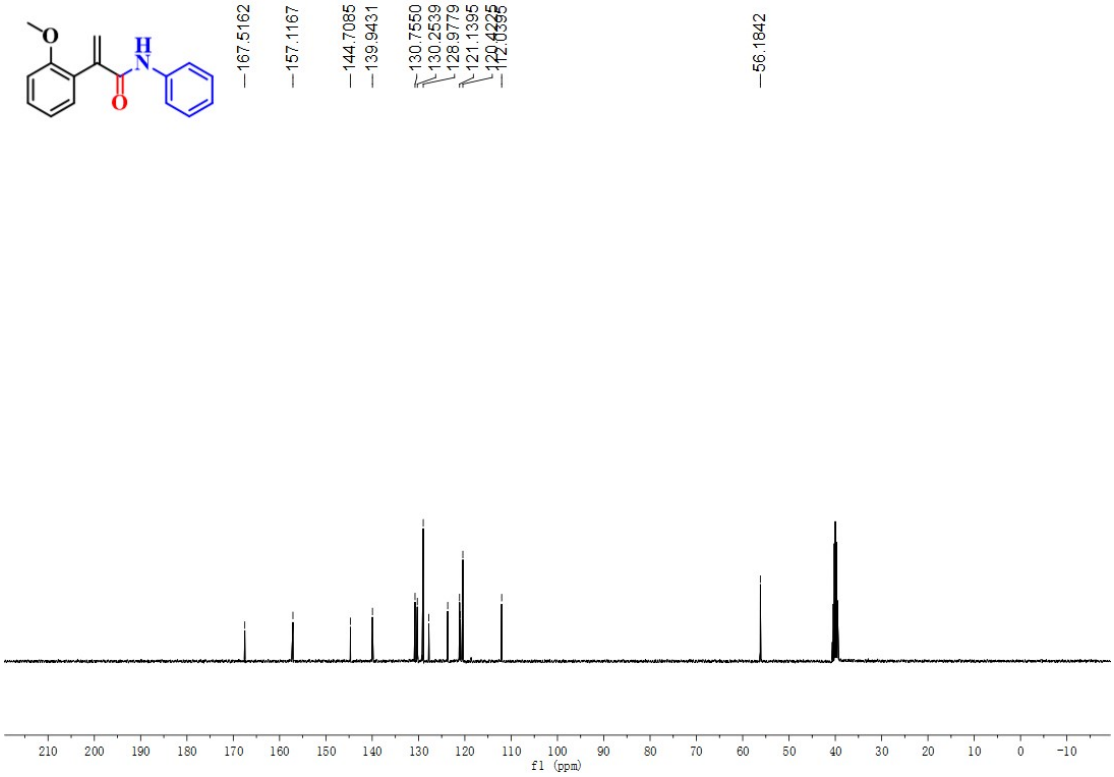
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ma



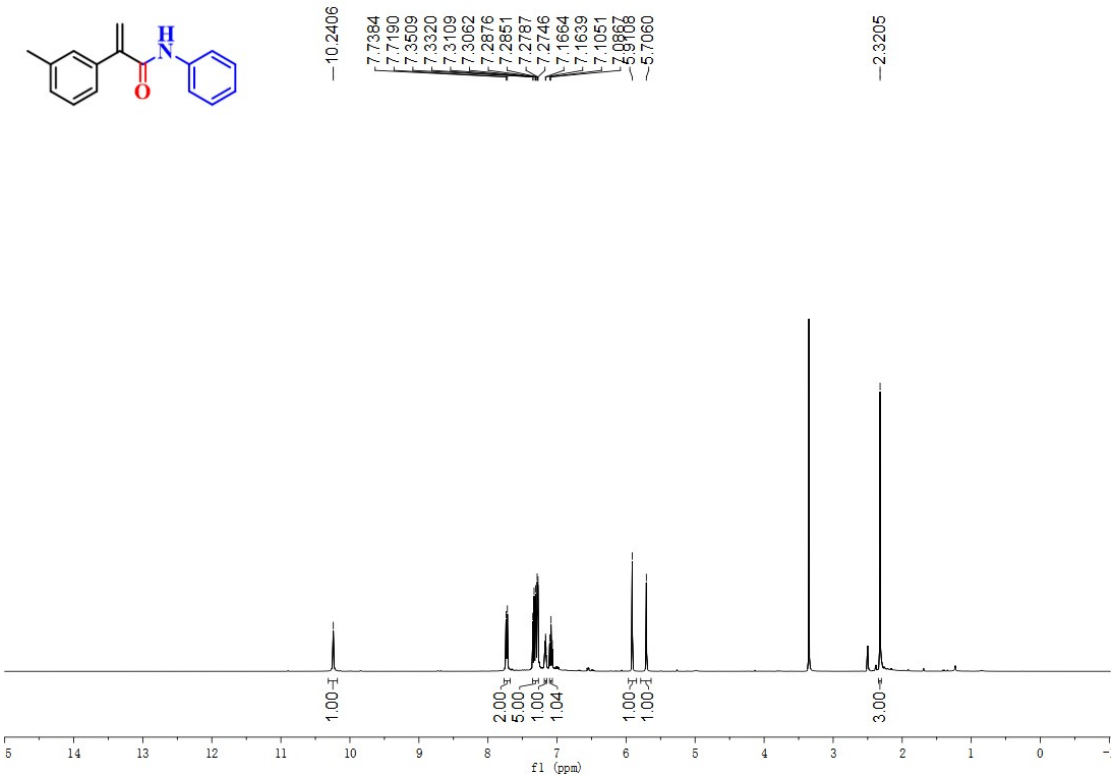
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ma



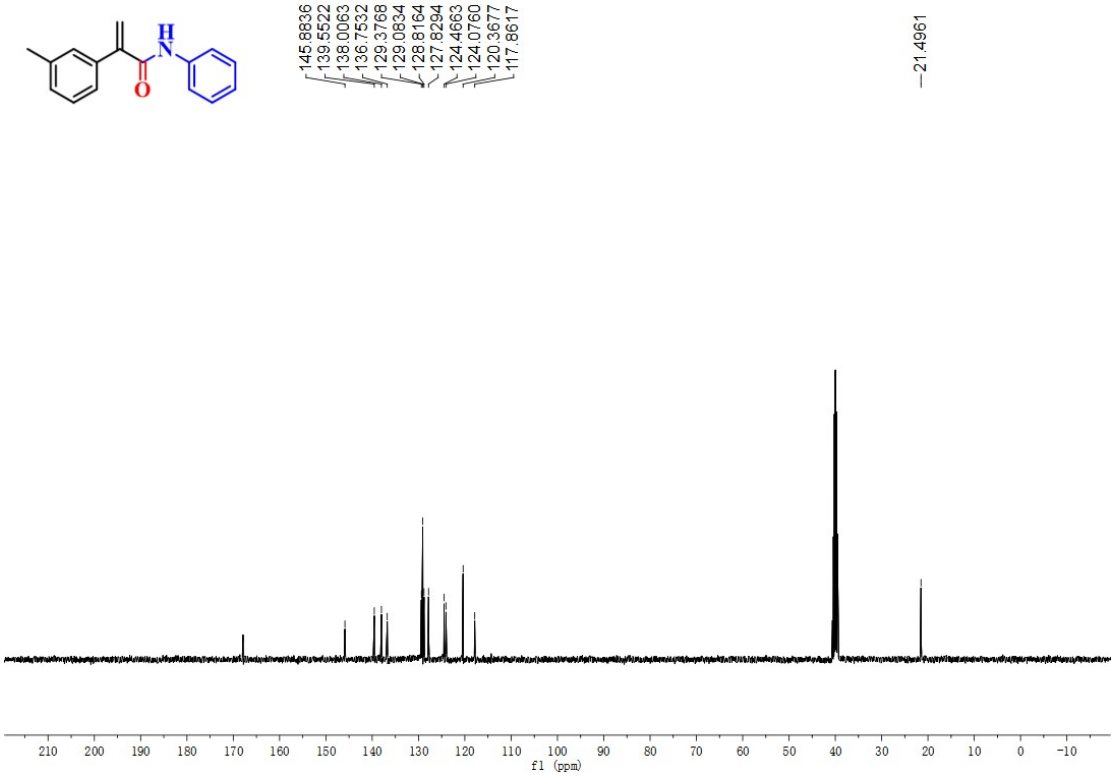
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3na



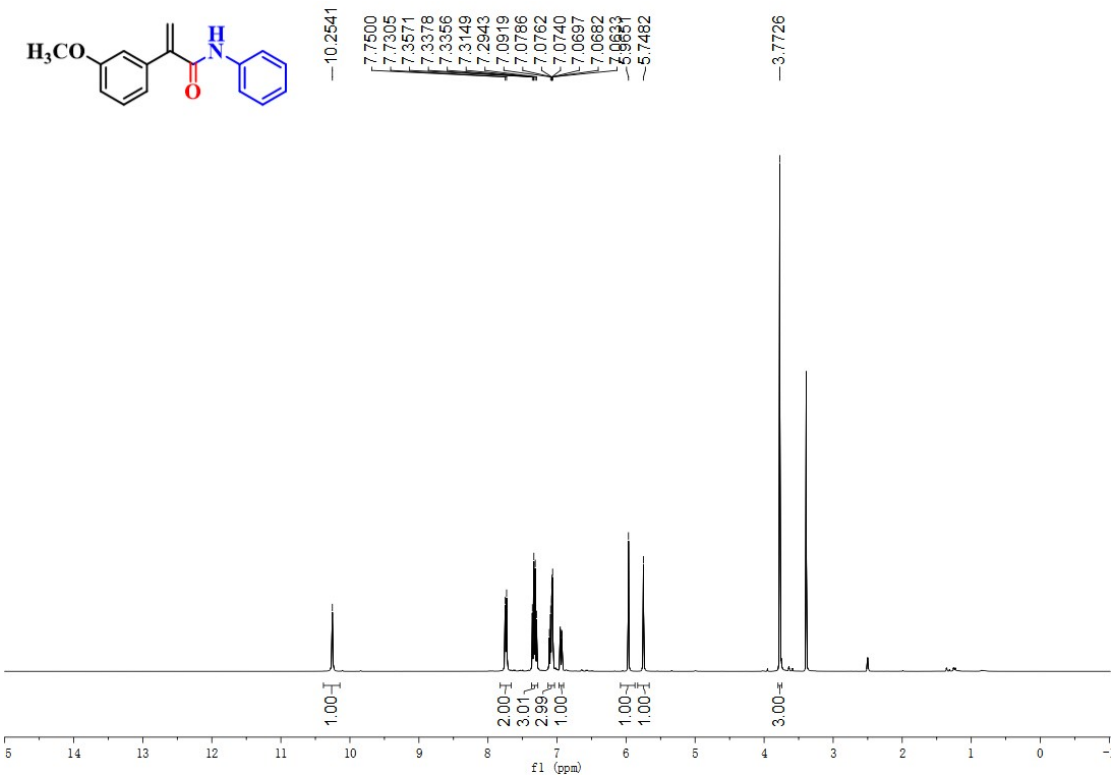
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3na



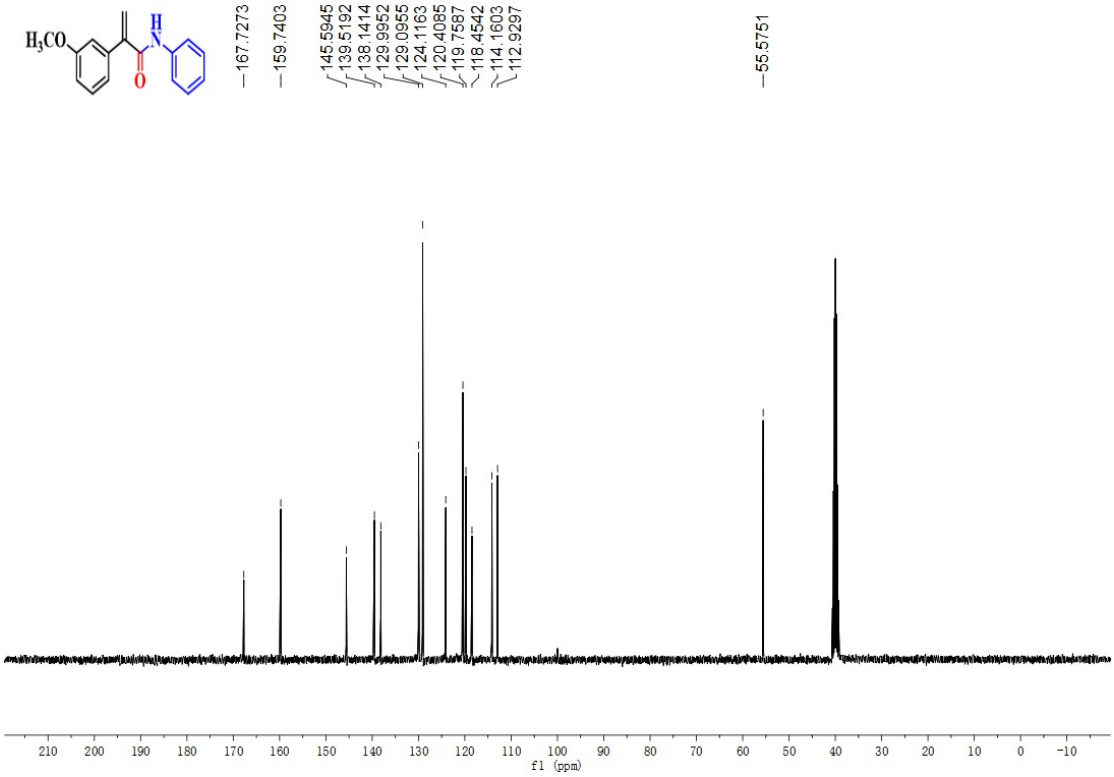
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3oa



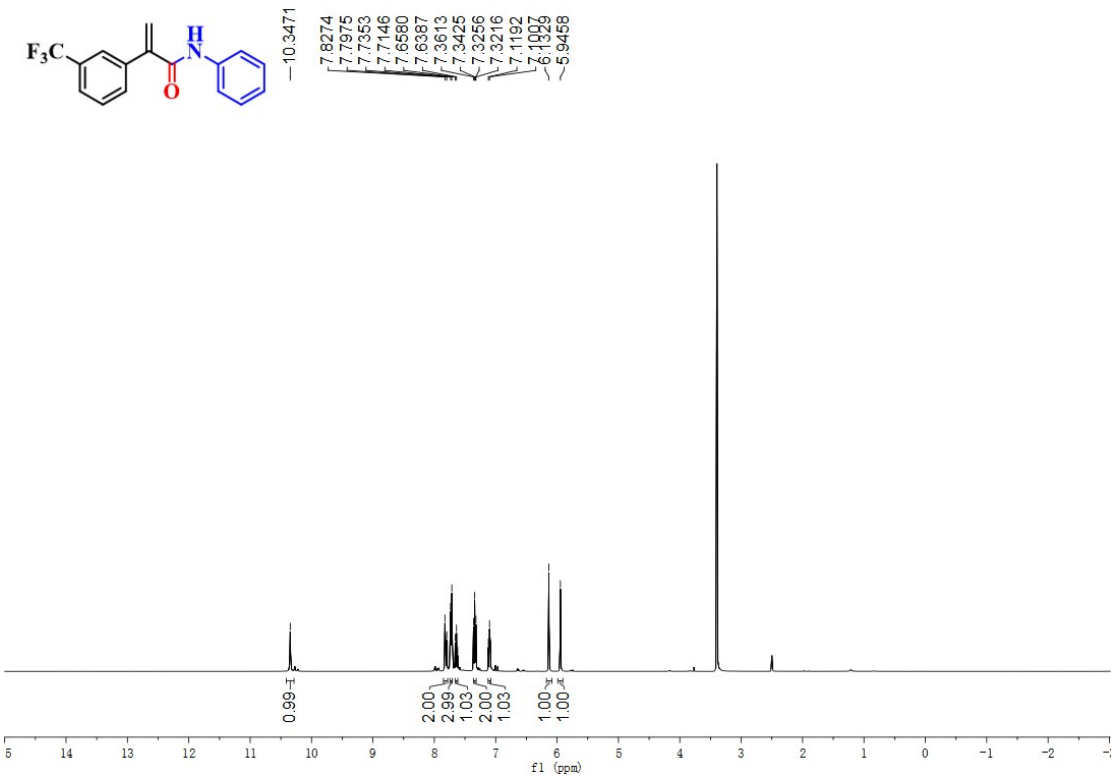
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3oa



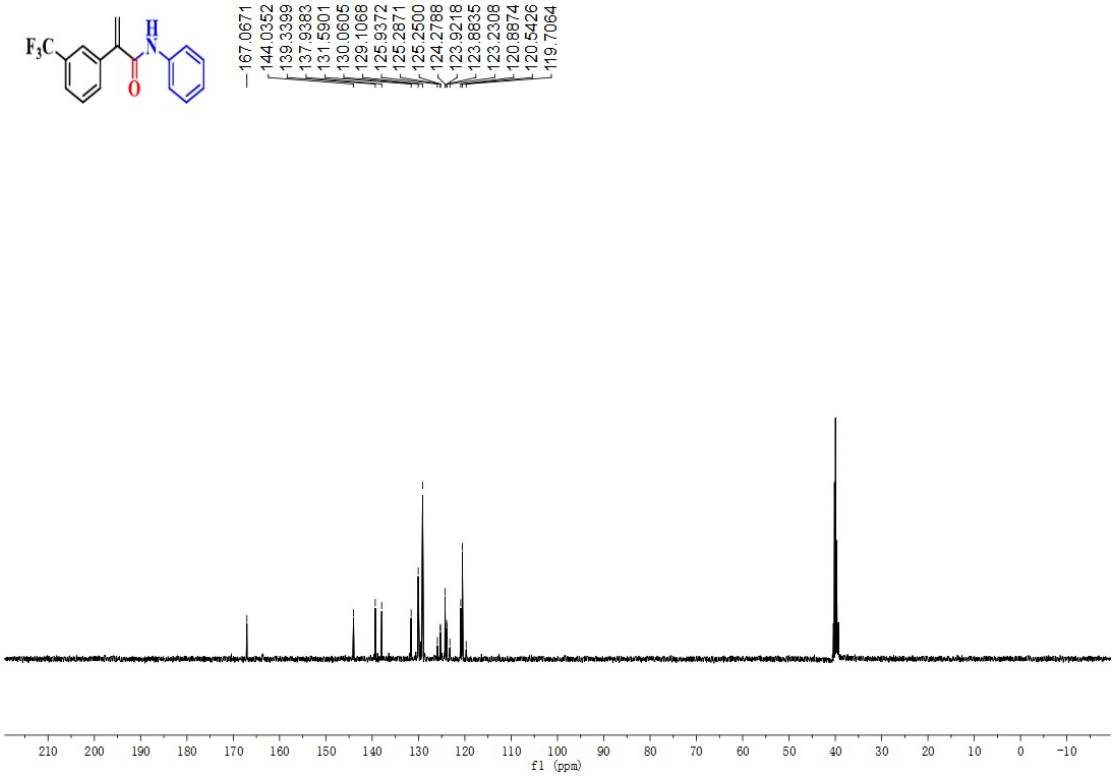
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3pa



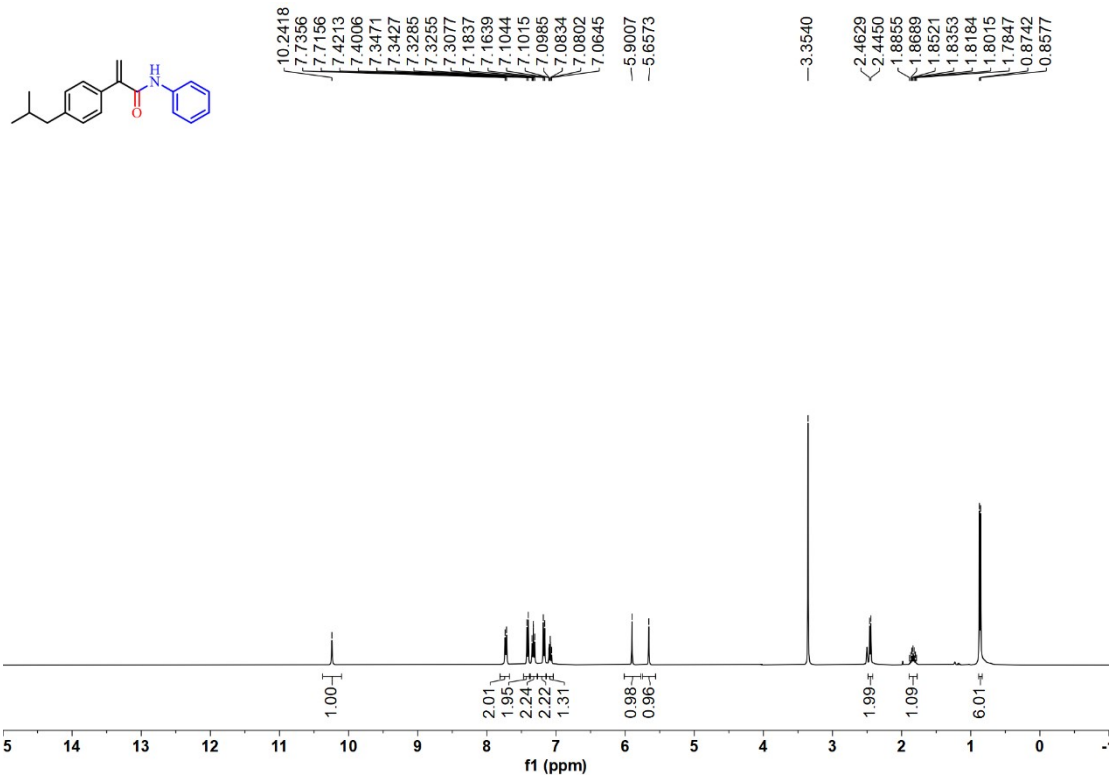
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3pa



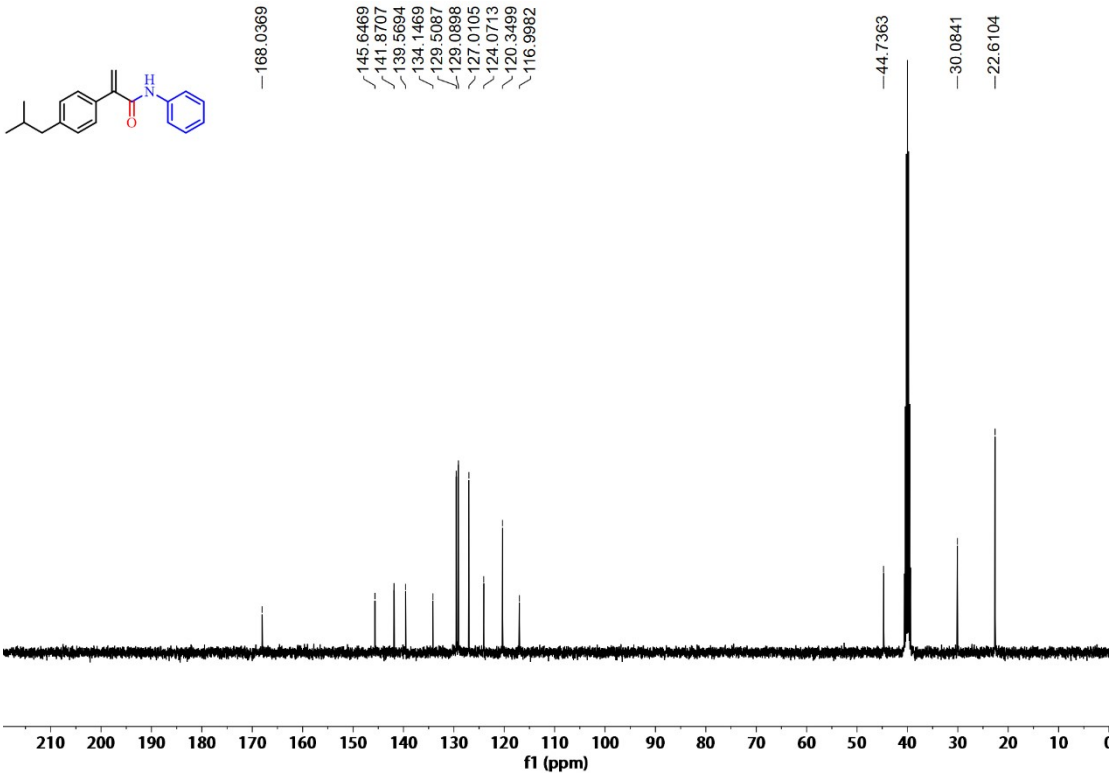
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3qa



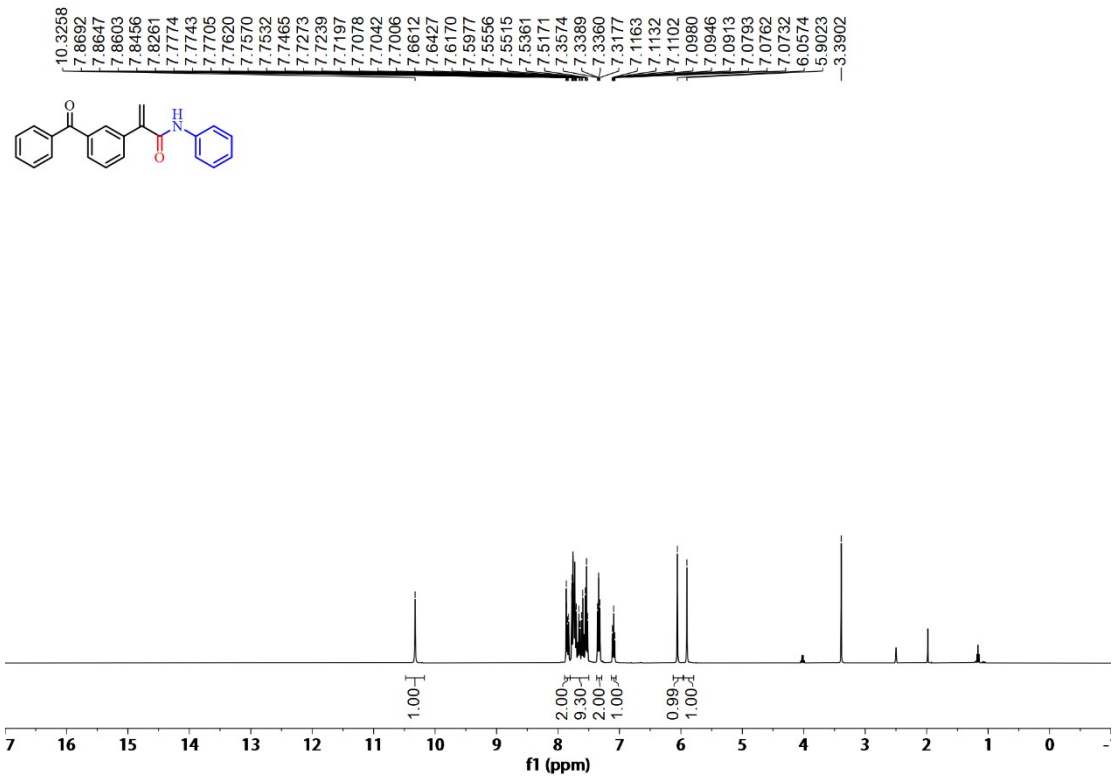
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3qa



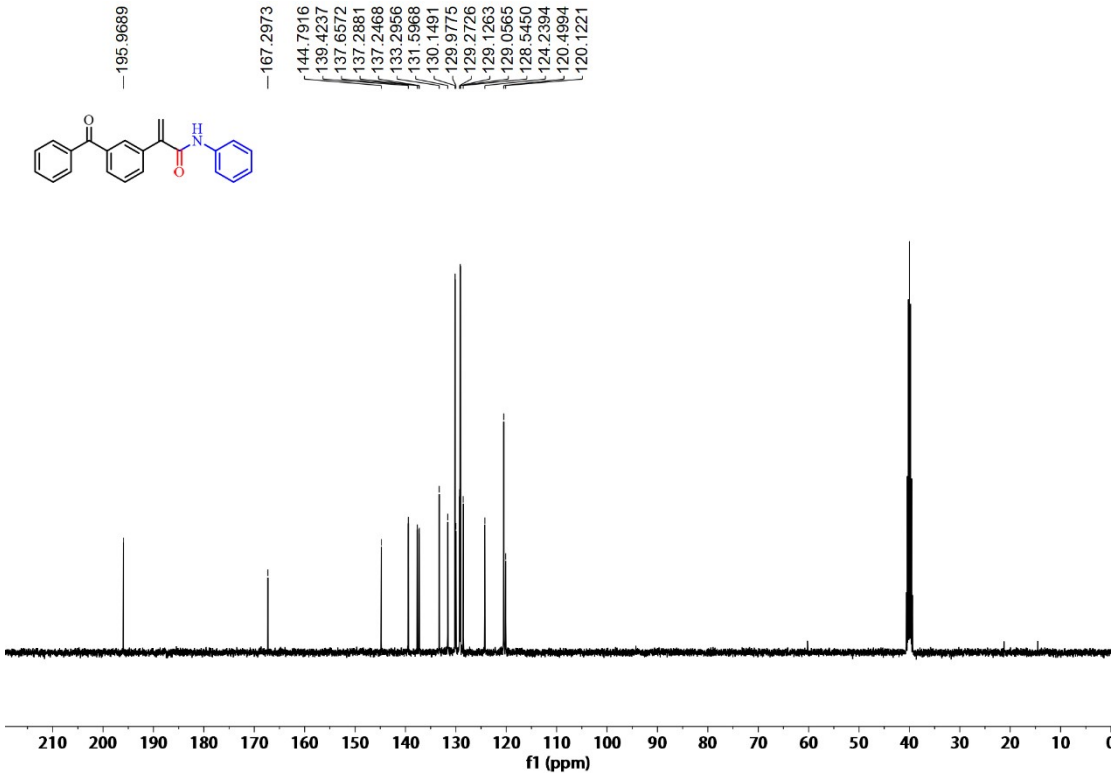
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ra



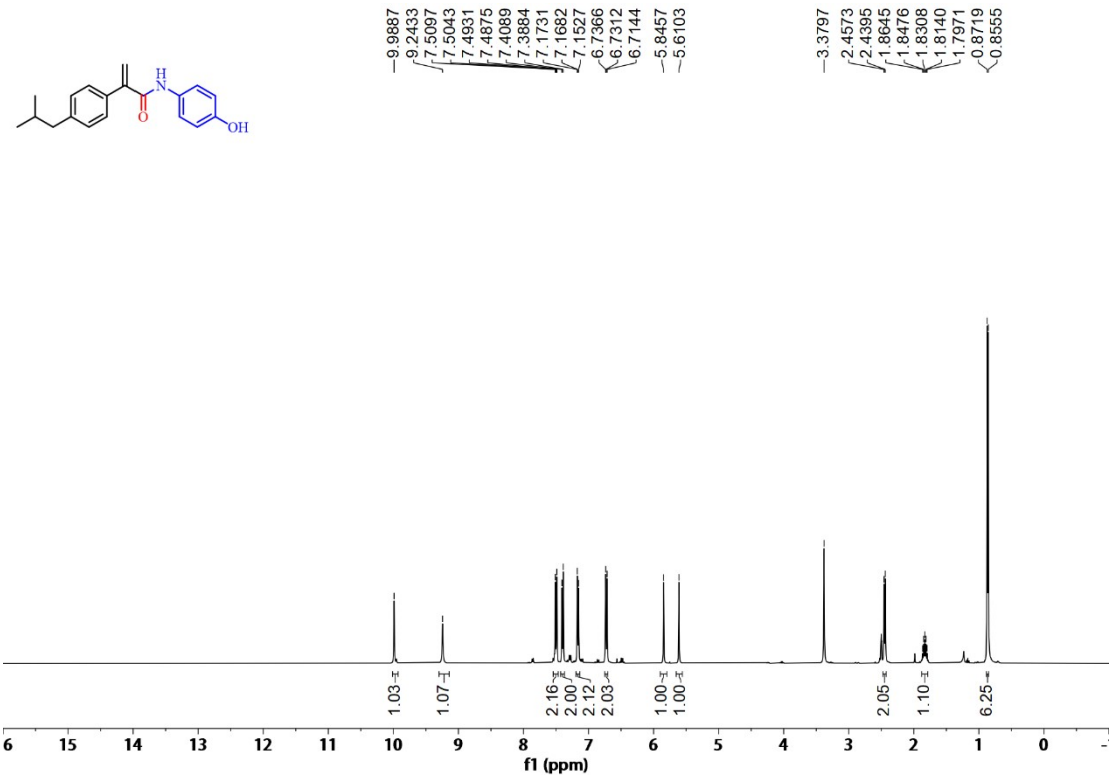
^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ra



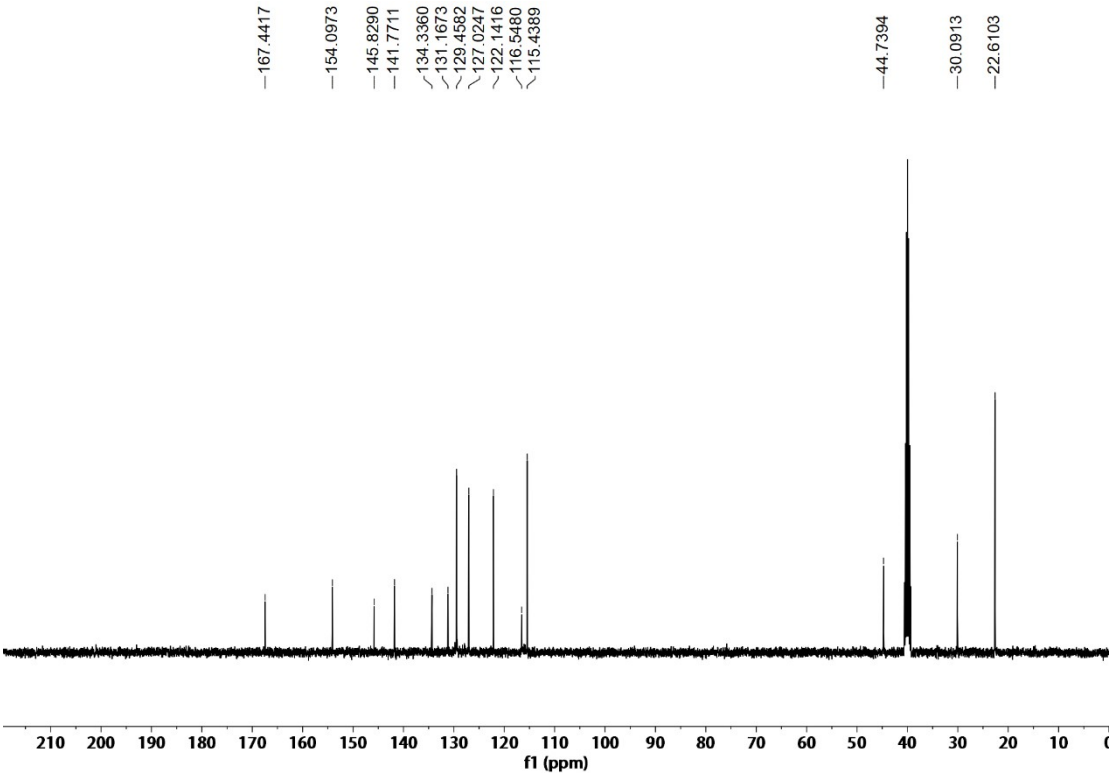
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3sa



^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3sa



^{1}H NMR (400 MHz, DMSO-d_6) spectrum of 3ta



^{13}C NMR (100 MHz, DMSO-d_6) spectrum of 3ta