Supporting Information

Electrochemical Site-Selective C(sp^3)-H Heteroarylation of Proline-Containing Peptides

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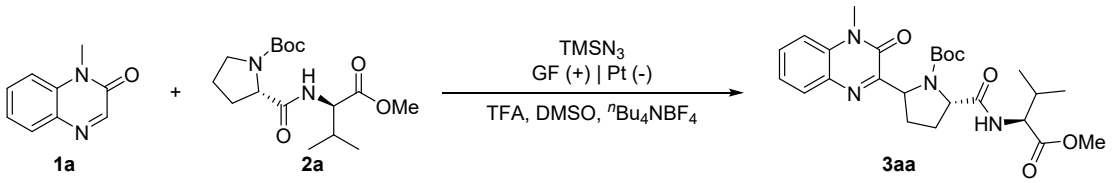
Contents

1. **General methods**

All reagents were obtained from commercial suppliers and used without further purification. Pentapeptides and hexapeptides are synthesized using SPPS. The reactions were monitored by TLC (thin layer chromatography). Column chromatography was performed using silica gel (300-400 mesh). ^{1}H NMR spectra were recorded on commercial instruments (600 MHz or 400 MHz). Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as the internal standard ($CDCl_3$, δ = 7.26). ^{13}C NMR spectra were collected on commercial instruments (151 MHz) with complete proton decoupling. Chemical shifts are reported in ppm from the tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$, δ = 77.0). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublets, q = quartet, dt = doublet of triplets, td = triplet of doublets.

2.Experimental procedures

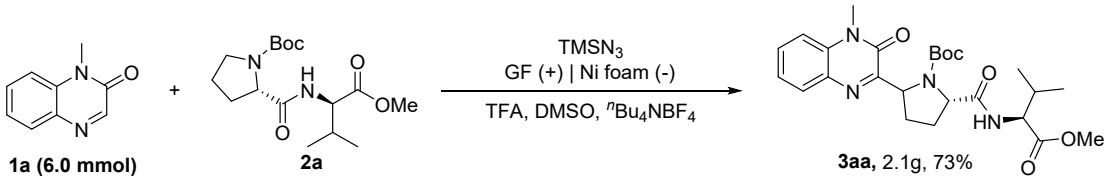
2.1 The general procedure for electrochemical reaction



1a 2a 3aa

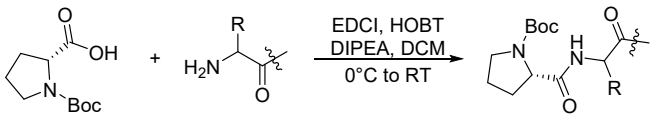
To an undivided cell (10 mL) were added quinoxalin-2(1*H*)-one (**1a**, 0.1 mmol, 1.0 equiv.), (*L*)-Boc-Pro-Val-OMe (**2a**, 0.3 mmol, 3.0 equiv.), $TMSN_3$ (23 mg, 26 μL, 0.2 mmol, 2.0 equiv.), TFA (45 mg, 30 μL, 0.4 mmol, 4.0 equiv.), $^{n}Bu_4NBF_4$ (130 mg, 0.4 mmol, 0.1 M), DMSO (4 mL). The cell was equipped with graphite felt as anode (10 mm×15 mm) and platinum plate electrode (10 mm×15 mm) as cathode. The reaction mixture was stirred and electrolyzed at a constant current (5 mA) under air at room temperature for 8 h. After the reaction was completed, the mixture was diluted with water (20 mL) and then extracted with ethyl acetate (3×30 mL). The combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated in vacuo and the crude product was obtained. The pure product was obtained by silica gel chromatography using petroleum ether/EtOAc (2:1) as the eluent.

2.2 Gram-scale synthesis of 3aa



To an undivided cell (100 mL) were added quinoxalin-2(1*H*)-one (**1a**, 6.0 mmol, 1.0 equiv.), (*L*)-Boc-Pro-Val-OMe (**2a**, 18 mmol, 3.0 equiv.), $TMSN_3$ (1.38 g, 1.56 mL, 12 mmol, 2.0 equiv.), TFA (2.73 g, 1.8 mL, 24 mmol, 4.0 equiv.),$^{n}Bu_4NBF_4$ (1.98 g, 6.0 mmol, 0.1 M), DMSO (60 mL). The flask was equipped with graphite felt as anode (35 mm×35 mm) and Ni foam (35 mm×35 mm) as cathode. The reaction mixture was stirred and electrolyzed at a constant current (30 mA) under air at room temperature for 45 h. After the reaction was completed, the mixture was diluted with water (200 mL) and then extracted with ethyl acetate (3×200 mL). The combined organic phases were dried over anhydrous Na_2SO_4, filtered, concentrated in vacuo and the crude product was obtained. The pure product was obtained by silica gel chromatography using petroleum ether/EtOAc (2:1) as the eluent.

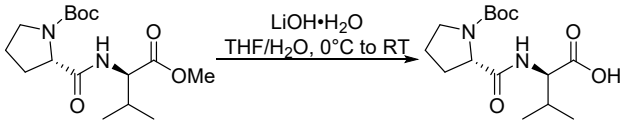
2.3 General Procedure for peptide coupling



Coupling of (*L*)-Boc-Pro-OH to (*L*)-H-AA-OMe. (*L*)-H-AA-OMe (1.0 equiv., 4.6 mmol) was weighed into a round bottom flask with a stir bar, diluted with CH_2Cl_2 (0.1-0.2 M), and cooled to 0 °C in an ice bath. To this solution was added *N,N*-Diisopropylethylamine (DIPEA) (1.0 equiv., 4.6 mmol) dropwise. Next were added, in the following order: 1) (*L*)-Boc-Pro-OH (1.0 equiv., 4.6 mmol), 2) hydroxybenzotriazole (HOBt, 1.1 equiv., 5.06 mmol), and 3) 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride (EDCI, 1.0 equiv., 4.6 mmol) and the reaction was warmed to room temperature. The reaction was then stirred overnight or until complete consumption of the carboxylic acid coupling partner was observed by TLC. The reaction contents were added to an appropriately sized separatory funnel and washed with a 1:1 volume each of $NaHCO_3$ (sat. aq.), citric acid (10 wt% aq.), and

brine. Following each of the first two washes, the aqueous layer was extracted with CH_2Cl_2 (2×30 mL), and the combined organic layers were taken on to the next wash. The combined organic layers were then dried over Na_2SO_4, filtered, and concentrated in vacuo to provide the crude which was taken on without further purification to the next step. The crude material can alternatively be purified via flash chromatography on silica gel to afford the desired product.

2.4 General Procedure for methyl ester hydrolysis

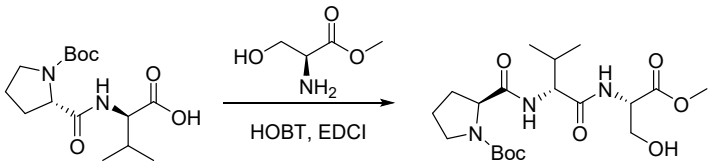


2a

To a glass round-bottom flask with teflon stir bar was added (*L*)-Boc-Pro-Val-OMe **2a** (1.0 equiv.) in 3:1 THF:H_2O (0.5 M). The solution was cooled to 0 ℃ in an ice bath, and LiOH (5.0 equiv.) was added in one portion. The reaction was held at 0 ℃ for 10 minutes, and then warmed to room temperature and stirred for 24 hours, or until complete conversion of the methyl ester was observed by TLC.

Upon complete conversion, the reaction was cooled back down to 0 ℃, and acidified to a pH of 4-5, was re-acidified with $KHSO_4$ (10 wt% aq.) to pH <2 via dropwise addition of $KHSO_4$ (10 wt% aq.). The solution was then diluted with ethyl acetate (~1:1 v/v) and the two layers were separated via separatory funnel. The pH of the aqueous layer was then taken, and if found to be >4-5, was re-acidified with $KHSO_4$ (10 wt% aq.) to pH <2. It was then extracted with ethyl acetate (2×30 mL), making sure to retain an acidic pH before extraction each time. The organic layers were combined and washed with water (1×30 mL) and brine (1×30 mL), dried over Na_2SO_4, filtered, and concentrated in vacuo to afford crude (*L*)-Boc-Pro-Val-OH (87% over two steps). The acid materials were typically obtained in >90% purity and carried on crude to further peptide coupling steps, but can also be purified via flash chromatography on silica gel.

2.5 General Procedure for tripeptides coupling



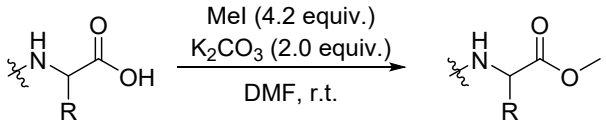
2as

Crude (*L*)-Boc-Pro-Val-OH (1.0 equiv., 4.6 mmol) was coupled with (*L*)-Serine methyl ester hydrochloride (1.0 equiv., 4.6 mmol) using DIPEA (1.0 equiv., 4.6 mmol), HOBt (1.1 equiv., 5.06 mmol) and EDCI (1.0 equiv., 4.6 mmol) according to the general procedure for peptide coupling.

2.6 Solid-Phase Peptide Synthesis (SPPS):

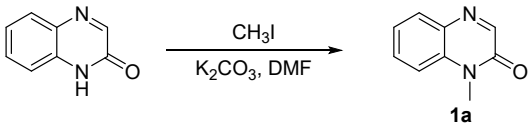
Using 2-chlorotrityl chloride resin. Inside each peptide synthesis tube were manually added 70 mg of resin (1.0 equiv.), followed by the chosen C-terminal Fmoc-protected monomer (4.0 equiv.), DIPEA (6.0 equiv.) and dichloromethane (0.04 M). The tube were shaken for 2 hours and the resin was washed with dimethylformamide (5×3.0 mL) and dichloromethane (5×3.0 mL). Capping was performed using a mixture Ac_2O:2,6-lutidine:DMF (5:6:89) and the resin was washed with dimethylformamide (4×3.0 mL). Fmoc protecting group was then removed by shaking the resin with 20% v/v piperidine in dimethylformamide at 400 rpm 5 minutes. After dimethylformamide (5×3.0 mL) and dichloromethane (5×3.0 mL) washes, the next coupling was carried out by shaking the resin with the chosen Fmoc-protected monomer (0.32 mmol, 4.0 equiv.), 1 [bis(dimethylamino)methylene]-1H-1,2,3-triazolo[4,5-b]pyridinium 3-oxide hexafluorophosphate (4.0 equiv.) and 4-methylmorpholine (NMM, 6.0 equiv.) in dimethylformamide (6.0 mM) at 400 rpm 30 minutes. The capping, Fmoc removal and coupling steps were repeated 4 or 5 times to obtain pentamers and hexamers, respectively.

2.7 General procedure for the methylation of amino acids and peptides



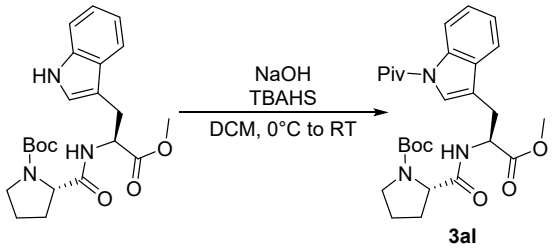
Potassium carbonate (2.0 equiv.) was added to a stirred solution of the chosen free acid (1.0 equiv.) in anhydrous dimethylformamide (0.6 M). To this suspension, a solution of iodomethane (4.2 equiv.) in anhydrous dimethylformamide (2.5 M) was added dropwise using a syringe. The reaction was stirred at room temperature overnight under a nitrogen atmosphere. The solvent was then removed under reduced pressure and the crude mixture was dissolved in ethyl acetate, washed with water and brine several times and extracted twice. The combined organic layers were dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure to afford the desired compound which was used without any further purification.

2.8 Preparation of substrates 1a



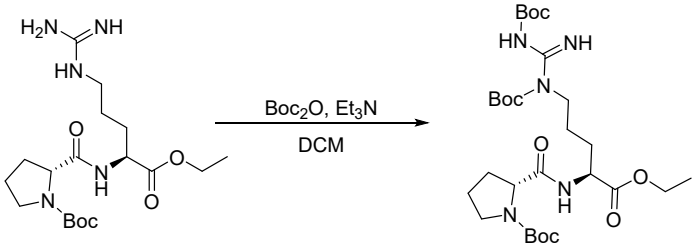
To a suspension of quinoxalinone (1.0 equiv.) in DMF was added potassium carbonate (1.2 equiv.) and the corresponding CH_3I (1.6 equiv.). The mixture was stirred at room temperature overnight. After the completion (as indicated by TLC), The mixture was then extracted with ethyl acetate and the collected organic layer was washed with brine, dried with Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by flash chromatography over silica gel to afford the desired product.

2.9 Synthesis of substrates



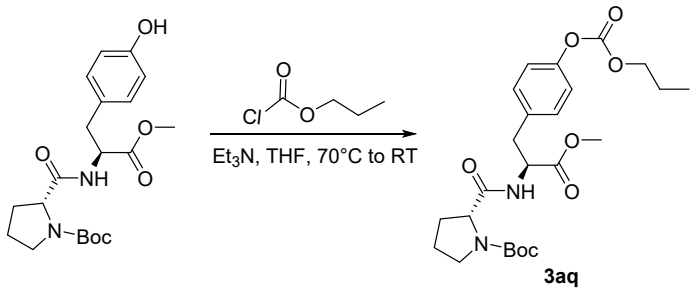
3al

To a solution of (*L*)-Boc-Pro-Trp-OMe (1.0 equiv.) in anhydrous dichloromethane (10 mL), NaOH (graininess, 2.0 equiv.) and TBAHS (tetrabutylammonium hydrogen sulfate, 0.1 equiv.) were added at 0 °C. The mixture was stirred for 30 minutes, and then PivCl (3.0 equiv.) was added slowly. The mixture was stirred for an additional 2 hours and gradually warmed to room temperature. After the completion of the reaction, it was quenched by adding a saturated solution of ammonium chloride. 10 mL of dichloromethane was added to the reaction mixture. The organic layer was separated, and then it was washed with a saturated solution of sodium chloride. Subsequently, the organic layer was dried using anhydrous Na_2SO_4 and evaporated to dryness. The crude product can also be purified via flash chromatography on silica gel.



3ao

To a suspension of (*L*)-Boc-Pro-Arg-OEt (1.0 equiv.) in CH_2Cl_2 (130 mL) at room temperature were added triethylamine (Et_3N, 3.0 equiv.) and *di-tert-butyl* dicarbonate (Boc_2O, 3.0 equiv.). The reaction mixture was stirred vigorously at room temperature overnight. Upon completion, the reaction mixture was transferred to a separatory funnel. The organic layer was washed with sat. aqueous $NaHCO_3$ (2×20 mL), aqueous NH_4Cl (1×20 mL), water (1×20 mL), and brine (1×20 mL). The organic layer was dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The resultant crude residue was purified by flash column chromatography to give as a colorless solid.

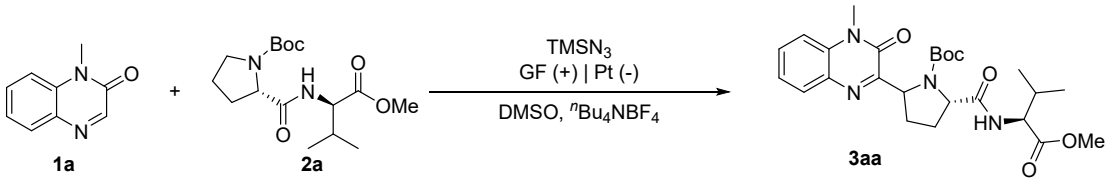


3aq

To a solution of (*L*)-Boc-Pro-Tyr-OMe (1.0 equiv.) in THF (0.1 M) was added anhydrous Et_3N (2.0 equiv.) followed by propyl chloroformate (1.3 equiv.). The reaction mixture was heated at reflux overnight. After cooling to room temperature, the reaction mixture was filtered, concentrated, redissolved in DCM, washed with water and then dried over Na_2SO_4 and concentrated in vacuo. Purification by column chromatography.

3 Optimization of reaction conditions

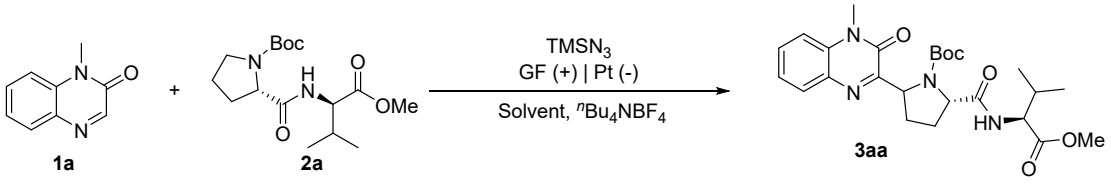
3.1 Effects of current on the reaction[a]



Entry	I (mA)	Yield (%)[b]
1	3	16
2	5	20
3	7	18

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), and DMSO (4 mL) in an undivided cell under a constant current in air at rt for 8 h. [b]Isolated yield.

3.2 Effects of different solvent on the reaction[a]

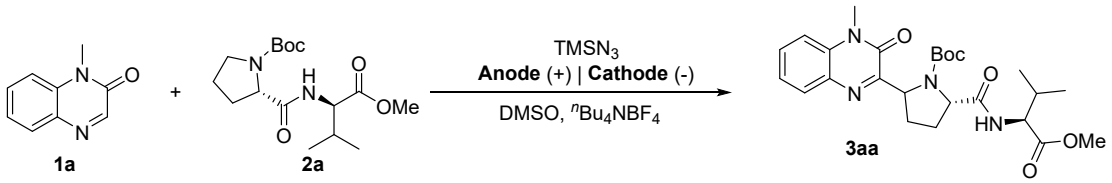


Entry	Solvent	Yield (%)[b]
1	DCE	Trace

2	DMF	Trace
3	CH_3CN	Trace

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), and solvent (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

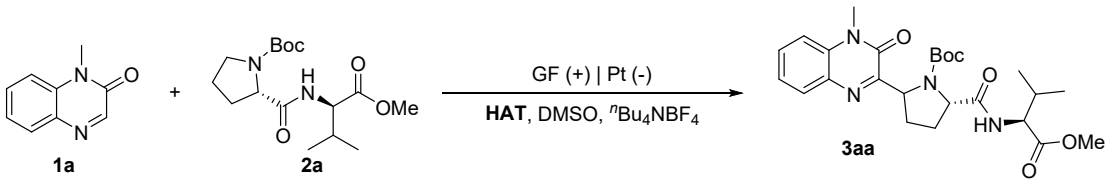
3.3 Effects of different electrode materials on the reaction[a]



Entry	electrode materials	Yield (%)[b]
1	GF(+)|nickel foam(-)	Trace
2	Carbon paper(+)|nickel foam(-)	16

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

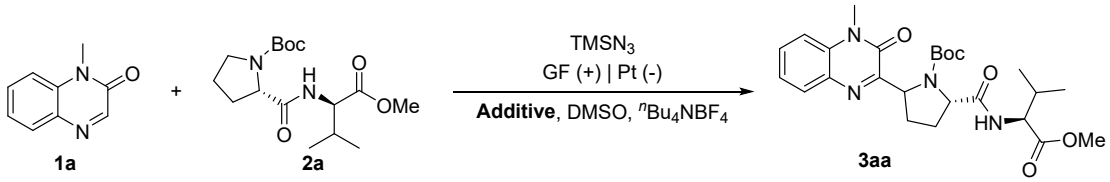
3.4 Effects of different HAT on the reaction[a]



Entry	HAT	Yield (%)[b]
1	$TMSN_3$	20
2	TEMPO	Trace
3	NHPI	10
4	Quinuclidine	18
5	Triethylenediamine	Trace
6	Bu_4N_3	Trace

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), HAT reagent (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

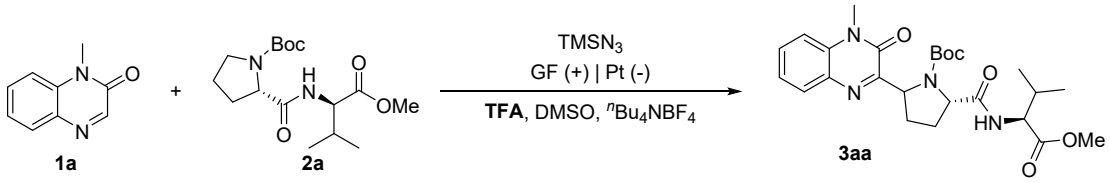
3.5 Effects of different additives on the reaction[a]



Entry	Acid additive	Yield (%)[b]
1	TFA	34
2	TFE	Trace
3	HFIP	Trace
4	CH_3OH	10
5	CH_3COOH	30

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), additive (0.2 mmol) and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

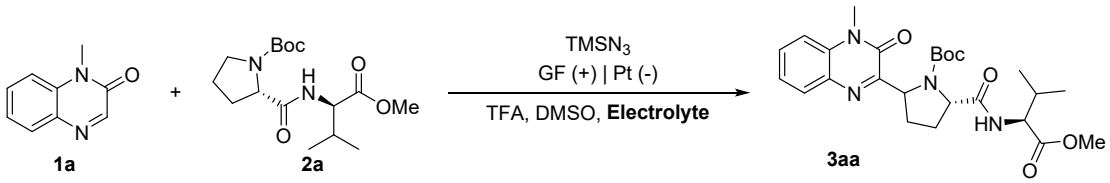
3.6 Effects of different additives concentration on the reaction[a]



Entry	TFA (mmol)	Yield (%)[b]
1	0.2	34
2	0.4	40
3	0.6	33

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), TFA (x mmol) and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

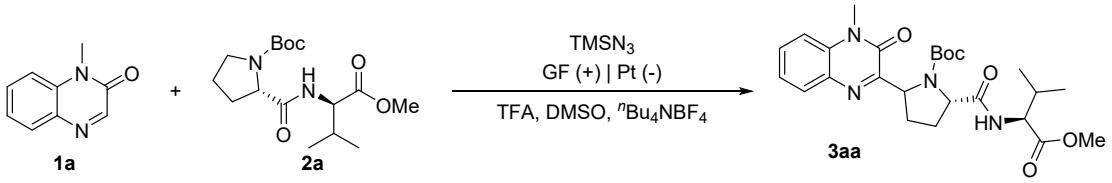
3.7 Effects of electrolytes on the reaction[a]



Entry	Electrolyte	Yield (%)[b]
1	$^nEt_4NBF_4$	35
2	$^nBu_4NClO_4$	41
3	$^nBu_4NCl$	34
4	$^nBu_4NOAc$	26

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.1 mmol), $TMSN_3$ (0.2 mmol), electrolyte (0.1 M), TFA (0.4 mmol) and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

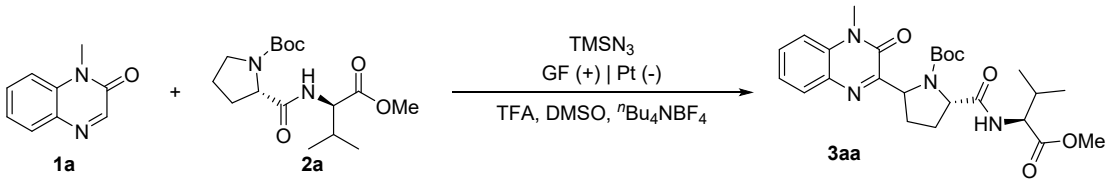
3.8 Effects of substrate ratio on the reaction[a]



Entry	Amounts of **1/2** (mmol)	Yield (%)[b]
1	0.1: 0.1	40
2	0.1: 0.2	75
3	0.1: 0.3	85

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (x mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), TFA (0.4 mmol) and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

3.9 Additional screening of anode materials[a]



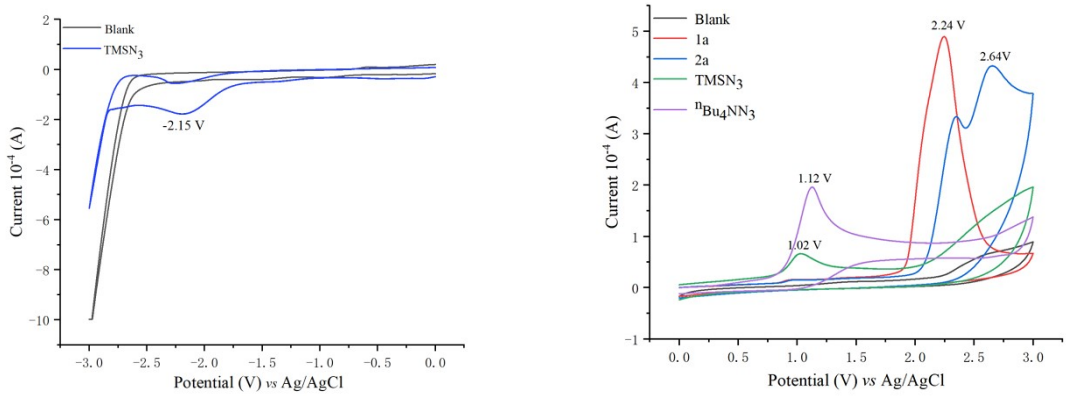
Entry	electrode materials	Yield (%)[b]
1	C plate(+)|Pt(-)	32
2	Carbon paper(+)|Pt(-)	41

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.3 mmol), $TMSN_3$ (0.2 mmol), $^nBu_4NBF_4$ (0.1 M), TFA (0.4 mmol) and DMSO (4 mL) in an undivided cell under a constant current of 5 mA in air at rt for 8 h. [b]Isolated yield.

4. Mechanistic investigations

4.1 Cyclic voltammetry studies

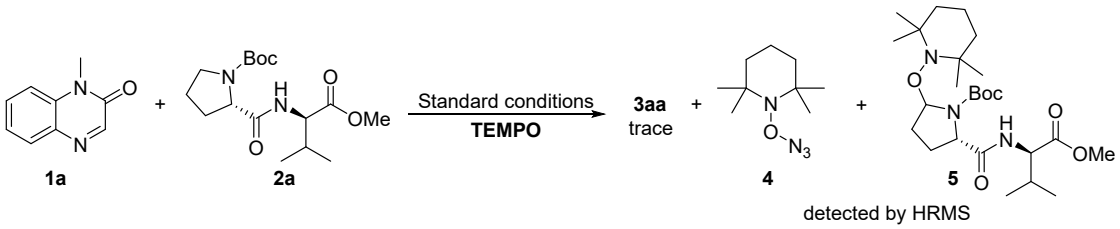
Cyclic voltammetry (CV) experiments were performed to detect the redox potential of substrates involving the process. As shown in figure, a reduction peak of $TMSN_3$ can be observed at -2.15 V *vs* Ag/AgCl (blue curve), which reveals that $TMSN_3$ may be reduced at cathode. By using $^nBu_4NN_3$ as the azide anion source, an oxidation peak at 1.12 V *vs* Ag/AgCl can be found, which indicates that the azide anion is more readily oxidized than **1a** (red curve), $TMSN_3$ (green curve) and **2a** (blue curve) in this electrochemical reaction process.



(a) (b)

CV scans (scan rate 100 mv·s^{-1}) of substrates: (a) Blank ($^nBu_4NBF_4$ (0.1 M) in CH_3CN); $TMSN_3$ (0.01 M, blue curve). (b) Blank ($^nBu_4NBF_4$ (0.1 M) in CH_3CN); $TMSN_3$ (0.01 M, green curve); **1a** (0.01 M red curve); **2a** (0.01 M, blue curve); $^nBu_4NN_3$ (0.01 M, purple curve). The CV is plotted by using the Origin conversion.

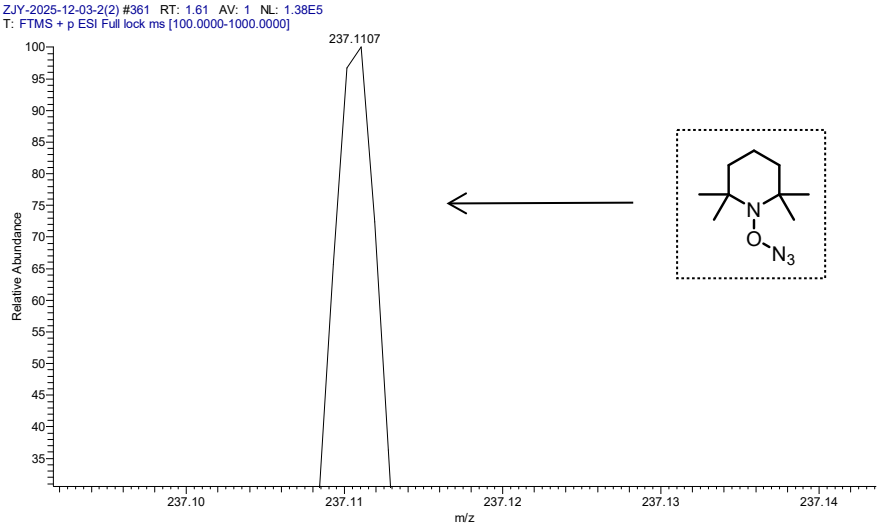
4.2 Radical capture experiment



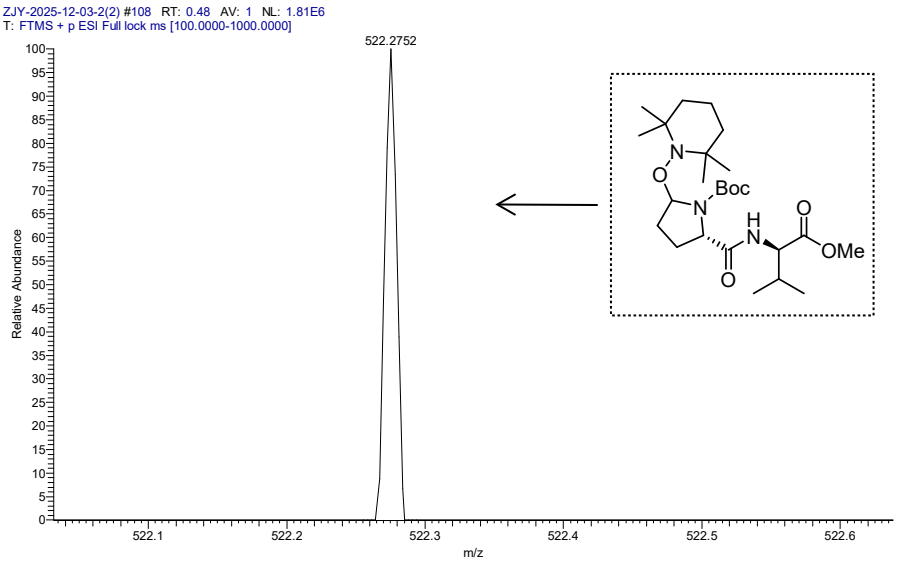
To an undivided cell (10 mL) were added quinoxalin-2(1*H*)-one (**1a**, 0.1 mmol, 1.0 equiv.), (*L*)-Boc-Pro-Val-OMe (**2a**, 0.3 mmol, 3.0 equiv.), $TMSN_3$ (23 mg, 26 μL, 0.2 mmol, 2.0 equiv.), $^nBu_4NBF_4$ (130 mg, 0.4 mmol, 0.1 M), TEMPO (78.1 mg, 0.5 mmol, 5.0 equiv.), and DMSO (4 mL). The flask was equipped with graphite felt as anode and

platinum plate electrode (10 mm×15 mm) as cathode. The reaction mixture was stirred and electrolyzed at a constant current (5 mA) under air at room temperature for 8 h. The reaction was significantly inhibited in the presence of TEMPO, yielding only trace amounts of **3aa**.

HRMS $[M+K]^+$ calcd for $C_9H_{18}N_4O$, 237.1112; found 237.1107.

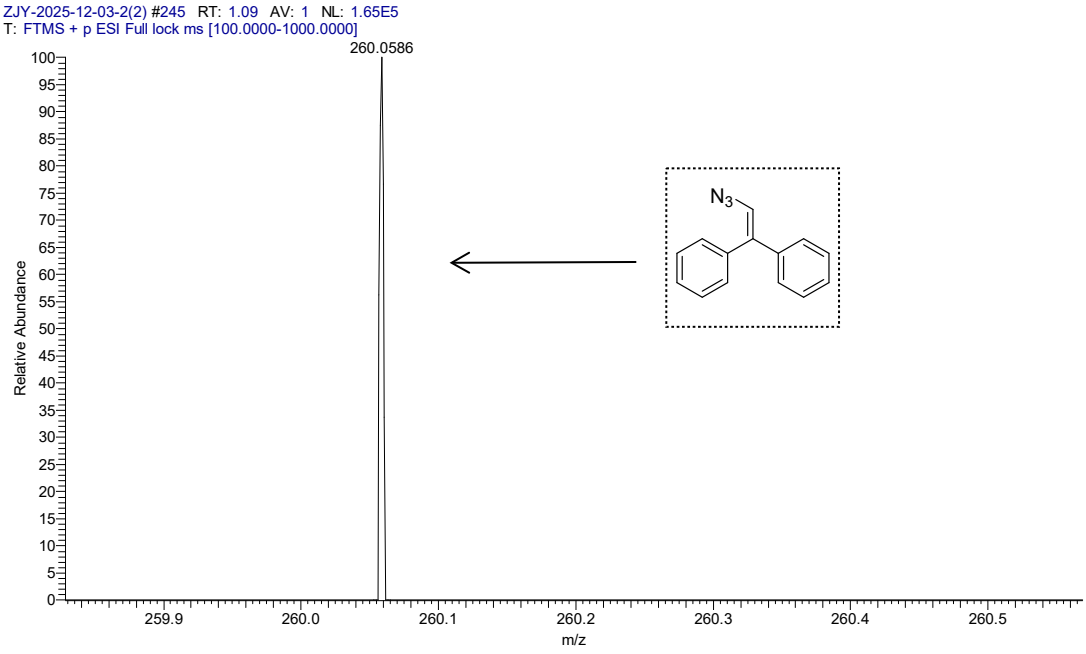


HRMS $[M+K]^+$ calcd for $C_{25}H_{45}N_3O_6$, 522.2939; found 522.2752.

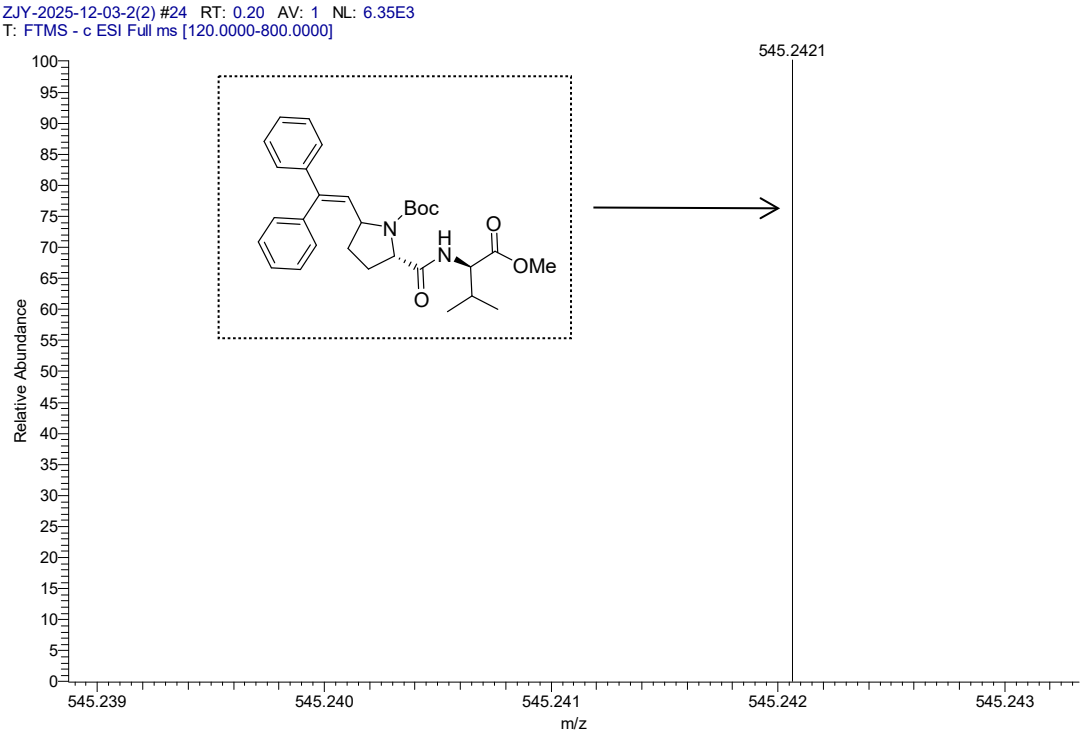


To an undivided cell (10 mL) were added quinoxalin-2(1*H*)-one (**1a**, 0.1 mmol, 1.0 equiv.), (*L*)-Boc-Pro-Val-OMe (**2a**, 0.3 mmol, 3.0 equiv.), $TMSN_3$ (23 mg, 26 μL, 0.2 mmol, 2.0 equiv.), $^nBu_4NBF_4$ (130 mg, 0.4 mmol, 0.1 M), 1,1-diphenylethylene (90.1 mg, 0.5 mmol, 5.0 equiv.), and DMSO (4 mL). The flask was equipped with graphite felt as anode and platinum plate electrode (10 mm×15 mm) as cathode. The reaction mixture was stirred and electrolyzed at a constant current (5 mA) under air at room temperature for 8 h. The reaction was significantly inhibited in the presence of 1,1-diphenylethylene, yielding only trace amounts of **3aa**.

HRMS $[M+K]^+$ calcd for $C_{14}H_{11}N_3$, 260.0590; found 260.0586.

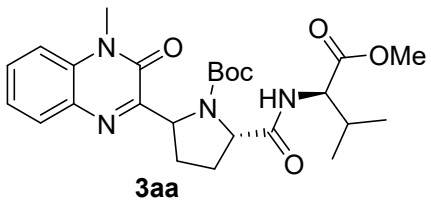


HRMS $[M+K]^+$ calcd for $C_{30}H_{38}N_2O_5$, 545.2412; found 545.2421.



5. Characterization of products

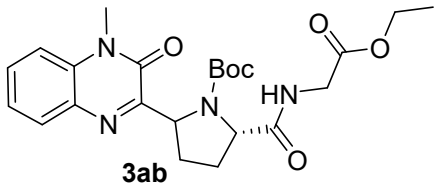
***tert*-butyl (2S)-2-(((R)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3aa

yellow oily liquid; 41.3 mg, 85% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.75 (m, 1H), 7.58-7.48 (m, 1H), 7.35-7.27 (m, 2H), 5.56 (m, 1H), 4.76-4.52 (m, 2H), 3.76-3.64 (m, 6H), 2.50-2.37 (m, 1H), 2.34-2.16 (m, 2H), 2.01 (s, 1H), 1.96 (m, 1H), 1.42 (s, 4H), 1.16 (s, 5H), 0.98 (dd, *J* = 11.4, 7.2 Hz, 3H), 0.90 (dd, *J* = 10.2, 6.6 Hz, 3H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.36, 172.17, 158.67, 155.51, 153.86, 133.18, 132.17, 130.29, 130.27, 123.97, 113.74, 80.24, 61.22, 59.48, 57.17, 52.11, 31.23, 29.81, 28.98, 28.42, 28.12, 19.11. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{25}H_{34}N_4O_6^+$ 487.2557, measured value:487.2551 .

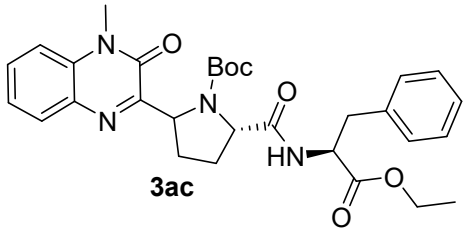
***tert*-butyl (2S)-2-((2-ethoxy-2-oxoethyl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ab

yellow oily liquid; 34.4 mg, 75% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.78 (m, 1H), 7.58-7.50 (m, 1H), 7.37-7.28 (m, 2H), 5.55 (m, 1H), 4.77-4.63 (m, 1H), 4.26-4.18 (m, 2H), 4.16-4.00 (m, 2H), 3.69 (d, *J* = 27.6 Hz, 3H), 2.56-2.39 (m, 1H), 2.35-2.24 (m, 1H), 2.18-2.06 (m, 1H), 2.02-1.92 (m, 1H), 1.43 (s, 4H), 1.29 (q, *J* = 7.2 Hz, 3H), 1.17 (s, 5H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.61, 169.91, 158.93, 155.60, 153.91, 133.21, 132.23, 130.36, 130.29, 130.21, 113.76, 80.38, 61.46, 61.20, 59.49, 41.64, 29.99, 28.61, 28.25, 26.08, 14.29. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{23}H_{31}N_4O_6^+$ 459.2244 measured, value: 459.2235.

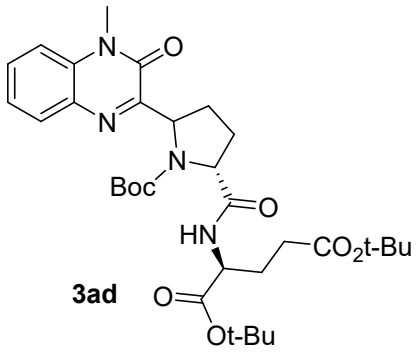
***tert*-butyl (2S)-2-(((S)-1-ethoxy-1-oxo-3-phenylpropan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ac

yellow oily liquid; 49.3 mg, 90% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.75 (m, 1H), 7.58-7.48 (m, 1H), 7.36-7.28 (m, 4H), 7.30-7.19 (m, 1H), 7.19-7.15 (m, 2H), 5.47 (m, 1H), 4.96-4.81 (m, 1H), 4.64 (m, 1H), 4.20-4.09 (m, 2H), 3.67 (d, *J* = 28.2 Hz, 3H), 3.23-3.03 (m, 2H), 2.50-2.33 (m, 1H), 2.18-2.07 (m, 1H), 2.04-1.86 (m, 2H), 1.37 (s, 4H), 1.20 (q, *J* = 7.2 Hz, 3H), 1.15 (s, 5H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.04, 171.37, 158.82, 155.35, 153.83, 136.18, 133.15, 132.14, 130.28, 129.48, 128.59, 127.30, 127.06, 123.97, 113.73, 80.19, 62.14, 61.29, 59.34, 53.35, 38.07, 29.79, 28.97, 28.36, 28.19, 14.19. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{30}H_{36}N_4O_6^+$ 549.2713, measured value: 549.2705.

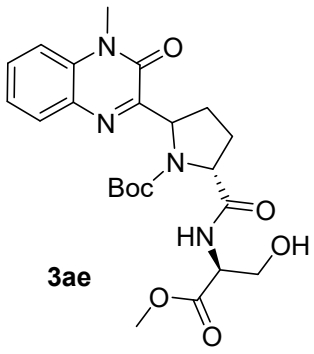
di-tert-butyl ((2R)-1-(tert-butoxycarbonyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-2-carbonyl)-L-glutamate



3ad

yellow oily liquid; 40 mg, 65% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.74 (m, 1H), 7.57-7.47 (m, 1H), 7.35-7.25 (m, 2H), 5.55 (m, 1H), 4.64 (m, 1H), 4.58-4.45 (m, 1H), 3.67 (d, *J* = 27.6 Hz, 3H), 2.50-2.22 (m, 4H), 2.22-2.09 (m, 2H), 2.00-1.80 (m, 2H), 1.48-1.42 (m, 9H), 1.44-1.37 (m, 15H), 1.15 (s, 3H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.92, 171.96, 170.75, 157.60, 154.76, 153.95, 133.52, 132.31, 130.28, 130.07, 123.64, 113.71, 82.42, 80.89, 80.18, 62.24, 60.03, 51.74, 31.56, 31.25, 29.80, 28.88, 28.43, 28.14, 28.07, 27.70. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{32}H_{46}N_4O_8^+$ 615.3394, measured value: 615.3389.

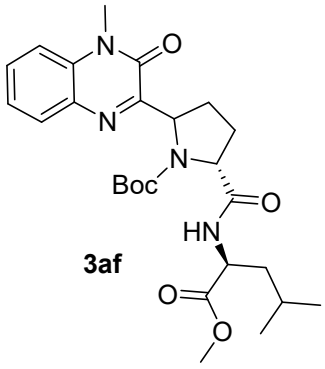
***tert*-butyl (2R)-2-(((S)-3-hydroxy-1-methoxy-1-oxopropan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ae

yellow oily liquid; 35.1 mg, 74% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.75 (m, 1H), 7.58-7.49 (m, 1H), 7.36-7.27 (m, 2H), 5.64-5.51 (m, 1H), 4.77-4.62 (m, 2H), 4.06 (m, 1H), 3.92-3.85 (m, 1H), 3.78 (d, *J* = 2.4 Hz, 3H), 3.68 (d, *J* = 31.2 Hz, 3H), 2.53-2.42 (m, 1H), 2.34-2.13 (m, 2H), 2.03-1.96 (m, 1H), 1.42 (s, 3H), 1.17 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.38, 170.91, 158.27, 155.91, 153.81, 133.20, 132.15, 130.42, 130.29, 124.05, 113.79, 80.97, 62.64, 61.78, 59.76, 55.07, 52.75, 29.64, 29.02, 28.13, 26.72. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{23}H_{30}N_4O_7^+$ 475.2193, measured value: 475.2186.

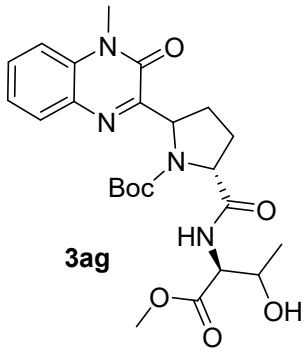
***tert*-butyl (2R)-2-(((S)-1-methoxy-4-methyl-1-oxopentan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3af

yellow oily liquid; 36.7 mg, 73% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.82-7.66 (m, 1H), 7.58-7.49 (m, 1H), 7.40-7.27 (m, 2H), 5.56 (m, 1H), 4.75-4.68 (m, 1H), 4.67-4.60 (m, 1H), 3.74-3.65 (m, 6H), 2.53-2.41 (m, 1H), 2.34-2.19 (m, 1H), 2.14-2.03 (m, 1H), 1.97 (m, 1H), 1.75-1.63 (m, 2H), 1.62-1.55 (m, 1H), 1.41 (s, 6H), 1.16 (s, 3H), 0.99-0.92 (m, 6H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.10, 172.11, 158.72, 154.96, 154.01, 133.56, 133.19, 132.20, 130.32, 123.73, 113.76, 80.94, 62.28, 60.12, 52.45, 50.39, 41.50, 29.87, 29.01, 28.37, 28.13, 24.84, 23.02. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{26}H_{36}N_4O_6^+$ 501.2713, measured value: 501.2705.

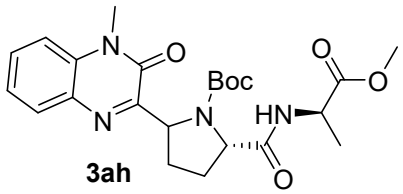
***tert*-butyl (2R)-2-(((2S)-3-hydroxy-1-methoxy-1-oxobutan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ag

yellow oily liquid; 32.2 mg, 66% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.74 (m, 1H), 7.59-7.47 (m, 1H), 7.35-7.28 (m, 2H), 5.57 (m, 1H), 4.70 (m 1H), 4.61 (m, 1H), 4.45-4.25 (m, 1H), 3.79-3.63 (m, 7H), 2.56-2.43 (m, 1H), 2.21-2.12 (m, 1H), 2.06 (dd, *J* = 13.2, 7.2 Hz, 1H), 2.00-1.93 (m, 1H), 1.41 (s, 4H), 1.24 (dd, *J* = 6.6, 2.4 Hz, 3H), 1.16 (s, 5H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.79, 171.41, 158.46, 155.37, 153.84, 133.16, 132.16, 130.34, 130.28, 124.01, 113.76, 80.48, 68.45, 61.52, 59.59, 57.43, 52.57, 29.62, 29.00, 28.11, 26.73, 20.05. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{24}H_{32}N_4O_7$ 489.2349, measured value: 489.2342.

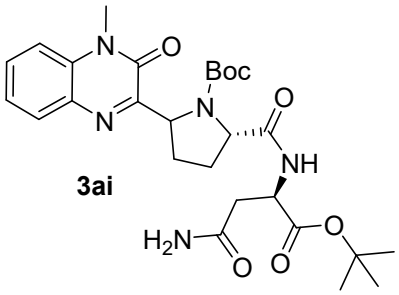
***tert*-butyl (2S)-2-(((R)-1-methoxy-1-oxopropan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylat**



3ah

yellow oily liquid; 32.1 mg, 70% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.78 (m, 1H), 7.59-7.51 (m, 1H), 7.43-7.28 (m, 2H), 5.56 (m, 1H), 4.75-4.59 (m, 2H), 3.80-3.64 (m, 6H), 2.55-2.40 (m, 1H), 2.29 (m, 1H), 2.15-2.03 (m, 1H), 1.98 (m, 1H), 1.47-1.38 (m, 9H), 1.29-1.23 (m, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.22, 172.76, 155.63, 154.75, 154.05, 133.61, 133.23, 132.44, 130.23, 123.75, 113.77, 80.88, 62.17, 61.23, 60.06, 52.66, 47.86, 30.00, 28.47, 25.87, 18.70. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{23}H_{30}N_4O_6^+$ 459.2244, measured value: 459.2237.

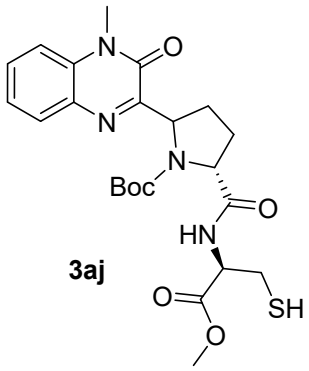
***tert*-butyl (2S)-2-(((R)-4-amino-1-(tert-butoxy)-1,4-dioxobutan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ai

yellow oily liquid; 35.8 mg, 66% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.75 (m, 1H), 7.58-7.45 (m, 1H), 7.36-7.26 (m, 2H), 5.56 (m, 1H), 4.77-4.68 (m, 1H), 4.68-4.58 (m, 1H), 3.68 (d, *J* = 29.4 Hz, 3H), 2.94-2.67 (m, 2H), 2.56-2.45 (m, 1H), 2.34-2.15 (m, 1H), 2.13-2.01 (m, 1H), 2.00-1.92 (m, 1H), 1.46 (s, 8H), 1.38 (s, 5H), 1.14 (s, 5H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.12, 172.33, 169.88, 158.59, 155.10, 153.83, 133.18, 132.17, 130.31, 130.14, 123.98, 113.74, 82.38, 80.28, 61.61, 59.54, 49.70, 37.72, 29.62, 28.99, 28.36, 28.13, 28.01. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{27}H_{37}N_5O_7^+$ 544.2771, measured value: 544.2762.

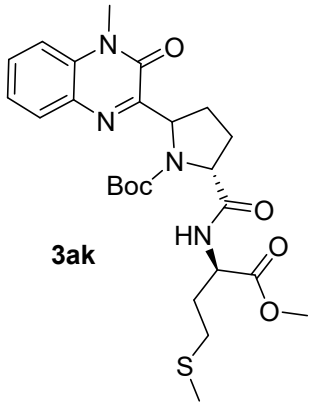
***tert*-butyl (2R)-2-(((R)-3-mercapto-1-methoxy-1-oxopropan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3aj

yellow oily liquid; 20.6 mg, 42% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.86-7.79 (m, 1H), 7.60-7.51 (m, 1H), 7.38-7.28 (m, 2H), 5.57 (m, 1H), 4.93-4.78 (m, 1H), 4.77-4.72 (m, 1H), 3.79-3.75 (m, 3H), 3.72 (d, *J* = 3.6 Hz, 3H), 3.67 (d, *J* = 14.4 Hz, 2H), 2.54-2.42 (m, 1H), 2.27-2.18 (m, 2H), 2.06-1.94 (m, 2H), 1.44 (s, 4H), 1.18 (s, 5H). **^{13}C NMR** (101 MHz, CHLOROFORM-*D*) δ 172.21, 170.38, 154.02, 153.90, 147.18, 133.55, 131.74, 130.15, 124.56, 123.98, 113.75, 80.73, 61.06, 59.35, 52.68, 47.08, 31.52, 30.28, 29.78, 28.46, 28.18. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{23}H_{30}N_4O_6S^+$ 491.1964, measured value: 491.1954.

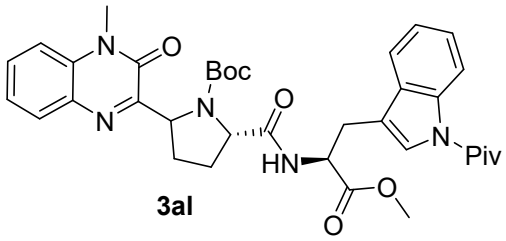
***tert*-butyl (2R)-2-(((R)-1-methoxy-4-(methylthio)-1-oxobutan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ak

yellow oily liquid; 20.7 mg, 40% yield, **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 7.88-7.70 (m, 1H), 7.61-7.45 (m, 1H), 7.37-7.27 (m, 2H), 5.66-5.48 (m, 1H), 4.93-4.19 (m, 2H), 3.81-3.63 (m, 6H), 2.86-2.39 (m, 2H), 2.36-2.15 (m, 2H), 2.13-1.80 (m, 5H), 1.45 (d, *J* = 8.8 Hz, 4H), 1.27-1.24 (m, 2H), 1.18 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.19, 171.29, 158.72, 155.66, 153.94, 130.36, 130.23, 124.51, 124.04, 123.75, 113.78, 80.40, 60.52, 59.56, 52.55, 51.59, 29.89, 29.44, 29.03, 28.53, 26.05, 21.18, 14.32. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{25}H_{34}N_4O_6S$ 519.2287, measured value: 519.2295.

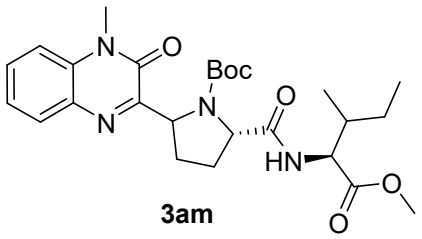
***tert*-butyl (2S)-2-(((S)-1-methoxy-1-oxo-3-(1-pivaloyl-1H-indol-3-yl)propan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3al

yellow oily liquid; 47.3 mg, 72% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.51-8.44 (m, 1H), 7.82-7.61 (m, 2H), 7.60-7.46 (m, 2H), 7.41-7.26 (m, 4H), 5.39 (m, 1H), 5.15-4.96 (m, 1H), 4.70-4.53 (m, 1H), 3.71 (d, *J* = 14.4 Hz, 3H), 3.66 (d, *J* = 19.2 Hz, 3H), 3.36-3.20 (m, 2H), 2.26-2.14 (m, 1H), 2.12-2.03 (m, 1H), 1.93-1.82 (m, 1H), 1.79 (s, 1H), 1.54-1.48 (m, 10H), 1.36 (s, 4H), 1.04 (s, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 177.11, 172.24, 172.07, 158.84, 155.36, 153.86, 137.08, 133.20, 132.21, 130.28, 129.77, 125.53, 123.97, 123.91, 123.81, 123.57, 118.41, 117.55, 116.24, 113.76, 80.17, 61.21, 59.50, 52.53, 52.18, 41.33, 29.94, 28.99, 28.74, 28.21, 28.00, 27.70. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{36}H_{43}N_5O_7$ 658.3241, measured value: 658.3256.

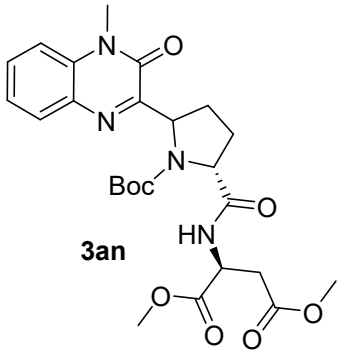
***tert*-butyl (2S)-2-(((2S)-1-methoxy-3-methyl-1-oxopentan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3am

yellow oily liquid; 35.5 mg, 71% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.74 (m, 1H), 7.56-7.49 (m, 1H), 7.36-7.27 (m, 2H), 5.56 (m, 1H), 4.73-4.56 (m, 2H), 3.74-3.65 (m, 6H), 2.50-2.36 (m, 1H), 2.32-2.20 (m, 1H), 2.14-2.00 (m, 1H), 1.99-1.90 (m, 2H), 1.52-1.36 (m, 6H), 1.16 (s, 5H), 0.97-0.88 (m, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.32, 172.01, 158.66, 155.49, 153.85, 133.17, 132.16, 130.27, 130.07, 123.96, 113.74, 80.22, 61.21, 59.46, 56.59, 52.05, 37.86, 29.82, 28.97, 28.39, 28.10, 24.99, 15.64, 11.66. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{26}H_{36}N_4O_6$ 501.2713, measured value:501.2721.

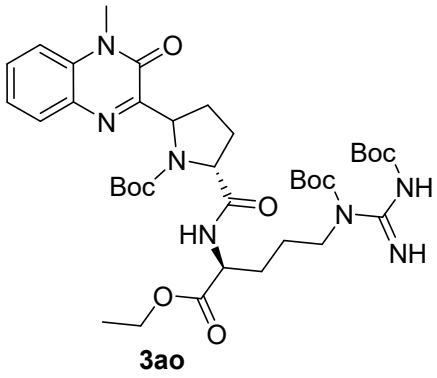
dimethyl ((2R)-1-(*tert*-butoxycarbonyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-2-carbonyl)-L-aspartate



3an

yellow oily liquid; 32.1 mg, 62% yield, **^{1}H NMR** 1H NMR (600 MHz, Chloroform-*d*) δ 7.83-7.71 (m, 1H), 7.60-7.51 (m, 1H), 7.37-7.26 (m, 2H), 5.60-5.45 (m, 1H), 4.95-4.85 (m, 1H), 4.72-4.58 (m, 1H), 3.78-3.75 (m, 3H), 3.72-3.65 (m, 6H), 3.07-2.84 (m, 2H), 2.50-2.18 (m, 2H), 2.16-1.92 (m, 2H), 1.43 (s, 4H), 1.17 (s, 5H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.05, 172.29, 171.28, 158.89, 155.26, 153.92, 133.21, 130.35, 130.28, 130.20, 124.00, 113.75, 80.20, 61.17, 59.42, 52.85, 52.09, 48.77, 36.37, 29.95, 29.01, 28.55, 28.20. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{25}H_{32}N_4O_8$ 517.2328, measured value: 517.2320.

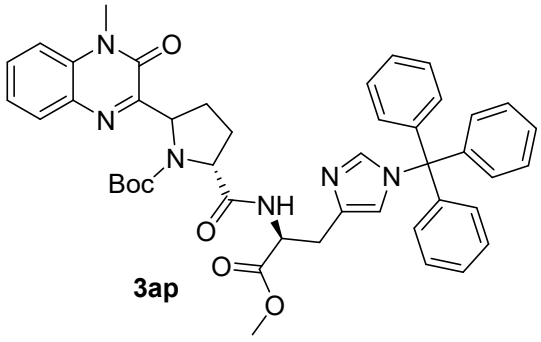
***tert*-butyl (2R)-2-(((S)-7-(*tert*-butoxycarbonyl)-6-imino-2,2-dimethyl-4,12-dioxo-3,13-dioxa-5,7-diazapentadecan-11-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3ao

yellow oily liquid; 37.7 mg, 50% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.37-8.25 (m, 1H), 7.79-7.64 (m, 1H), 7.55-7.46 (m, 1H), 7.40-7.28 (m, 2H), 5.62-5.41 (m, 1H), 4.72-4.49 (m, 2H), 4.31-4.04 (m, 3H), 3.71-3.58 (m, 3H), 3.45-3.34 (m, 2H), 2.46-2.38 (m, 1H), 2.30-1.98 (m, 3H), 1.93-1.63 (m, 4H), 1.47-1.39 (m, 22H), 1.29-1.20 (m, 5H), 1.14-1.11 (m, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.93, 171.96, 163.58, 158.66, 156.20, 155.47, 153.79, 153.21, 133.12, 132.11, 130.22, 130.03, 123.90, 113.69, 80.82, 80.22, 79.18, 61.66, 61.11, 59.43, 51.92, 40.44, 29.83, 29.63, 28.91, 28.64, 28.41, 28.32, 28.08, 24.84, 14.20. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{37}H_{55}N_7O_{10}$ 758.4129, measured value: 758.4121.

***tert*-butyl (2R)-2-(((S)-1-methoxy-1-oxo-3-(1-trityl-1H-imidazol-4-yl)propan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**

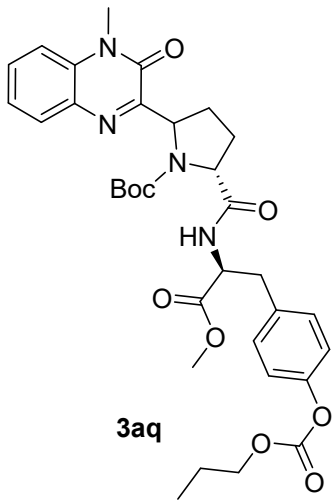


3ap

yellow oily liquid; 53.6 mg, 70% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.78 (m, 1H), 7.57-7.47 (m, 1H), 7.41 (m, 1H), 7.34-7.30 (m, 11H), 7.14-7.09 (m, 6H), 6.55 (dd, *J* = 8.4, 1.8 Hz, 1H), 5.57 (m, 1H), 4.87-4.79 (m, 1H), 4.64 (m, 1H), 3.67 (d, *J* = 33 Hz, 3H), 3.59 (d, *J* = 4.2 Hz, 3H), 3.16-2.85 (m, 2H), 2.56-2.46 (m, 1H), 2.17-2.08 (m, 1H), 2.07-2.02 (m, 1H), 1.94-1.86 (m, 1H), 1.37 (s, 5H), 1.10 (s, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.42, 171.73, 158.25, 154.22, 154.00, 142.43, 138.92, 136.49, 133.49, 132.48, 129.87, 129.81, 128.15, 128.12, 128.06, 123.53, 119.27, 113.58, 80.13, 75.31,

62.15, 59.66, 52.39, 52.10, 29.98, 29.75, 28.82, 28.45, 28.19. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{45}H_{46}N_6O_6$ 767.3557, measured value: 767.3574.

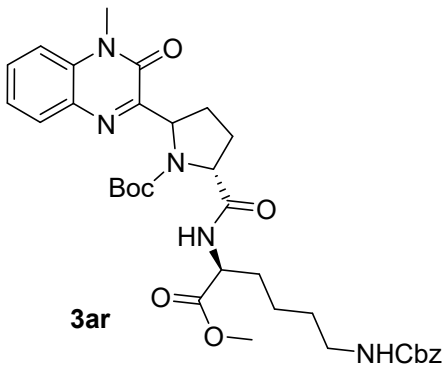
***tert*-butyl (2R)-2-(((S)-1-methoxy-1-oxo-3-(4-((propoxycarbonyl)oxy)phenyl)propan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3aq

yellow oily liquid; 44.3 mg, 70% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.77-7.66 (m, 1H), 7.56-7.45 (m, 1H), 7.33 (m, 2H), 7.19-7.04 (m, 4H), 5.47 (m, 1H), 4.94-4.79 (m, 1H), 4.71-4.52 (m, 1H), 4.21-4.06 (m, 2H), 3.76-3.54 (m, 6H), 3.10 (q, *J* = 14.4, 6 Hz, 2H), 2.46-2.31 (m, 1H), 2.28-2.02 (m, 2H), 2.00-1.84 (m, 1H), 1.77-1.67 (m, 2H), 1.47-1.28 (m, 4H), 1.12 (m, 5H), 1.00-0.91 (m, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 171.99, 171.61, 158.70, 155.42, 154.46, 153.74, 150.18, 133.91, 133.08, 132.05, 130.39, 130.20, 129.99, 123.87, 121.05, 113.69, 80.18, 70.28, 61.11, 59.32, 53.31, 52.25, 37.43, 29.77, 28.89, 28.08, 26.00, 21.96, 10.18. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{33}H_{40}N_4O_9$ 637.2874, measured value: 637.2887.

***tert*-butyl (2R)-2-(((S)-6-(((benzyloxy)carbonyl)amino)-1-methoxy-1-oxohexan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**

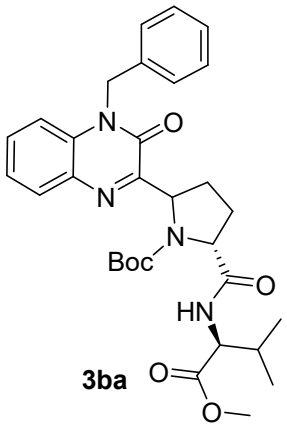


3ar

yellow oily liquid; 48.7 mg, 75% yield,**^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.82-7.68 (m, 1H), 7.58-7.48 (m, 1H), 7.40-7.28 (m, 3H), 7.21-7.16 (m, 2H), 7.13-7.07 (m, 2H), 5.58-5.40 (m, 1H), 4.97-4.54 (m, 2H), 4.23-4.14 (m, 2H), 3.73-3.62 (m, 6H), 3.19-3.05 (m, 2H), 2.46-2.36 (m, 1H), 2.20-2.01 (m, 1H), 2.01-1.87 (m, 2H), 1.81-1.68 (m, 2H), 1.50-1.41 (m, 1H), 1.41-1.31 (m, 4H), 1.27-1.19 (m, 1H), 1.18-1.12 (m, 5H),

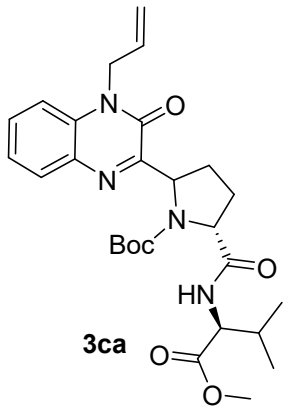
1.03-0.95 (m, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.59, 171.98, 158.44, 156.50, 155.33, 153.70, 136.78, 133.03, 132.00, 130.20, 130.11, 129.93, 128.41, 127.97, 123.85, 113.68, 80.21, 66.33, 61.15, 59.39, 52.26, 51.74, 40.56, 32.21, 31.82, 29.63, 28.86, 28.28, 27.95, 22.62. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{34}H_{44}N_5O_8$ 650.3190, measured value: 650.3187.

***tert*-butyl (5R)-2-(4-benzyl-3-oxo-3,4-dihydroquinoxalin-2-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**



yellow oily liquid; 34.3 mg, 61% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.76 (m, 1H), 7.44-7.35 (m, 1H), 7.30-7.26 (m, 3H), 7.25-7.18 (m, 4H), 5.70-5.61 (m, 1H), 5.59-5.52 (m, 1H), 5.36 (m, 1H), 4.72 (m, 1H), 4.59 (m, 1H), 3.73 (d, *J* = 12.6 Hz, 3H), 2.54-2.42 (m, 1H), 2.39-2.26 (m, 1H), 2.26-2.12 (m, 2H), 1.99 (dd, *J* = 13.2, 6.6 Hz, 1H), 1.44 (s, 4H), 1.18 (s, 5H), 0.99 (dd, *J* = 11.4, 7.2 Hz, 3H), 0.92 (dd, *J* = 10.2, 7.2 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.31, 172.11, 158.86, 155.48, 153.94, 135.24, 132.84, 132.44, 130.37, 130.18, 129.00, 127.85, 126.89, 123.99, 114.50, 80.24, 61.25, 59.43, 57.18, 52.09, 45.61, 31.21, 29.91, 28.42, 28.12, 19.11. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{31}H_{38}N_4O_6$ 563.2870, measured value: 563.2870.

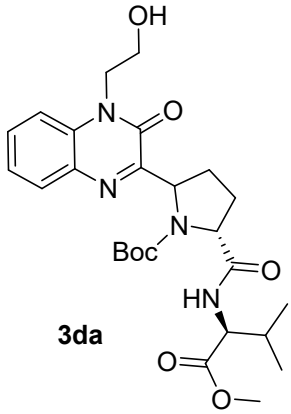
***tert*-butyl (5R)-2-(4-allyl-3-oxo-3,4-dihydroquinoxalin-2-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**



yellow oily liquid; 38.1 mg, 73% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.77 (m, 1H), 7.54-7.47 (m, 1H), 7.35-7.27 (m, 2H), 5.98-5.88 (m, 1H), 5.58 (m, 1H), 5. 29-5.10 (m, 2H), 5.03-4.79 (m, 2H), 4.77-4.65 (m, 1H), 4.60 (m, 1H), 3.74 (d, *J* = 12.6 Hz, 3H), 2.52-2.39 (m, 1H), 2.37-2.10 (m, 3H), 2.03-1.91 (m, 1H), 1.44 (s, 4H), 1.18 (s, 5H), 1.00 (dd, *J* = 10.2, 6.6 Hz, 3H), 0.92 (dd,

J = 9.6, 7.2 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.42, 172.20, 158.91, 155.56, 153.47, 132.86, 132.43, 130.68, 130.45, 130.21, 123.99, 118.14, 114.34, 80.29, 61.29, 59.43, 57.24, 52.17, 44.32, 31.29, 29.93, 28.49, 28.19, 19.18. **HR MS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{27}H_{36}N_4O_6$ 513.2713, measured value: 513.2716.

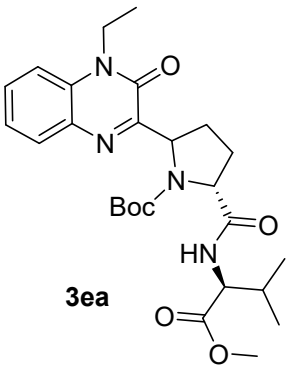
***tert*-butyl (5R)-2-(4-(2-hydroxyethyl)-3-oxo-3,4-dihydroquinoxalin-2-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**



3da

yellow oily liquid; 28.4 mg, 55% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.76 (m, 1H), 7.57-7.42 (m, 2H), 7.36-7.27 (m, 1H), 5.55 (m, 1H), 4.69 (m, 1H), 4.58 (m, 1H), 4.52-4.34 (m, 2H), 3.99 (m, 2H), 3.73 (d, *J* = 13.8 Hz, 3H), 2.51-2.38 (m, 1H), 2.36-2.09 (m, 3H), 2.01-1.90 (m, 1H), 1.42 (s, 4H), 1.24 (q, *J* = 7.8 Hz, 1H), 1.16 (s, 4H), 0.98 (dd, *J* = 11.4, 6.6 Hz, 3H), 0.91 (dd, *J* = 10.8, 6.6 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.04, 172.25, 158.63, 155.47, 154.56, 133.16, 132.66, 130.52, 130.29, 124.10, 114.06, 80.32, 62.31, 60.32, 59.29, 57.21, 52.14, 44.60, 31.46, 29.88, 28.80, 28.11, 19.30. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{26}H_{36}N_4O_7$ 517.2662, measured value: 517.2656.

***tert*-butyl (5R)-2-(4-ethyl-3-oxo-3,4-dihydroquinoxalin-2-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**

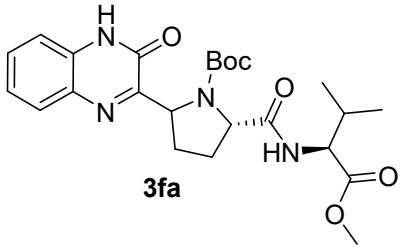


3ea

yellow oily liquid; 38.7 mg, 77% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.77 (m, 1H), 7.58-7.49 (m, 1H), 7.38-7.26 (m, 2H), 5.58 (m, 1H), 4.71 (m, 1H), 4.59 (m, 1H), 4.38-4.25 (m, 2H), 3.74 (d, *J* = 13.8 Hz, 3H), 2.51-2.38 (m, 1H), 2.28-2.15 (m, 2H), 1.97 (m, 1H), 1.77 (s, 1H), 1.44 (s, 4H), 1.39-1.36 (m, 3H), 1.16 (s, 5H), 0.99 (dd, *J* = 12, 6.6 Hz, 3H), 0.92 (dd, *J* = 11.4, 6.6 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.40, 172.22, 158.95, 155.53, 153.38, 132.55, 132.09, 130.62, 130.23, 123.77, 113.59, 80.22, 61.29, 59.30, 57.22, 52.15,

37.20, 31.28, 29.92, 28.47, 28.13, 19.16, 12.63. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{26}H_{36}N_4O_6$ 501.2713, measured value: 501.2715.

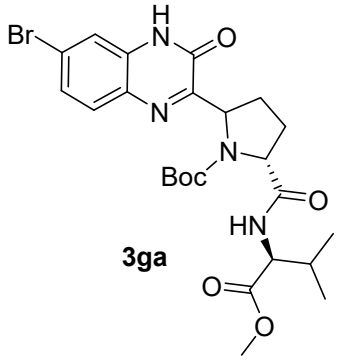
***tert*-butyl (2S)-2-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)-5-(3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3fa

yellow oily liquid; 35.1 mg, 74% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.76 (m, 1H), 7.55-7.47 (m, 1H), 7.44-7.39 (m, 1H), 7.38-7.29 (m, 1H), 5.65 (m, 1H), 4.74 (m, 1H), 4.63 (m, 1H), 3.76 (d, *J* = 18.6 Hz, 3H), 2.56-2.44 (m, 1H), 2.41-2.06 (m, 3H), 2.05-1.97 (m, 1H), 1.44 (s, 4H), 1.18 (s, 5H), 1.01 (dd, *J* = 13.2, 7.2 Hz, 3H), 0.93 (dd, *J* = 9.6, 6.6 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.57, 172.31, 159.45, 155.71, 155.45, 132.33, 131.13, 130.40, 129.33, 124.56, 115.93, 80.45, 61.30, 58.85, 57.25, 52.18, 31.28, 30.03, 28.47, 28.17, 19.19. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{24}H_{32}N_4O_6$ 473.2400, measured value: 473.2397.

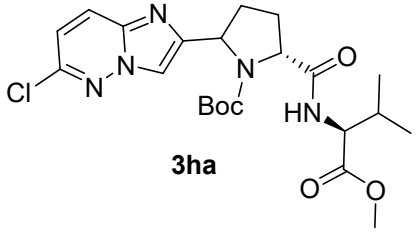
***tert*-butyl (5R)-2-(6-bromo-3-oxo-3,4-dihydroquinoxalin-2-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**



3ga

yellow oily liquid; 24.7 mg, 45% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.64-7.57 (m, 1H), 7.53-7.37 (m, 2H), 5.70-5.48 (m, 1H), 4.78-4.54 (m, 2H), 3.76-3.68 (m, 3H), 2.57-2.43 (m, 1H), 2.36-2.13 (m, 3H), 2.04-1.95 (m, 1H), 1.45-1.42 (m, 4H), 1.18-1.15 (m, 5H), 1.01-0.95 (m, 3H), 0.95-0.89 (m, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.45, 172.29, 159.93, 158.74, 155.26, 132.38, 131.03, 130.46, 127.79, 124.19, 118.64, 80.48, 61.16, 58.78, 57.28, 52.15, 31.16, 29.89, 28.81, 28.12, 19.13. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{24}H_{31}BrN_4O_6$ 551.1505, measured value: 551.1511.

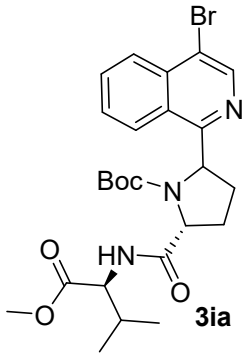
***tert*-butyl (5R)-2-(6-chloroimidazo[1,2-b]pyridazin-2-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**



3ha

yellow oily liquid; 38.4 mg, 80% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.91-7.66 (m, 3H), 5.62 (m, 1H), 4.74-4.55 (m, 2H), 3.71 (dd, *J* = 14.4, 1.8 Hz, 3H), 2.33-2.23 (m, 2H), 2.22-2.15 (m, 1H), 2.10-1.97 (m, 2H), 1.38 (d, *J* = 1.8 Hz, 4H), 1.14 (d, *J* = 1.8 Hz, 5H), 0.96-0.92 (m, 3H), 0.88 (m, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 172.09, 171.17, 154.47, 146.86, 143.92, 136.29, 133.94, 117.40, 113.56, 81.41, 60.88, 57.50, 57.33, 52.15, 31.64, 31.08, 29.60, 28.02, 19.07. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{22}H_{30}ClN_5O_5$ 480.2014, measured value: 480.2014.

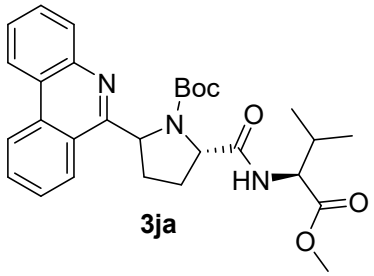
***tert*-butyl (5R)-2-(4-bromoisoquinolin-1-yl)-5-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)pyrrolidine-1-carboxylate**



3ia

yellow oily liquid; 32 mg, 60% yield, **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 8.61 (m, 1H), 8.29-8.16 (m, 2H), 7.87-7.62 (m, 2H), 5.95-5.67 (m, 1H), 4.80-4.67 (m, 1H), 4.62-4.49 (m, 1H), 3.66 (d, *J* = 10.8 Hz, 3H), 2.59-2.47 (m, 1H), 2.45-2.30 (m, 2H), 2.30-2.18 (m, 1H), 2.05-1.97 (m, 1H), 1.41 (s, 5H), 1.25 (s, 1H), 1.17-1.11 (m, 3H), 1.11-1.04 (m, 3H), 0.95 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 174.06, 172.70, 160.33, 154.26, 142.86, 135.36, 131.76, 128.58, 128.55, 127.10, 124.52, 119.04, 81.07, 62.99, 59.83, 57.42, 51.93, 31.43, 31.04, 30.29, 28.40, 19.53. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{25}H_{32}BrN_3O_5$ 534.1604, measured value: 534.1603.

***tert*-butyl (2S)-2-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)-5-(phenanthridin-6-yl)pyrrolidine-1-carboxylate**

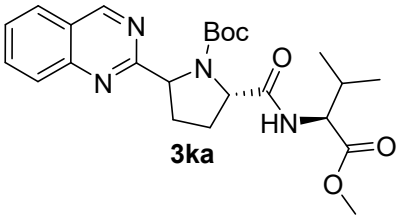


3ja

yellow oily liquid; 36.8 mg, 73% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.68 (m, 1H), 8.57 (m, 1H), 8.28 (dd, *J* = 15, 8.4 Hz, 1H), 8.19-8.07 (m, 1H), 7.92-7.82

(m, 1H), 7.76-7.60 (m, 3H), 5.98-5.80 (m, 1H), 4.81-4.60 (m, 2H), 3.32 (m, 3H), 2.68-2.57 (m, 1H), 2.52-2.30 (m, 3H), 2.21-2.05 (m, 1H), 1.44 (s, 5H), 1.19 (m, 3H), 1.11 (dd, J = 12.6, 6.6 Hz, 3H), 0.92 (s, 4H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.94, 172.26, 160.94, 154.08, 143.18, 133.51, 130.89, 129.68, 128.44, 127.61, 126.92, 125.30, 123.93, 122.77, 122.17, 80.02, 62.42, 60.45, 57.55, 51.63, 33.01, 31.66, 30.30, 28.46, 19.44. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{29}H_{35}N_3O_5$ 506.2655, measured value: 506.2642.

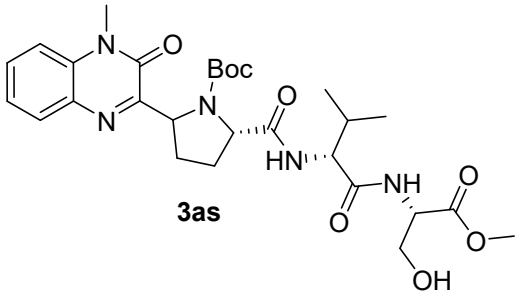
***tert*-butyl (2S)-2-(((S)-1-methoxy-3-methyl-1-oxobutan-2-yl)carbamoyl)-5-(quinazolin-2-yl)pyrrolidine-1-carboxylate**



3ka

yellow oily liquid; 23.7 mg, 52% yield, **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 9.22 (d, J = 39.6 Hz, 1H), 8.19-8.05 (m, 2H), 7.99-7.89 (m, 1H), 7.73-7.64 (m, 1H), 5.91-5.72 (m, 1H), 4.80-4.71 (m, 1H), 4.63-4.52 (m, 1H), 3.64 (d, J = 16.2 Hz, 3H), 2.59-2.51 (m, 1H), 2.50-2.38 (m, 1H), 2.39-2.23 (m, 2H), 2.22-2.09 (m, 1H), 1.41 (s, 5H), 1.16-1.04 (m, 6H), 0.96 (s, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.77, 172.58, 170.21, 154.21, 154.05, 150.47, 134.30, 129.52, 128.18, 123.73, 122.53, 81.37, 62.87, 59.45, 57.43, 51.98, 32.34, 31.34, 28.40, 27.87, 19.53. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{24}H_{32}N_4O_5$ 457.2451, measured value: 457.2438.

***tert*-butyl (2S)-2-(((R)-1-(((S)-3-hydroxy-1-methoxy-1-oxopropan-2-yl)amino)-3-methyl-1-oxobutan-2-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**

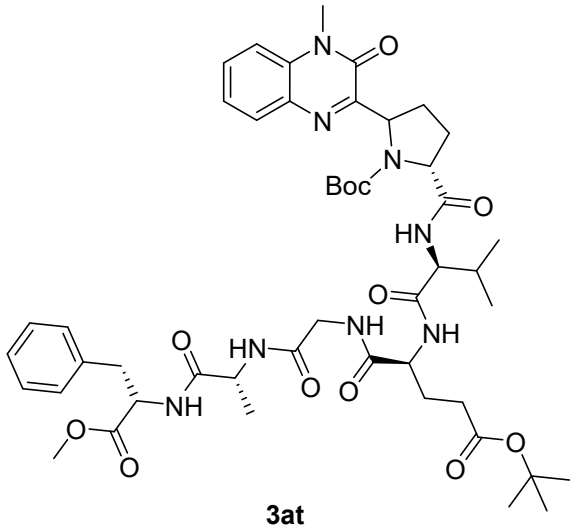


3as

yellow oily liquid; 36.2 mg, 63% yield, **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 7.80-7.68 (m, 1H), 7.59-7.48 (m, 1H), 7.37-7.29 (m, 2H), 5.69-5.42 (m, 1H), 4.72-4.60 (m, 2H), 4.45-4.32 (m, 1H), 3.96-3.90 (m, 2H), 3.78 (d, J = 6 Hz, 3H), 3.69 (d, J = 17.6 Hz, 3H), 2.60-2.37 (m, 1H), 2.37-2.25 (m, 1H),

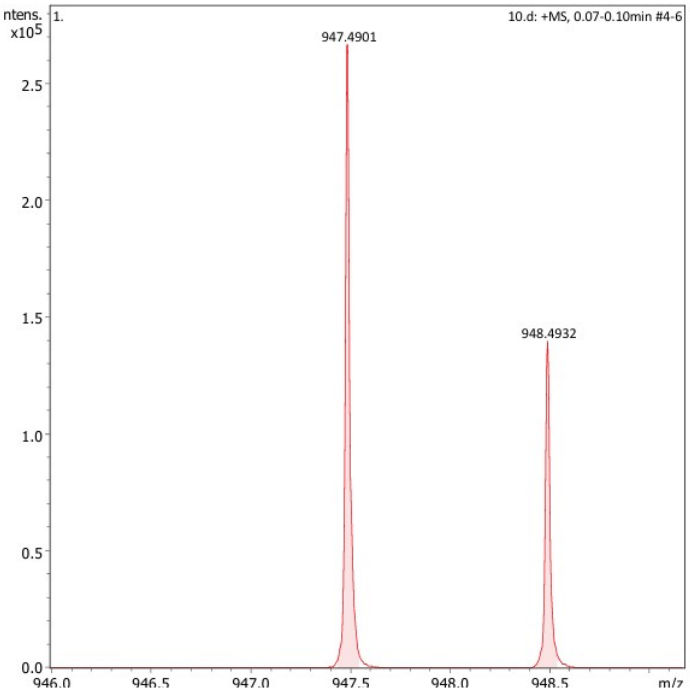
2.25-2.15 (m, 1H), 2.02-1.94 (m, 1H), 1.43 (d, J = 9.2 Hz, 3H), 1.17 (d, J = 11.2 Hz, 6H), 1.09-1.01 (m, 3H), 1.01-0.96 (m, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 173.27, 171.45, 170.76, 158.63, 155.36, 154.01, 133.21, 132.20, 130.37, 130.28, 124.03, 113.80, 81.05, 62.84, 61.54, 59.84, 58.59, 55.15, 52.69, 30.29, 29.76, 29.02, 28.42, 28.16, 19.46. **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{28}H_{39}N_5O_8$ 574.2877, measured value: 574.2891.

***tert*-butyl 2-((4-benzyl-13-(3-(tert-butoxy)-3-oxopropyl)-7,17-dimethyl-3,6,9,12,15-pentaoxo-2-oxa-5,8,11,14-tetraazaoctadecan-16-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



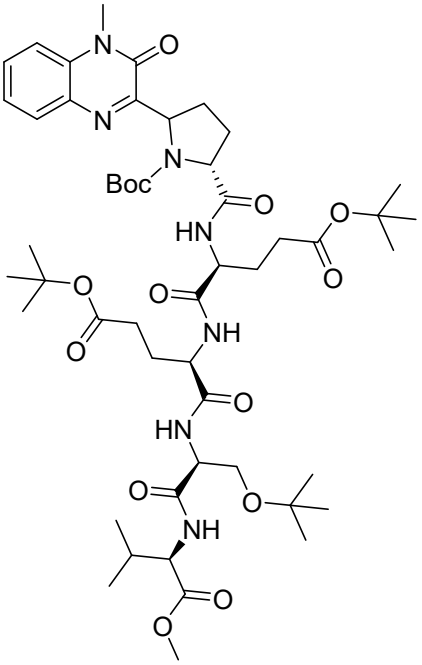
3at

yellow oily liquid; 28.5 mg, 30% yield, **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 7.65-7.60 (m, 1H), 7.57-7.49 (m, 2H), 7.33-7.29 (m, 1H), 7.28-7.26 (m, 1H), 7.24-7.20 (m, 2H), 7.18-7.14 (m, 2H), 5.67-5.50 (m, 1H), 4.84-4.77 (m, 1H), 4.60-4.44 (m, 2H), 4.13-3.95 (m, 4H), 3.69 (d, *J* = 3.2 Hz, 6H), 3.18-3.05 (m, 2H), 2.41-2.31 (m, 3H), 2.30-2.19 (m, 2H), 2.14-2.06 (m, 2H), 2.05-1.97 (m, 2H), 1.44-1.39 (m, 11H), 1.25 (s, 3H), 1.13 (s, 7H), 1.03 (d, *J* = 6.8 Hz, 3H), 1.00 (d, *J* = 6.8 Hz, 3H). **HRMS (ESI) m/z:** $[M+H]^+$ caalue: $C_{48}H_{66}N_8O_{12}$ 947.4898, measured value: 947.4901.



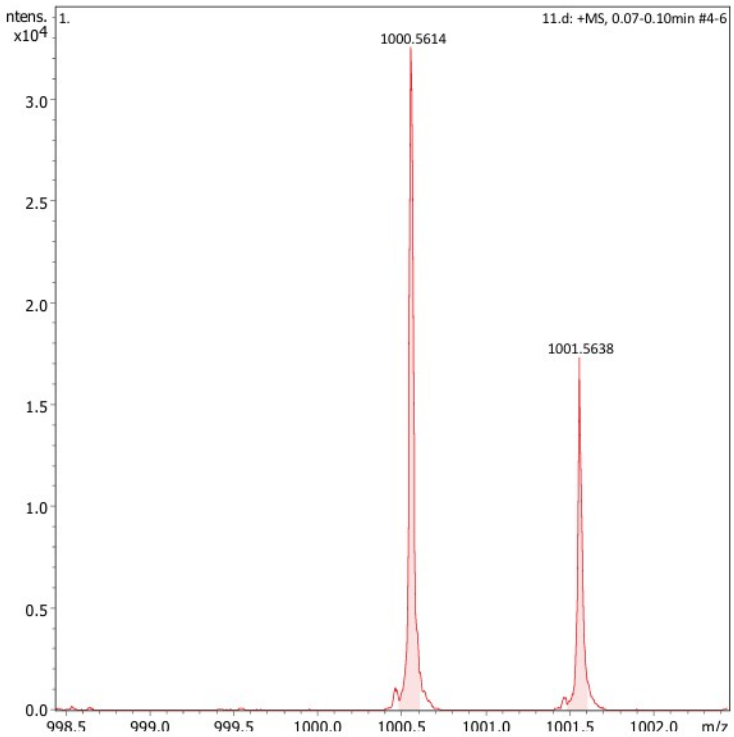
Meas. m/z	#	Ion Formula	m/z	err [ppm]	mSigma	# mSigma	Score	rdb	e⁻	Conf N-Rule
947.4901	1	C48H67N8O12	947.4873	-2.9	24.6	1	100.00	20.0	even	ok

***tert*-butyl 2-((10-(3-(tert-butoxy)-3-oxopropyl)-7-(tert-butoxymethyl)-4-isopropyl-18,18-dimethyl-3,6,9,12,16-pentaoxo-2,17-dioxa-5,8,11-triazanonadecan-13-yl)carbamoyl)-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)pyrrolidine-1-carboxylate**



3au

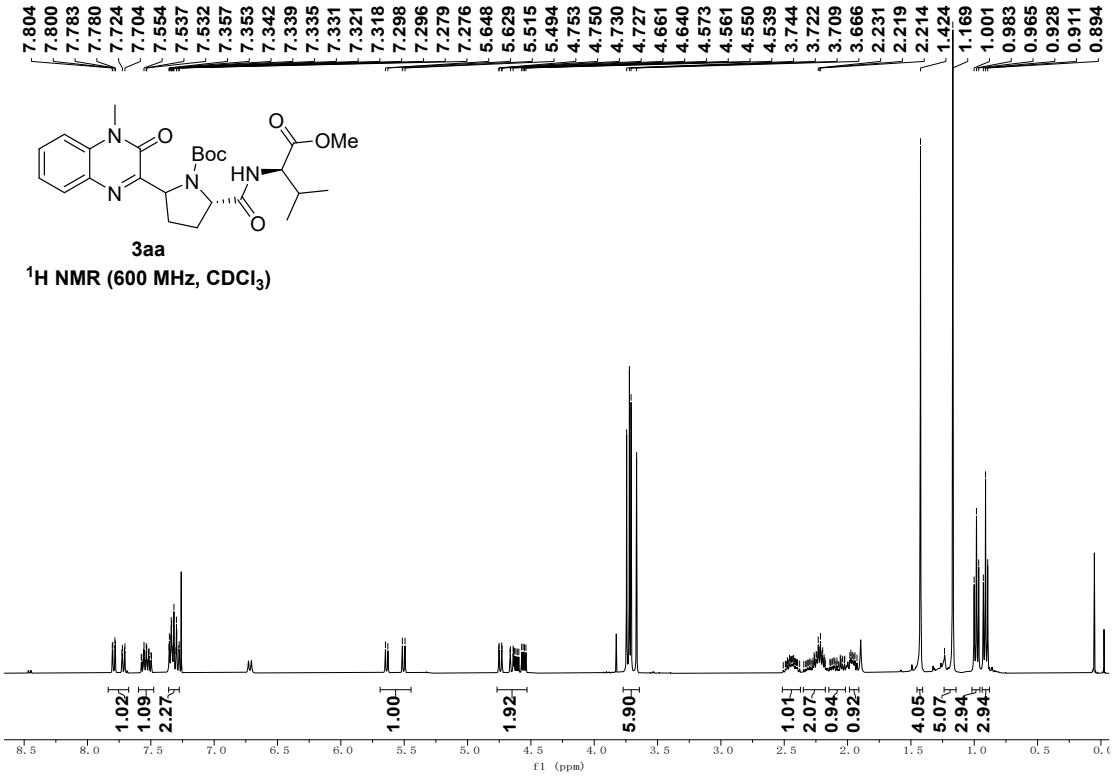
yellow oily liquid; 34.1 mg, 34% yield, **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 7.51-7.38 (m, 1H), 7.37-7.28 (m, 1H), 7.25-7.11 (m, 2H), 4.58-4.33 (m, 5H), 4.22-4.06 (m, 1H), 3.81-3.64 (m, 5H), 3.54-3.31 (m, 3H), 2.45-2.30 (m, 4H), 2.29-2.22 (m, 2H), 2.21-2.10 (m, 4H), 2.02 (s, 1H), 1.95-1.78 (m, 3H), 1.42 (s, 28H), 1.20 (s, 8H), 0.94-0.87 (m, 6H). **HRMS (ESI) m/z:** $[M+H]^+$ calculated value: $C_{50}H_{77}N_7O_{14}$ 1000.5607, measured value: 1000.5614.



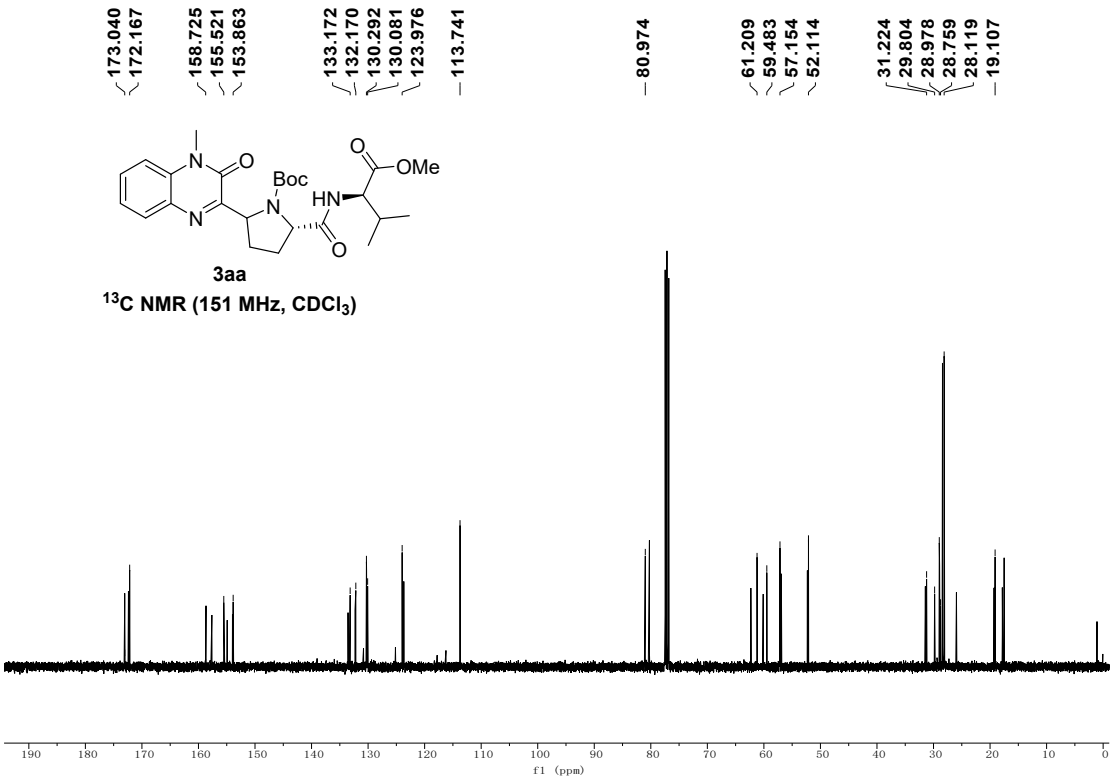
Meas. m/z	#	Ion Formula	m/z	err [ppm]	mSigma	# mSigma	Score	rdb	e⁻	Conf N-Rule
1000.5614	1	C50H78N7O14	1000.5601	-1.3	35.2	1	100.00	16.0	even	ok

6. Copies of NMR spectra

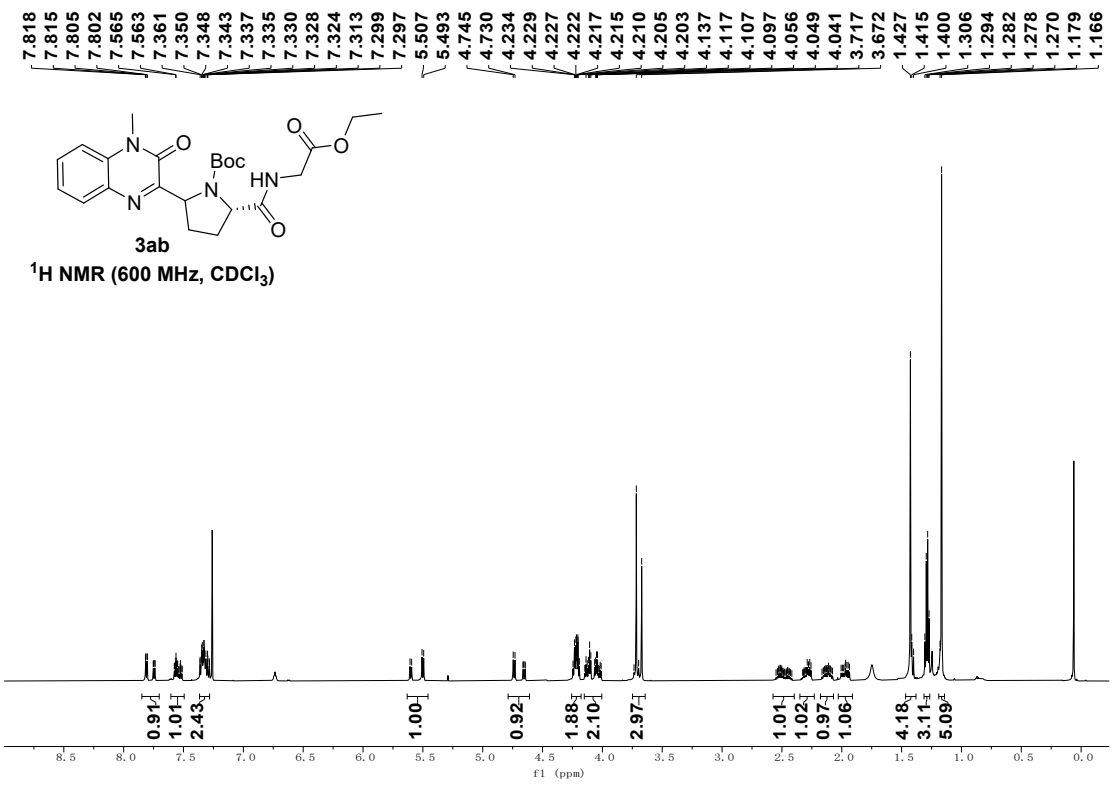
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3aa**



^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3aa**

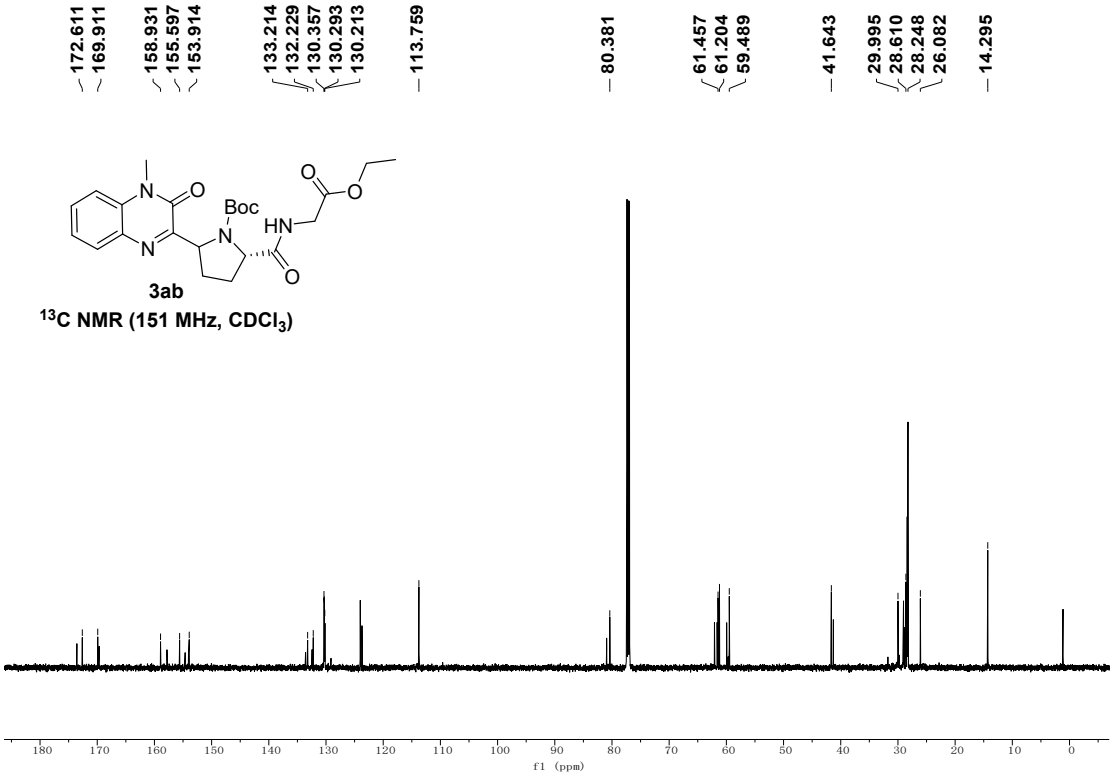


^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ab**



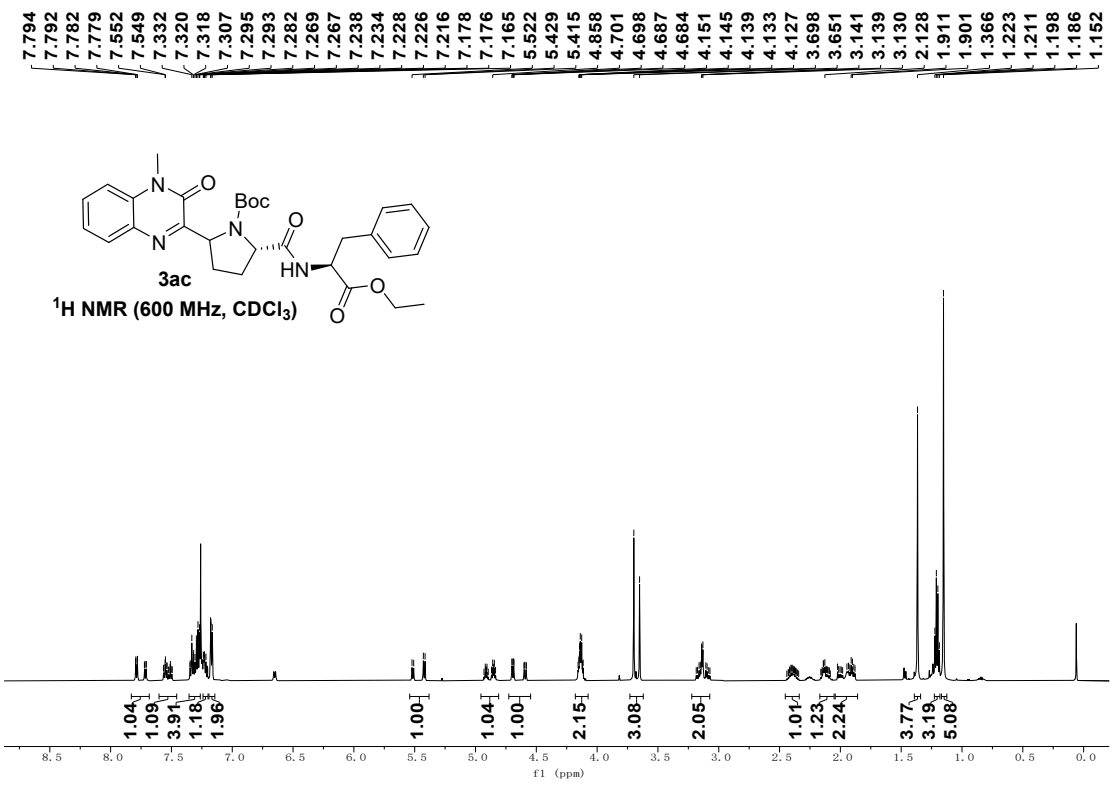
^{1}H NMR (600 MHz, $CDCl_3$)

^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ab**

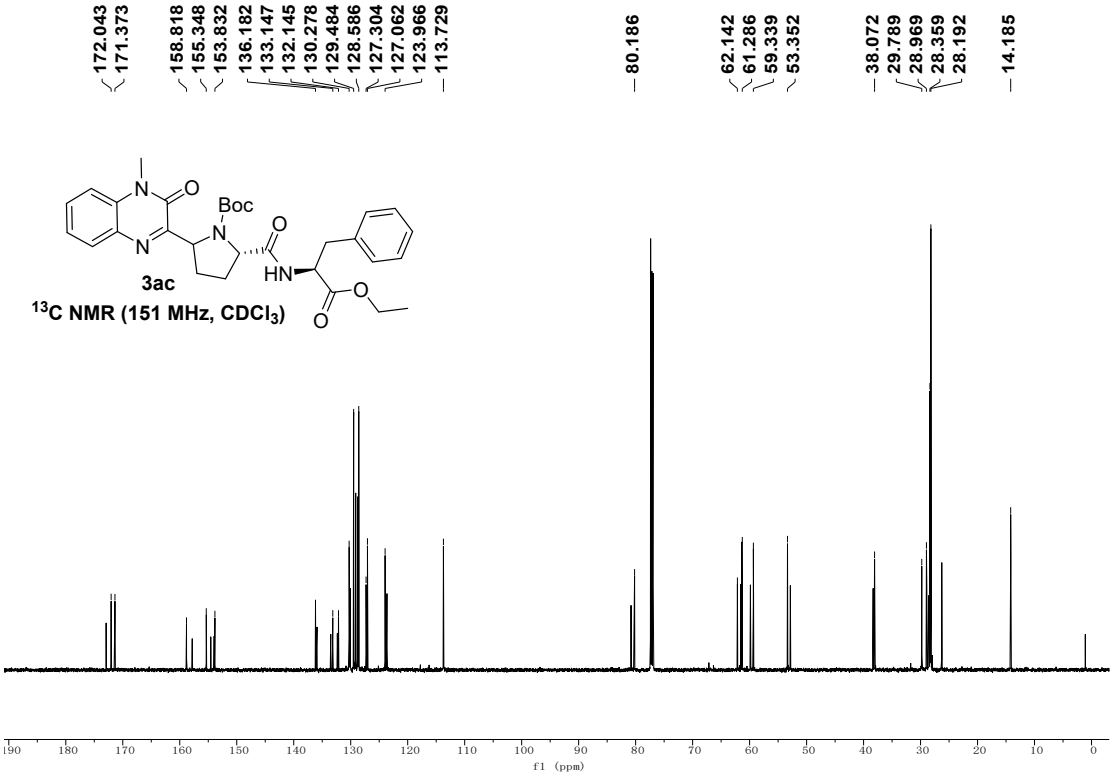


^{13}C NMR (151 MHz, $CDCl_3$)

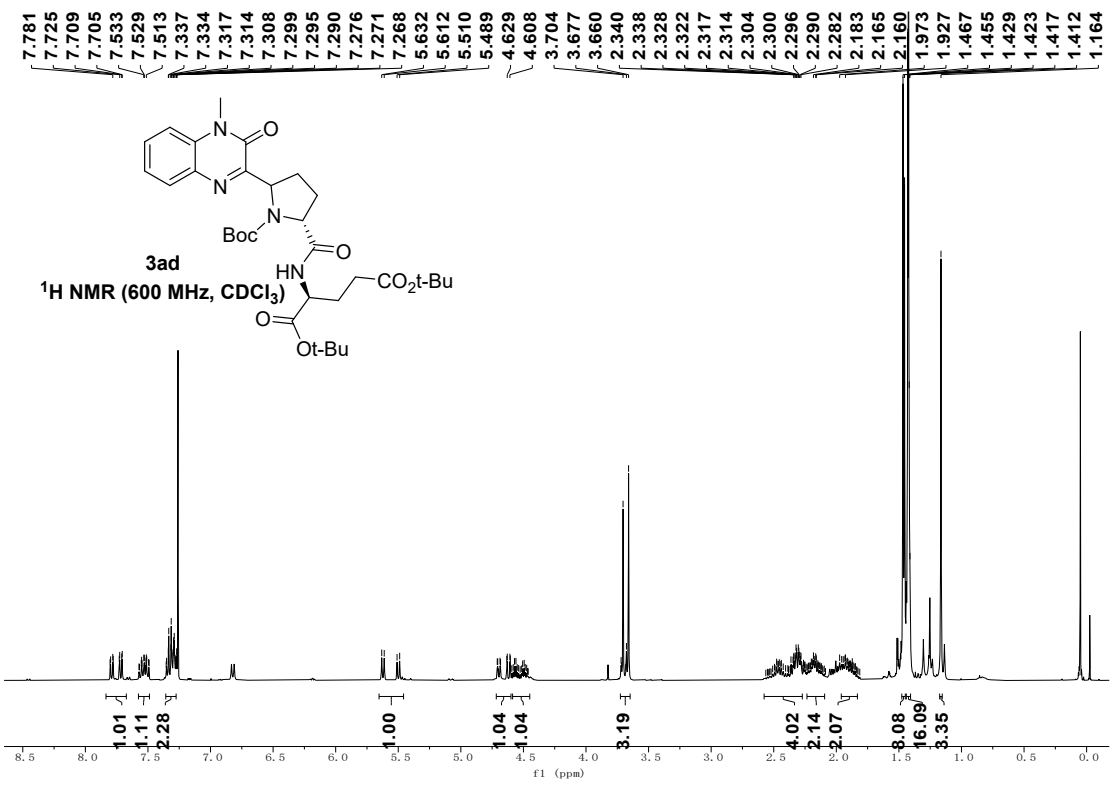
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ac**



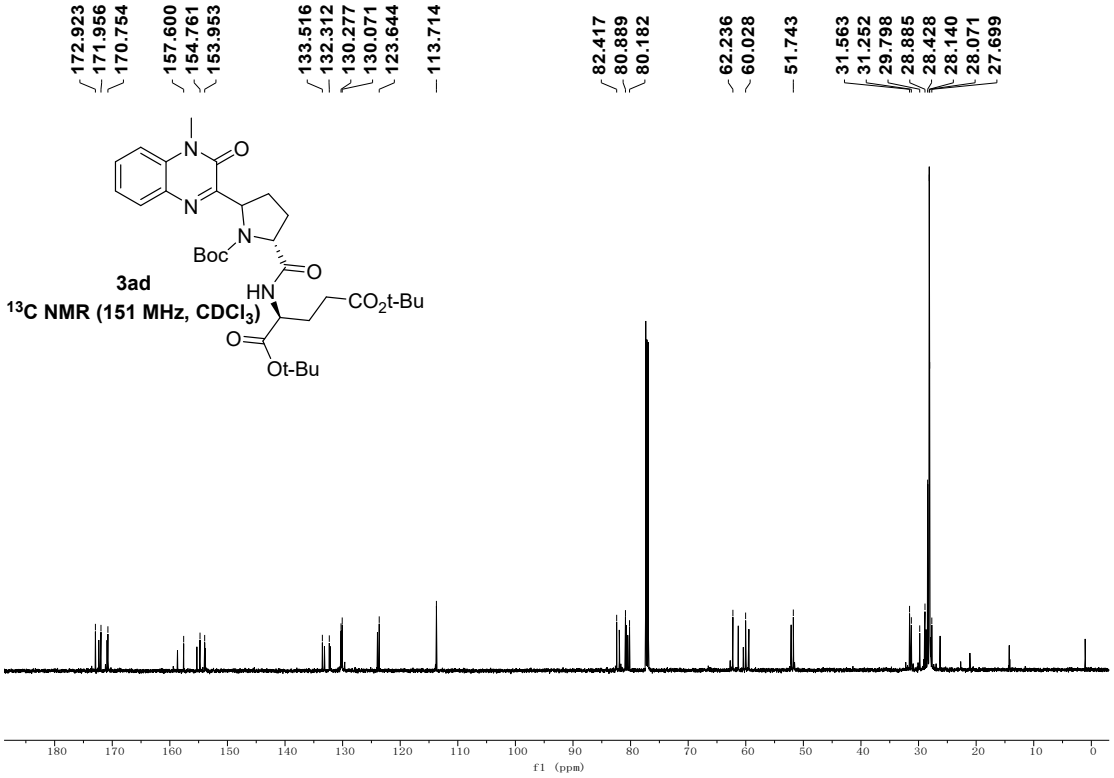
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ac**



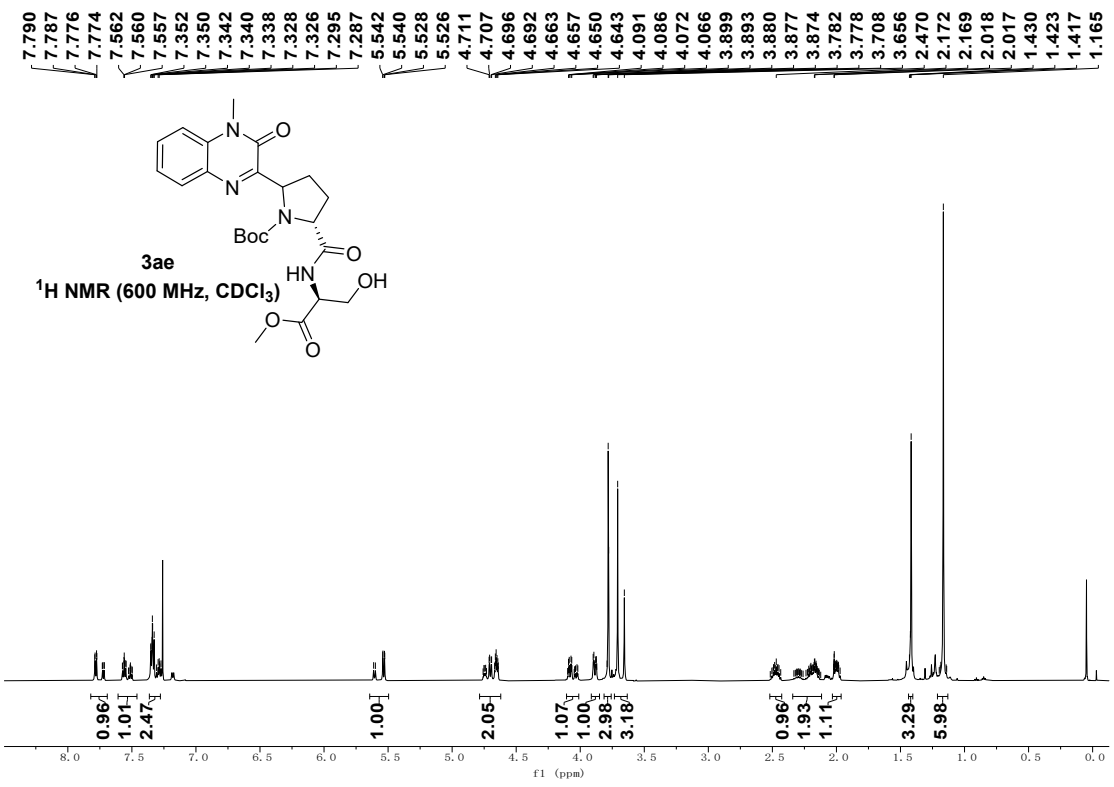
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ad**



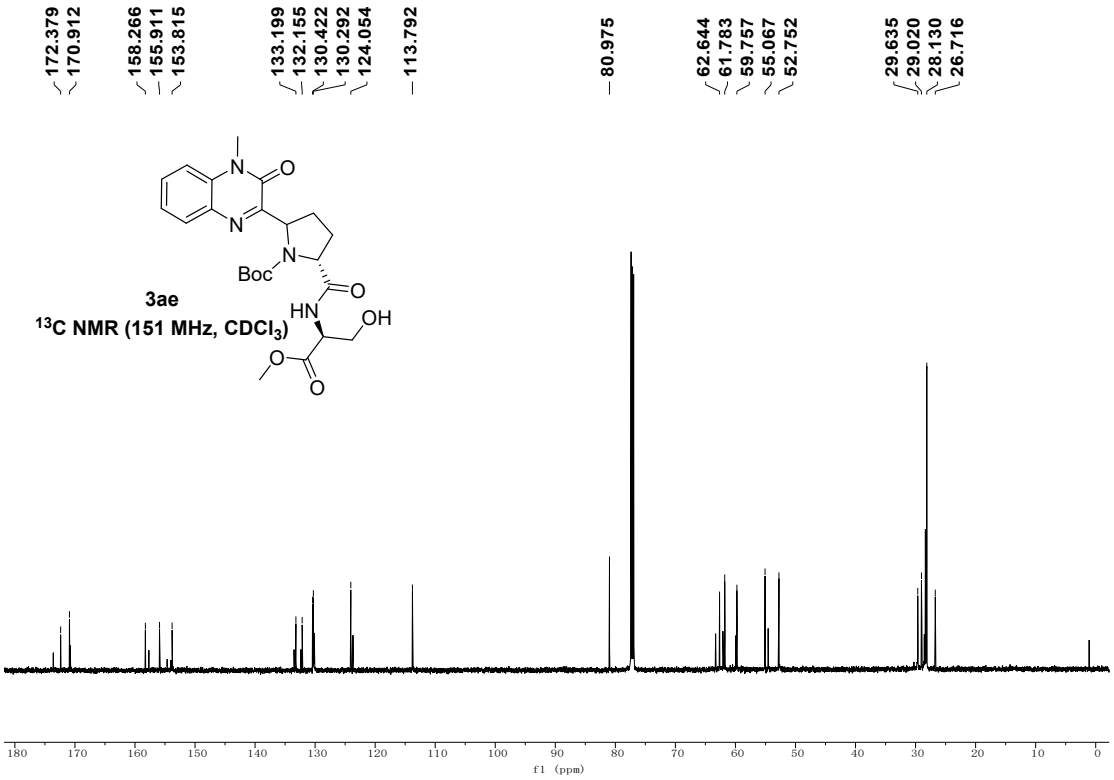
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ad**



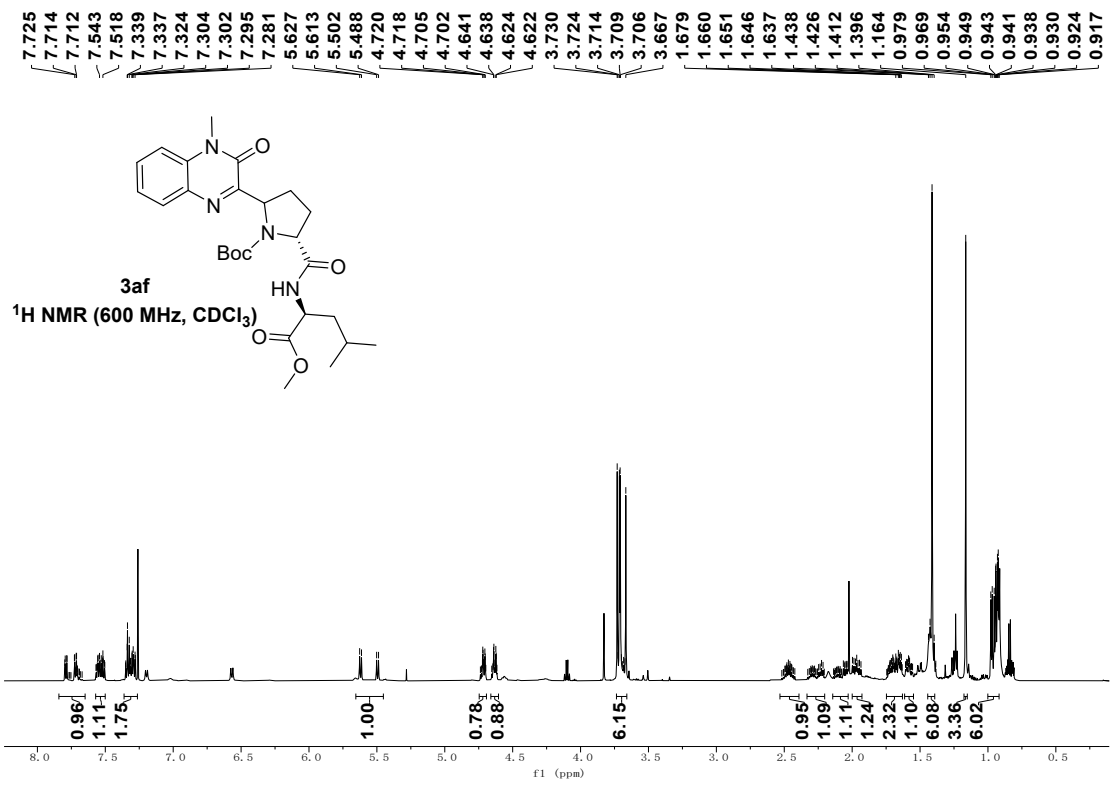
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ae**



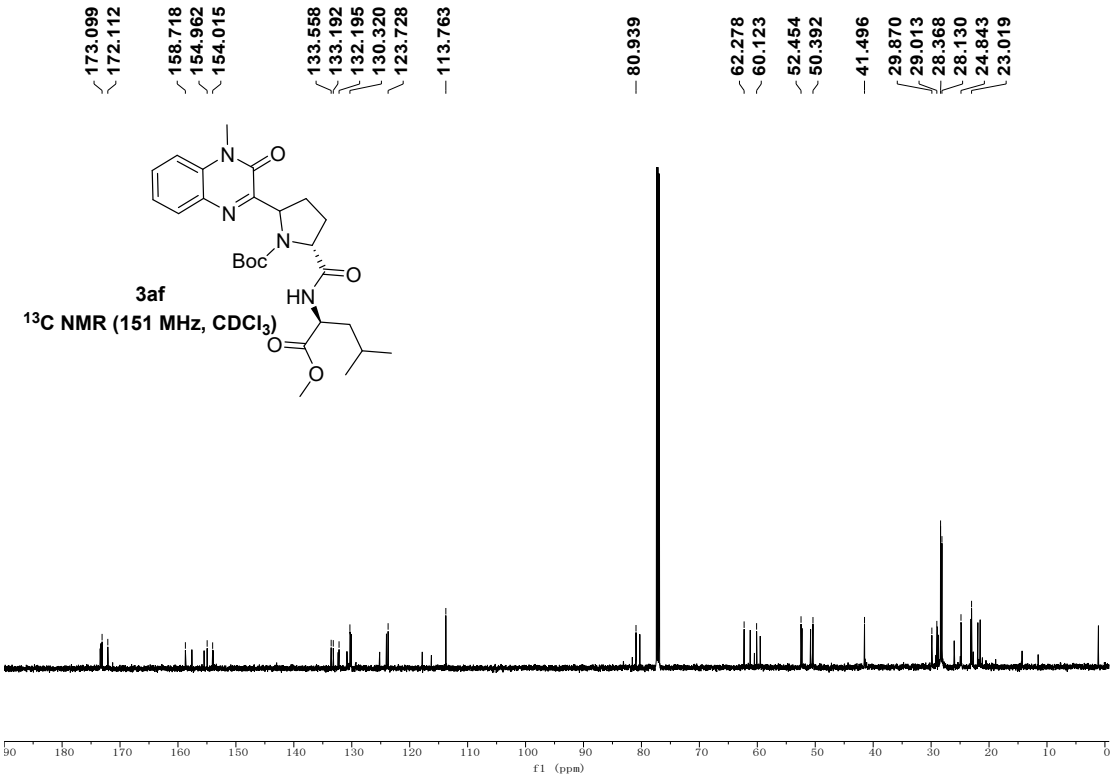
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ae**



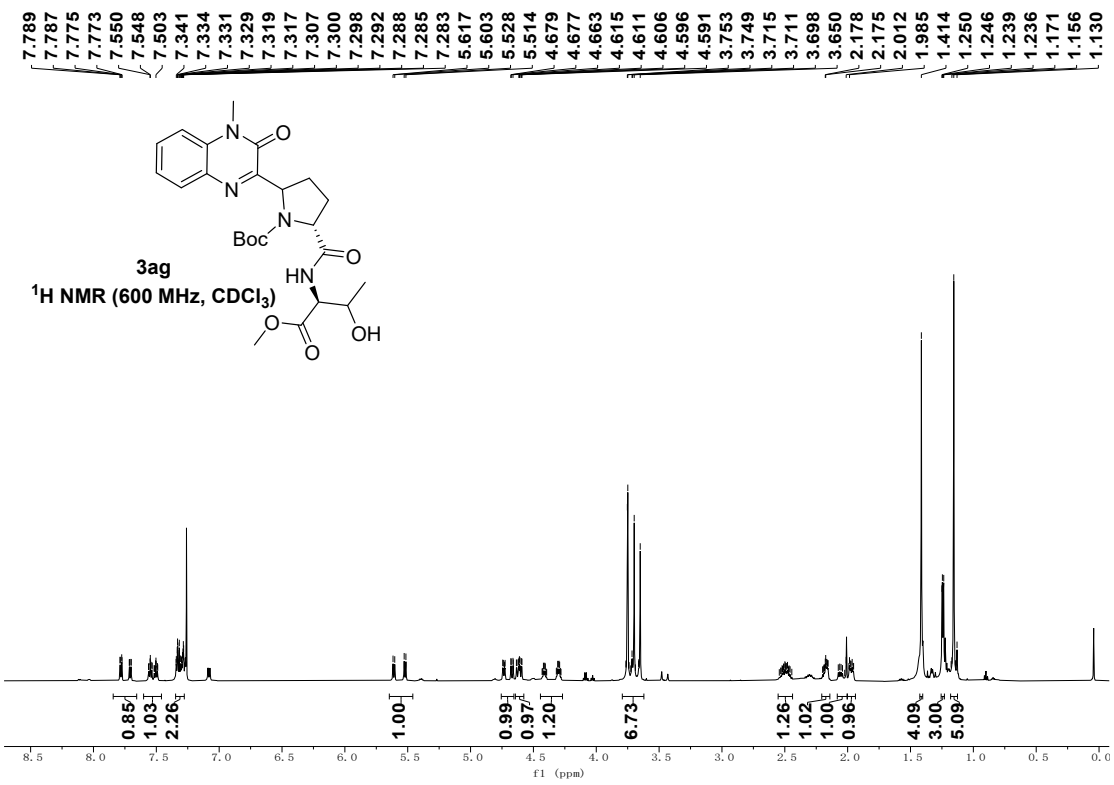
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3af**



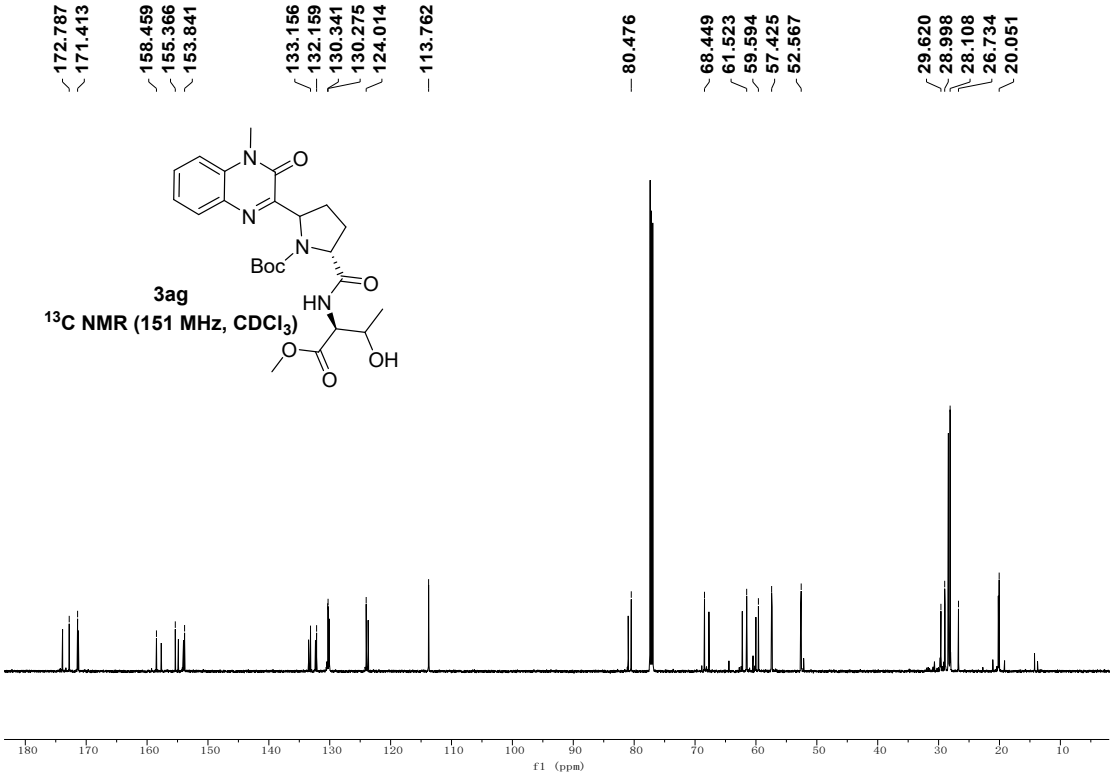
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3af**



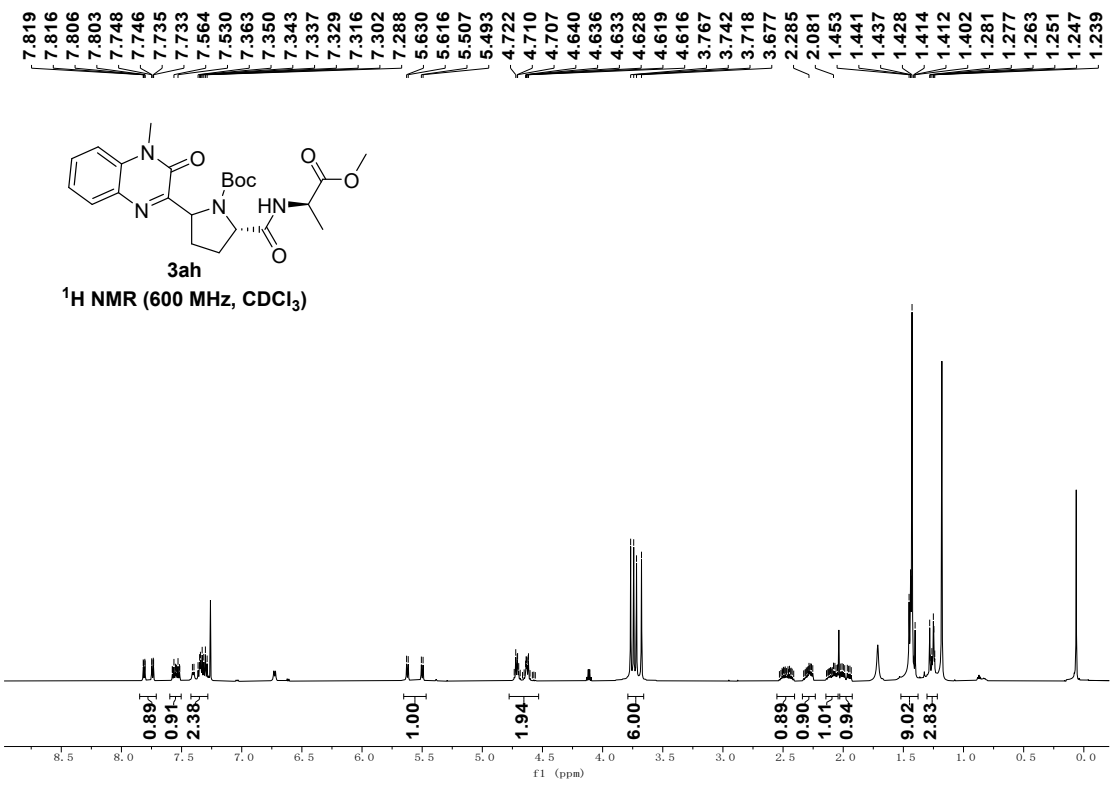
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ag**



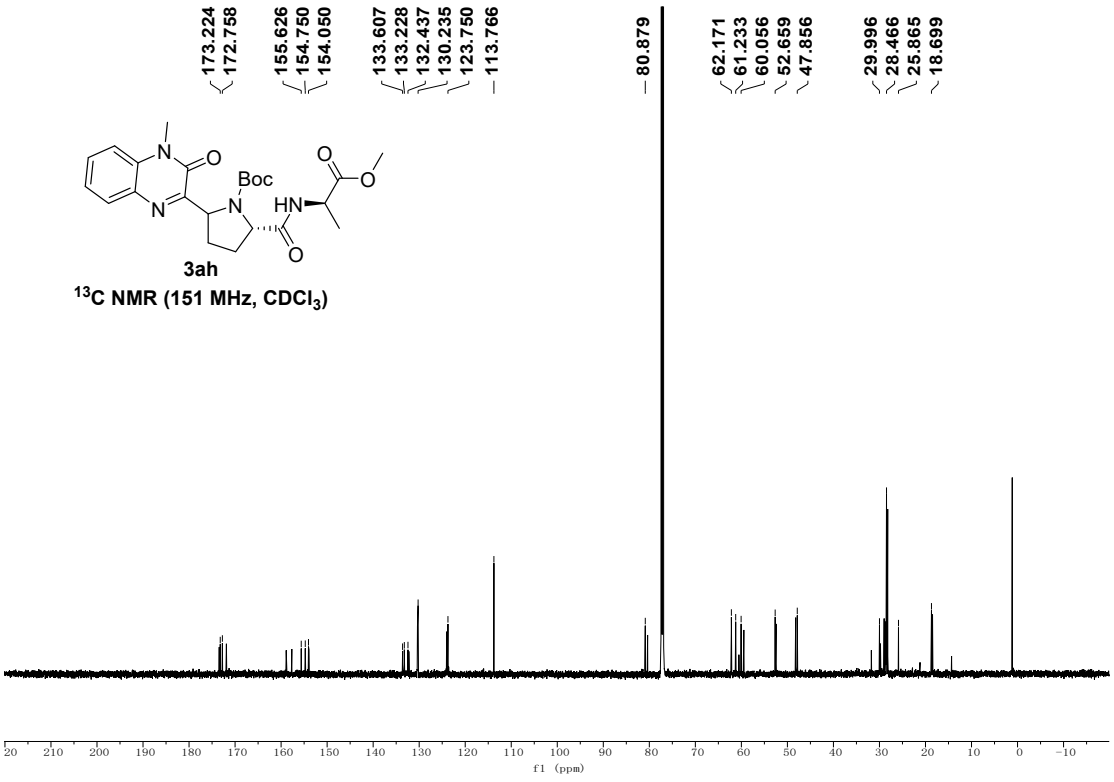
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ag**



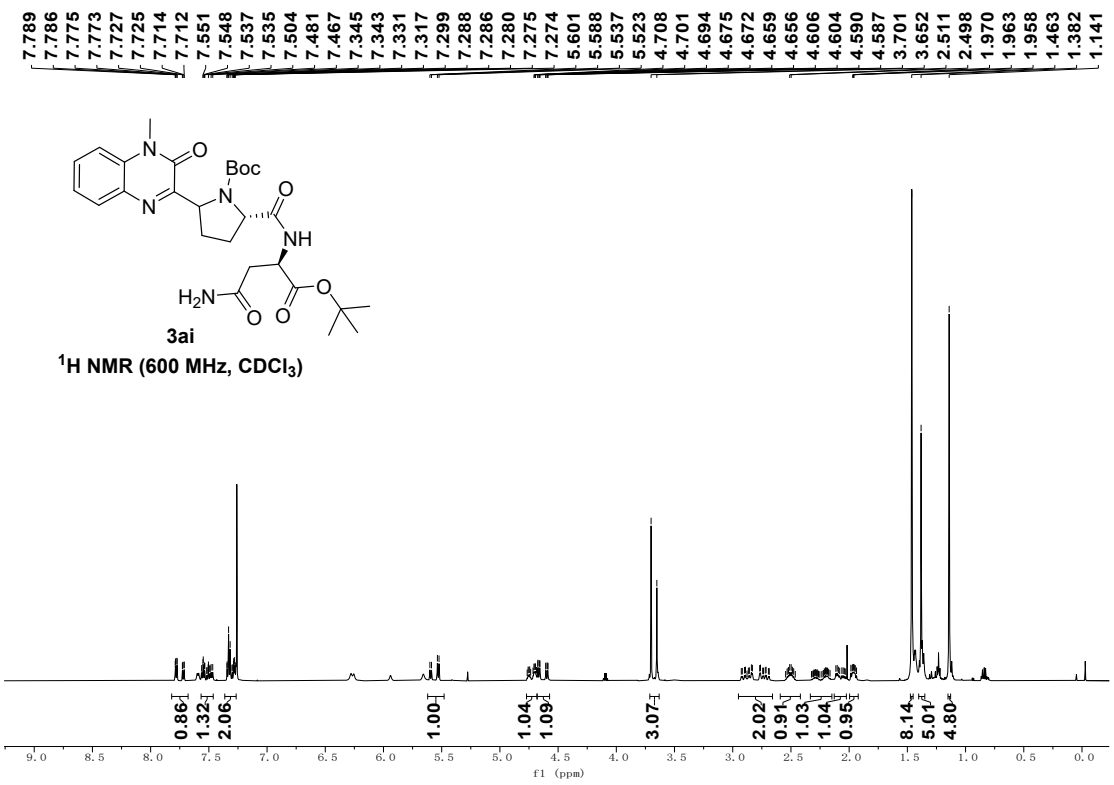
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ah**



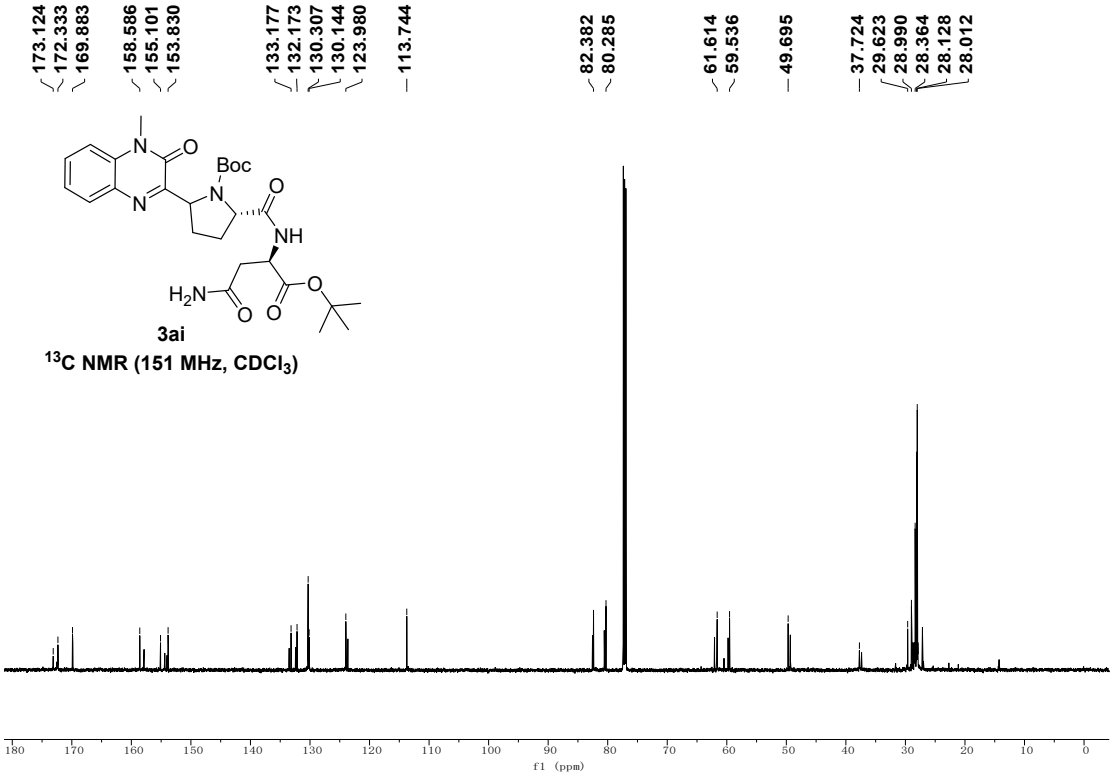
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ah**



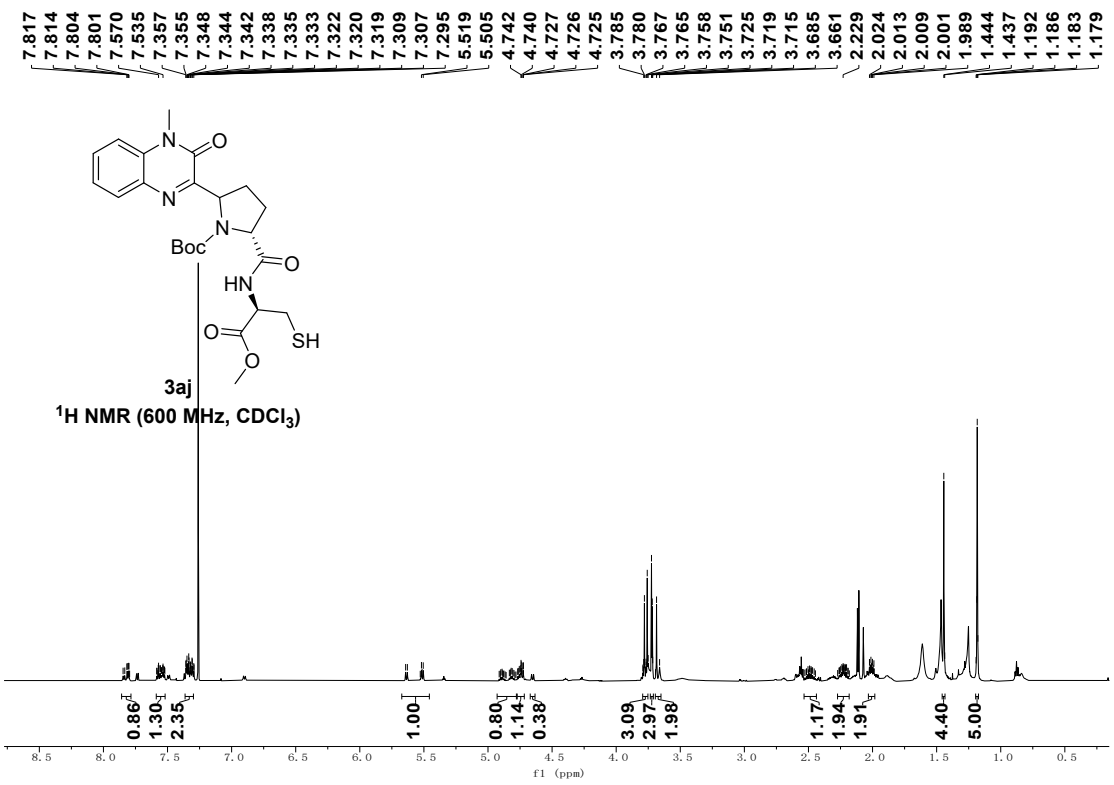
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ai**



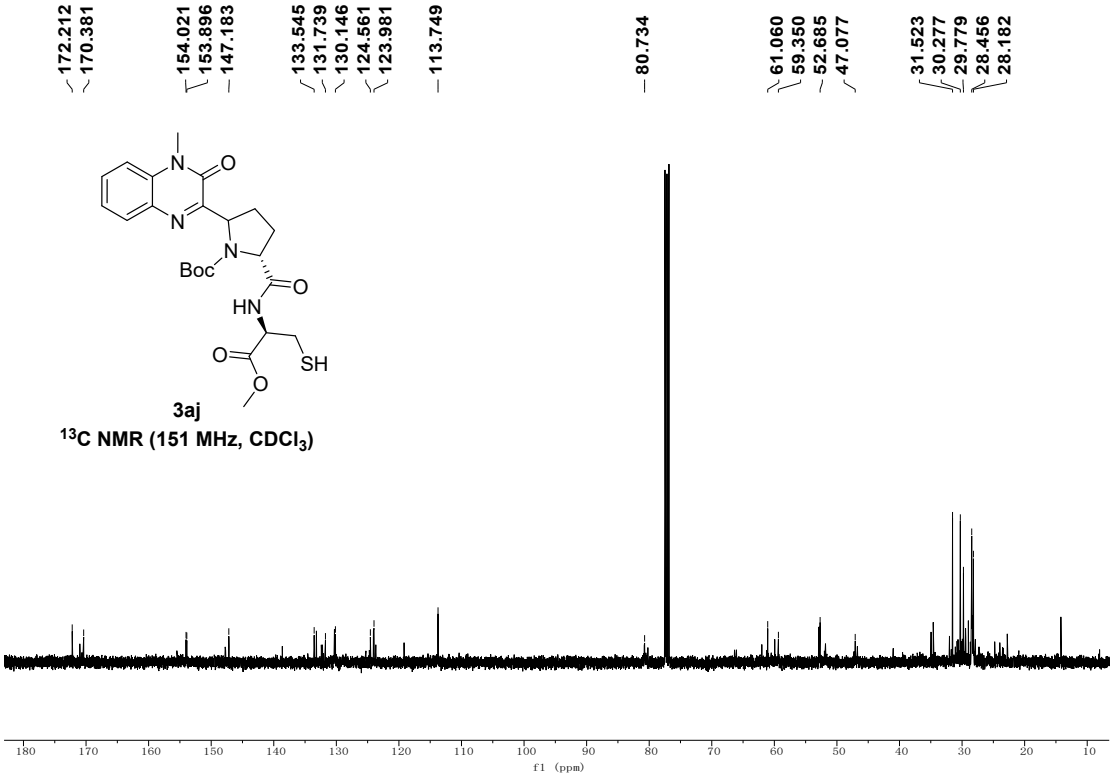
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ai**



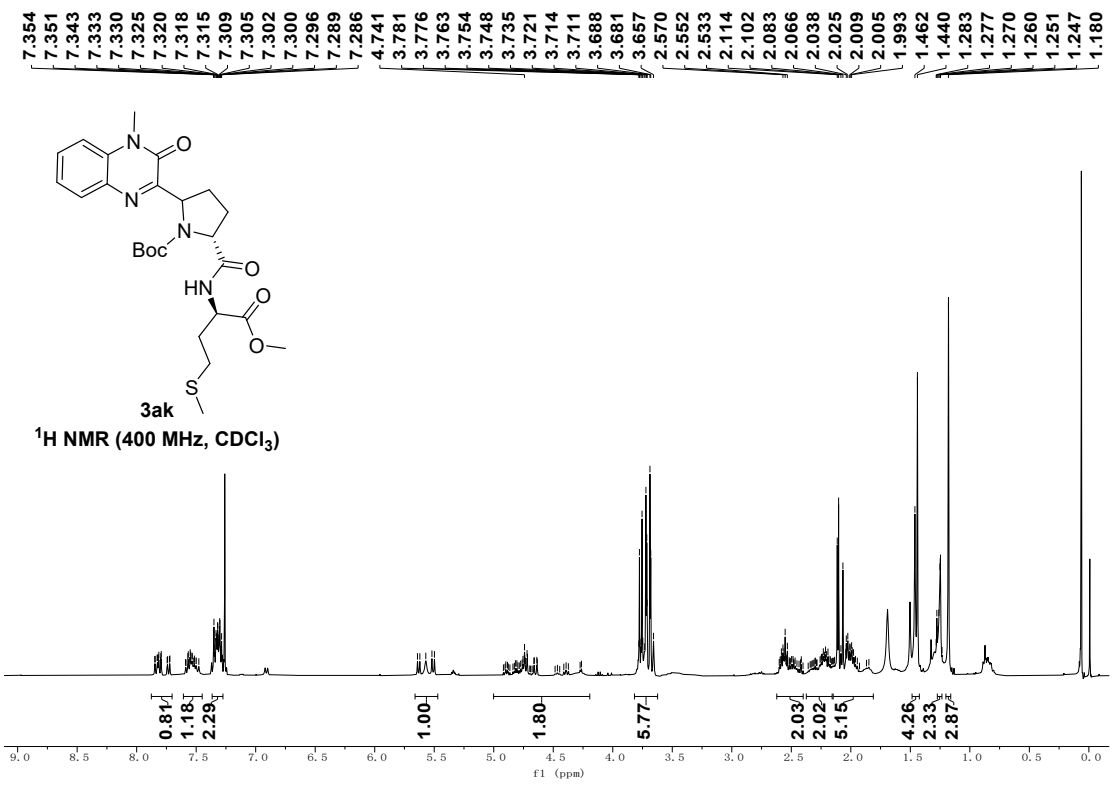
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3aj**



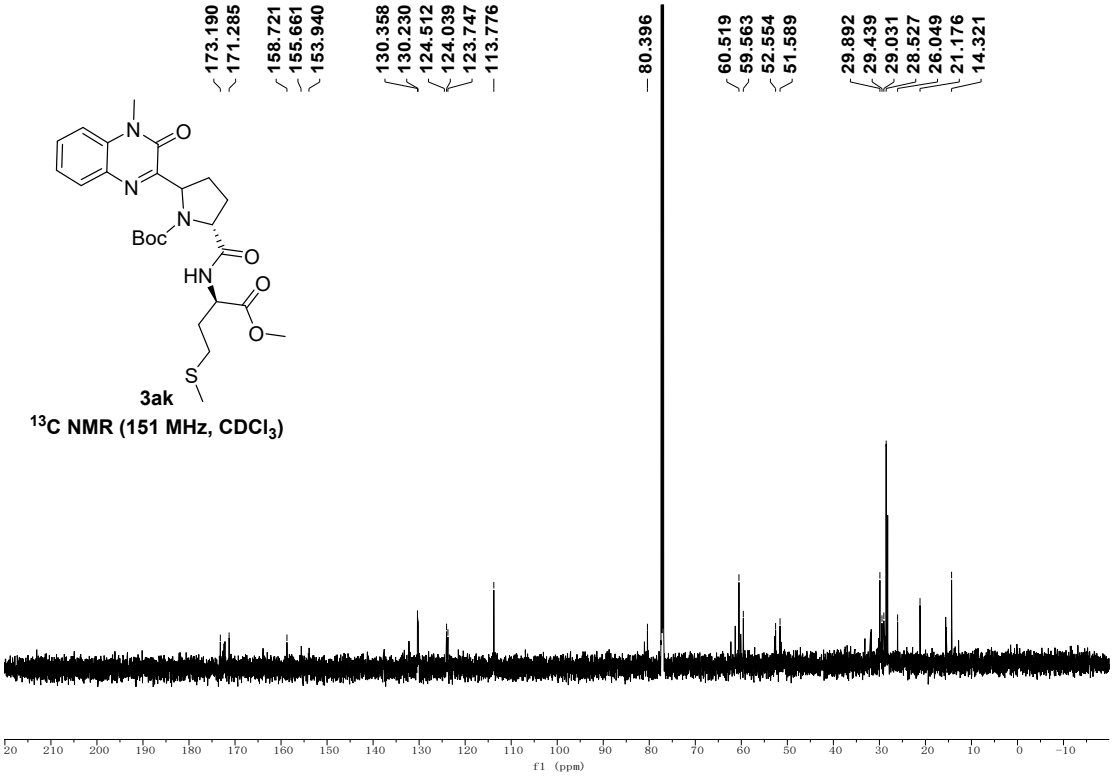
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3aj**



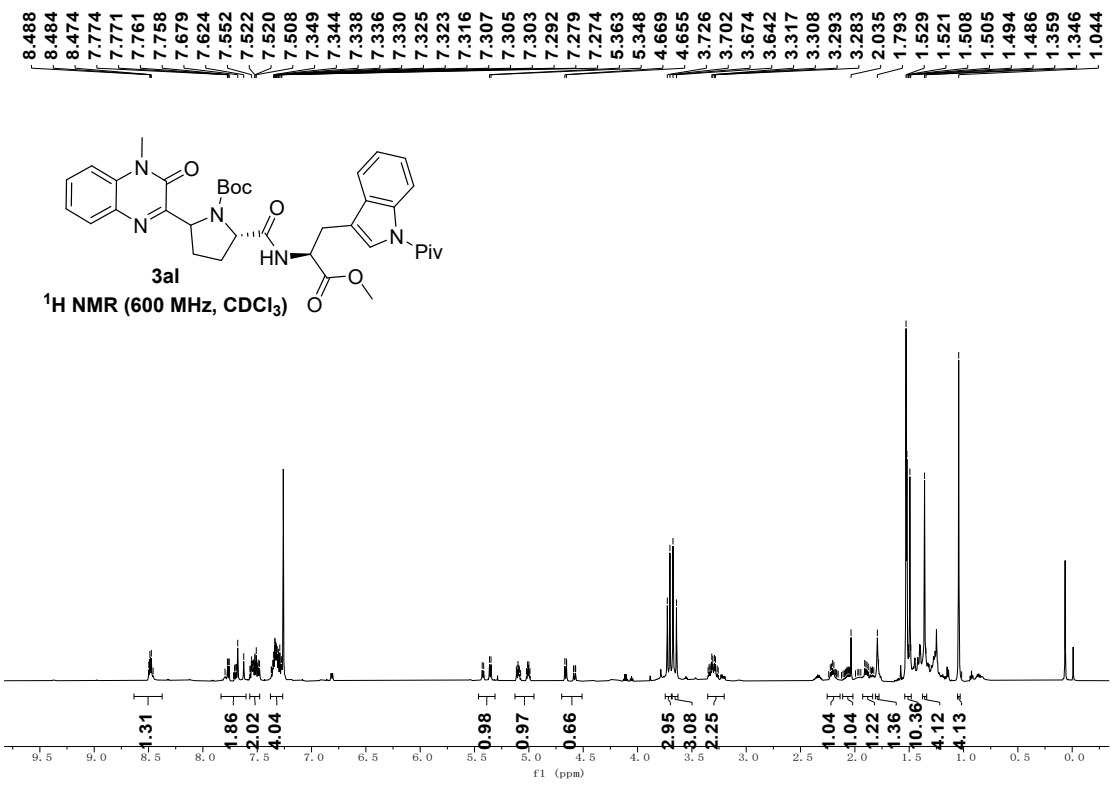
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of **3ak**



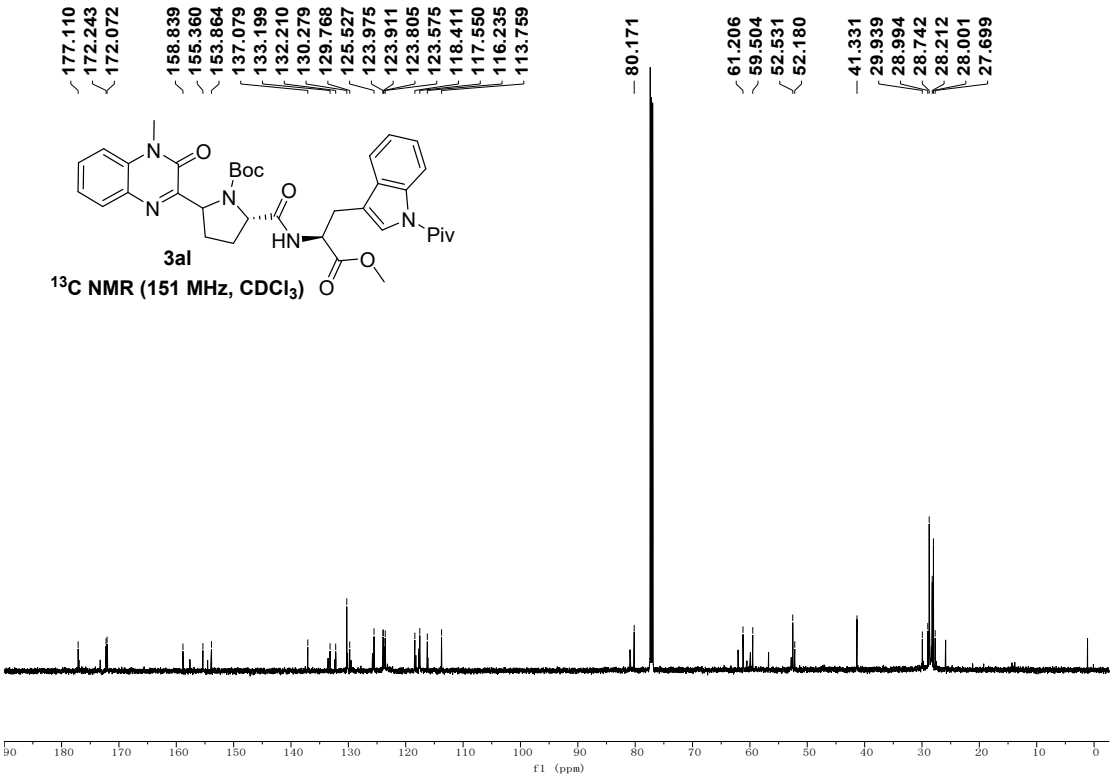
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ak**



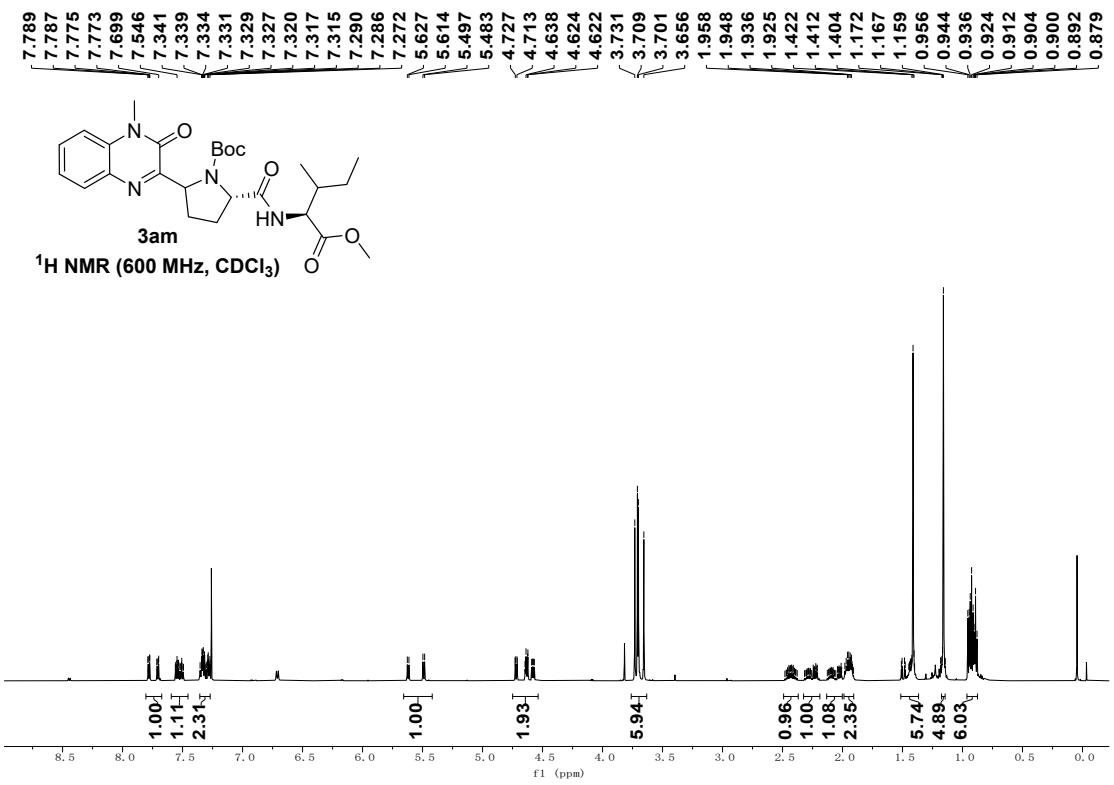
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3al**



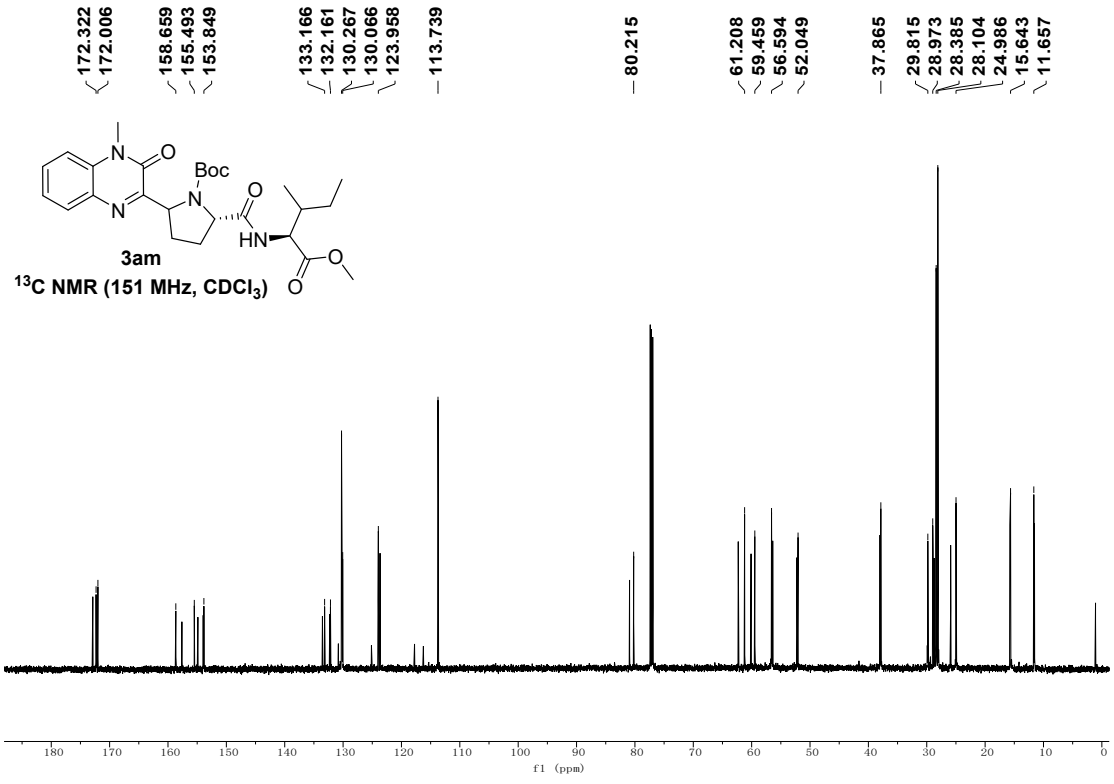
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3al**



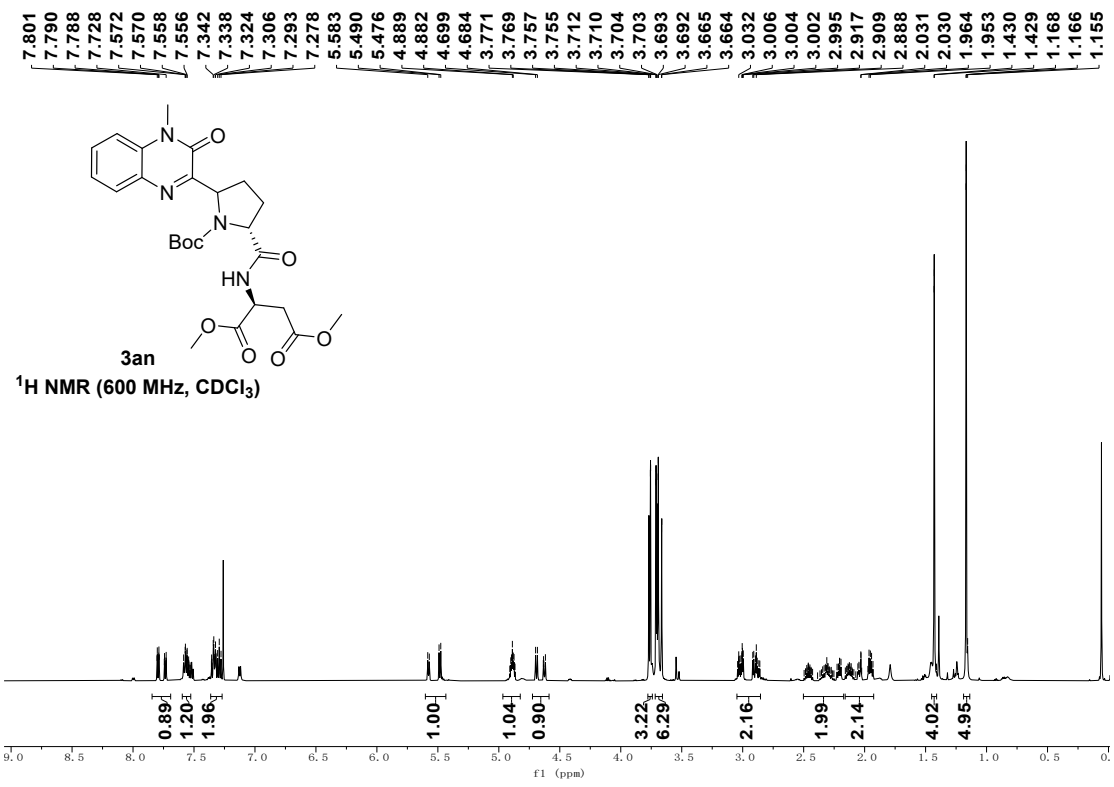
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3am**



^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3am**

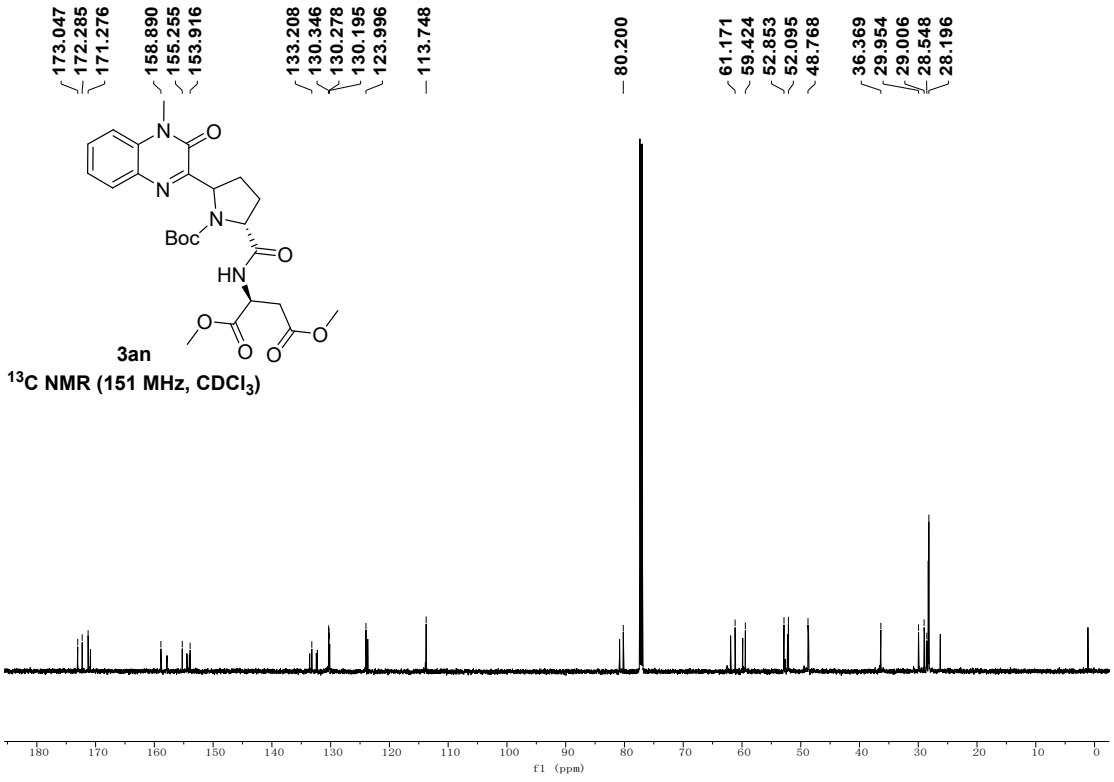


^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3an**



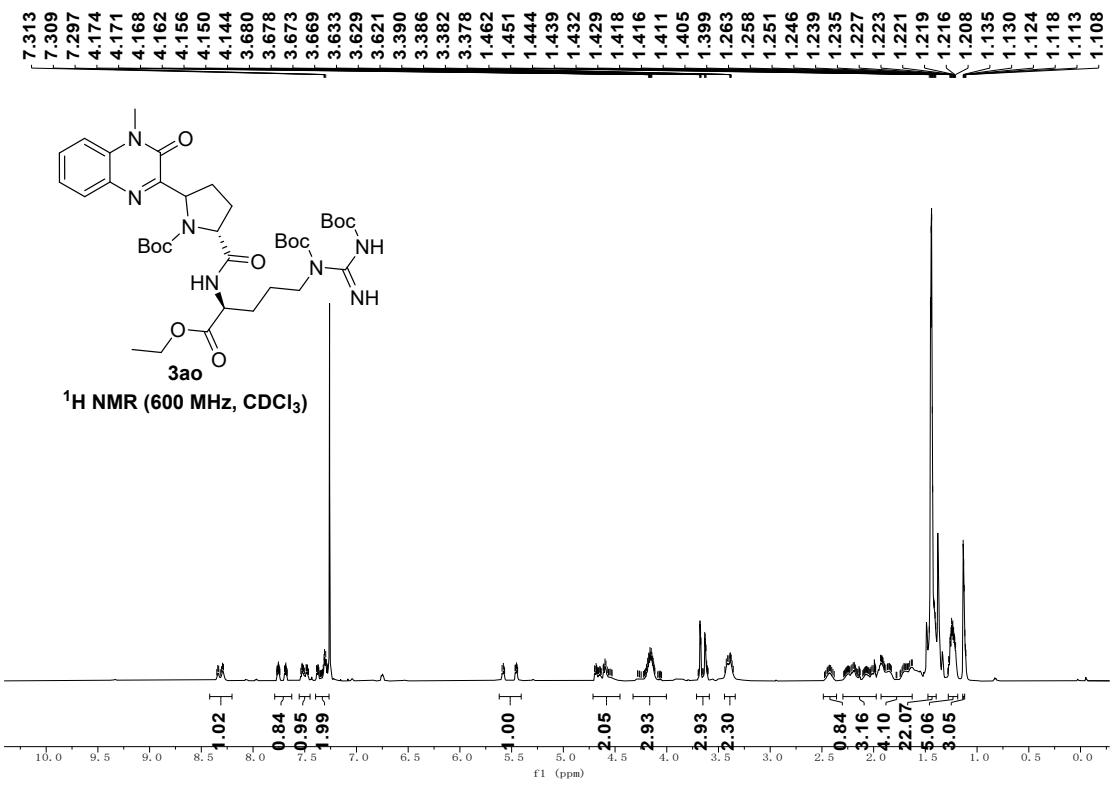
^{1}H NMR (600 MHz, $CDCl_3$)

^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3an**

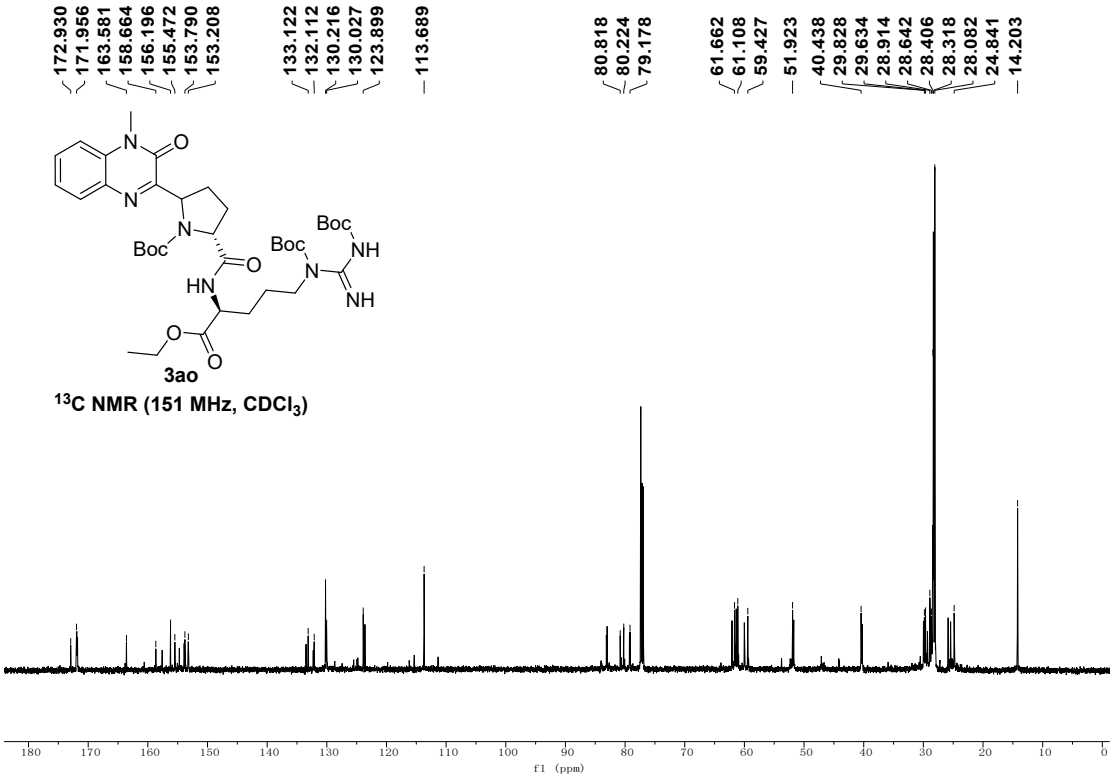


^{13}C NMR (151 MHz, $CDCl_3$)

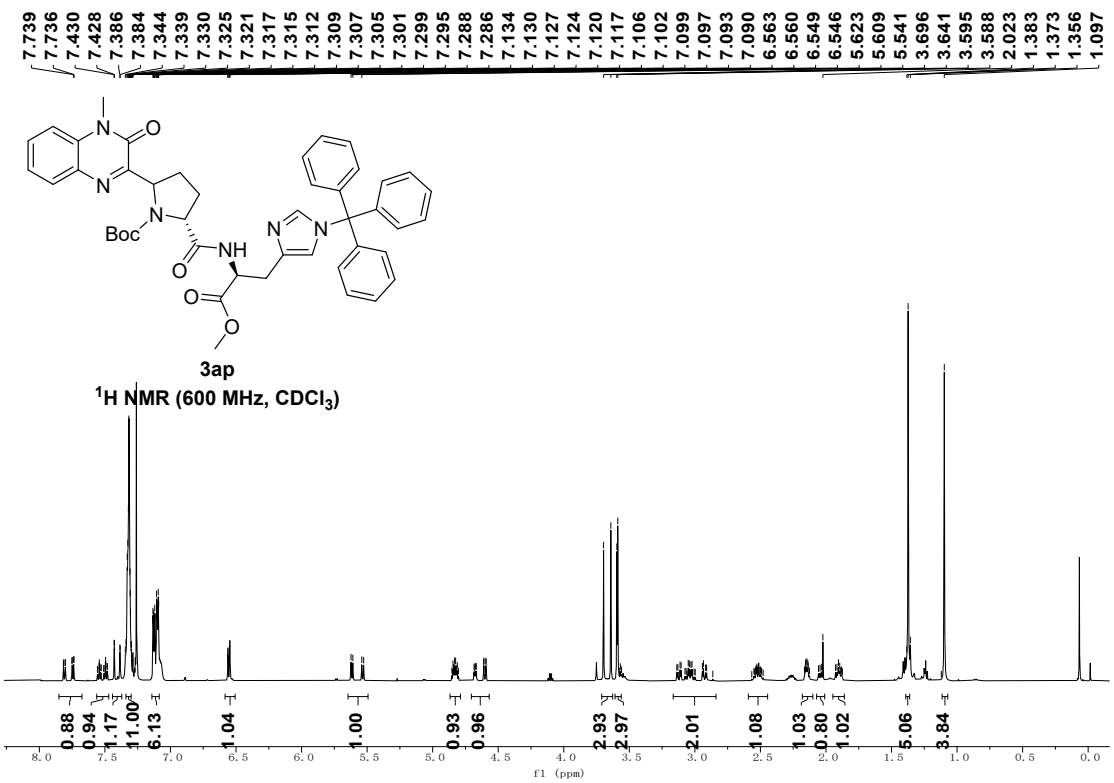
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ao**



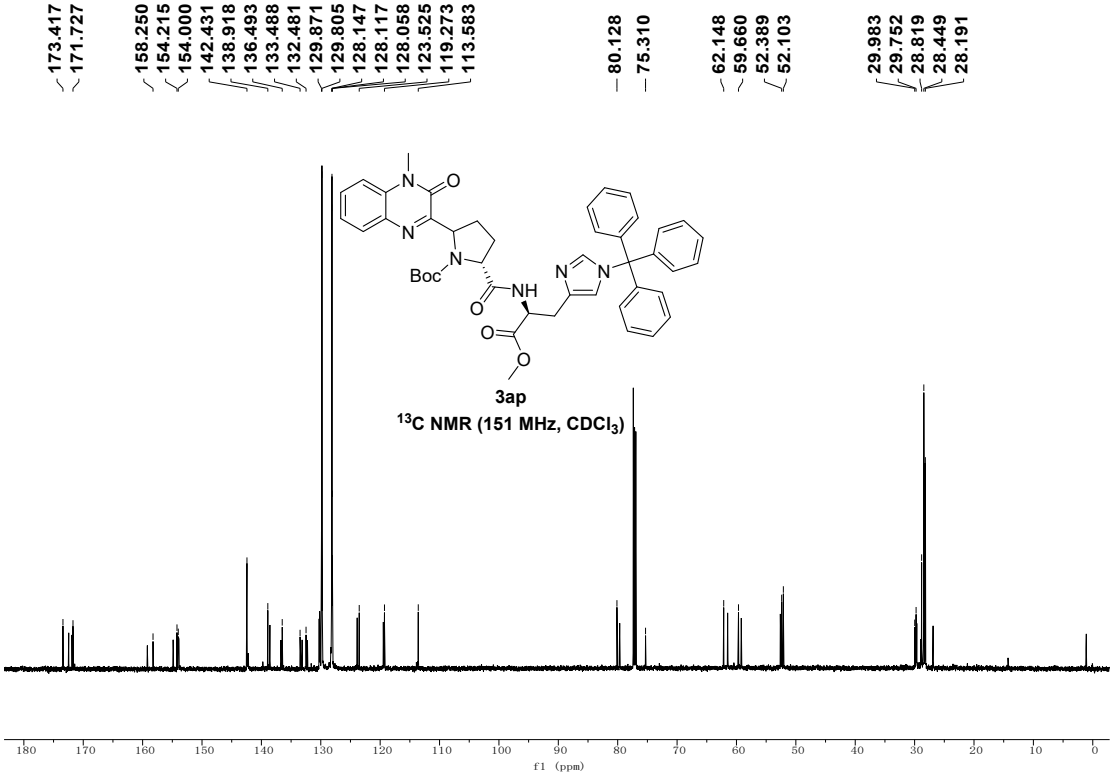
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ao**



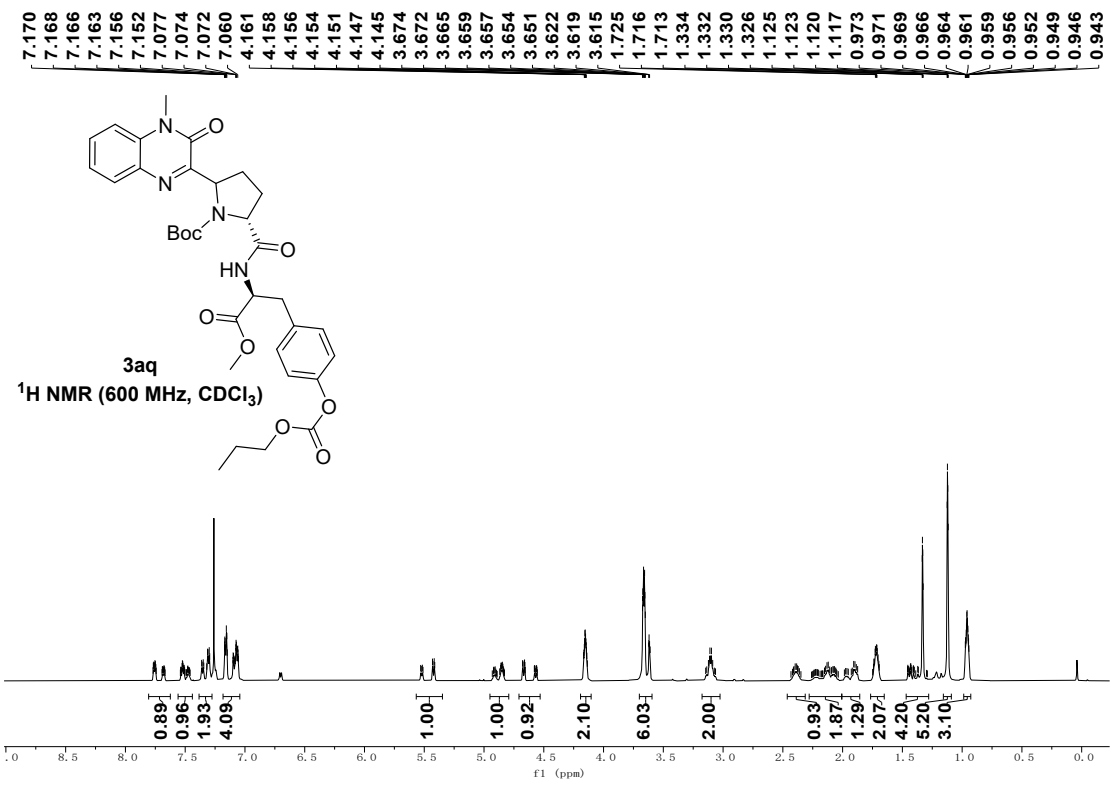
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ap**



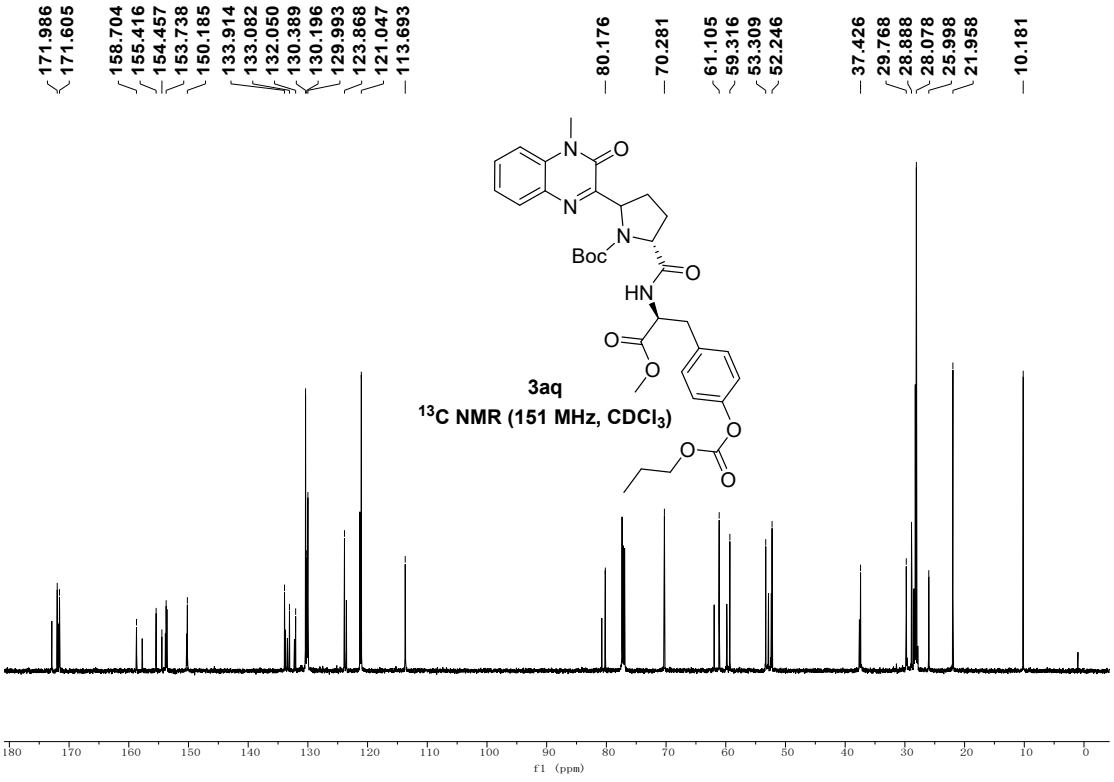
^{13}C NMR (151 MHz, CDCl$_3$) spectrum of **3ap**



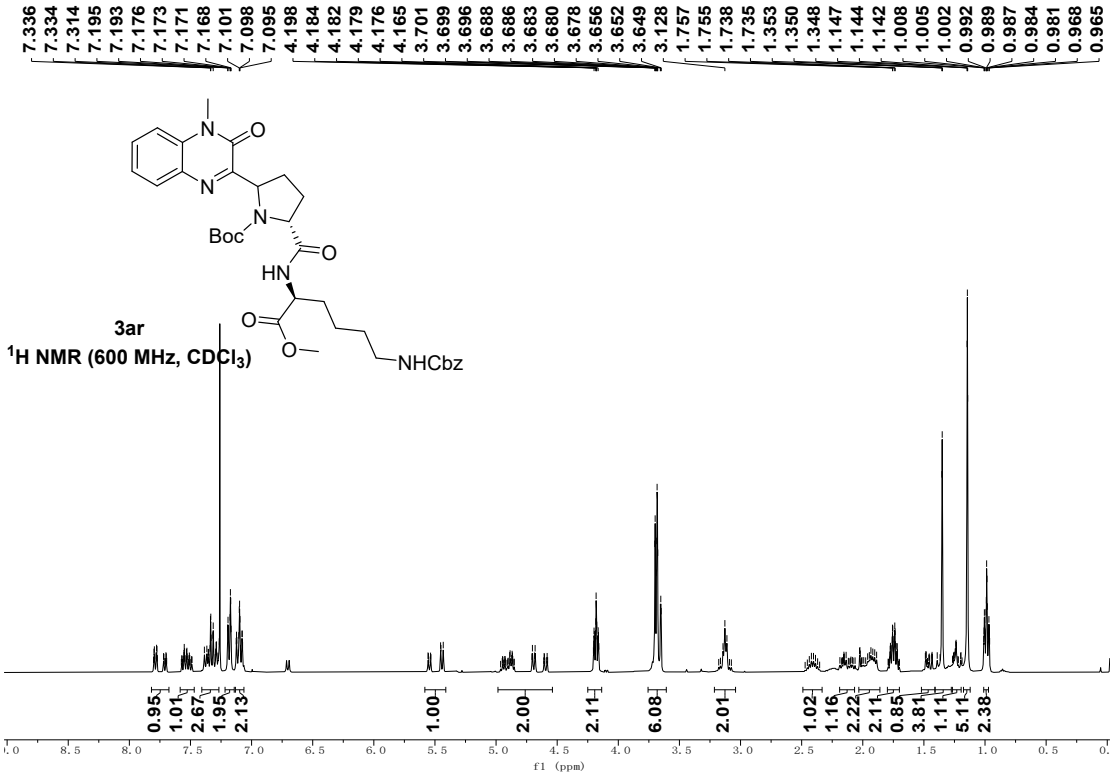
^{1}H NMR (600 MHz, CDCl$_3$) spectrum of **3aq**



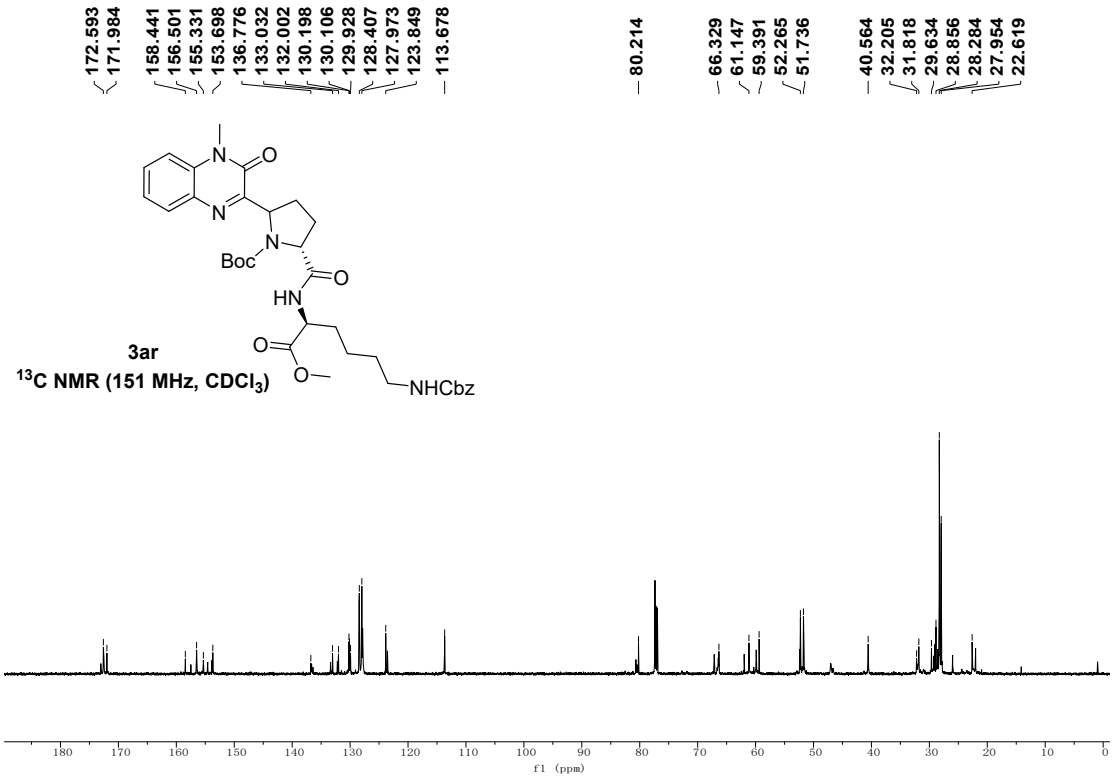
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3aq**



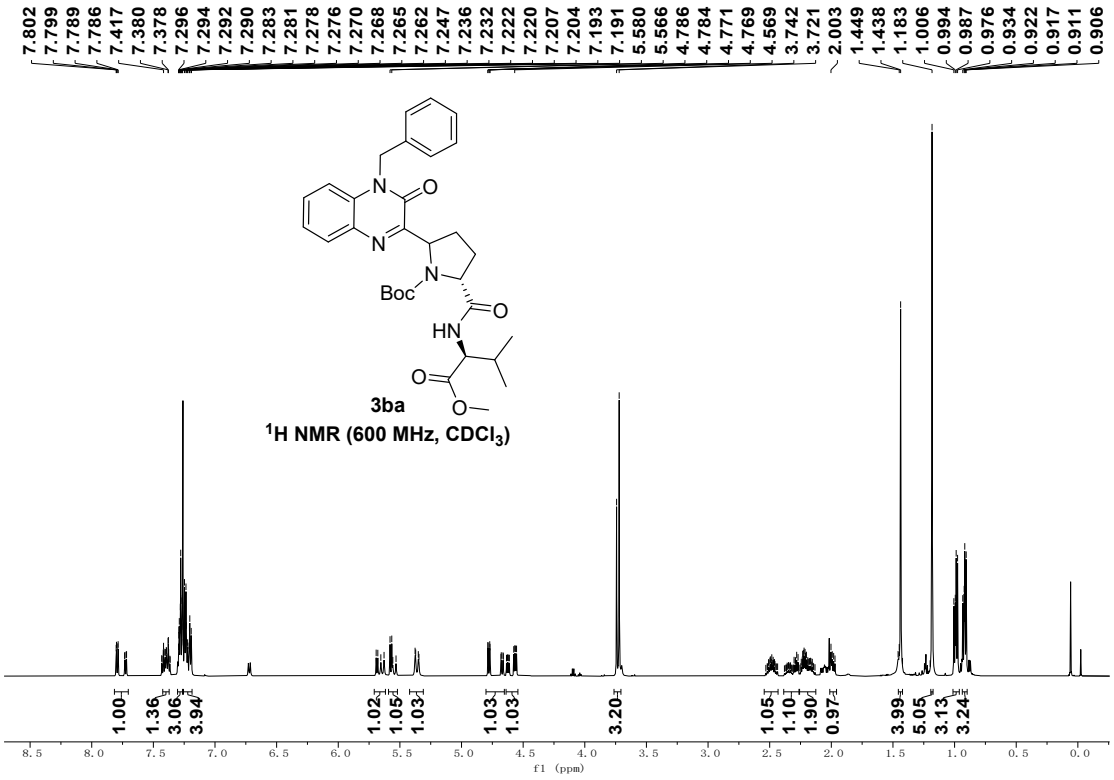
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ar**



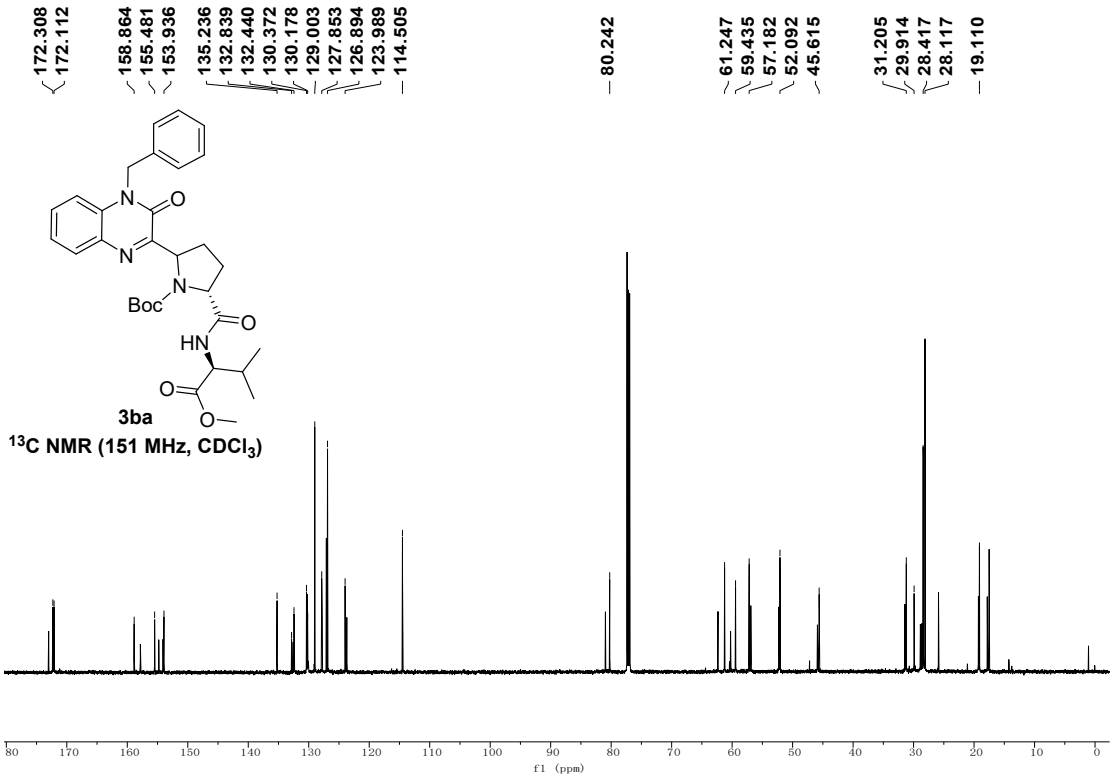
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ar**



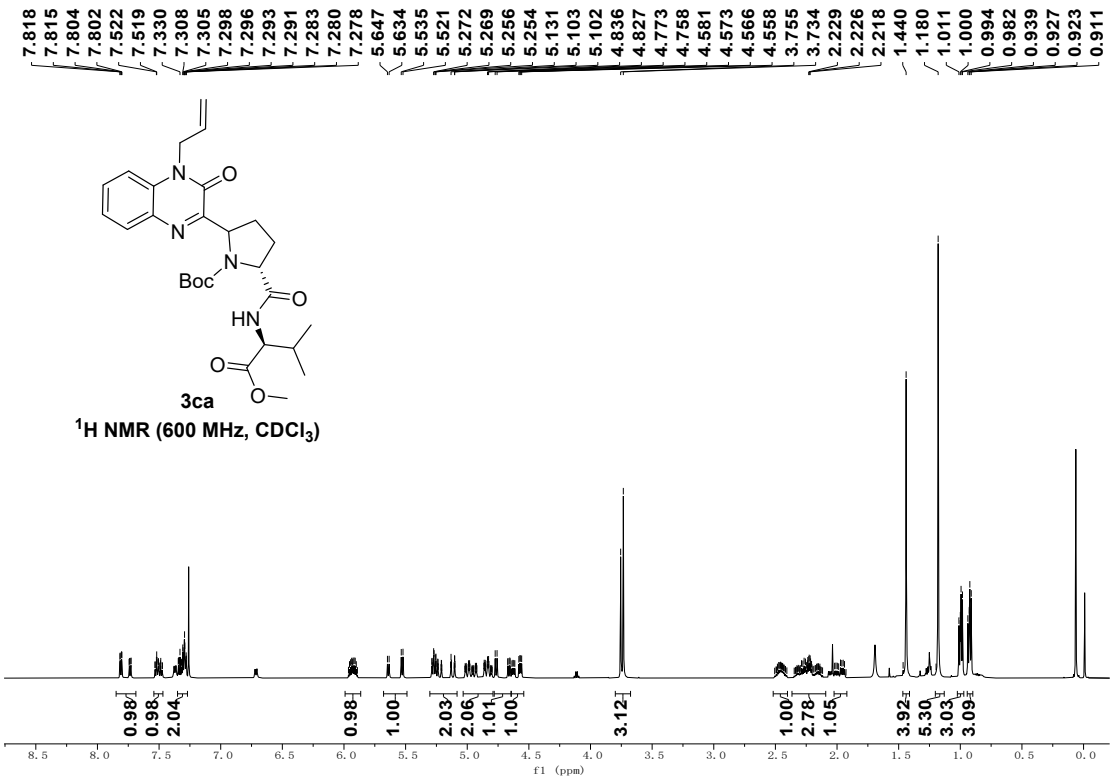
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ba**



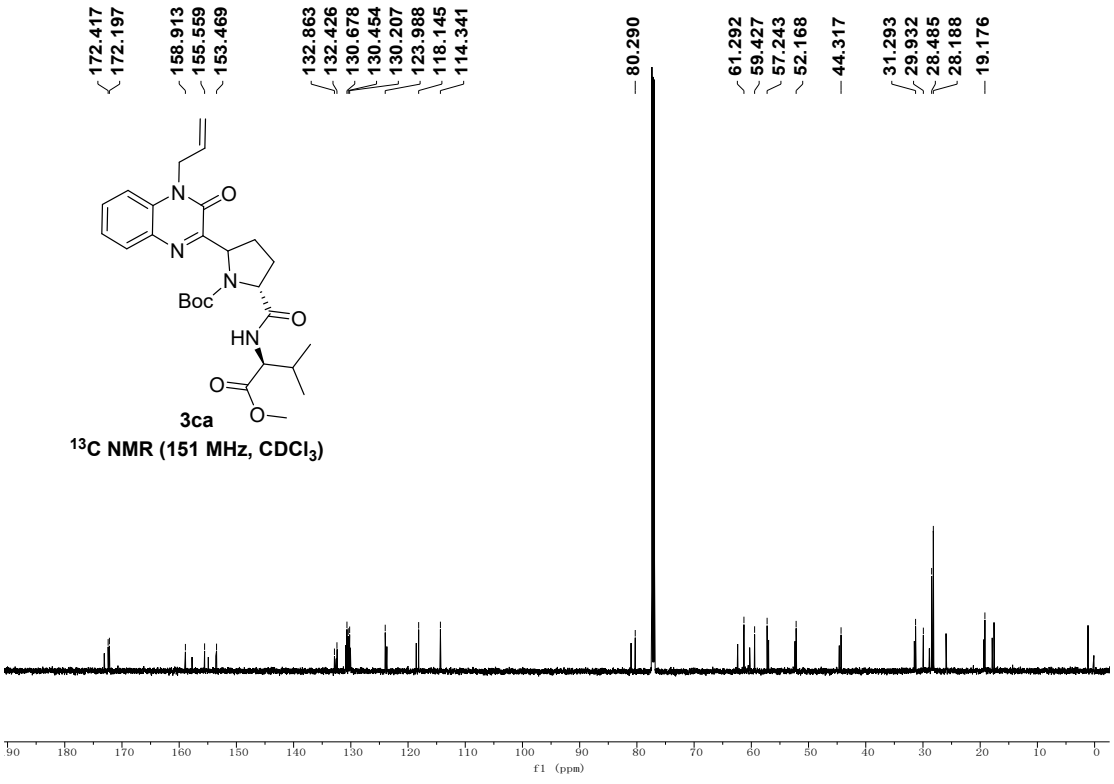
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ba**



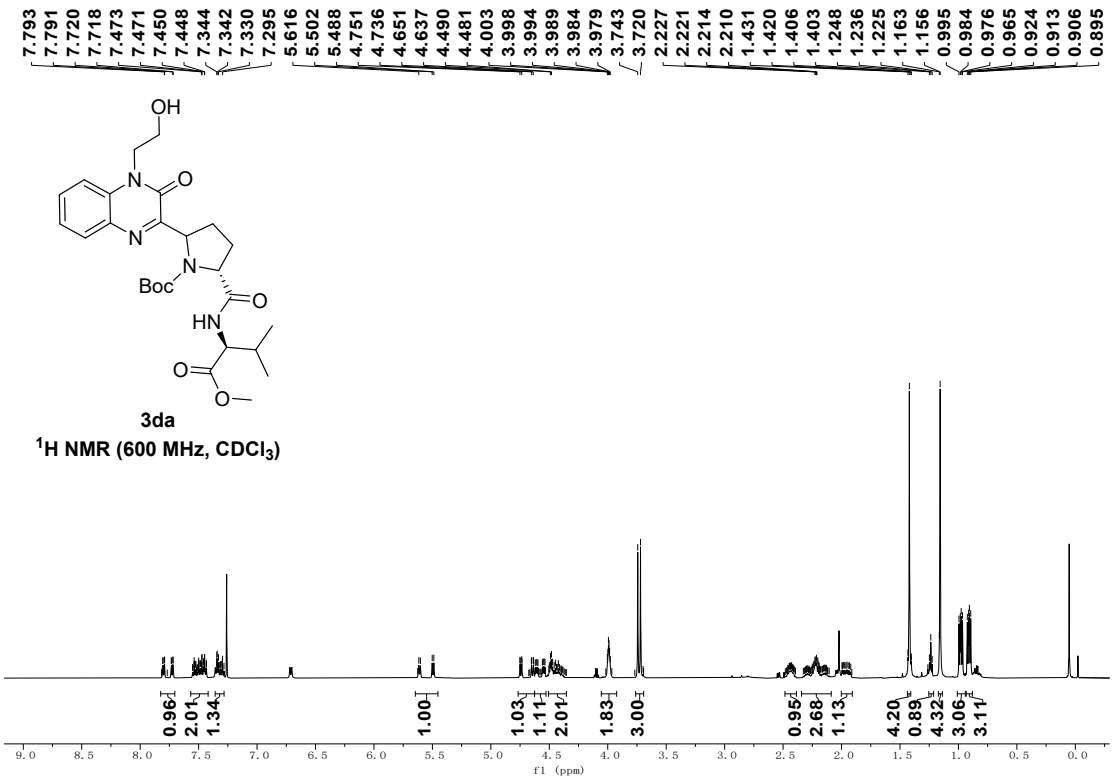
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ca**



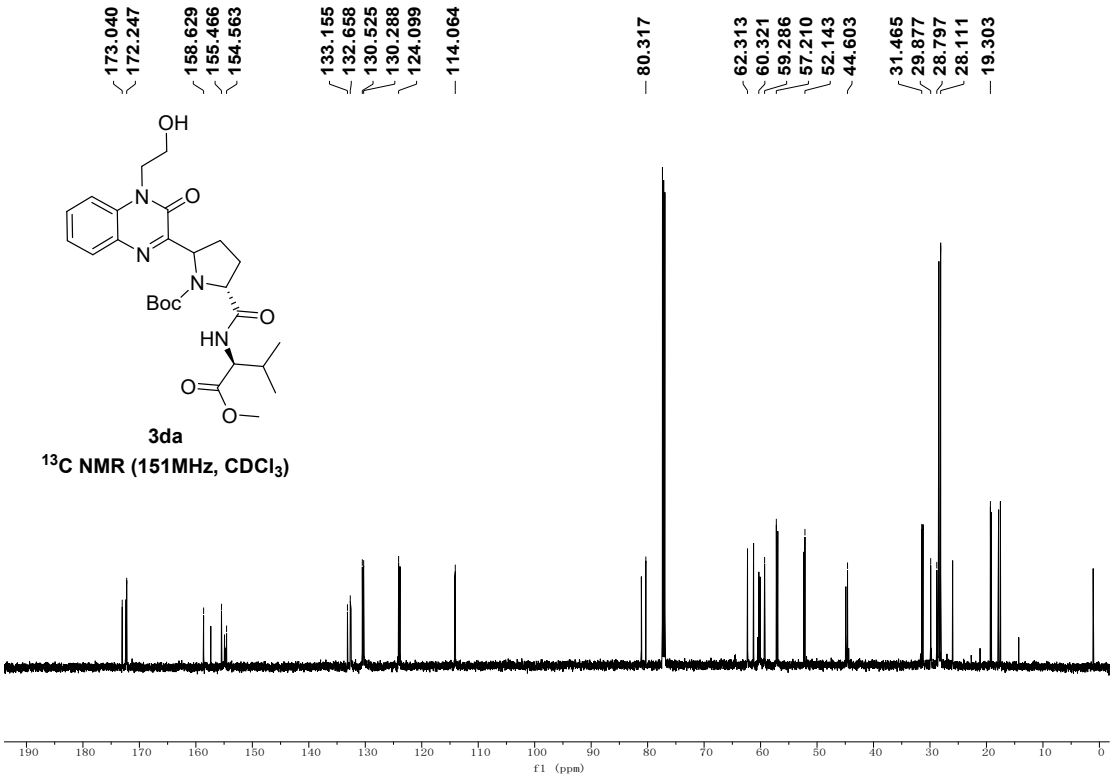
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ca**



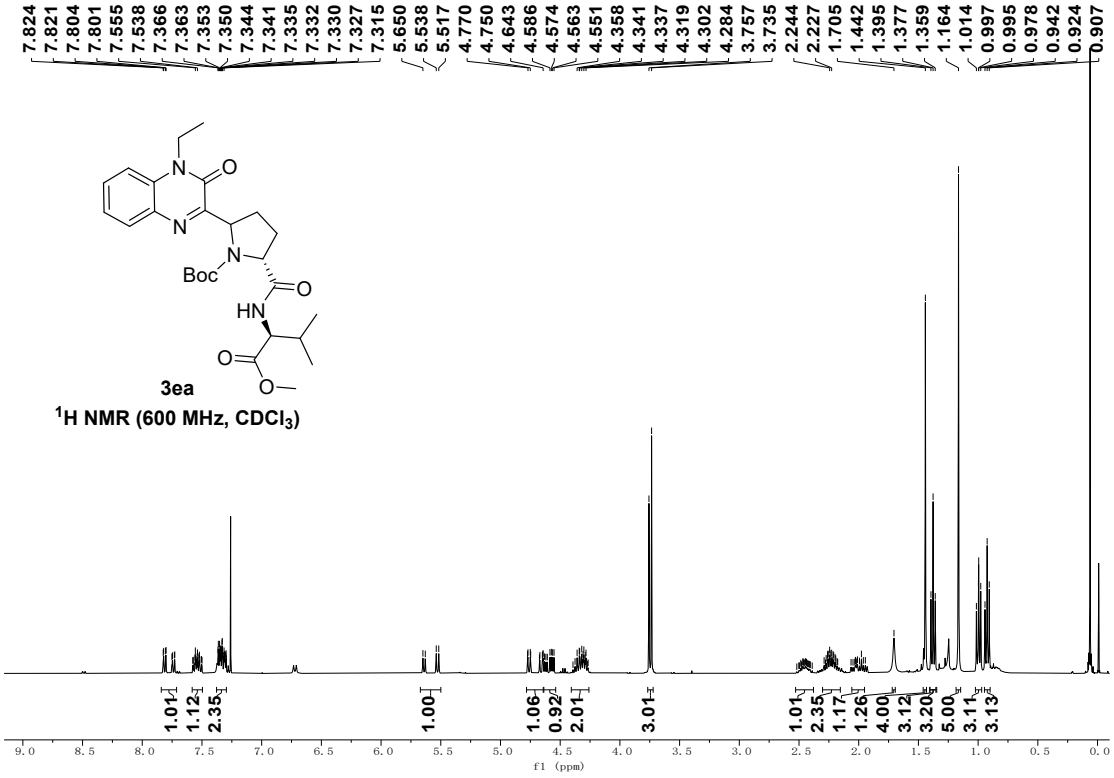
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3da**



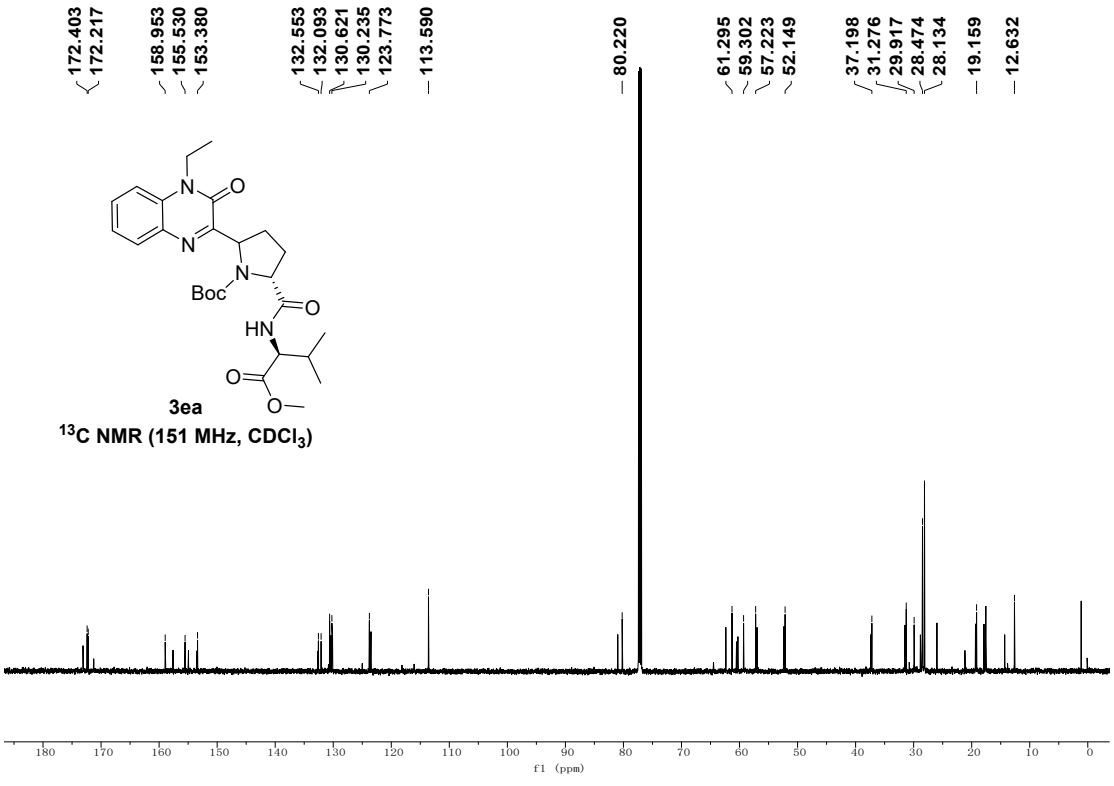
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3da**



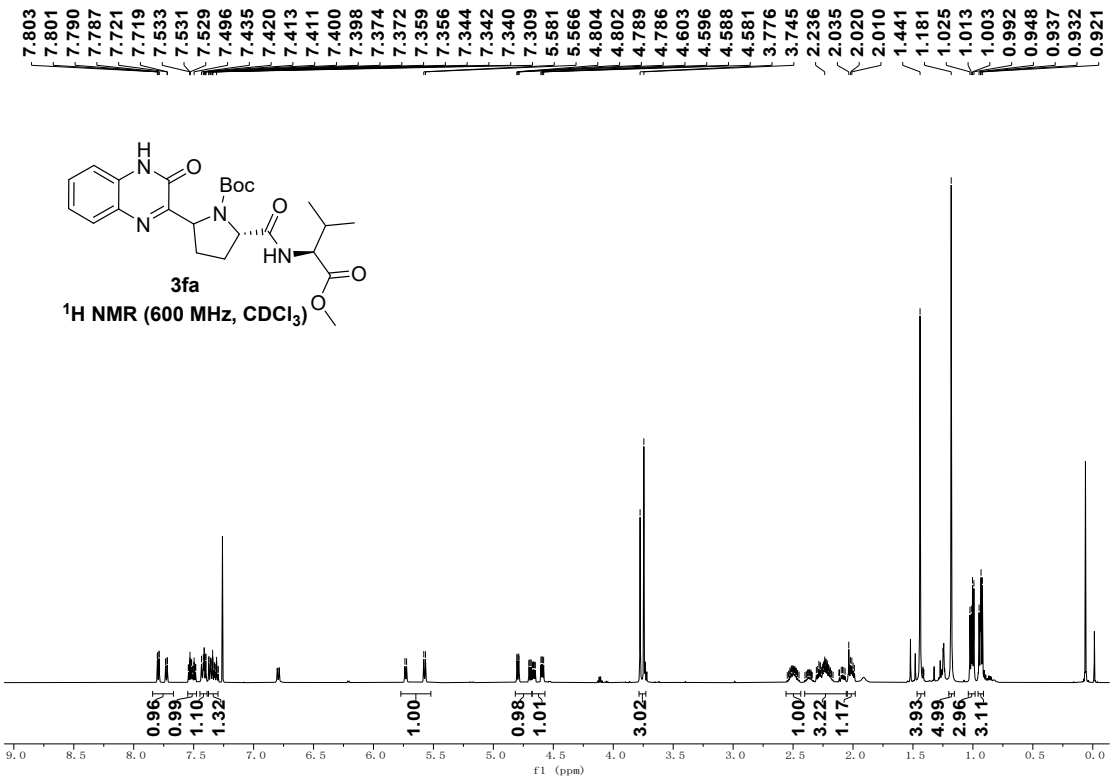
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ea**



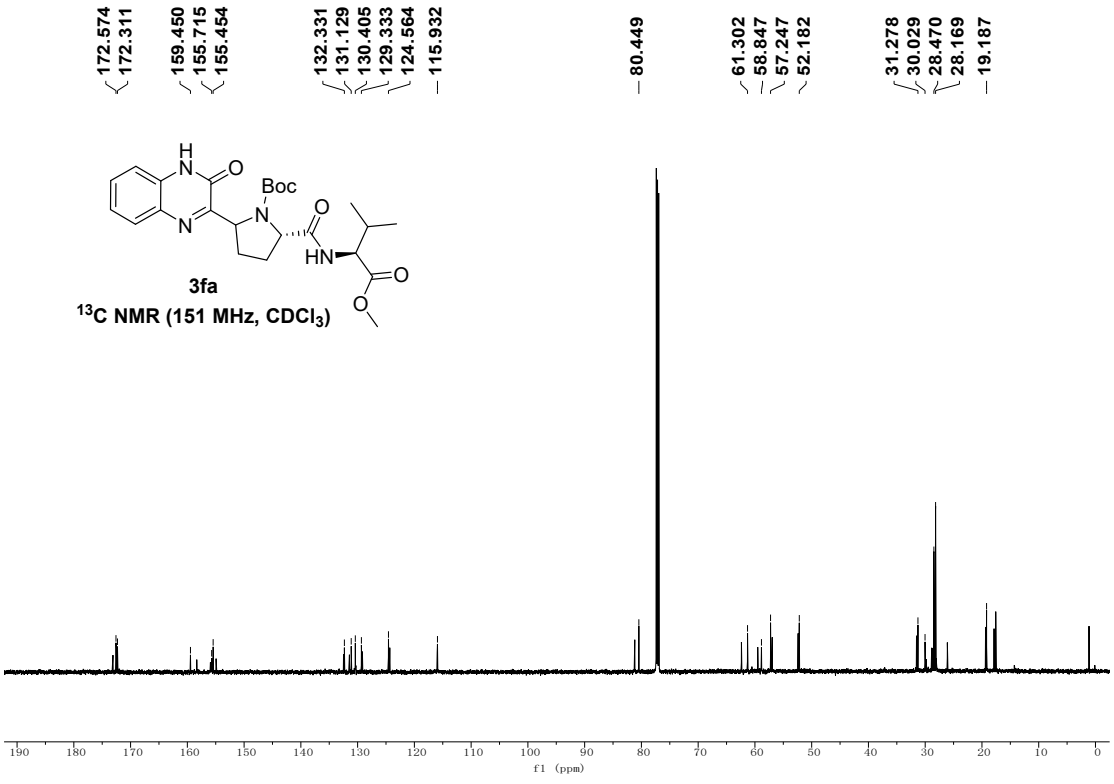
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ea**



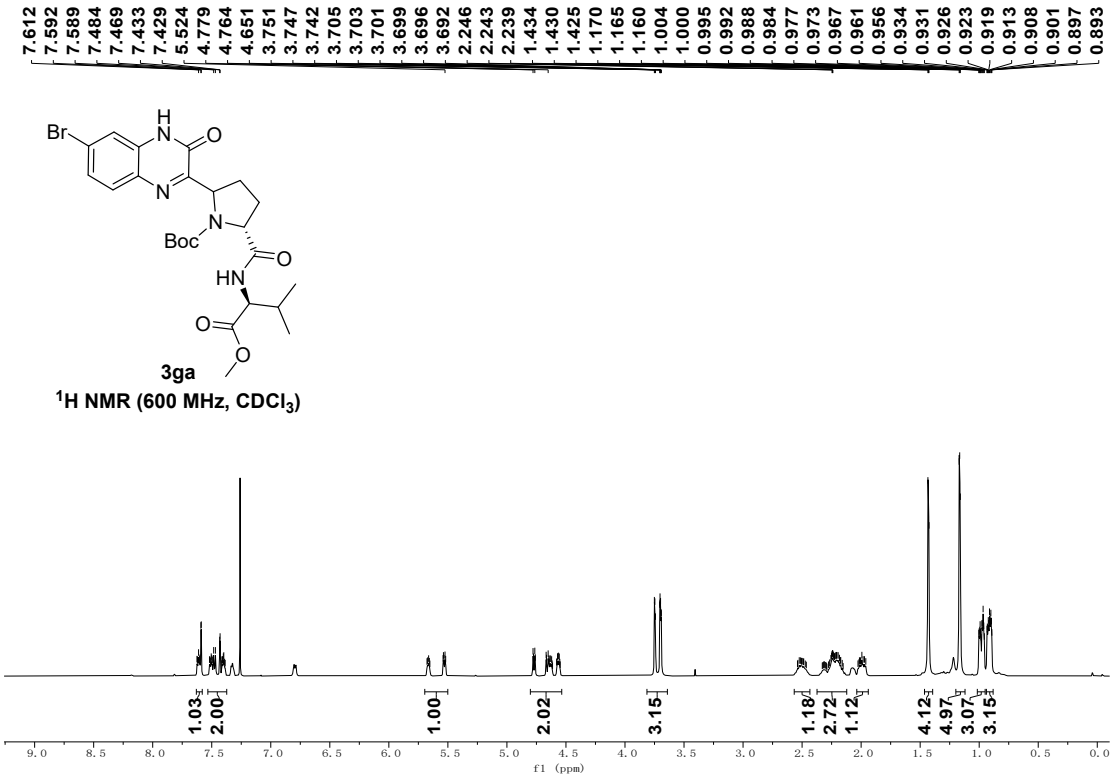
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3fa**



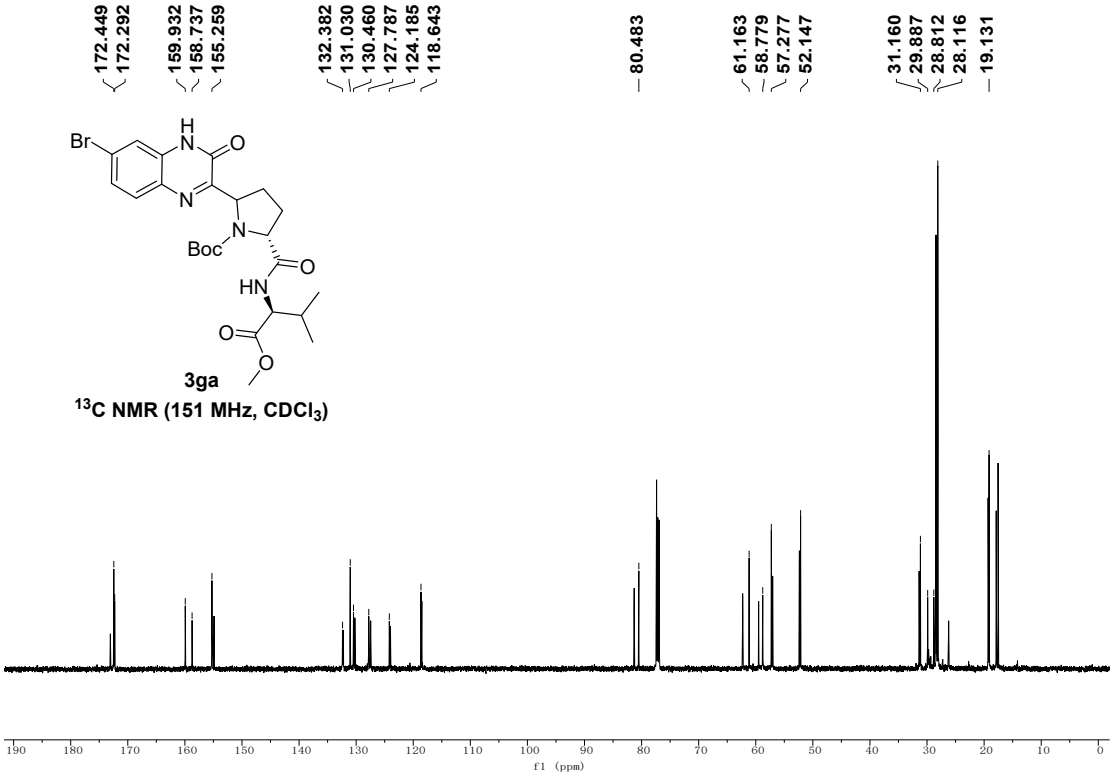
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3fa**



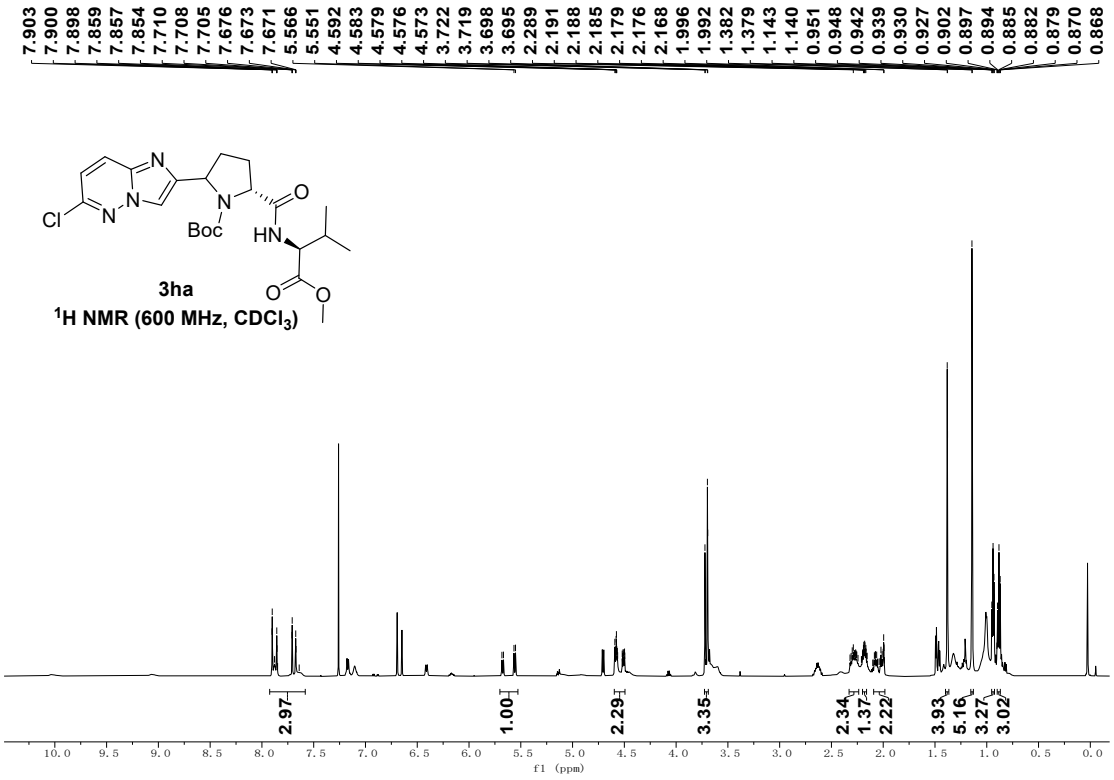
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ga**



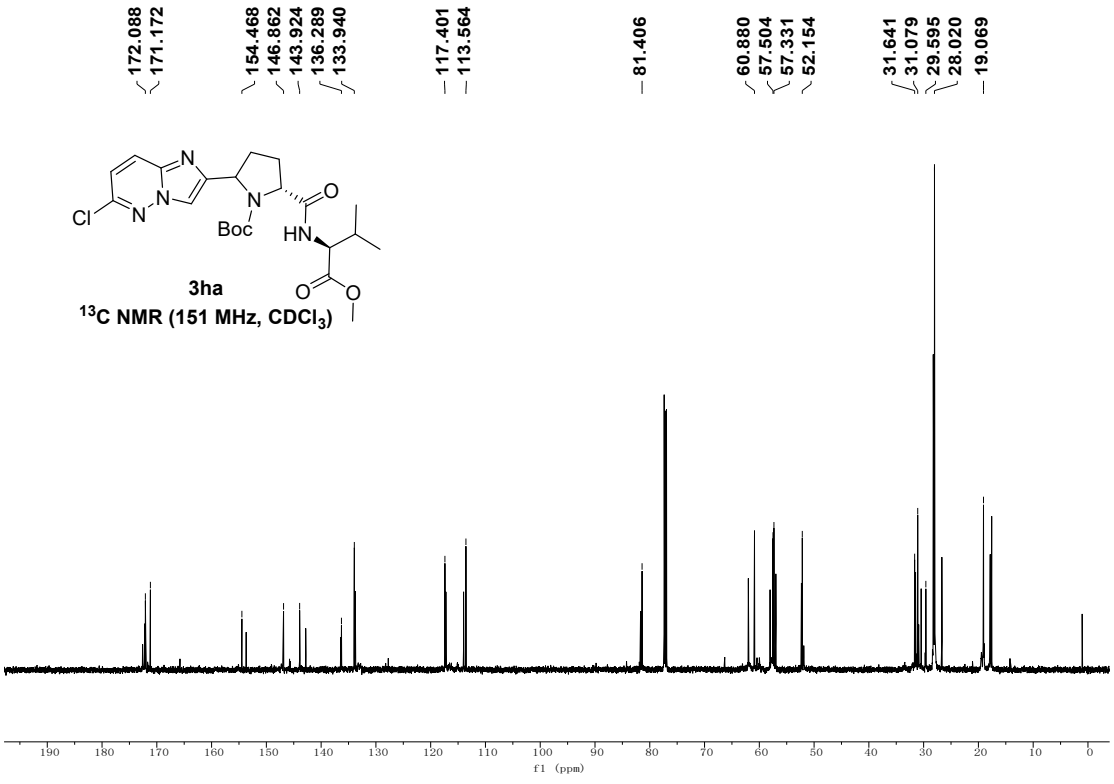
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ga**



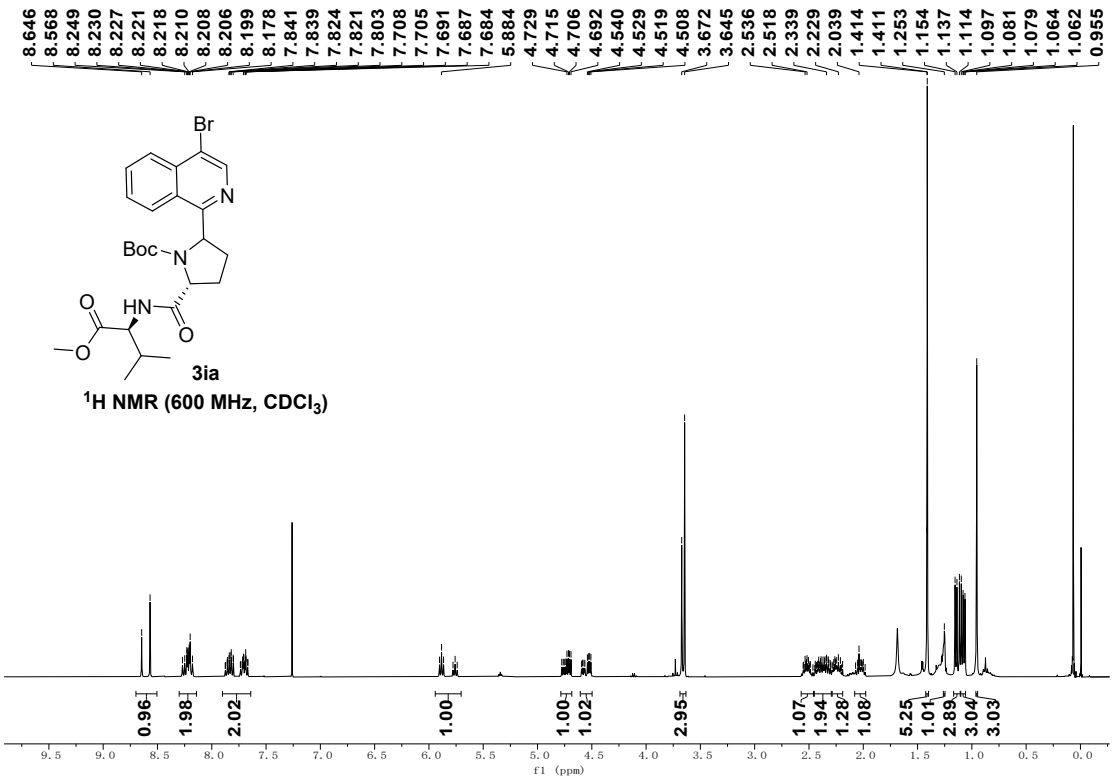
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ha**



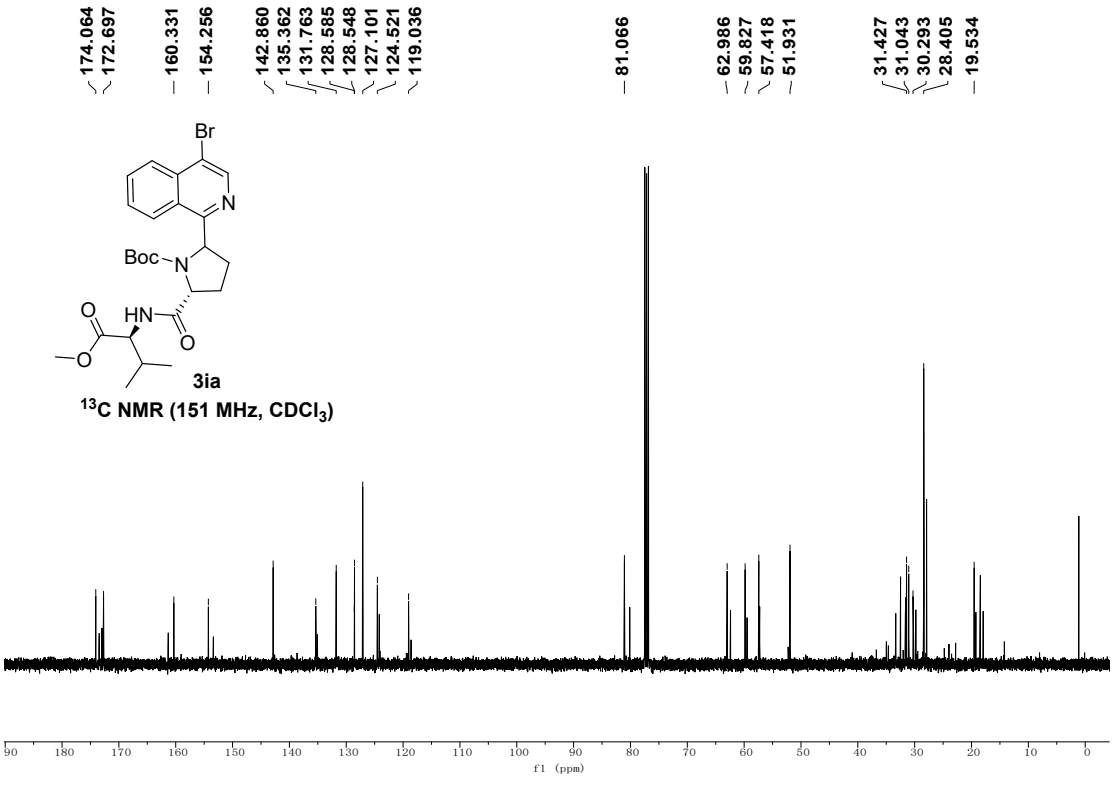
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ha**



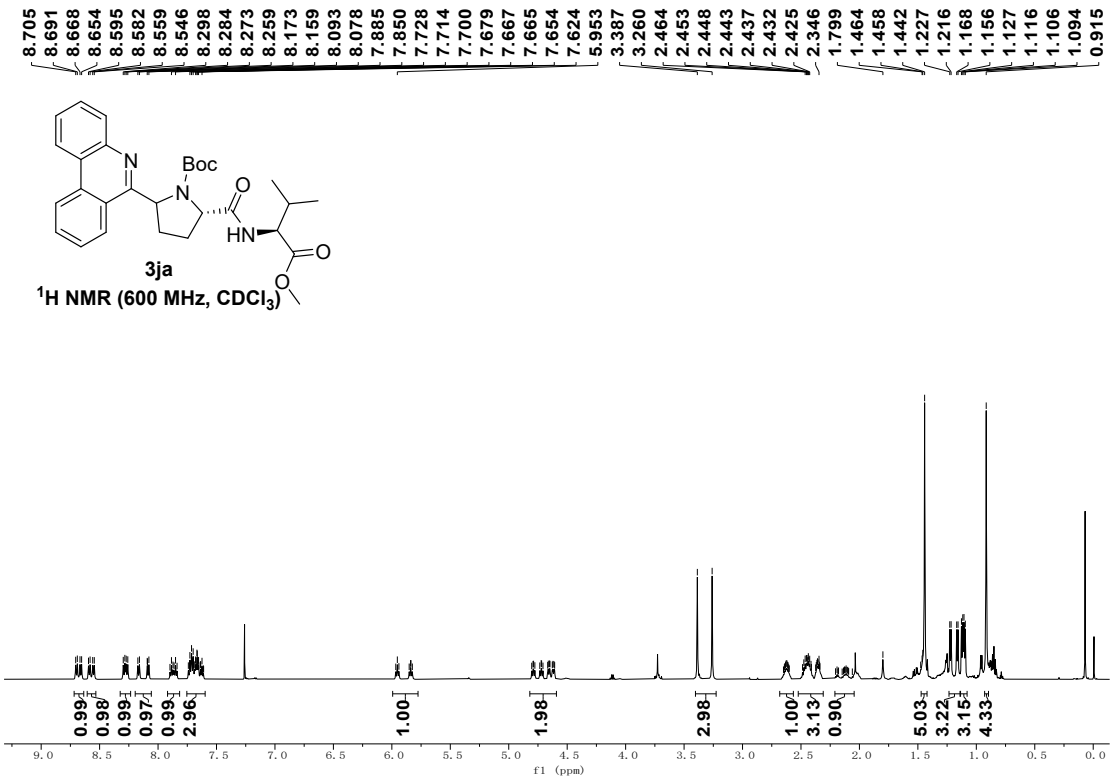
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of **3ia**



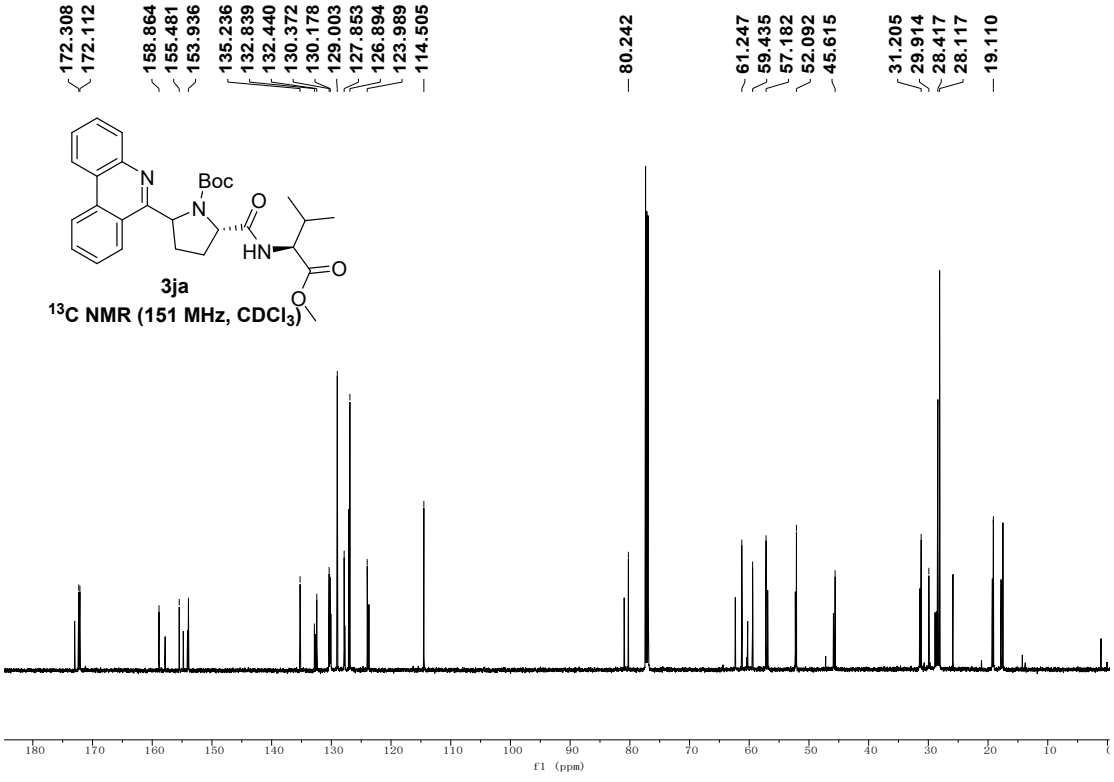
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ia**



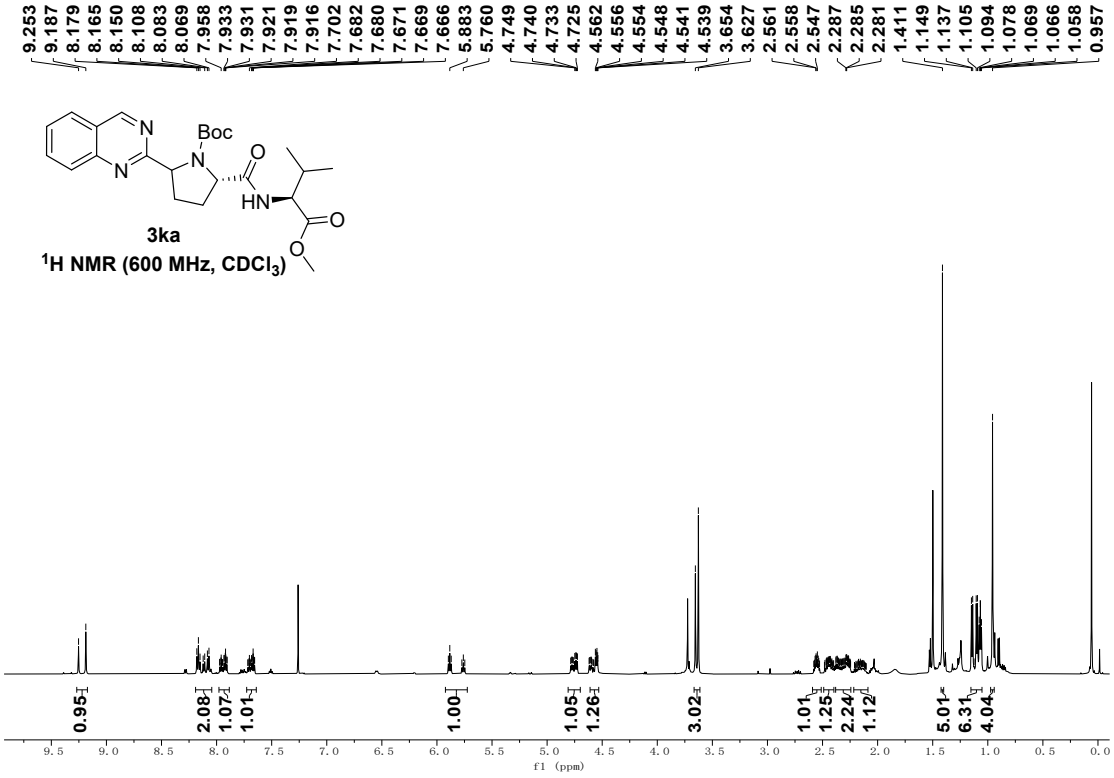
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ja**



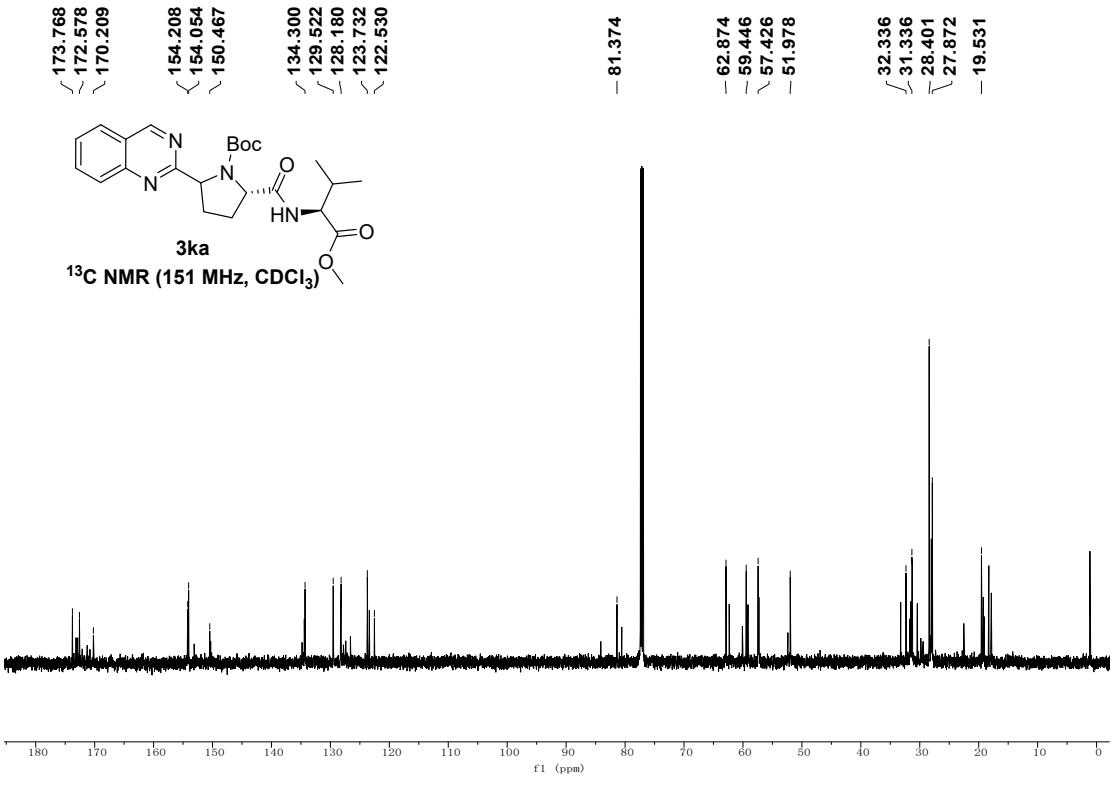
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ja**



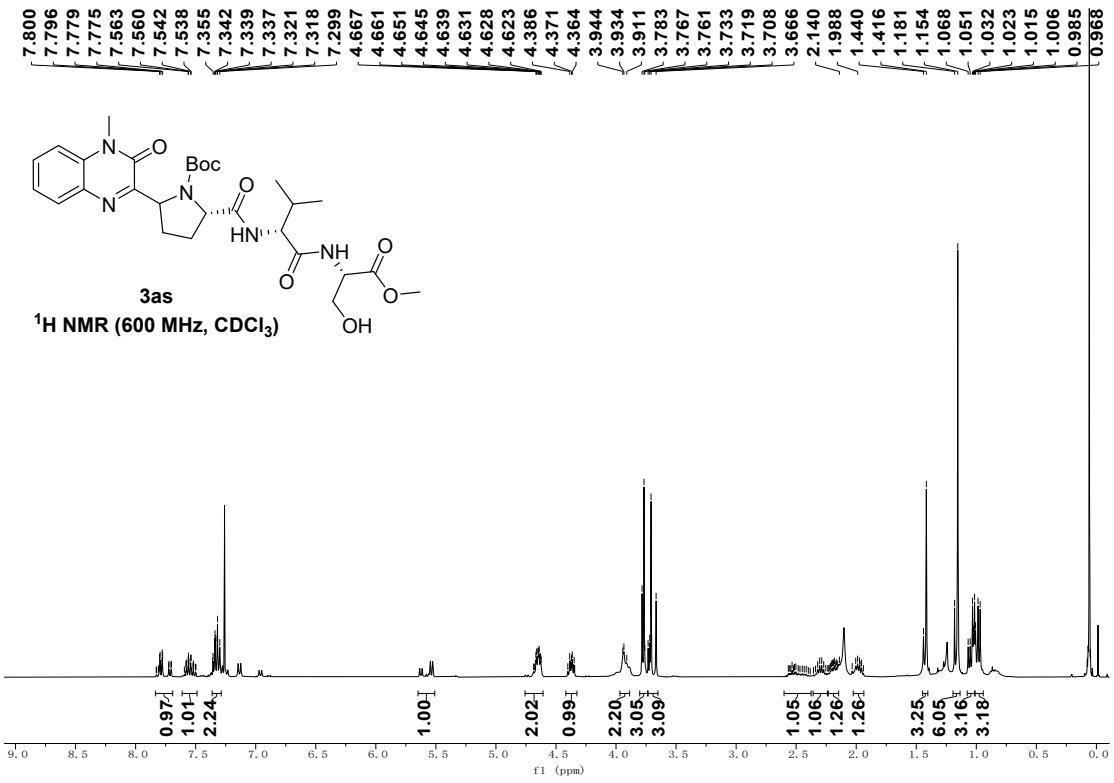
^{1}H NMR (600 MHz, $CDCl_3$) spectrum of **3ka**



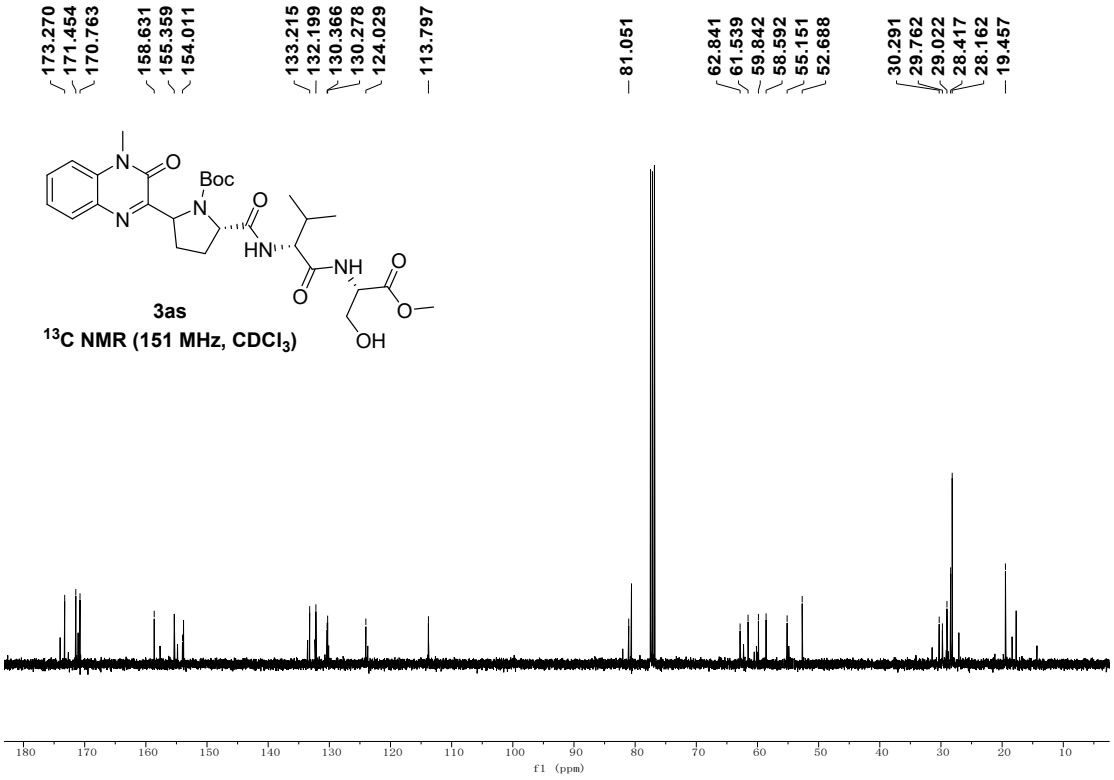
^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3ka**



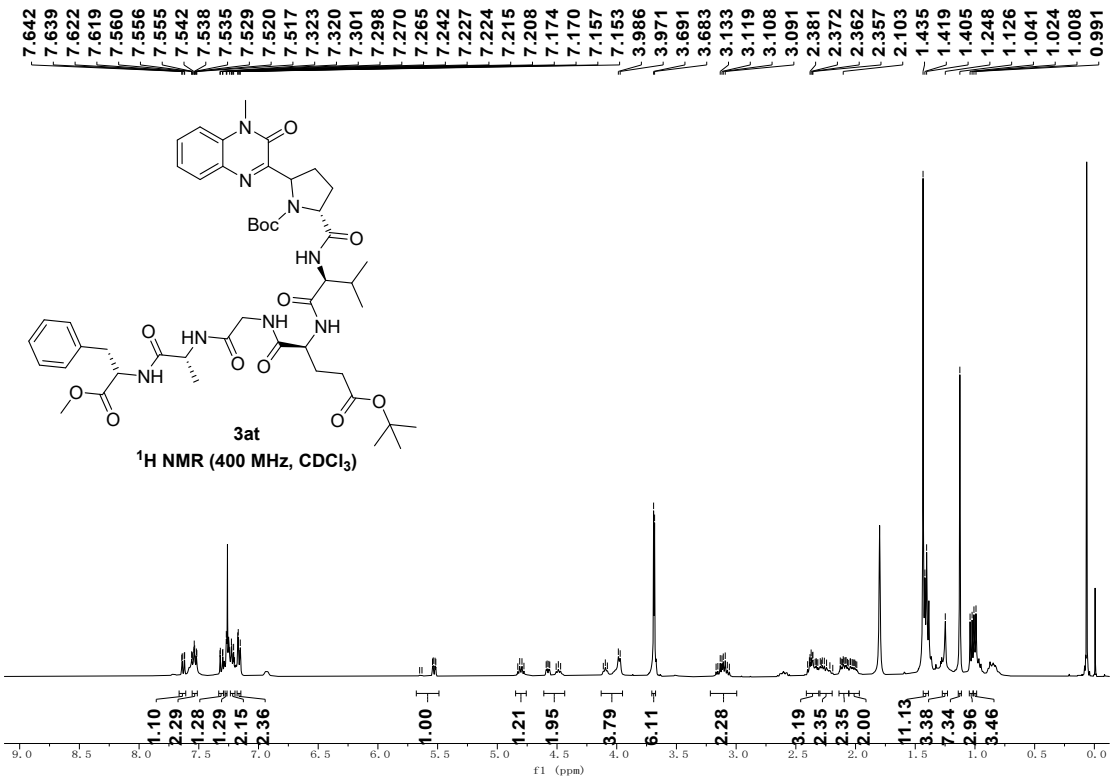
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of **3as**



^{13}C NMR (151 MHz, $CDCl_3$) spectrum of **3as**



^{1}H NMR (400 MHz, $CDCl_3$) spectrum of **3at**



^{1}H NMR (400 MHz, $CDCl_3$) spectrum of **3au**