Supporting Information

Harnessing the Reactivity of Captodative Radicals: Controlled Bond Formation through Reversible Radical Coupling

Ken Yamazaki,* Shuta Akimoto and Tomoya Miura*

Division of Applied Chemistry, Okayama University, Tsushimanaka, Okayama 700-8530, Japan

Email: k-yamazaki@okayama-u.ac.jp, tmiura@okayama-u.ac.jp

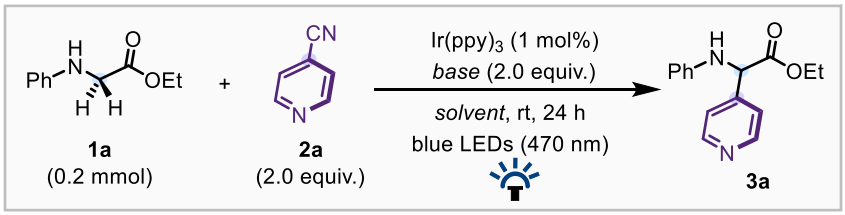
Table of Contents:

1. General Methods and Materials

All reactions were carried out under a nitrogen atmosphere unless otherwise noted. IR measurements were performed on a SHIMADZU IRAffinity-1 spectrophotometer and a JASCO FTIR-4X with ATR Pro 4X. Irradiation of photoreactions was carried out using a CCS LEDs lamp (Controller: PD3-5024-4-PI, Head: LDL2-146X30BL2, 470 nm). ^{1}H and $^{13}C\{^{1}H\}$ NMR spectra were recorded on a JEOL ECS 400 MHz or 600 MHz spectrometer. NMR data were obtained in $CDCl_3$ unless otherwise noted. Proton chemical shifts were referenced to the residual proton signal of the solvent at 7.26 ppm ($CHCl_3$). Carbon chemical shifts were referenced to the carbon signal of the solvent at 77.0 ppm ($CDCl_3$). High-resolution mass spectra were recorded on ESI-TOF mass spectrometers, Bruker Daltonics microTOF II. Preparative thin-layer chromatography (PTLC) was performed on silica gel plates with silica gel 60 PF254 indicator (Aldrich). Flash column chromatography was performed with silica gel 60N (Kanto). Gel permeation chromatography (GPC) was carried out with a Japan Analytical Industry LC-9210 (JAIGEL-H). Emission spectra were recorded on HITACHI F-2700 fluorescence spectrophotometer.

All chemicals and anhydrous solvents were obtained from commercial suppliers and used without further purification unless otherwise noted. Anhydrous CH_3CN (FUJIFILM Wako Pure Chemical Corporation [FUJIFILM Wako] and Kanto Chemical Co., Inc. [Kanto]), EtOAc (Kanto), 1,4-dioxane (Kanto), CH_2Cl_2 (FUJIFILM Wako and Kanto), THF (FUJIFILM Wako and Kanto) were degassed before use. Aniline derivatives were obtained from commercial suppliers and used without further purification [aniline (FUJIFILM Wako), *p*-anisidine (Tokyo Chemical Industry [TCI]), *p*-toluidine (TCI), 4-aminobenzotrifluoride (FUJIFILM Wako), 4-fluoroaniline (TCI), 2-fluoroaniline (TCI), 4-bromoaniline (TCI), 4-iodoaniline (TCI), 2,4,6-trimethylaniline (TCI)]. Protected amino acids were obtained from commercial suppliers and used without further purification [glycine ethyl ester hydrochloride (TCI), L-alanine methyl ester hydrochloride (TCI), L-valine methyl ester hydrochloride (TCI), L-leucine methyl ester hydrochloride (Kanto), L-phenylalanine methyl ester hydrochloride (Sigma Aldrich), L-serine methyl ester hydrochloride (Kanto), *N*-(*tert*-butoxycarbonyl)-L-alanine (TCI), *N*-(*tert*-butoxycarbonyl)-L-valine (TCI), *N*-(*tert*-butoxycarbonyl)-L-leucine monohydrate (TCI), *N*-(*tert*-butoxycarbonyl)-L-isoleucine hemihydrate (TCI), *N*-(*tert*-butoxycarbonyl)-L-phenylalanine (TCI), *N*-(*tert*-butoxycarbonyl)-L-methionine (Watanabe Chemical industries, Ltd.)]. 1-Hydroxybenzotriazole monohydrate (TCI), 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (TCI), ethyl chloroacetate (Kanto), 1,4-Diazabictclo[2,2,2]octane (TCI), triethylamine (Kanto), Tris(2-phenylpyridinato)iridium(III) (Sigma Aldrich and TCI), LiCl (Nacalai Tesque, Inc. [Nacalai]), NaOH (Nacalai), MeOH (Kanto), trifluoroacetic acid (Kanto), $CuSO_4$ (Sigma Aldrich), L(+)-ascorbic acid sodium salt (Kanto), trimethylsilylacetylene (TCI), CuI (TCI), bis(triphenylphosphine)palladium(ii) dichloride (Wako), tetrabutylammonium fluoride (TCI), Ethyl Glyoxylate Polymer form (47% in Toluene) (TCI), Magnesium Sulfate (Anhydrous) (Kanto), Methylmagnesium bromide, in tetrahydrofuran (Kanto) were obtained from commercial suppliers.

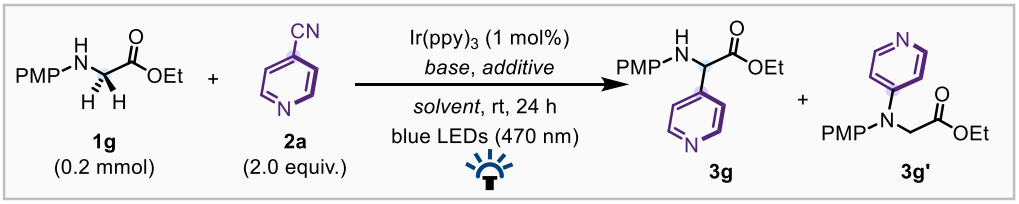
2. Optimization of Reaction Conditions



entry	*base*	*solvent*	**3a** (%)[a]
1	DBU	MeCN	0
2	Et_3N	MeCN	0
3	DIPEA	MeCN	0
4	$LiCO_3$	MeCN	0
5	MeONa	MeCN	0
6	K_2CO_3	MeCN	0
7	Cs_2CO_3	MeCN	0
8	DABCO	MeCN	75
9	DABCO	1,4-dioxane	44
10	DABCO	toluene	54
11	DABCO	acetone	70
12	DABCO	DMF	65
13	DABCO	THF	48
14	DABCO	MeCN/1,4-dioxane = 1/1	85
15	DABCO	MeCN/1,4-dioxane = 3/1	88
16[b]	DABCO	MeCN/1,4-dioxane = 3/1	88 (78)

[a] NMR yields (isolated yield in parenthesis). [b] DABCO (1.5 equiv.).

Table S1. Optimization of reaction conditions.



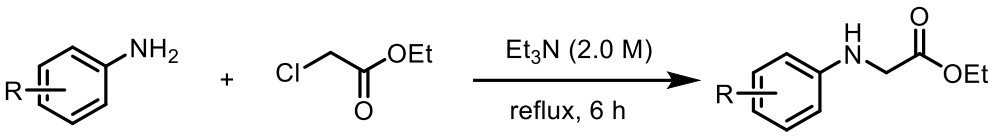
entry	*base* (equiv.)	*additive* (equiv.)	*solvent* [M]	**3g** (%)[a]	**3g'** (%)[a]
1	DABCO (1.5)	-	MeCN/1,4-dioxane = 3/1 [0.1]	54 (39)	43 (28)
2	DABCO (2.0)	-	MeCN/1,4-dioxane = 3/1 [0.1]	79	25
3	DABCO (2.5)	-	MeCN/1,4-dioxane = 3/1 [0.1]	82	24
4	DABCO (2.5)	-	toluene [0.1]	40	6
5	DABCO (2.5)	-	DMF [0.1]	54	40
6	DABCO (2.5)	-	MeCN [0.1]	66	30
7	DABCO (2.5)	-	EtOAc [0.1]	41	9
8	DABCO (2.5)	NaBr (1)	EtOAc [0.067]	39	6
9	DABCO (2.5)	LiCl (1)	EtOAc [0.067]	88	7
10	DABCO (2.5)	LiCl (1.2)	EtOAc [0.067]	89 (78)	8

[a] NMR yields (isolated yield in parenthesis).

Table S2. Optimization of reaction conditions. PMP = *para*-methoxyphenyl.

3. Synthetic Procedures

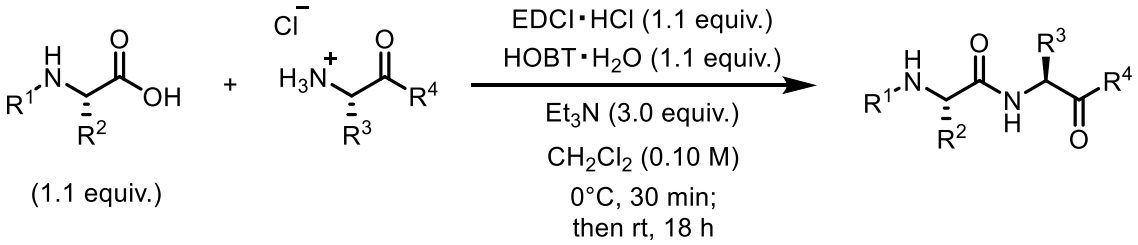
General Procedure A: Synthesis of *N*-Arylglycine Ethyl Esters



10.0 mmol (1.0 equiv.) **1**

A modified literature procedure was used.[1] To an oven-dried 50 ml vial equipped with a stirring bar was added corresponding aniline (10.0 mmol), ethyl chloroacetate (10.0 mmol), and Et_3N (2.0 M). The mixture was then stirred and heated to reflux for 6 hours. The crude mixture was then cooled to room temperature, filtered through a pad of Celite® to remove white solid, and concentrated *in vacuo*. The residue was purified by flash column chromatography (hexane/EtOAc) to afford the corresponding *N*-arylglycine ethyl ester.

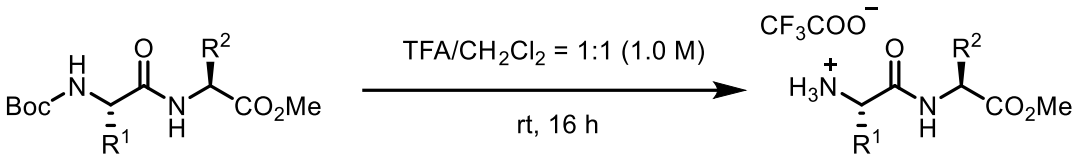
General Procedure B: Synthesis of Peptide Derivatives



(1.1 equiv.)

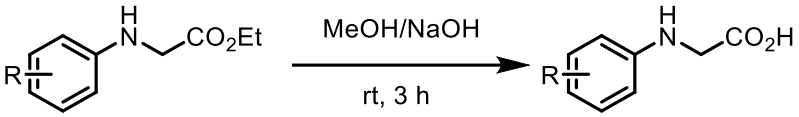
A modified literature procedure was used.[2] To an oven-dried 200 ml round-bottom flask equipped with a stirring bar was added the corresponding carboxylic acid (1.1 equiv.), CH_2Cl_2 (0.10 M), the corresponding amine (1.0 equiv.), HOBT·H_2O (1.1 equiv.), EDCI·HCl (1.1 equiv.), and Et_3N (3.0 equiv.) at 0 °C. After stirring for 30 minutes at the same temperature, the reaction mixture was then allowed to warm to room temperature and stirred for another 18 hours. The resulting mixture was washed with 0.5 M hydrochloric acid (twice), saturated aq. $NaHCO_3$ solution, and brine. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by flash column chromatography to afford the corresponding peptide.

General Procedure C: Deprotection of Boc Group



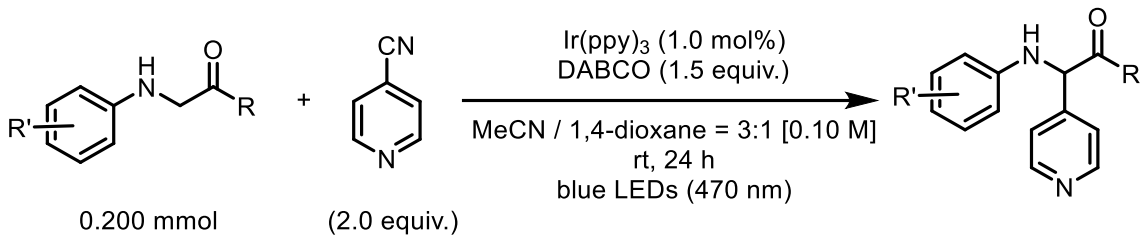
A modified literature procedure was used.[2] To an oven-dried 100 ml round-bottom flask equipped with a stirring bar was added corresponding *N*-Boc protected amino acid (1.0 equiv.), CH_2Cl_2 (1.0 M), and trifluoroacetic acid (1.0 M) at room temperature. After the mixture was stirred for 16 hours, volatiles were removed *in vacuo*, and the product was used without further purification.

General Procedure D: Hydrolysis of Esters



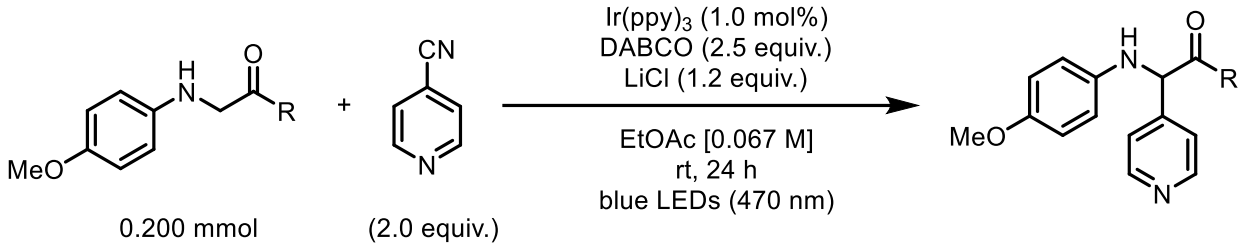
A modified literature procedure was used.[2] To an oven-dried 100 ml round-bottom flask equipped with a stirring bar was added the corresponding ethyl ester (10.0 mmol), MeOH (20.0 ml), and 1 N NaOH aq. (10.0 ml). The mixture was stirred for 3 hours at room temperature. The resulting mixture was concentrated under reduced pressure to remove MeOH, and the residue was extracted with EtOAc. The aqueous layer was acidified to pH 2-3 by the addition of 2 N HCl aq. and then extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The product was used without further purification.

General Procedure E: Pyridination of *N*-Phenyl Amino Acids



To an oven-dried 4 ml vial equipped with a stirring bar was added the corresponding amino acid derivative (0.200 mmol), DABCO (1.5 equiv.), $Ir(ppy)_3$ (1.0 mol%), 4-cyanopyridine (2.0 equiv.), MeCN (1.5 ml), and 1,4-dioxane (0.50 ml). The reaction mixture was stirred for 24 hours under blue light irradiation (470 nm, 23W). The resulting mixture was added saturated aq. $NaHCO_3$ and extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by flash column chromatography to afford the corresponding product.

General Procedure F: Pyridination of *N*-(4-Methoxyphenyl) Amino Acids

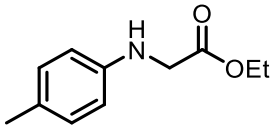


0.200 mmol (2.0 equiv.)

To an oven-dried 4 ml vial equipped with a stirring bar was added the corresponding amino acid derivative (0.200 mmol), DABCO (2.5 equiv.), $Ir(ppy)_3$ (1.0 mol%), 4-cyanopyridine (2.0 equiv.), LiCl (1.2 equiv.), and EtOAc (3.0 ml). The reaction mixture was stirred for 24 hours under blue light irradiation (470 nm, 23 W). The resulting mixture was added saturated aq. $NaHCO_3$ and extracted with EtOAc. The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by flash column chromatography to afford the corresponding product.

3. Analytical Data of Substrates and Reactants

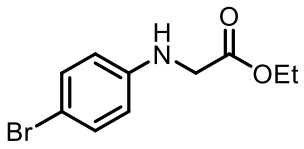
1b



According to General Procedure A, ethyl *p*-tolylglycinate **1b** was obtained (0.870 g, 4.50 mmol, 45%) as a white solid using *p*-toluidine (1.07 g, 10.0 mmol). Data are consistent with the literature.[1]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.02 (d, J = 8.3 Hz, 2H), 6.55 (d, J = 8.7 Hz, 2H), 4.25 (q, J = 7.2 Hz, 2H), 4.16 (bs, 1H), 3.89 (d, J = 5.5 Hz, 2H), 2.25 (s, 3H), 1.30 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.2 (C), 144.8 (C), 129.7 (CH), 127.4 (C), 113.1 (CH), 61.2 (CH_2), 46.2 (CH_2), 20.3 (CH_3), 14.1 (CH_3).

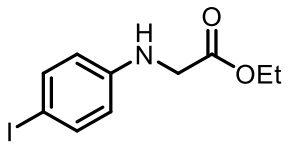
1c



According to General Procedure A, ethyl (4-bromophenyl)glycinate **1c** was obtained (1.68 g, 6.50 mmol, 65%) as a white solid using 4-bromoaniline (1.70 g, 10.0 mmol). Data are consistent with the literature.[1]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.27-7.23 (m, 2H), 6.48-6.44 (m, 2H), 4.34 (bs, 1H), 4.23 (q, J = 7.0 Hz, 2H), 3.83 (s, 2H), 1.28 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.7 (C), 145.9 (C), 131.9 (CH), 114.5 (CH), 109.8 (C), 61.4 (CH_2), 45.7 (CH_2), 14.1 (CH_3).

1d

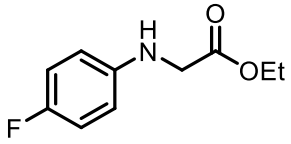


According to General Procedure A, ethyl (4-iodophenyl)glycinate **1d** was obtained (1.13 g, 3.70 mmol, 37%) as a white solid using 4-iodoaniline (2.19 g, 10.0 mmol). Data are consistent with the literature.[1]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45-7.42 (m, 2H), 6.40-6.37 (m, 2H), 4.35 (bs, 1H), 4.24 (q, J = 7.0 Hz, 2H), 3.85 (s, 2H), 1.29 (t, J = 7.1 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 170.7 (C), 146.5 (C), 137.8 (CH), 115.1 (CH), 79.0 (CH), 61.4 (CH_2), 45.5 (CH_2), 14.1 (CH_3).

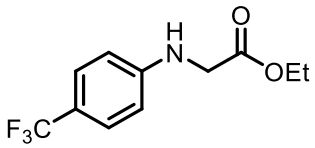
1e



According to General Procedure A, ethyl (4-fluorophenyl)glycinate **1e** was obtained (1.05 g, 5.30 mmol, 53%) as a white solid using 4-fluoroaniline (1.11 g, 10.0 mmol). Data are consistent with the literature.[1] Amine N−H peak was not visible in the ^{1}H NMR spectrum.

^{1}H NMR (400 MHz, $CDCl_3$): δ 6.92-6.88 (m, 2H), 6.57-6.54 (m, 2H), 4.24 (q, J = 7.2 Hz, 2H), 3.86 (s, 2H), 1.29 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.0 (C), 156.3 (d, J = 236.8 Hz, C), 143.3 (C), 115.8 (d, J = 30.3 Hz, CH) 114.0 (d, J = 10.1 Hz, CH), 61.3 (CH_2), 46.5 (CH_2), 14.1 (CH_3).
^{19}F NMR (376 MHz, $CDCl_3$): δ -127.1 (s, 1F).

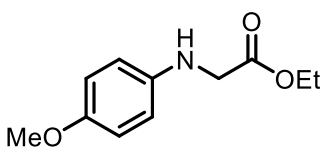
1f



According to General Procedure A, ethyl (4-(trifluoromethyl)phenyl)glycinate **1f** was obtained (1.36 g, 5.50 mmol, 55%) as a white solid using 4-(trifluoromethyl)aniline (1.61 g, 10.0 mmol). Data are consistent with the literature.[7]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.42 (d, J = 8.7 Hz, 2H), 6.61 (d, J = 8.7 Hz, 2H), 4.74 (bs, 1H), 4.26 (q, J = 7.0 Hz, 2H), 3.92 (s, 2H), 1.31 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.4 (C), 149.4 (C), 126.7 (q, J = 3.8 Hz, C), 124.8 (q, J = 272.6 Hz, CH), 119.7 (q, J = 32.8 Hz, C), 112.1 (CH), 61.6 (CH_2), 45.2 (CH_2), 14.1 (CH_3);
^{19}F NMR (376 MHz, $CDCl_3$): δ -61.0 (s, 3F).

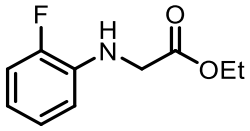
1g



According to General Procedure A, ethyl (4-methoxyphenyl)glycinate **1g** was obtained (1.40 g, 6.70 mmol, 67%) as a yellow solid using 4-methoxyaniline (1.23 g, 10.0 mmol) Data are consistent with the literature.[1]. Amine N−H peak was not visible in the ^{1}H NMR spectrum.

^{1}H NMR (400 MHz, $CDCl_3$): δ 6.81-6.77 (m, 2H), 6.60-6.56 (m, 2H), 4.23 (q, J = 7.2 Hz, 2H), 3.85 (s, 2H), 3.74 (s, 3H), 1.28 (t, J = 7.3 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.3 (C), 152.6 (C), 141.2 (C), 114.8 (CH), 114.3 (CH), 61.1 (CH_2), 55.6 (CH_3), 46.8 (CH_2), 14.1 (CH_3).

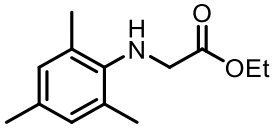
1h



According to General Procedure A, ethyl (2-fluorophenyl)glycinate **1h** was obtained (0.830 g, 4.20 mmol, 42%) as a white solid using 2-fluoroaniline (1.11 g, 10.0 mmol). Data are consistent with the literature.[8]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.02-6.97 (m, 2H), 6.70-6.65 (m, 1H), 6.61-6.57 (m, 1H), 4.52 (bs, 1H), 4.25 (q, J = 7.2 Hz, 2H), 3.94 (d, J = 5.5 Hz, 2H), 1.30 (t, J = 7.1 Hz, 3H)
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.6 (C), 151.2 (d, J = 240.8 Hz, C), 135.5 (d, J = 11.6 Hz, C), 124.5 (d, J = 2.8 Hz, CH), 117.6 (d, J = 6.8 Hz, CH), 114.6 (d, J = 18.3 Hz, CH), 112.2 (d, J = 2.9 Hz, CH), 61.3 (CH_2), 45.4 (CH_2), 14.1 (CH_3).
^{19}F NMR (376 MHz, $CDCl_3$): δ -135.7 (s, 1F).

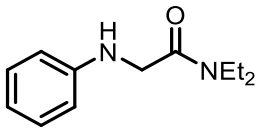
1i



According to General Procedure A, ethyl mesitylglycinate **1i** was obtained (1.53 g, 6.90 mmol, 69%) as a orange liquid using 2,4,6-Trimethylaniline (1.35 g, 10.0 mmol). Data are consistent with the literature.[9]

^{1}H NMR (400 MHz, $CDCl_3$): δ 6.86 (s, 2H), 4.26 (q, J = 7.2 Hz, 2H), 3.86 (bs, 1H), 3.81 (s, 2H), 2.34 (s, 6H), 2.27 (s, 3H), 1.32 (t, J = 7.3 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 172.2 (C), 143.0 (C), 131.1 (C), 129.4 (CH), 128.7 (C), 61.0 (CH_2), 50.1 (CH_2), 20.4 (CH_3), 18.4 (CH_3), 14.1 (CH_3).

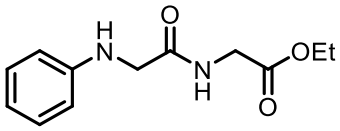
1j



According to General Procedure A, *N*,*N*-diethyl-2-(phenylamino)acetamide **1j** was obtained (1.22 g, 5.90 mmol, 59%) as a white solid using aniline (0.93 g, 10.0 mmol). Data are consistent with the literature.[10]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.21-7.18 (m, 2H), 6.74-6.70 (m, 1H), 6.65-6.62 (m, 2H), 4.93 (bs, 1H), 3.87 (s, 2H), 3.46 (q, J = 7.2 Hz, 2H), 3.32 (q, J = 7.2 Hz, 2H), 1.24 (t, J = 7.1 Hz, 3H), 1.17 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 167.6 (C), 147.3 (C), 128.9 (CH), 117.0 (C), 112.7 (CH), 44.7 (CH_2), 40.6 (CH_2), 40.2 (CH_2), 13.8 (CH_3), 12.7 (CH_3).

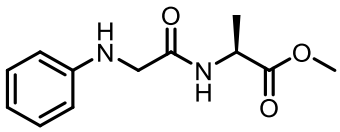
1k



According to General Procedure B and D, methyl phenylglycylglycinate **1k** was obtained (3.40 g, 14.4 mmol, 96%) as a white solid using L-glycine ethyl ester hydrochloride (2.08 g, 15.0 mmol). Data are consistent with the literature.[11]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.24-7.20 (m, 2H), 7.17 (bs, 1H), 6.83-6.80 (m, 1H), 6.64 (dd, J = 8.7, 0.9 Hz, 2H), 4.28 (bt, J = 5.5 Hz, 1H), 4.18 (q, J = 7.2 Hz, 2H), 4.05 (d, J = 5.5 Hz, 2H), 3.85 (d, J = 6.0 Hz, 2H), 1.25 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.0 (C), 169.6 (CH), 147.0 (C), 129.4 (CH), 119.2 (C), 113.3 (CH), 61.5 (CH_2), 48.7 (CH_2), 41.0 (CH_2), 14.1 (CH_3).

1l

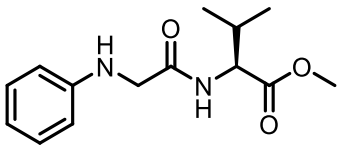


According to General Procedure B and D, methyl phenylglycyl-L-alaninate **1l** was obtained (0.240 g, 1.00 mmol, 48%) as a white solid using L-alanine methyl ester hydrochloride (0.290 g, 2.10 mmol).

IR (ATR): 3399, 3341, 2984, 2945, 1740, 1643, 1601, 1505, 1434, 1315, 1267, 1262, 1208, 1164, 1155, 980, 748, 690 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.21 (t, J = 8.0 Hz, 2H), 7.16 (bd, J = 7.2 Hz, 1H), 6.81 (t, J = 7.3 Hz, 1H), 6.63 (d, J = 7.8 Hz, 2H), 4.65 (dq, J = 7.6, 7.2 Hz, 1H), 4.30 (bt, J = 4.8 Hz, 1H), 3.81 (dd, J = 5.6, 1.6 Hz, 2H), 3.71 (s, 3H), 1.38 (d, J = 6.9 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.0 (C), 170.3 (C), 147.1 (C), 129.3 (CH), 119.1 (C), 113.3 (CH), 52.4 (CH_3), 48.9 (CH), 47.7 (CH_2), 18.2 (CH_3);
HRMS (ESI): Calcd for $C_{12}H_{16}N_2O_3Na^+$ $[M+Na]^+$ 259.1053, Found m/z 259.1053.
m.p.: 89.0-94.1 ˚C

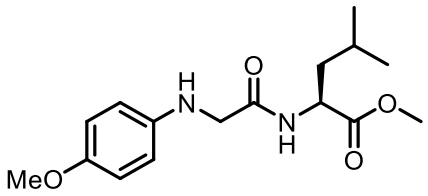
1m



According to General Procedure B and D, methyl phenylglycyl-L-valinate **1m** was obtained (0.609 g, 2.31 mmol, 77%) as a white solid using L-valine methyl ester hydrochloride (0.448 g, 3.00 mmol).

IR (ATR): 3360, 3310, 3029, 2969, 2891, 1733, 1656, 1605, 1515, 1492, 1310, 1179, 987, 751, 693 cm $^{-1}$;
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.20 (t, J = 7.6 Hz, 2H), 7.14 (bd, J = 9.2 Hz, 1H), 6.80 (t, J = 7.1 Hz, 1H), 6.64 (d, J = 8.7 Hz, 2H), 4.57 (dd, J = 9.2, 5.2 Hz, 1H), 3.83 (d, J = 3.0 Hz, 2H), 3.69 (s, 3H), 2.19-2.07 (m, 1H), 0.88 (d, J = 7.2 Hz, 3H), 0.77 (d, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 172.1 (C), 170.5 (C), 146.9 (C), 129.3 (CH), 119.1 (C), 113.3 (CH), 56.8 (CH), 52.1 (CH_3), 48.8 (CH_2), 31.1 (CH), 19.0 (CH_3), 17.5 (CH_3);
HRMS (ESI): Calcd for $C_{14}H_{20}N_2O_3Na^+$ $[M+Na]^+$ 287.1366, Found m/z 287.1365.
m.p.: 94.7-98.5 ˚C

1n

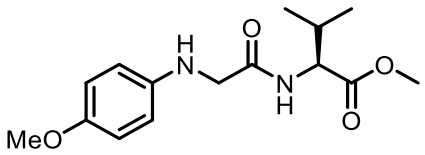


According to General Procedure B and D, methyl (4-methoxyphenyl)glycyl-L-leucinate **1n** was obtained (0.360 g, 1.20 mmol, 49%) as a white solid using L-leucine methyl ester hydrochloride (0.440 g, 2.40 mmol).

IR (KBr): 3092, 3058, 3027, 3000, 1958, 1889, 1802, 1626, 1601, 1495, 1457, 1445, 1075, 996, 899, 697 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.09 (bd, J = 8.4 Hz, 1H), 6.81-6.77 (m, 2H), 6.61-6.58 (m, 2H), 4.67 (dt, J = 9.2, 5.2 Hz, 1H), 4.01 (bt, J = 5.6 Hz, 1H), 3.78 (dd, J = 5.2, 3,6 Hz, 2H), 3.75 (s, 3H), 3.70 (s, 3H), 1.64-1.46 (m, 3H), 0.90 (d, J = 6.4 Hz, 3H), 0.87 (d, J = 6.0 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 173.1 (C), 170.8 (C), 153.2 (C), 141.1 (C), 114.9 (CH), 114.6 (CH), 55.7 (CH_3), 52.2 (CH_3), 50.3 (CH), 49.7 (CH_2), 41.3 (CH_2), 24.8 (CH), 22.8 (CH_3), 21.7 (CH_3);

HRMS (ESI): Calcd for $C_{16}H_{24}N_2O_4Na^+$ $[M+Na]^+$ 331.1628, Found m/z 331.1608.
m.p.: 70.6-74.4 ˚C

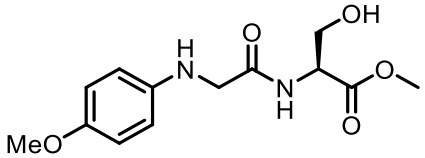
1o



According to General Procedure B and D, methyl (4-methoxyphenyl)glycyl-L-valinate **1o** was obtained (1.08 g, 3.70 mmol, 90%) as a white solid using L-serine methyl ester hydrochloride (0.671 g, 4.00 mmol).

IR (ATR): 3368, 3325, 2959, 2902, 2878, 2834, 1736, 1655, 1440, 1250, 1034 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.25 (bd, J = 10.4 Hz, 1H), 6.81-6.77 (m, 2H), 6.62-6.58 (m, 2H), 4.56 (dd, J = 9.2, 4.4 Hz, 1H), 4.06 (bs, 1H), 3.78 (d, J = 6.4 Hz, 2H), 3.74 (s, 3H), 3.70 (s, 3H), 2.18-2.10 (m, 1H), 0.88 (d, J = 7.2 Hz, 3H), 0.79 (d, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 172.2 (C), 170.9 (C), 153.2 (C), 141.1 (C), 114.9 (CH), 114.6 (CH), 56.8 (CH), 55.7 (CH_3), 52.1 (CH_3), 49.7 (CH_2), 31.1 (CH), 19.0 (CH_3), 17.6 (CH_3);
HRMS (ESI): Calcd for $C_{15}H_{22}N_2O_4Na^+$ $[M+Na]^+$ 317.1472, Found m/z 317.1467.
m.p.: 69.9-74.4 ˚C

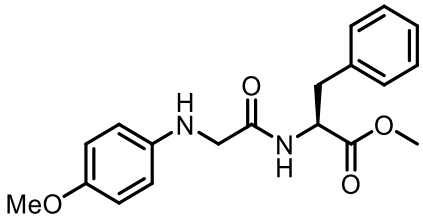
1p



According to General Procedure B and D, methyl (4-methoxyphenyl)glycyl-L-serinate **1p** was obtained (0.430 g, 1.60 mmol, 52%) as a white solid using L-serine methyl ester hydrochloride (0.471 g, 3.00 mmol).

IR (ATR): 3368, 3345, 3242, 2957, 2927, 2879, 2838, 1732, 1644, 1512, 1296, 1186, 1032, 817 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63 (bd, J = 7.6 Hz, 1H), 6.80-6.76 (m, 2H), 6.60-6.56 (m, 2H), 4.67 (dt, J = 8.0, 3.6 Hz, 1H), 4.12 (bs, 1H), 3.95 (dd, J = 11.6, 4.4 Hz, 1H), 3.86 (dd, J = 11.2, 3.2 Hz, 1H), 3.77 (s, 2H), 3.73 (s, 3H), 3.73 (s, 3H), 2.96 (bs, 1H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.7 (C), 170.6 (C), 153.1 (C), 141.1 (C), 114.9 (CH), 114.5 (CH), 63.0 (CH_2), 55.7 (CH_3), 54.4 (CH), 52.7 (CH_3), 49.6 (CH_2);
HRMS (ESI): Calcd for $C_{13}H_{18}N_2O_5Na^+$ $[M+Na]^+$ 305.1108, Found m/z 305.1130.
m.p.: 95.5-98.4 ˚C

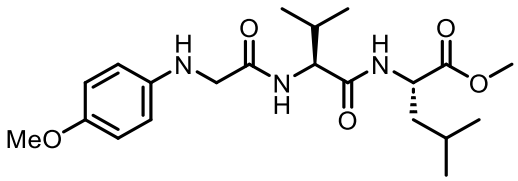
1q



According to General Procedure B and D, methyl (4-methoxyphenyl)glycyl-L-phenylalaninate **1q** was obtained (0.540 g, 1.60 mmol, 53%) as a white solid using L-phenylalanine methyl ester (0.650 g, 3.00 mmol). Data are consistent with the literature.[12]

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.31-7.14 (m, 4H), 6.96-6.93 (m, 2H), 6.80-6.76 (m, 2H), 6.56-6.49 (m, 2H), 4.94 (dt, J = 8.4, 6.4 Hz, 1H), 3.91 (bs, 1H), 3.78-3.65 (m, 2H), 3.76 (s, 3H), 3.70 (s, 3H), 3.12-3.10 (m, 2H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.7 (C), 170.6 (C), 153.2 (C), 141.0 (C), 135.6 (C), 129.1 (CH), 128.5 (CH), 127.0 (C), 114.9 (CH), 114.5 (CH), 55.7 (CH_3), 52.5, 52.3, 49.5 (CH_2), 37.9 (CH_2).

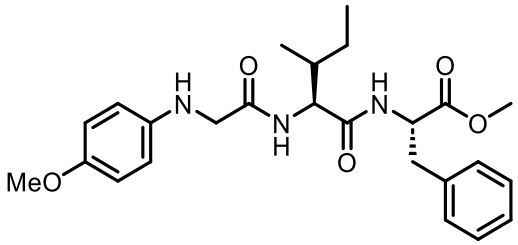
1r



According to General Procedure B, C and D, methyl (4-methoxyphenyl)glycyl-L-valyl-L-leucinate **1r** was obtained (0.520 g, 1.30 mmol, 46%) as a white solid using L-Valyl-L-leucine methyl ester (0.680 g, 2.80 mmol).

IR (KBr): 3365, 3282, 3085, 2961, 1749, 1647, 1551, 1515, 1241, 1039, 822 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.33 (bd, J = 9.2 Hz, 1H), 6.79-6.75 (m, 2H), 6.59-6.54 (m, 3H), 4.57-4.52 (m, 1H), 4.35 (dd, J = 9.2, 7.2 Hz, 1H), 4.12 (bs, 1H), 3.77 (d, J = 4.8 Hz, 2H), 3.73 (s, 3H), 3.71 (s, 3H), 2.13-2.04 (dt, J = 13.5, 6.9 Hz, 1H), 1.64-1.47 (m, 3H), 0.92-0.88 (m, 9H), 0.81 (d, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 173.1 (C), 170.9 (C), 170.8 (C), 153.0 (C), 141.0 (C), 114.9 (CH), 114.3 (CH), 58.0 (CH), 55.6 (CH_3), 52.2 (CH_3), 50.7 (CH), 49.4 (CH_2), 41.0 (CH_2), 31.0 (CH), 24.7 (CH), 22.7 (CH_3), 21.8 (CH_3), 19.1 (CH_3), 17.9 (CH_3);
HRMS (ESI): Calcd for $C_{21}H_{33}N_3O_5Na^+$ $[M+Na]^+$ 430.2312, Found m/z 430.2302.
m.p.: 122.1-125.9 ˚C

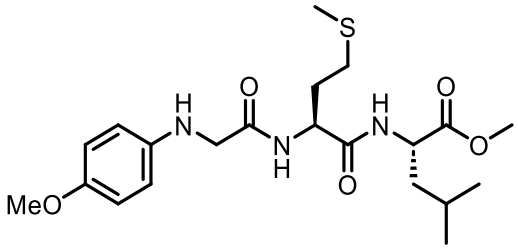
1s



According to General Procedure B, C and D, methyl (4-methoxyphenyl)glycyl-L-alloisoleucyl-L-phenylalaninate **1s** was obtained (0.380 g, 0.840 mmol, 30%) as a white solid using methyl L-alloisoleucyl-L-phenylalaninate (0.820 g, 2.80 mmol).

IR (KBr): 3300, 3063, 2951, 1752, 1646, 1566, 1512, 1439, 1387, 1242, 1039, 824, 763, 699 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.29-7.18 (m, 4H), 7.08-7.05 (m, 2H), 6.80-6.76 (m, 2H), 6.58-6.54 (m, 2H), 6.45 (bd, J = 8.0 Hz, 1H), 4.85-4.80 (m, 1H), 4.32 (dd, J = 8.7, 6.9 Hz, 1H), 4.04 (bs, 1H), 3.73 (s, 3H), 3.72 (s, 2H), 3.71 (s, 3H), 3.11 (dd, J = 13.6, 6.0 Hz, 1H), 2.98 (dd, J = 13.6, 6.8 Hz, 1H), 1.85-1.78 (m, 1H), 1.29-1.20 (m, 1H), 0.97-0.84 (m, 1H), 0.82 (d, J = 6.8 Hz, 3H), 0.77 (t, J = 7.6 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 171.6 (C), 170.8 (C), 170.5 (C), 153.2 (C), 140.9 (C), 135.7 (C), 129.2 (CH), 128.6 (CH), 127.1 (C), 115.0 (CH), 114.4 (CH), 57.3 (CH), 55.7 (CH_3), 53.0 (CH), 52.3 (CH_3), 49.4 (CH_2), 37.8 (CH_2), 36.8, (CH) 24.5 (CH_2), 15.3 (CH_3), 11.1 (CH_3);
HRMS (ESI): Calcd for $C_{25}H_{33}N_3O_5Na^+$ $[M+Na]^+$ 478.2312, Found m/z 478.2309.
m.p.: 159.9-164.4 ˚C

1t



According to General Procedure B, C and D, methyl (4-methoxyphenyl)glycyl-L-methionyl-L-leucinate **1t** was obtained (1.05 g, 2.40 mmol, 60%) as a white solid using L-Methionyl-L-leucine methyl ester (1.11 g, 4.00 mmol).

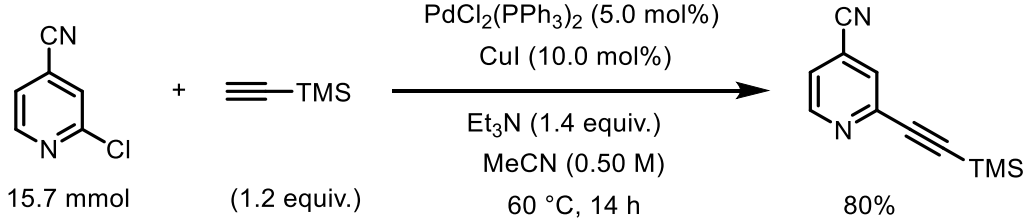
IR (KBr): 3380, 3281, 3061, 2958, 1735, 1653, 1517, 1436, 1239, 1037, 824, 700 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.41 (bd, J = 8.4 Hz, 1H), 6.79-6.76 (m, 2H), 6.62 (bd, J = 8.0 Hz, 1H), 6.57-6.53 (m, 2H), 4.68 (dt, J = 8.4, 6.8 Hz, 1H), 4.54 (dt, J = 9.2, 5.2 Hz, 1H), 4.05 (bs, 1H), 3.77 (d, J = 2.8 Hz, 2H), 3.74 (s, 3H), 3.72 (s, 3H), 2.50 (t, J = 7.2 Hz, 2H), 2.10-2.01 (m, 4H), 1.98-1.91 (m, 1H), 1.64-1.48 (m, 3H), 0.91 (t, J = 5.7 Hz, 6H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 172.9 (C), 170.9 (C), 170.6 (C), 153.2 (C), 140.9 (C), 115.0 (CH), 114.3 (CH), 55.7 (CH_3), 52.3 (CH_3), 51.5 (CH), 50.8 (CH), 49.4 (CH_2), 41.1 (CH_2), 30.9 (CH_2), 29.9 (CH_2), 24.8 (CH), 22.7 (CH_3), 21.8 (CH_3), 15.0 (CH_3);

HRMS (ESI): Calcd for $C_{21}H_{33}N_3O_5SNa^+$ $[M+Na]^+$ 462.2033, Found m/z 462.2031.

m.p.: 91.4-94.9 ˚C

2b (2-((Trimethylsilyl)ethynyl)isonicotinonitrile)

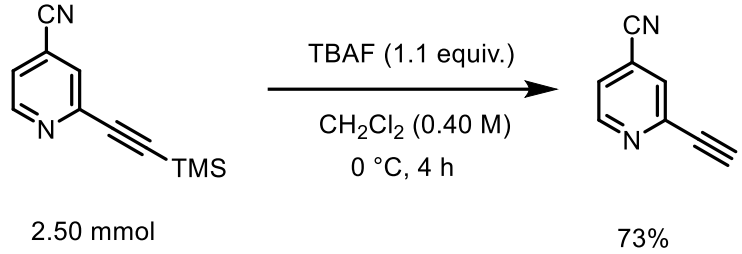


A modified literature procedure was used.[3] To an oven-dried 100 ml round-bottom flask equipped with a stirring bar was added 2-chloroisonicotinonitrile (2.18 g, 15.7 mmol), $PdCl_2(PPh_3)_2$ (0.550 g, 5.0 mol%) and CuI (0.303 g, 10 mol%), Et_3N (2.21 g, 1.4 equiv.) and MeCN (31.0 ml, 0.50 M). Subsequently, (trimethylsilyl)acetylene (1.85 g, 1.2 equiv.) was added under nitrogen, and the mixture was stirred for 14 hours at 60 °C. The reaction mixture was filtered through a pad of Celite® and the filtrate was concentrated *in vacuo*. The crude was purified by silica gel flash column chromatography (hexane:EtOAc = 6:1) to afford 2-((trimethylsilyl)ethynyl)isonicotinonitrile (**2b**) as white solid (2.52 g, 12.5 mmol, 80%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.74 (d, J = 5.2 Hz, 1H), 7.67-7.66 (m, 1H), 7.44 (dd, J = 4.8, 1.6 Hz, 1H), 0.28 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 150.7 (CH), 144.2 (C), 128.4 (CH), 123.9 (CH), 120.7 (C), 115.6 (C), 101.5 (C), 98.3 (C), -0.7 (CH_3).

2c (2-Ethynylisonicotinonitrile)

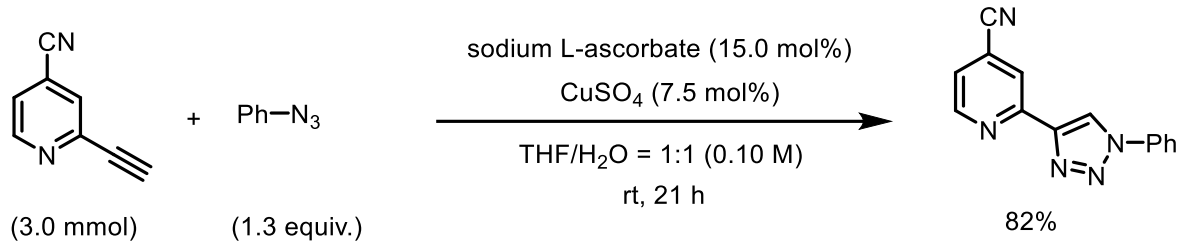


A modified literature procedure was used.[3] To an oven-dried 100 ml round-bottom flask equipped with a stirring bar was added 2-((trimethylsilyl)ethynyl)isonicotinonitrile (0.501 g, 2.50 mmol), CH_2Cl_2 (6.3 mL, 0.40 M), and 1.0 M tetrabutylammonium fluoride (TBAF) solution in THF (2.8 mL, 1.1 equiv.) at 0 °C. The reaction mixture was stirred for 4 hours at the same temperature, at which point the reaction was quenched with water. The organic layer was separated, washed with water, dried over Na_2SO_4, filtered, and concentrated *in vacuo*. The residue was purified by silica gel flash column chromatography (hexane:EtOAc = 3:1) to afford the 2-

ethynylisonicotinonitrile as brown solid (**2c**) (0.234 g, 1.83 mmol, 73%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.76 (d, J = 4.8 Hz, 1H), 7.68 (d, J = 4.0 Hz, 1H), 7.49 (dd, J = 5.2, 1.6 Hz, 1H), 3.31 (s, 1H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 151.0 (CH), 143.6 (C), 128.7 (CH), 124.6 (CH), 120.9 (C), 115.6 (CN), 80.9 (C), 79.9 (CH).

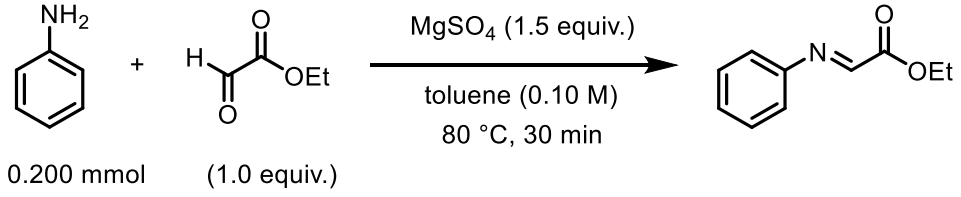
2d (2-(1-Phenyl-1*H*-1,2,3-triazol-4-yl)isonicotinonitrile)



A modified literature procedure was used.[4] To an oven-dried 100 ml round-bottom flask equipped with a stirring bar was added copper sulfate (24.2 mg, 7.5 mol%), sodium L-ascorbate (59.4 mg, 15 mol%), 2-ethynylisonicotinonitrile (0.380 g, 3.00 mmol), THF (15.0 ml), and H_2O (15.0 ml). Phenyl azide (0.471 g, 1.3 equiv.) was then added and the reaction mixture was stirred for 21 hours at room temperature. The reaction mixture was quenched with water. The organic layer was separated, washed with water, dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by silica gel flash column chromatography (hexane:EtOAc = 2:1) to afford the 2-(1-phenyl-1H-1,2,3-triazol-4-yl)isonicotinonitrile (**2d**) as brown solid (0.608 g, 2.48 mmol, 82%).

IR (ATR): 3161, 2236, 2158, 1977, 1595,1542, 1504, 1463, 1357, 1240, 1032, 910, 837 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.78 (dd, J = 4.8, 0.8 Hz, 1H), 8.62 (s, 1H), 8.48 (d, J = 1.4 Hz, 1H), 7.83-7.80 (m, 2H), 7.59-7.55 (m, 2H), 7.51-7.46 (m, 2H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 151.5 (C), 150.5 (CH), 147.3 (C), 136.7 (C), 129.9 (CH), 129.2 (CH), 124.1 (CH), 122.0 (CH), 121.5 (C), 120.8 (CH), 120.5 (CH), 116.4 (C);
HRMS (ESI): Calcd for $C_{14}H_{10}N_5$ $[M+Na]^+$ 270.0750, Found m/z 270.0745.
m.p.: 186.1-193.2 ˚C

1a' (Ethyl 2-(phenylimino)acetate)



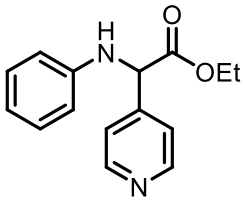
A modified literature procedure was used.[6] To a flame dried Schlenk tube were added the aniline (18.6 mg,

0.200 mmol), ethyl glyoxylate (47% in toluene, 1.0 equiv.), $MgSO_4$ (36.1 mg, 1.5 equiv.) and toluene (2.0 ml). The resulting mixture was stirred at 80 °C for 30 min. The combined organic layers were filtered and concentrated *in vacuo*. The product was used without further purification.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 (s, 1H), 7.44-7.40 (m, 2H), 7.36-7.32 (m, 1H), 7.30-7.27 (m, 2H), 4.43 (q, J = 6.8 Hz, 2H), 1.42 (t, J = 7.2 Hz, 3H).

4. Analytical Data of Products

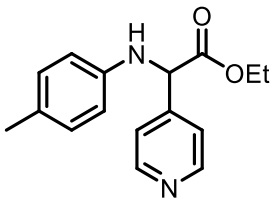
3a



According to General Procedure E, ethyl 2-(phenylamino)-2-(pyridin-4-yl)acetate **3a** was obtained (40.0 mg, 0.156 mmol, 78%) as a yellow solid using ethyl phenylglycinate (35.8 mg, 0.200 mmol).

IR (KBr): 3424, 2977, 2904, 1736, 1607, 1593, 1508, 1366, 1320, 1274, 1225, 1185, 1020 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.59-8.58 (m, 2H), 7.46-7.45 (m, 2H), 7.14-7.10 (m, 2H), 6.73 (t, J = 7.3 Hz, 1H), 6.52-6.50 (m, 2H), 5.16 (s, 1H), 5.16 (s, 1H), 4.27-4.15 (m, 2H), 1.23 (t, J =7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.2 (C), 150.2 (CH), 147.0 (C), 145.3 (C), 129.3 (CH), 122.2 (CH), 118.5 (CH), 113.4 (CH), 62.4 (CH_2), 60.0 (CH), 13.9 (CH_3);
HRMS (ESI): Calcd for $C_{15}H_{17}N_2O_2^+$ $[M+H]^+$ 257.1285, Found m/z 257.1295.
m.p.: 99.4-106.2 ˚C

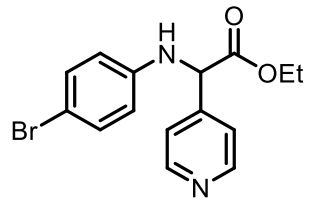
3b



According to General Procedure E, ethyl 2-(pyridin-4-yl)-2-(*p*-tolylamino)acetate **3b** was obtained (43.5 mg, 0.134 mmol, 67%) as a yellow solid using ethyl *p*-tolylglycinate (38.7 mg, 0.200 mmol).

IR (KBr): 3403, 3379, 2988, 2905, 1686, 1619, 1595, 1522, 1368, 1320, 1274, 1220, 1181, 1023, 813 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.58 (d, J = 4.4 Hz, 2H), 7.45 (d, J = 4.4 Hz, 2H), 6.94 (d, J = 8.0 Hz, 2H), 6.43 (d, J = 8.0 Hz, 2H), 5.03 (d, J = 4.8 Hz, 1H), 4.92 (bd, J = 5.6 Hz, 1H), 4.27-4.16 (m, 2H), 2.20 (s, 3H), 1.23 (t, J = 7.2 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.4 (C), 150.2 (CH), 147.1 (C), 143.0 (C), 129.8 (CH), 127.7 (C), 122.2 (CH), 113.5 (CH), 62.3 (CH_2), 60.2 (CH), 20.3 (CH_3), 13.9 (CH_3);
HRMS (ESI): Calcd for $C_{16}H_{19}N_2O_2^+$ $[M+H]^+$ 271.1441, Found m/z 271.1442.
m.p.: 93.3-100.1 ˚C

3c



According to General Procedure E, ethyl 2-((4-bromophenyl)amino)-2-(pyridin-4-yl)acetate **3c** was obtained (43.6 mg, 0.130 mmol, 65%) as a yellow solid using ethyl (4-bromophenyl)glycinate (51.6 mg, 0.200 mmol).

IR (KBr): 3390, 3376, 3071, 3036, 2986, 2907, 1735, 1595, 1506, 1416, 1370, 1323, 1276, 1220, 1179, 1073, 1023, 879, 817, 770 cm^{-1};

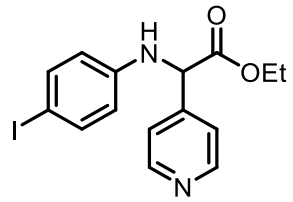
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.60-8.59 (m, 2H), 7.43-7.41 (m, 2H), 7.22-7.18 (m, 2H), 6.39-6.36 (m, 2H), 5.10 (bd, J = 5.2 Hz, 1H), 4.99 (d, J = 5.6 Hz, 1H), 4.28-4.15 (m, 2H), 1.23 (t, J = 7.1 Hz, 4H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 169.9 (C), 150.3 (CH), 146.3 (C), 144.2 (C), 132.0 (CH), 122.1 (CH), 115.0 (CH), 110.3 (C), 62.5 (CH_2), 59.8 (CH), 13.9 (CH_3);

HRMS (ESI): Calcd for $C_{15}H_{16}N_2O_2Br^+$ $[M+H]^+$ 335.0390, Found m/z 335.0375.

m.p.: 99.2-107.6 ˚C

3d



According to General Procedure E, ethyl 2-((4-iodophenyl)amino)-2-(pyridin-4-yl)acetate **3d** was obtained (52.7 mg, 0.138 mmol, 69%) as a yellow solid using ethyl (4-iodophenyl)glycinate (61.0 mg, 0.200 mmol).

IR (KBr): 3375, 3069, 3032, 2985, 2907, 1739, 1591, 1499, 1414, 1371, 1319, 1276, 1221, 1178, 1063, 1020, 878, 812, 773 cm^{-1};

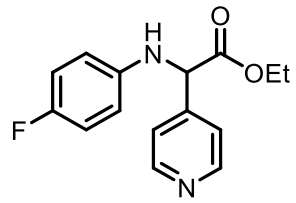
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.60-8.58 (m, 2H), 7.41-7.40 (m, 2H), 7.37-7.35 (m, 2H), 6.29-6.27 (m, 2H), 5.13 (bd, J = 5.5 Hz, 1H), 4.99 (d, J = 4.8 Hz, 1H), 4.27-4.14 (m, 2H), 1.22 (t, J = 7.1 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 169.9 (C), 150.3 (CH), 146.2 (C), 144.8 (C), 137.9 (CH), 122.0 (CH), 115.5 (CH), 79.5 (C), 62.5 (CH_3), 59.6 (CH), 13.9 (CH_3);

HRMS (ESI): Calcd for $C_{15}H_{16}N_2O_2I^+$ $[M+H]^+$ 383.0251, Found m/z 383.0263.

m.p.: 96.5-103.2 ˚C

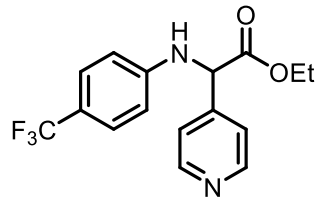
3e



According to General Procedure E, ethyl 2-((4-fluorophenyl)amino)-2-(pyridin-4-yl)acetate **3e** was obtained (40.1 mg, 0.0140 mmol, 72%) as an orange solid using ethyl (4-fluorophenyl)glycinate (39.4 mg, 0.200 mmol).

IR (KBr): 3402, 3381, 3248, 3037, 2991, 1745, 1600, 1510, 1417, 1332, 1222, 1186, 1020, 825, 701 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.60 (d, J = 6.0 Hz, 2H), 7.44-7.43 (m, 2H), 6.85-6.81 (m, 2H), 6.45-6.42 (m, 2H), 4.98 (d, J = 5.2 Hz, 1H), 4.95 (bd, J = 5.6 Hz, 1H), 4.27-4.15 (m, 2H), 1.22 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.2 (C), 156.3 (d, J = 237.9 Hz, C), 150.3 (CH), 146.7 (C), 141.7 (d, J = 1.9 Hz, C), 122.2 (C), 115.8 (d, J = 27.3 Hz, CH), 114.3 (d, J = 7.7 Hz, CH), 62.5 (CH_2), 60.5 (CH), 13.9 (CH_3);
^{19}F NMR (376 MHz, $CDCl_3$): δ -126.4 (s, 1F);
HRMS (ESI): Calcd for $C_{15}H_{16}N_2O_2F^+$ $[M+H]^+$ 275.1190, Found m/z 275.1191.
m.p.: 91.4-98.1 ˚C

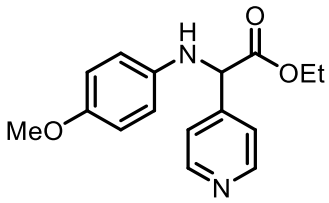
3f



According to General Procedure E, ethyl 2-(pyridin-4-yl)-2-((4-(trifluoromethyl)phenyl)amino)acetate **3f** was obtained (11.0 mg, 0.0340 mmol, 17%) as a yellow solid using ethyl (4-(trifluoromethyl)phenyl)glycinate (49.4 mg, 0.200 mmol).

IR (KBr): 3389, 3262, 3037, 2988, 1734, 1616, 1539, 1419, 1319, 1186, 1110, 1021, 828, 733 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.61-8.60 (m, 2H), 7.43-7.42 (m, 2H), 7.35 (d, J = 8.0 Hz, 2H), 6.51 (d, J = 8.8 Hz, 2H), 5.44 (bd, J = 5.2 Hz, 1H), 5.07 (d, J = 4.8 Hz, 1H), 4.29-4.16 (m, 2H), 1.23 (t, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 169.7 (C), 150.4 (C), 147.7 (C), 146.0 (C), 126.7 (q, J = 3.8 Hz, CH), 124.6 (q, J = 271.6 Hz, C), 122.0 (CH), 120.2 (q, J = 32.8 Hz, C), 112.7 (CH), 62.7 (CH_2), 59.4 (CH), 13.9 (CH_3);
^{19}F NMR (376 MHz, $CDCl_3$): δ -61.2 (s, 3F);
HRMS (ESI): Calcd for $C_{15}H_{16}N_2O_2F_3^+$ $[M+H]^+$ 325.1158, Found m/z 325.1132.
m.p.: 68.1-74.4 ˚C

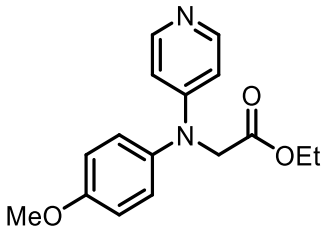
3g



According to General Procedure E, ethyl 2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetate **3g** was obtained (22.3 mg, 0.0780 mmol, 39%) as an orange solid using ethyl (4-methoxyphenyl)glycinate (41.9 mg, 0.200 mmol). When according to General Procedure F, **2c** was obtained (44.7 mg, 0.156 mmol, 78%).

IR (KBr): 3371, 2986, 2935, 2835, 1729, 1594, 1515, 1240, 1177, 1042, 823, 782 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.58 (d, J = 6.0 Hz, 2H), 7.45-7.43 (m, 2H), 6.72-6.69 (m, 2H), 6.50-6.46 (m, 2H), 4.98 (d, J = 5.2 Hz, 1H), 4.78 (bd, J = 5.6 Hz, 1H), 4.25-4.14 (m, 2H), 3.69 (s, 3H), 1.22 (t, J = 7.1 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.5 (C), 152.7 (C), 150.2 (CH), 147.1 (C), 139.5 (C), 122.2 (CH), 114.9 (CH), 114.7 (CH), 62.3 (CH_2), 60.9 (CH), 55.6 (CH_3), 13.9 (CH_3);
HRMS (ESI): Calcd for $C_{16}H_{18}N_2O_3Na^+$ $[M+H]^+$ 309.1210, Found m/z 309.1183.
m.p.: 83.2-86.9 ˚C

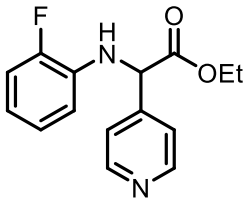
3g'



According to General Procedure E, ethyl *N*-(4-methoxyphenyl)-*N*-(pyridin-4-yl)glycinate **3g'** was obtained (16.0 mg, 0.0560 mmol, 28%) as an orange solid using ethyl (4-methoxyphenyl)glycinate (41.9 mg, 0.200 mmol).

IR (KBr): 3020, 2974, 2844, 1750, 1607, 1550, 1509, 1379, 1294, 1247, 1202, 1100, 1029, 986, 809, 751 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.16 (d, J = 6.4 Hz, 2H), 7.26-7.22 (m, 2H), 6.95-6.91 (m, 2H), 6.35-6.34 (m, 2H), 4.32 (s, 2H), 4.20 (q, J = 7.2 Hz, 2H), 3.81 (s, 3H), 1.25 (t, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 169.6 (C), 158.5 (C), 153.4 (C), 149.9 (CH), 137.5 (C), 129.2 (CH), 115.2 (CH), 107.7 (CH), 61.4 (CH_3), 55.4 (CH_3), 53.5 (CH_2), 14.1 (CH_3);
HRMS (ESI): Calcd for $C_{16}H_{19}N_2O_3^+$ $[M+H]^+$ 287.1390, Found m/z 287.1397.
m.p.: 78.0-87.8 ˚C

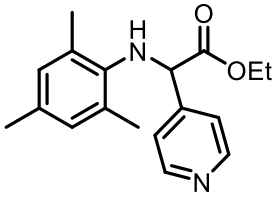
3h



According to General Procedure E, ethyl 2-((2-fluorophenyl)amino)-2-(pyridin-4-yl)acetate **3h** was obtained (18.1 mg, 0.0661 mmol, 33%) as a yellow solid using ethyl (2-fluorophenyl)glycinate (39.4 mg, 0.200 mmol).

IR (KBr): 3430, 2986, 2927, 2905, 1743, 1623, 1596, 1517, 1324, 1273, 1221, 1183, 798, 751 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.61 (d, J = 5.6 Hz, 2H), 7.45 (d, J = 6.0 Hz, 2H), 7.01 (ddd, J = 11.8, 5.5, 1.6 Hz, 1H), 6.84 (t, J = 7.8 Hz, 1H), 6.68-6.65 (m, 1H), 6.31 (td, J = 8.8, 1.6 Hz, 1H), 5.30 (bs, 1H), 5.06 (d, J = 5.2 Hz, 1H), 4.29-4.17 (m, 2H), 1.24 (t, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 169.8 (C), 151.6 (d, J = 241.7 Hz, C), 150.3 (CH), 146.5 (CH), 133.8 (d, J = 11.5 Hz, C), 124.5 (d, J = 2.9 Hz, CH), 122.1 (CH), 118.2 (d, J = 7.7 Hz, CH) 114.8 (d, J = 18.4 Hz, CH), 112.9 (d, J = 1.9 Hz, CH), 62.5 (CH_2), 59.7 (CH), 13.9 (CH_3);
^{19}F NMR (376 MHz, $CDCl_3$): δ -135.0 (s, 1F).
HRMS (ESI): Calcd for $C_{15}H_{16}N_2O_2F^+$ $[M+H]^+$ 275.1190, Found m/z 275.1196.
m.p.: 87.0-93.9 ˚C

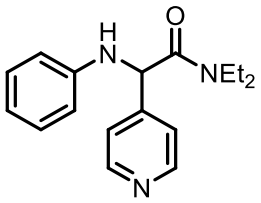
3i



According to General Procedure E, ethyl 2-(mesitylamino)-2-(pyridin-4-yl)acetate **3i** was obtained (22.1 mg, 0.0738 mmol, 37%) as an orange oil using ethyl mesitylglycinate (44.3 mg, 0.200 mmol).

IR (KBr): 3375, 3028, 2982, 2919, 2862, 1730, 1597, 1487, 1205, 1177, 1018, 856, 753 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.60-8.58 (m, 2H), 7.43-7.42 (m, 2H), 6.78 (s, 2H), 4.80 (s, 1H), 4.38 (bs, 1H), 4.21-4.13 (m, 2H), 2.20 (s, 3H), 2.18 (s, 6H), 1.20 (t, J = 7.6 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 172.4 (C), 149.9 (CH), 147.8 (C), 141.5 (C), 131.5 (C), 129.7 (CH), 128.9 (C), 122.0 (CH), 63.5 (CH), 62.0 (CH_2), 20.4 (CH_3), 18.8 (CH_3), 13.9 (CH_3);
HRMS (ESI): Calcd for $C_{17}H_{21}N_3ONa^+$ $[M+Na]^+$ 306.1577, Found m/z 306.1572.

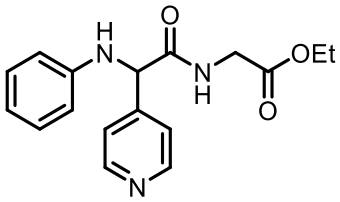
3j



According to General Procedure E, *N,N*-diethyl-2-(phenylamino)-2-(pyridin-4-yl)acetamide **3j** was obtained (31.2 mg, 0.110 mmol, 55%) as an orange liquid using *N,N*-diethyl-2-(phenylamino)acetamide (41.3 mg, 0.200 mmol).

IR (KBr): 3338, 3030, 2977, 2936, 1938, 1835, 1643, 1603, 1563, 1507, 1463, 1425, 1123, 1070, 994, 912, 796, 752, 731, 694 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.58-8.56 (m, 2H), 7.38-7.37 (m, 2H), 7.15-7.10 (m, 2H), 6.71-6.67 (m, 1H), 6.63-6.60 (m, 2H), 5.34 (bs, 1H), 5.24 (s, 1H), 3.52-3.42 (m, 2H), 3.35-3.25 (m, 2H), 1.10-1.06 (m, 6H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 168.6 (C), 150.2 (CH), 147.9 (C), 145.8 (C), 129.3 (CH), 122.6 (CH), 118.2 (C), 113.5 (CH), 57.1 (CH), 41.7 (CH_3), 40.8 (CH_3), 14.1 (CH_3), 12.6 (CH_3);
HRMS (ESI): Calcd for $C_{18}H_{22}N_2O_2Na^+$ $[M+Na]^+$ 321.1573, Found m/z 321.1578.

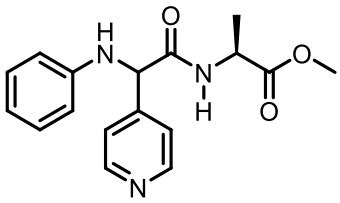
3k



According to General Procedure E, ethyl (2-(phenylamino)-2-(pyridin-4-yl)acetyl)glycinate **3k** was obtained (40.7 mg, 0.130 mmol, 65%) as a yellow solid using ethyl phenylglycylglycinate (47.3 mg, 0.200 mmol).

IR (ATR): 3344, 3329, 3318, 3301, 3049, 3028, 2981, 2964, 2934, 1739, 1661, 1596, 1503, 1414, 1255, 1020, 750, 691 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.60-8.58 (m, 2H), 7.43-7.41 (m, 2H), 7.29-7.27 (bt, J = 4.8 Hz, 1H), 7.20-7.16 (m, 2H), 6.81 (t, J = 7.2 Hz, 1H), 6.62 (d, J = 7.6 Hz, 2H), 4.85 (d, J = 3.6 Hz, 1H), 4.67 (bd, J = 3.2 Hz, 1H), 4.20-4.12 (m, 3H), 3.93-3.87 (m, 1H), 1.24 (t, J = 6.8 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.1 (C), 169.3 (C), 150.5 (CH), 147.1 (C), 145.9 (C), 129.4 (CH), 122.3 (CH), 119.5 (CH), 113.9 (CH), 62.7 (CH_2), 61.6 (CH), 41.3 (CH_2), 14.0 (CH_3);
HRMS (ESI): Calcd for $C_{19}H_{23}N_3O_3^+$ $[M+H]^+$ 342.1812, Found m/z 342.1805.
m.p.: 99.3-101.1 ˚C

3l



According to General Procedure E, methyl (2-(phenylamino)-2-(pyridin-4-yl)acetyl)-L-alaninate **3l** was obtained (50.1 mg, 0.160 mmol, 80%, *d.r.* = 1:1) as a yellow gum using methyl phenylglycyl-L-alaninate (47.3 mg, 0.200 mmol).

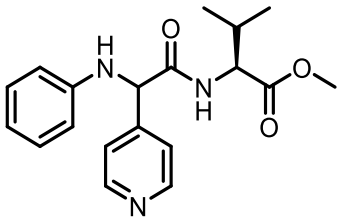
IR (KBr): 3327, 3054, 3037, 2953, 1744, 1669, 1601, 1507, 1436, 1319, 1219, 1156, 1056, 994, 753, 694 cm^{-1};

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.59-8.58 (m, 2H), 7.41-7.31 (m, 3H), 7.20-7.15 (m, 2H), 6.83-6.77 (m, 1H), 6.62-6.59 (m, 2H), 4.84-4.81 (m, 1H), 4.77-4.65 (m, 1H), 4.62-4.53 (m, 1H), 3.70 (s, 3H), 3.64 (s, 3H), 1.39 (d, J = 6.8 Hz, 3H), 1.31 (d, J = 7.6 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 172.9 (C), 172.5 (C), 169.4 (C), 169.4 (C), 150.4 (CH), 150.4 (CH), 147.3 (C) , 147.1 (C), 145.8 (C), 145.8 (C), 129.4 (CH), 129.3 (CH), 122.4 (CH), 122.1 (CH), 119.5 (C), 119.3 (C), 113.9 (CH), 113.8 (CH), 62.8 (CH), 62.5(CH), 52.5 (CH_3), 52.4 (CH_3), 48.2 (CH), 48.0 (CH), 18.0 (CH_3), 17.9 (CH_3,);

HRMS (ESI): Calcd for $C_{17}H_{19}N_3O_3Na^+$ $[M+Na]^+$ 336.1319, Found m/z 336.1318.

3m



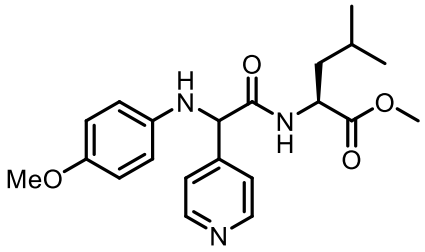
According to General Procedure E, methyl (2-(phenylamino)-2-(pyridin-4-yl)acetyl)-L-valinate **3m** was obtained (49.2 mg, 0.144 mmol, 72%, *d.r.* = 1.3:1) as a yellow gum using methyl phenylglycyl-L-valinate (52.9 mg, 0.200 mmol).

IR (ATR): 3329, 3318, 3301, 3049, 2964, 1737, 1659, 1597, 1504, 1433, 1313, 1207, 1180, 994, 909, 729 691 cm^{-1};

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.62-8.60 (m, 2H), 7.44-7.40 (m, 2H), 7.20-7.11 (m, 3H), 6.83-6.79 (m, 1H), 6.64-6.61 (m, 2H), 4.86 (s, 1H, minor), 4.84 (s, 1H, major), 4.72 (bs, 1H, minor), 4.66 (bs, 1H, major), 4.55 (dd, J = 8.8, 4.8 Hz, 1H, major), 4.50 (dd, J = 8.8, 4.8 Hz, 1H, minor), 3.72 (s, 3H, major), 3.61 (s, 3H, minor), 2.19-2.10 (m, 1H), 0.89 (d, J = 6.8 Hz, 3H, minor), 0.86 (d, J = 6.8 Hz, 3H, minor), 0.77 (d, J = 6.8 Hz, 3H, major), 0.68 (d, J = 6.8 Hz, 3H, major);

^{13}C NMR (101 MHz, $CDCl_3$): δ 172.0 (C, major), 171.4 (C, minor), 169.8 (C, minor), 169.6 (C, major), 150.5 (CH, major), 150.5 (CH, minor), 147.4 (C, major), 147.3 (C, minor), 145.8 (C, minor), 145.7 (C, major), 129.4 (CH, major), 129.3 (C, minor), 122.4 (C, major), 122.1 (CH, minor), 119.6 (C, major), 119.6 (C, minor), 114.1 (CH, minor), 113.9 (CH, major), 63.0 (CH, minor), 62.8 (CH, major), 57.4 (CH, minor), 57.0 (CH, major), 52.2 (CH_3, major), 52.1 (CH_3, minor), 31.1 (CH, minor), 31.1 (CH, major), 18.9 (CH_3, minor), 18.9 (CH_3, major), 17.7 (CH_3, minor), 17.2 (CH_3, major);
HRMS (ESI): Calcd for $C_{19}H_{23}N_3O_3^+$ $[M+H]^+$ 342.1812, Found m/z 342.1805.

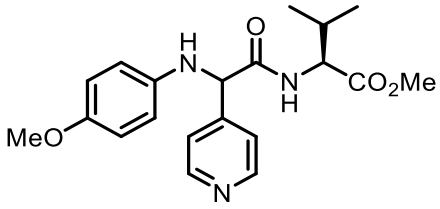
3n



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-leucinate **3n** was obtained (50.1 mg, 0.130 mmol, 65%, *d.r.* = 1.3:1) as a yellow gum using methyl (4-methoxyphenyl)glycyl-L-leucinate (61.7 mg, 0.200 mmol).

IR (KBr): 3335, 3310, 2956, 1745, 1661, 1600, 1515, 1240, 1155, 1035, 823 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.61-8.60 (m, 2H), 7.42-7.40 (m, 2H, major), 7.37-7.36 (m, 2H, minor), 7.28-7.26 (m, 1H, major), 7.19-7.17 (m, 1H, minor), 6.79-6.75 (m, 2H), 6.63-6.57 (m, 2H), 4.73 (s, 1H), 4.65-4.56 (m, 1H), 4.31 (br, 1H, minor), 4.26 (br, 1H, major) 3.73 (s, 3H, major), 3.73 (s, 3H, minor), 3.70 (s, 3H, major), 3.64 (s, 3H, minor)1.67-1.34 (m, 3H), 0.90-0.86 (m, 3H), 0.89, (d, J = 6.4 Hz, 3H, minor), 0.87 (d, J = 6.4 Hz, 3H, minor), 0.83 (d, J = 6.4 Hz, 3H, major), 0.79 (d, J = 6.4 Hz, 3H, major)
^{13}C NMR (101 MHz, $CDCl_3$): δ 173.0 (C, major), 172.5 (C, minor), 170.0 (C, minor), 169.9 (C, major), 153.5 (C, minor), 153.5 (C, major)150.4 (CH, major), 150.4 (C, minor), 147.3 (C, minor), 147.2 (C, major), 139.9 (C, minor), 139.7 (C, major), 122.4 (CH, major), 122.1 (CH, minor), 115.6 (CH, minor), 115.1 (CH, major), 114.8 (CH, major), 114.8 (CH, minor), 64.0 (CH, minor), 63.7 (CH, major), 55.6 (CH_3, major), 55.6 (CH_3, minor), 52.3 (CH_3, major), 52.2 (CH_3, minor), 50.8 (CH, minor), 50.5 (CH, major), 41.0 (CH_2, minor), 40.9 (CH_2, major), 24.9 (CH_3, minor), 24.6 (CH_3, major), 22.7 (CH, major), 22.7 (CH, minor), 21.6 (CH_3, minor), 21.4 (CH_2, major);
HRMS (ESI): Calcd for $C_{21}H_{27}N_3O_4Na^+$ $[M+Na]^+$ 408.1894, Found m/z 408.1889.

3o



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-valinate **3o** was obtained (49.2 mg, 0.132 mmol, 66%, *d.r.* = 1.4:1) as a yellow solid using methyl (4-methoxyphenyl)glycyl-L-valinate (58.9 mg, 0.200 mmol).

IR (ATR): 3328, 3320, 2961, 2934, 2908, 1737, 1659, 1597, 1505, 1464, 1436, 1235, 1207, 1149, 818, 783, 754 cm^{-1};

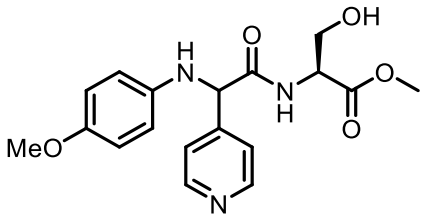
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.57-8.56 (m, 2H), 7.40-7.34 (m, 3H), 6.76-6.73 (m, 2H), 6.60-6.57 (m, 2H), 4.76-4.74 (m, 1H), 4.51 (dd, J = 8.8, 4.4 Hz, 1H, major), 4.48 (dd, J = 8.8, 4.8 Hz, 1H, minor), 4.41 (bs, 1H), 3.71 (s, 3H, major), 3.70 (s, 3H, minor), 3.69 (s, 3H, major), 3.61 (s, 3H, minor), 2.18-2.08 (m, 1H), 0.85 (d, J = 6.8 Hz, 3H, minor), 0.84 (d, J = 6.4 Hz, 3H, minor), 0.77 (d, J = 6.8 Hz, 3H, major), 0.68 (d, J = 6.8 Hz, 3H, major);

^{13}C NMR (101 MHz, $CDCl_3$): δ 172.0 (C, major), 171.5 (C, minor), 170.2 (C, minor), 169.9 (C, major), 153.4 (C, minor), 153.4 (C, major), 150.4 (CH, major), 150.3 (CH, minor), 147.3 (C, major), 147.3 (C, minor), 139.8 (C, minor), 139.7 (C, major), 122.3 (CH, major), 122.0 (CH, minor), 115.6 (CH, minor), 115.1 (CH, major), 114.8 (CH, major), 114.7 (CH, minor), 64.0 (CH, minor), 63.6 (CH, major), 57.2 (CH, minor), 56.9 (CH, major), 55.6 (CH_3, major), 55.5 (CH_3, minor) 52.1 (CH_3, major), 52.0 (CH_3, minor), 31.0 (CH, minor), 30.9 (CH, major), 18.9 (CH_3), 18.9 (CH_3), 17.7 (CH, minor), 17.2 (CH, major);

HRMS (ESI): Calcd for $C_{20}H_{26}N_3O_4^+$ $[M+H]^+$ 3721918, Found m/z 372.1906.

m.p.: 137.2-144.0 ˚C

3p



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-serinate **3p** was obtained (48.7 mg, 0.136 mmol, 68%, *d.r.* = 1.1:1) as a yellow solid using methyl (4-methoxyphenyl)glycyl-L-serinate (56.5 mg, 0.200 mmol).

IR (ATR): 3359, 3312, 2948, 2935, 1736, 1658, 1602, 1509, 1463, 1233, 1031, 820, 512 cm^{-1};

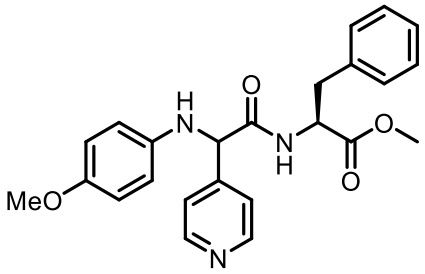
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.56-8.52 (m, 2H), 7.70 (d, J = 8.4 Hz, 1H, major), 7.64 (d, J = 7.6 Hz, 1H, minor), 7.43-7.42 (m, 2H, major), 7.40-7.39 (m, 2H, minor), 6.78-6.76 (m, 2H), 6.62-6.59 (m, 2H), 4.78 (d, J = 2.4 Hz, 1H), 4.69-4.60 (m, 1H), 4.35 (bs, 1H), 4.04-3.79 (m, 2H), 3.75 (s, 3H, major), 3.73 (s, 6H), 3.68 (3H, minor);

^{13}C NMR (101 MHz, $CDCl_3$): δ 170.5 (C, major), 170.5 (C, mimor), 170.3 (C), 170.3 (C), 153.6 (C, major), 153.5 (C, minor), 150.3 (CH, major), 150.3 (CH, minor), 147.4 (C, minor), 147.2 (C, major), 139.8 (C, minor), 139.8 (C, major), 122.5 (CH, major), 122.3 (CH, minor), 115.5 (CH, minor), 115.2 (CH, major), 114.9 (CH, major), 114.9 (CH, minor), 63.8 (CH_2), 63.8 (CH_2, major), 62.7 (CH, major), 62.6 (CH, minor), 55.6 (CH_3, major), 55.6 (CH_3, minor), 54.7 (CH), 54.4 (CH), 52.8 (CH_3, major), 52.7 (CH_3, minor);

HRMS (ESI): Calcd for $C_{18}H_{22}N_3O_5^+$ $[M+H]^+$ 360.1554, Found m/z 360.1558.

m.p.: 122.1-127.9 ˚C

3q



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-phenylalaninate **3q** was obtained (50.3 mg, 0.120 mmol, 60%, *d.r.* = 1.6:1) as a yellow gum using methyl (4-methoxyphenyl)glycyl-L-phenylalaninate (68.5 mg, 0.200 mmol).

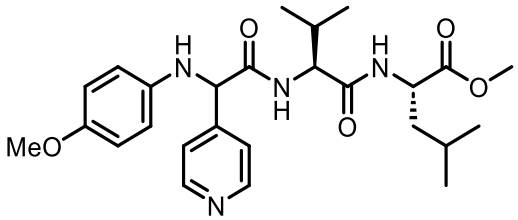
IR (KBr): 3337, 3031, 2953, 2834, 1744, 1669, 1600, 1513, 1457, 1440, 1416, 1238, 1179, 1036, 822, 702 cm^{-1};

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.59-8.57 (m, 2H, major), 8.50-8.49 (m, 2H, minor), 7.36-7.02 (m, 8H), 6.78-6.73 (m, 3H), 6.61-6.49 (m, 2H), 4.96-4.84 (m, 1H), 4.69 (s, 1H, major), 4.64 (s, 1H, minor), 4.1あたり (bs追加), 3.75-3.68 (m, 6H), 3.26 (dd, 1H ,minor), 3.28-2.96 (m, 2H, major + 1H, minor);

^{13}C NMR (101 MHz, $CDCl_3$): δ 171.5 (C, major), 171.3 (C, minor), 169.9 (C, minor), 169.5 (C, major), 153.6 (C, minor), 153.4 (C, major), 150.5 (CH, major), 150.4 (CH, minor), 147.1 (C, major), 146.8 (C, minor), 139.9 (C, minor), 139.7 (C, major), 135.7 (C, minor), 135.0 (C, major), 129.1 (CH, minor), 129.0 (CH, major), 128.7 (CH, minor), 128.6 (CH, major), 127.2 (CH, minor), 127.1 (CH, major), 122.4 (CH, major), 122.1 (CH, minor), 115.6 (CH, minor), 115.0 (CH, major), 114.9 (CH, major), 114.8 (CH, minor), 64.3 (CH, minor), 63.5 (CH, major), 55.7 (CH_3, major), 55.6 (CH_3, minor), 53.0 (CH, minor), 52.6 (CH, major), 52.4 (CH_3), 52.4 (CH_3), 37.6 (CH_2, major), 37.4 (CH_2, minor);

HRMS (ESI): Calcd for $C_{24}H_{25}N_3O_4Na^+$ $[M+Na]^+$ 442.1737, Found m/z 442.1737.

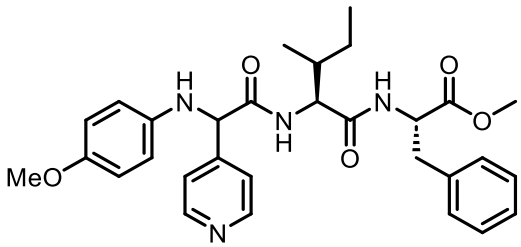
3r



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-valyl-L-leucinate **3r** was obtained (63.0 mg, 0.130 mmol, 65%, *d.r.* = 1.3:1) as a yellow solid using methyl (4-methoxyphenyl)glycyl-L-valyl-L-leucinate (81.5 mg, 0.200 mmol).

IR (KBr): 3288, 2961, 1747, 1646, 1239, 1210, 1039, 822 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.57-8.54 (m, 2H), 7.81 -7.68 (m, 1H), 7.40-7.37 (m, 2H), 7.16-7.03 (br, 1H), 6.74-6.70 (m, 2H), 6.61-6.54 (m, 2H), 4.95 (m, 1H, minor), 4.88 (m, 1H, major), 4.65-4.50 (m, 2H), 4.38-4.32 (m, 1H), 3.71-3.68 (m, 6H), 2.08-1.93 (m, 1H), 1.59-1.24 (m, 3H), 0.88-0.63 (m, 12H);
^{13}C NMR (151 MHz, $CDCl_3$): δ 173.1 (C, major), 173.1 (C, minor), 171.0 (C, major), 170.8 (C, minor), 170.4 (C, minor), 170.2 (C, major), 153.2 (CH, minor), 153.1 (CH, major), 150.3 (C, major), 150.2 (C, minor), 147.7 (C, major), 147.5 (C, minor), 139.8 (C, minor), 139.6 (major), 122.3 (CH, major), 121.8 (C, minor), 115.4 (CH, minor), 115.0 (CH, major), 114.8 (CH, minor), 114.8 (CH, major), 63.1 (CH, minor), 63.0 (CH, major), 58.6 (CH, major), 58.3 (CH, minor), 55.6 (CH_3, major), 55.5 (CH_3, minor), 52.2 (CH_3, minor), 52.2 (CH_3, major), 50.7 (CH, major), 50.5 (CH, minor), 40.9 (CH_2, major), 40.7 (CH_2, minor), 31.2 (CH, major), 31.1 (CH, minor), 24.7 (CH, minor), 24.7 (CH, major), 22.7 (CH_3, minor), 22.6 (CH_3, major), 21.6 (CH_3, major), 21.5 (CH_3, minor), 19.0 (CH_3, major), 19.0 (CH_3, minor), 18.1 (CH_3, minor), 17.9 (CH_3, major);
HRMS (ESI): Calcd for $C_{26}H_{37}N_4O_5$ $[M+H]^+$ 485.2758, Found m/z 485.2764.
m.p.: 181.6-189.3 ˚C

3s



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-alloisoleucyl-L-phenylalaninate **3s** was obtained (72.4 mg, 0.136 mmol, 68%, *d.r.* = 1.3:1) as a yellow solid using methyl (4-methoxyphenyl)glycyl-L-alloisoleucyl-L-phenylalaninate (91.1 mg, 0.200 mmol).

IR (KBr): 3281, 3065, 2964, 1740, 1678, 1601, 1514, 1239, 1037, 822, 701 cm^{-1};

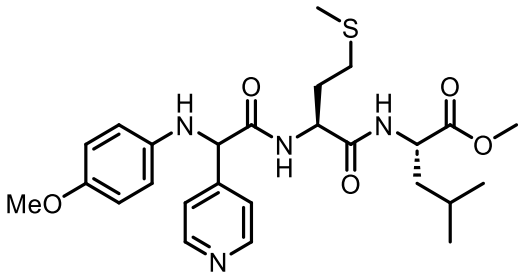
^{1}H NMR (600 MHz, $CDCl_3$): δ 8.61-8.60 (m, 2H, minor), 8.59-8.58 (m, 2H, major), 7.38 (m, 2H), 7.33 (bd, *J* = 8.4 Hz, 1H, major), 7.29 (bd, *J* = 8.4 Hz, 1H, minor), 7.24-7.19 (m, 3H), 7.00-6.99 (m, 2H, major), 6.96-6.95 (m, 2H, minor), 6.78-6.75 (m, 2H), 6.61-6.57 (m, 2H), 6.35-6.34 (m, 1H, major), 6.24-6.23 (m, 1H, minor), 4.84-4.75 (m, 2H), 4.37 (bs, 1H), 4.27-4.24 (m, 1H), 3.73 (s, 3H, major), 3.71 (s, 3H, minor), 3.70 (s, 3H, minor), 3.69 (s, 3H, major), 3.04 (d, *J* = 4.0 Hz, 1H), 3.01 (dd, *J* = 9.2, 4.0 Hz, 1H, major), 2.83 (dd, *J* = 9.2, 4.8 Hz, 1H,minor), 1.87-1.73 (m, 1H), 1.25-1.16 (m, 1H), 0.97-0.70 (m, 7H);

^{13}C NMR (151 MHz, $CDCl_3$): δ 171.5 (C, minor), 171.4 (C, major), 170.3 (C, major), 170.0 (C, minor), 169.9 (C, minor), 169.8 (C, major), 153.6 (C, minor), 153.4 (C, major), 150.6 (CH, major), 150.5 (CH, minor), 147.4 (C, major), 147.1 (C, minor), 139.7 (C, minor), 139.6 (C, major), 135.5 (C, minor), 135.3 (C, major), 129.1 (CH, major), 129.0 (CH, minor), 128.6 (CH, major), 128.6 (CH, minor), 127.2 (CH, major), 127.1 (CH, minor), 122.2 (CH, major), 122.0 (CH, minor), 115.4 (CH, minor), 115.1 (CH, major), 115.0 (CH, minor), 114.8 (CH, major), 63.9 (CH, minor), 63.5 (CH, major), 57.7 (CH, minor), 57.4 (CH, major), 55.6 (CH_3, major), 55.6 (CH_3, minor), 53.1 (CH_3, major), 53.0 (CH_3, minor), 52.4 (CH, major), 52.4 (CH, minor), 37.7 (CH_2, major), 37.7 (CH_2, minor), 37.2 (CH, major), 37.1 (CH, minor), 24.6 (CH_2, minor), 24.5 (CH_2, major), 15.2 (CH_3, minor), 15.2 (CH_3, major), 11.3 (CH_3, minor), 10.9 (CH_3, major);

HRMS (ESI): Calcd for $C_{30}H_{36}N_4O_5Na^+$ $[M+Na]^+$ 555.2578, Found m/z 555.2574.

m.p.: 153.9-158.3 ˚C

3t



According to General Procedure F, methyl (2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetyl)-L-methionyl-L-leucinate **3t** was obtained (72.3 mg, 0.140 mmol, 70%, *d.r.* = 1.3:1) as a yellow solid using methyl (4-methoxyphenyl)glycyl-L-methionyl-L-leucinate (87.9 mg, 0.200 mmol).

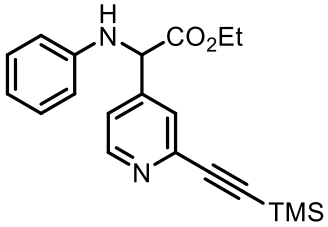
IR (KBr): 3306, 3300, 3284, 3060, 2959, 2915, 1743, 1648, 1588, 1540, 1515, 1440, 1239, 1152, 1038, 824 cm^{-1};

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.57 (d, *J* = 4.4 Hz, 2H), 7.67 (bd, *J* = 7.6 Hz, 1H), 7.38-7.36 (m, 2H), 6.91-6.79 (m, 1H), 6.74 (t, *J* = 9.6 Hz, 2H), 6.55 (dd, *J* = 9.2, 2.8 Hz, 2H), 4.80 (d, *J* = 4.0 Hz, 1H, minor), 4.75 (d, *J* = 3.6 Hz, 1H, major), 4.65 (m, 1H), 4.54-4.38 (m, 2H), 3.71-3.69 (m, 6H), 2.50 (bt, *J* = 6.8 Hz, 1H), 2.37-2.34 (m, 1H), 2.03-1.86 (m, 5H), 1.57-1.40 (m, 3H), 0.84-0.80 (m, 6H);

^{13}C NMR (151 MHz, $CDCl_3$): δ 173.1 (C, major), 173.0 (C, minor), 170.8 (C, major), 170.5 (C, minor), 170.4 (C, minor), 170.4 (C, major), 153.5 (C, major), 153.4 (C, minor), 150.5 (CH, major), 150.4 (CH, minor), 147.4 (C, minor), 147.4 (CH, major), 139.8 (C, minor), 139.7 (C, major), 122.4 (CH, major), 122.2 (CH, minor), 115.4

(CH, minor), 115.2 (CH, major), 115.0 (CH, major), 115.0 (CH, minor), 63.5 (CH, major), 63.3 (CH, minor), 55.7 (CH_3, major), 55.7 (CH_3, minor), 52.5 (CH_3, major), 52.4 (CH_3, minor), 52.2 (CH, minor), 51.8 (CH, major), 51.0 (major), 50.9 (CH, minor), 41.0 (CH_2, major), 40.9 (CH_2, minor), 31.3 (CH_2, minor), 31.3 (CH_2, major), 29.9 (CH_2, minor), 29.6 (CH_2, major), 24.9 (CH, minor), 24.8 (CH, major), 22.8 (CH_3, minor), 22.8 (CH_3, major), 21.8 (CH_3, major), 21.7 (CH_3, minor), 15.1 (CH_3, minor), 15.1 (CH_3, major);
HRMS (ESI): Calcd for $C_{26}H_{36}N_4O_5SNa^+$ $[M+Na]^+$ 539.2299, Found m/z 539.2273.
m.p.: 120.4-128.0 ˚C

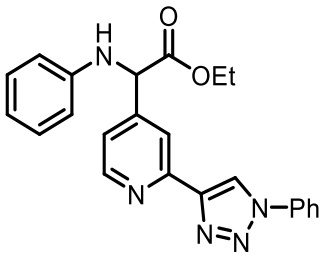
3u



According to General Procedure E, ethyl 2-(phenylamino)-2-(2-((trimethylsilyl)ethynyl)pyridin-4-yl)acetate **3u** was obtained (48.6 mg, 0.144 mmol, 69%) as a yellow oil using ethyl phenylglycinate (35.8 mg, 0.200 mmol).

IR (ATR): 3395, 3051, 2960, 2899, 1735, 1590, 1503, 1248, 1162, 1019, 840 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.54 (d, J = 5.2 Hz, 1H), 7.63 (s, 1H), 7.39 (dd, J = 5.2, 1.6 Hz, 1H), 7.15-7.11 (m, 2H), 6.74 (t, J = 7.2 Hz, 1H), 6.49 (d, J = 7.6 Hz, 2H), 5.07 (d, J = 4.8 Hz, 1H), 5.00 (d, J = 4.8 Hz, 1H), 4.30-4.11 (m, 2H), 1.23 (t, J = 7.1 Hz, 3H), 0.27 (s, 9H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 169.9 (C), 150.3 (CH), 147.5 (C), 145.2 (C), 143.5 (C), 129.3 (CH), 125.6 (CH), 121.6 (CH), 118.6 (CH), 113.4 (CH), 103.5 (C), 95.2 (C), 62.5 (CH_2), 59.9 (CH), 13.9 (CH_3), -0.4 (CH_3);
HRMS (ESI): Calcd for $C_{24}H_{24}N_2O_2Si^+$ $[M+H]^+$ 353.1680, Found m/z 353.1693.

3v

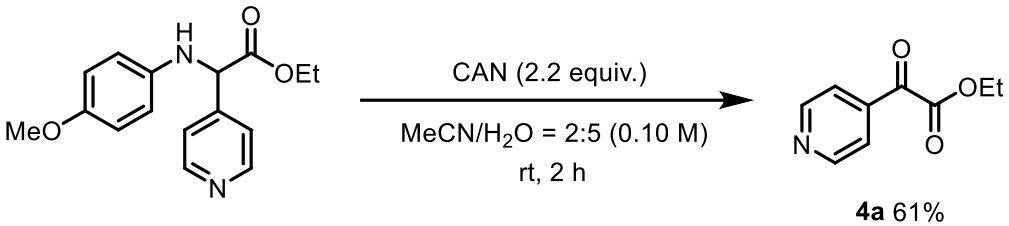


According to General Procedure E, ethyl 2-(2-(1-phenyl-1*H*-1,2,3-triazol-4-yl)pyridin-4-yl)-2-(phenylamino)acetate **3v** was obtained (55.1 mg, 0.144 mmol, 69%) as a white solid using ethyl phenylglycinate (35.8 mg, 0.200 mmol).

IR (ATR): 3406, 3157, 3050, 2986, 1728, 1599, 1508, 1319, 1271, 1235, 1171, 1026, 756, 744, 692, 684 cm^{-1};

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.60 (s, 1H), 8.58 (d, J = 5.2 Hz, 1H), 8.46 (d, J = 0.8 Hz, 1H), 7.81 (d, J = 8.4 Hz, 2H), 7.57-7.53 (m, 2H), 7.48-7.41 (m, 2H), 7.15-7.11 (m, 2H), 6.72 (t, J = 7.2 Hz, 1H), 6.58-6.56 (m, 2H), 5.16 (s, 1H), 5.16 (s, 1H), 4.24 (m, 2H), 1.26-1.23 (t, J = 7.2 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 170.2 (C), 150.4 (C), 150.0 (CH), 148.7 (C), 148.4 (C), 145.3 (C), 136.9 (C), 129.8 (CH), 129.3 (CH), 128.9 (CH), 121.3 (CH), 120.4 (CH), 120.2 (CH), 119.2 (CH), 118.5 (CH), 113.4 (CH), 62.5 (CH_2), 60.1 (CH), 14.0 (CH_3);
HRMS (ESI): Calcd for $C_{23}H_{21}N_5O_2Na^+$ $[M+Na]^+$ 422.1587, Found m/z 422.1577.
m.p.: 127.8-130.2 ˚C

4a (Ethyl 2-oxo-2-(pyridin-4-yl)acetate)



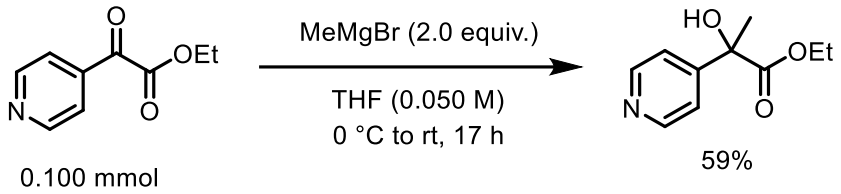
0.600 mmol

4a 61%

A solution of ethyl 2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetate (0.171 g, 0.600 mmol) in MeCN (1.8 ml) and H_2O (4.3 ml) was added ammonium cerium nitrate (CAN, 0.682 g, 2.2 equiv.) and stirred for 2 hours at room temperature. The reaction mixture was quenched with 2N HCl, and the aqueous phase was basified with saturated aq. $NaHCO_3$. The resulting suspension was extracted with EtOAc, and dried over anhydrous $MgSO_4$, filtered, and concentrated *in vacuo*. The residue was purified by silica gel flash column chromatography (hexane:EtOAc = 2:1) to afford the ethyl 2-oxo-2-(pyridin-4-yl)acetate (**4a**) as a yellow oil (76.7 mg, 0.432 mmol, 61%).

IR (ATR): 3291, 2157, 2024, 1977, 1747, 1740, 1605, 1410,1249, 1216, 1135, 1055, 833, 691 cm^{-1};
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.87-8.85 (m, 2H), 7.84-7.83 (m, 2H), 4.46 (q, J = 7.2 Hz, 2H), 1.43 (t, J = 7.3 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 185.0 (C), 161.9 (C), 151.0 (CH), 138.5 (C), 122.4 (CH), 62.9 (CH_2), 14.0 (CH_3);
HRMS (ESI): Calcd for $C_9H_{10}NO_3^+$ $[M+H]^+$ 180.0655, Found m/z 180.0647.

4b (Ethyl 2-hydroxy-2-(pyridin-4-yl)propanoate)



A solution of ethyl 2-oxo-2-(pyridin-4-yl)acetate (17.9 mg, 0.100 mmol) in THF (2.0 ml) was added methylmagnesium bromide (2.0 equiv., 1.0 M in THF) at 0 °C and stirred at room temperature for 17 h. The reaction mixture was quenched with water, and the resulting suspension was concentrated *in vacuo*. The residue was purified by silica gel flash column chromatography (hexane:EtOAc = 1:1) to afford ethyl 2-hydroxy-2-(pyridin-4-yl)propanoate (**4b**) as yellow solid (11.5 mg, 0.118 mmol, 59%). Data are consistent with the literature.[5]

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.58 (bs, 2H), 7.50 (d, J = 6.0 Hz, 2H), 4.31-4.18 (m, 2H), 4.02 (s, 1H), 1.76 (s, 3H), 1.27 (t, J = 7.2 Hz, 3H);
^{13}C NMR (101 MHz, $CDCl_3$): δ 174.5 (C), 151.6 (C), 149.8 (CH), 120.4 (CH), 75.0 (C), 63.0 (CH_2), 26.7 (CH_3), 14.0 (CH_3).

5. Mechanistic Studies

Control Experiments

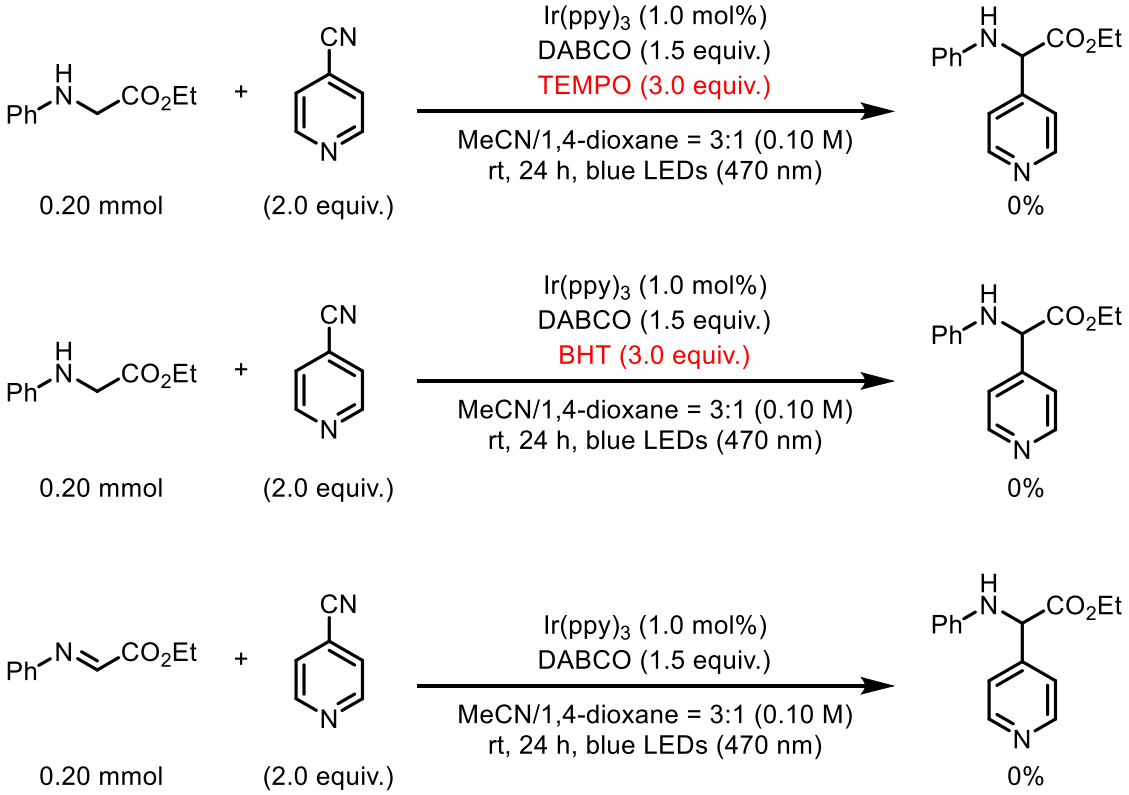


Figure S1. Control experiments.

Stern-Volmer Fluorescence Quenching Studies

Fluorescence quenching studies were carried out. In each experiment, $Ir(ppy)_3$ (1.0×10^{-5} M) and variable concentrations of 4-cyanopyridine, DABCO and *N*-phenyl glycine ethyl ester were combined in CH_3CN degassed by sparging with N_2 gas for 10 min. Similarly, the solution in quartz cuvettes was irradiated at 425 nm and the emission intensity was observed at 516 nm. Stern-Volmer plots for the quenching are given below. This analysis revealed that *N*-phenyl glycine ethyl ester is more capable of quenching excited Ir(III)* catalysts.

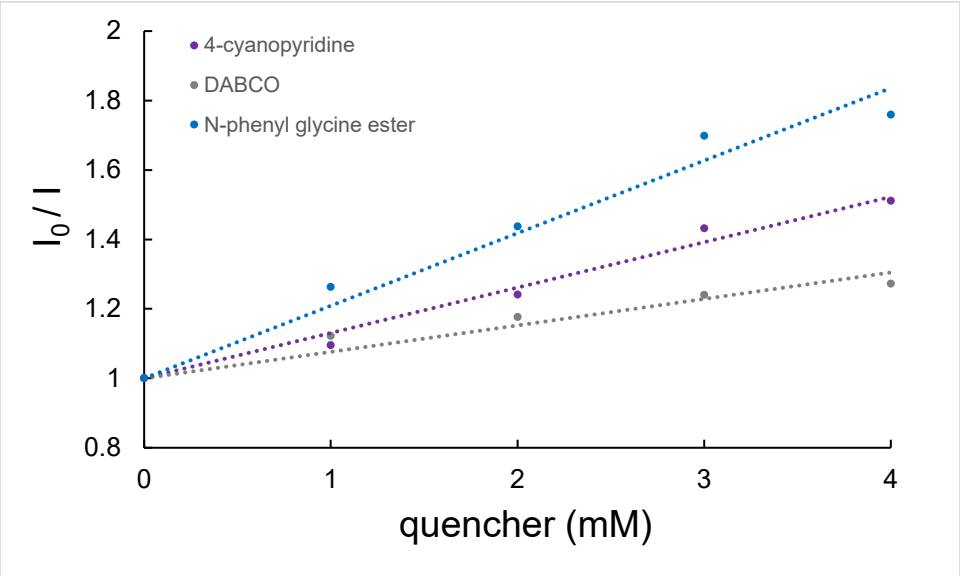


Figure S2. Stern-Volmer plots of $Ir(ppy)_3$ and 1) 4-cyanopyridine, 2) DABCO, 3) *N*-phenyl glycine ethyl ester.

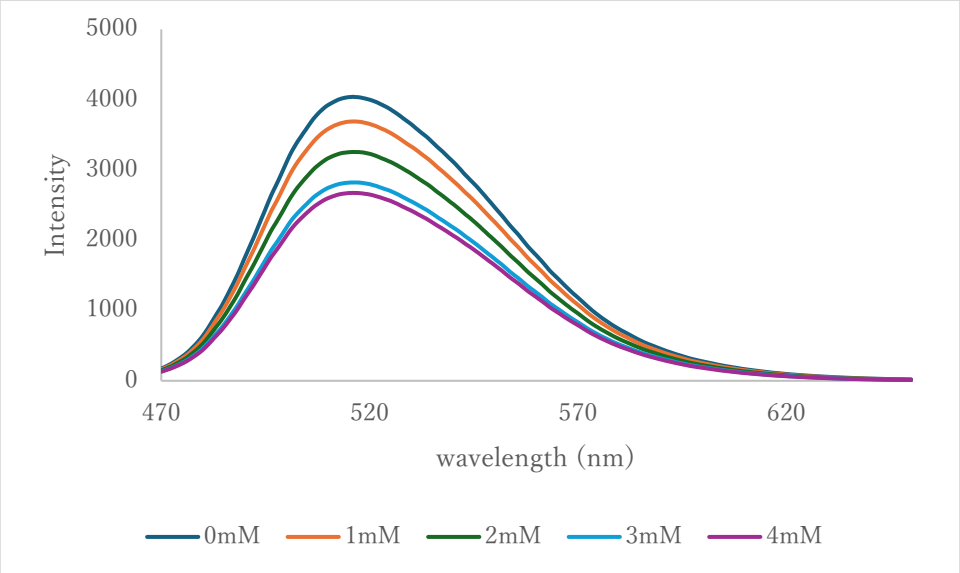


Figure S3. Fluorescence of 4-cyanopyridne. 1) 1.0 mM, 2) 2.0 mM, 3) 3.0 mM, and 4) 4.0 mM.

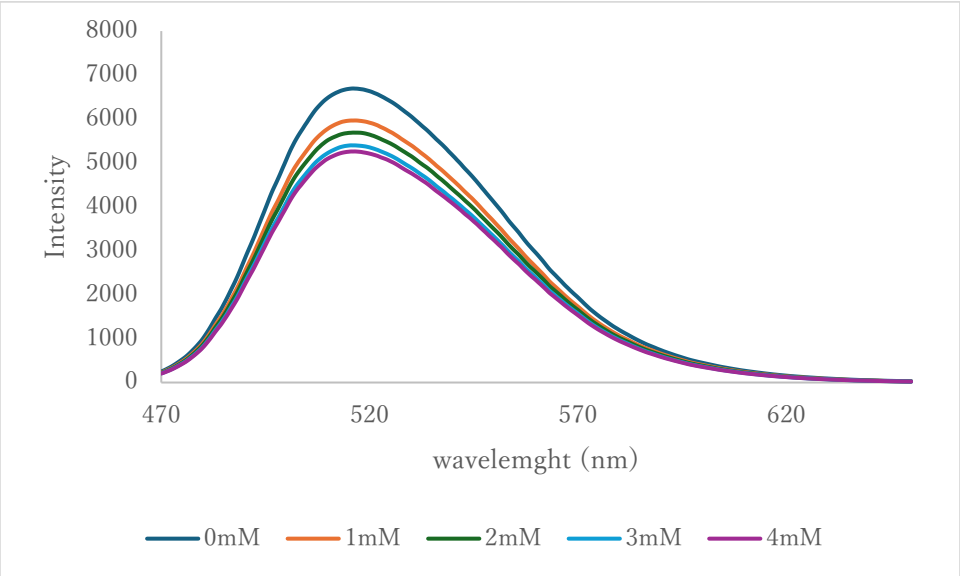


Figure S4. Fluorescence of DABCO. 1) 1.0 mM, 2) 2.0 mM, 3) 3.0 mM, and 4) 4.0 mM.

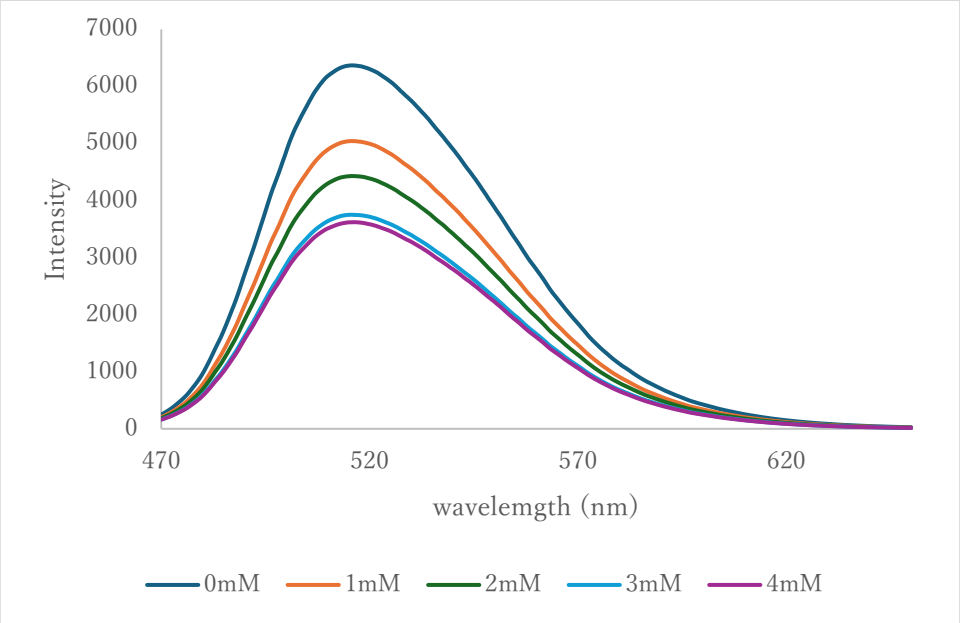


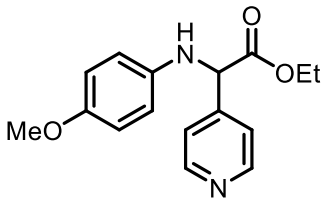
Figure S5. Fluorescence of *N*-phenyl glycine ethyl ester. 1) 1.0 mM, 2) 2.0 mM, 3) 3.0 mM, and 4) 4.0 mM.

6. Single Crystal X-Ray Diffraction Data

Graphite-monochromated Mo Kα radiation (λ = 0.71075 Å) was used. Details of the crystal data and a summary of the intensity data collection parameters are listed in Tables S3 and S4. The structure was solved with SHELXT and refined by full-matrix least-squares techniques against F2 (SHELXL).[13,14] The non-hydrogen atoms were refined anisotropically. Hydrogen atoms were placed using AFIX instructions. Calculations were performed by using Olex2.[15]

CCDC 2389158 and CCDC 2388516 contain the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

3g (CCDC 2389158)



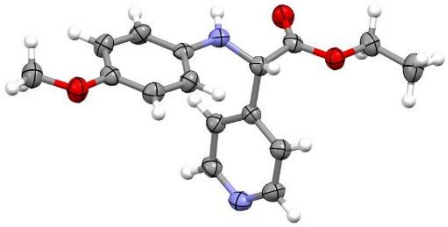
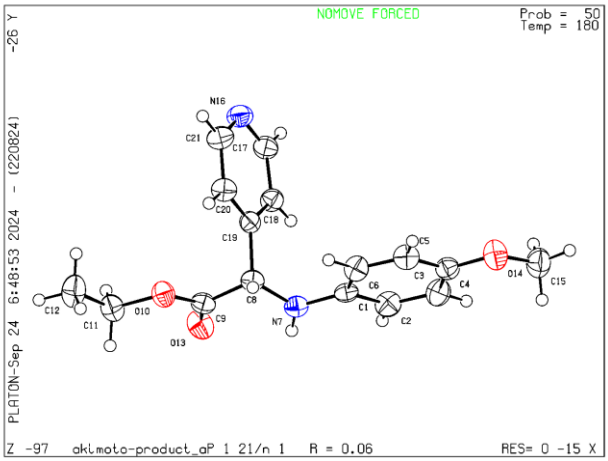
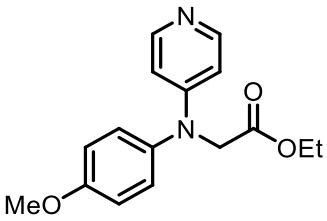


Table S3. Crystal data and structure refinement for ethyl 2-((4-methoxyphenyl)amino)-2-(pyridin-4-yl)acetate (3g).

Identification code	2389158
Empirical formula	$C_{16}H_{18}N_2O_3$
Formula weight	286.32
Temperature/K	180.15
Crystal system	monoclinic
Space group	P21/n
a/Å	7.4927(6)
b/Å	18.0971(12)
c/Å	11.2308(9)
α/°	90
β/°	103.978(7)
γ/°	90
Volume/Å3	1477.8(2)
Z	4
ρ calcg/cm3	1.287
μ/mm-1	0.090
F(000)	608.0
Crystal size/mm3	0.68 × 0.4 × 0.22
Radiation	Mo Kα (λ = 0.71073)
2Θ range for data collection/°	7.19 to 59.536
Index ranges	-9 ≤ h ≤ 10, -24 ≤ k ≤ 18, -12 ≤ l ≤ 14
Reflections collected	11009
Independent reflections	3575 [Rint = 0.0410, Rsigma = 0.0463]
Data/restraints/parameters	3575/0/192
Goodness-of-fit on F2	1.046
Final R indexes [I>=2σ (I)]	R1 = 0.0610, wR2 = 0.1629
Final R indexes [all data]	R1 = 0.0866, wR2 = 0.1765
Largest diff. peak/hole / e Å-3	0.52/-0.51



3g' (CCDC 2388516)



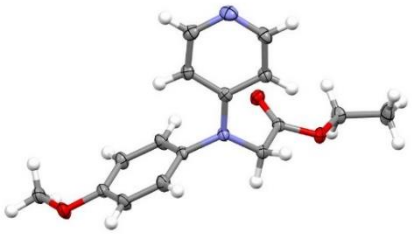
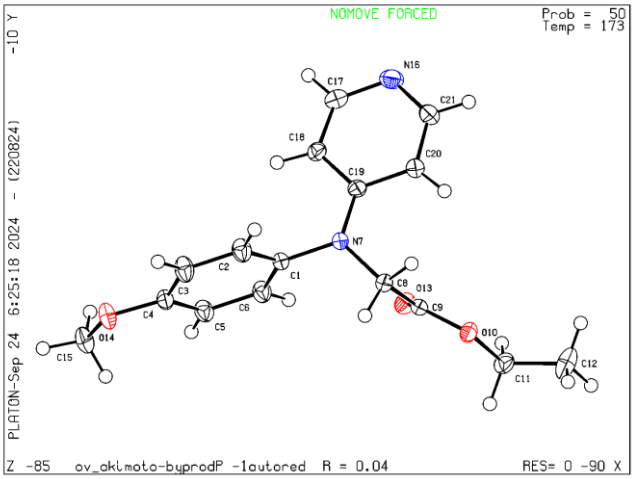


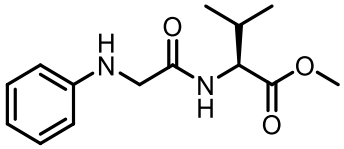
Table S4. Crystal data and structure refinement for ethyl *N*-(4-methoxyphenyl)-*N*-(pyridin-4-yl)glycinate (3g').

Identification code	2388516
Empirical formula	$C_{16}H_{18}N_2O_3$
Formula weight	286.32
Temperature/K	173.15
Crystal system	triclinic
Space group	P-1
a/Å	8.1083(5)
b/Å	9.6805(5)
c/Å	10.8014(5)
α/°	84.851(4)
β/°	69.482(5)
γ/°	67.945(5)
Volume/Å3	735.08(8)
Z	2
ρ calcg/cm3	1.294
μ/mm-1	0.090
F(000)	304.0
Crystal size/mm3	0.82 × 0.39 × 0.28
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	8.066 to 59.316
Index ranges	-11 ≤ h ≤ 11, -13 ≤ k ≤ 12, -14 ≤ l ≤ 14
Reflections collected	9424
Independent reflections	3513 [Rint = 0.0220, Rsigma = 0.0271]
Data/restraints/parameters	3513/0/192
Goodness-of-fit on F2	1.065
Final R indexes [I>=2σ (I)]	R1 = 0.0382, wR2 = 0.0986
Final R indexes [all data]	R1 = 0.0455, wR2 = 0.1028
Largest diff. peak/hole / e Å-3	0.30/-0.18

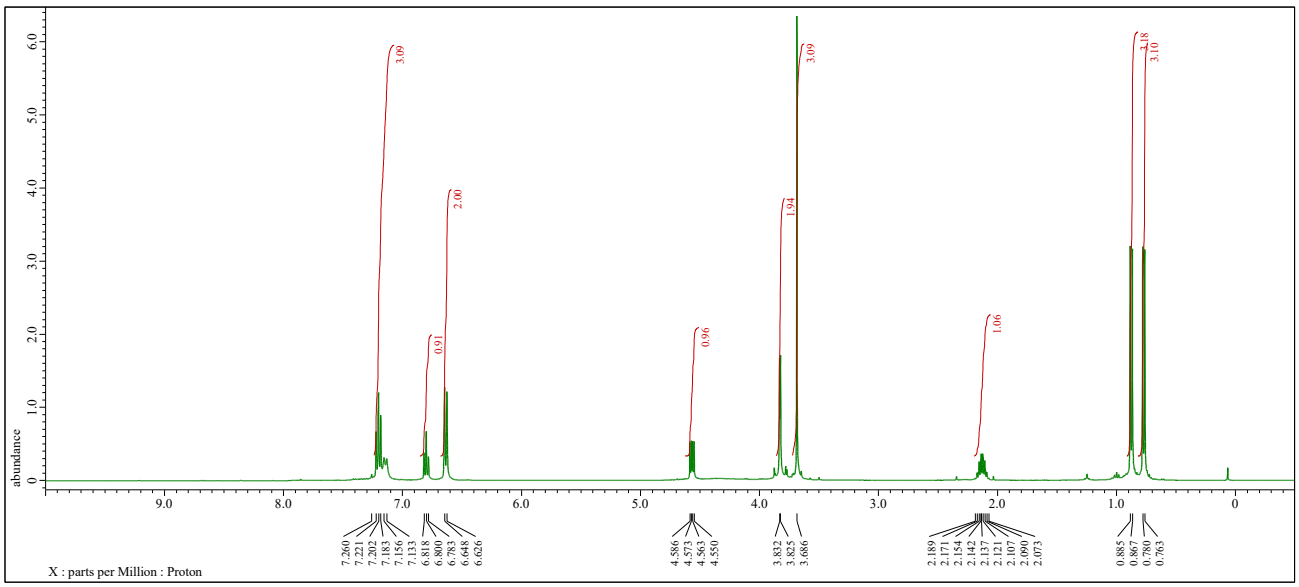


7. NMR Spectra

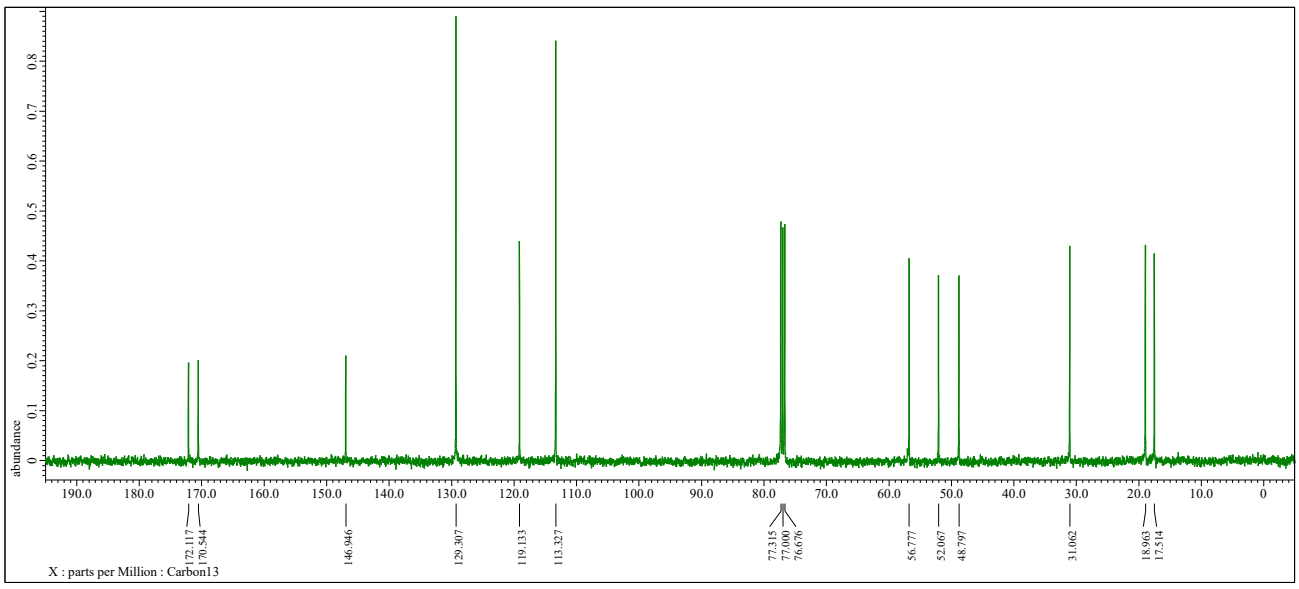
1m



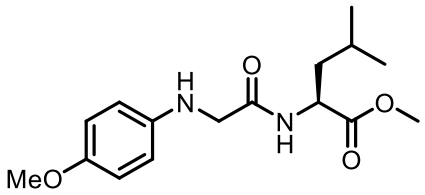
^{1}H NMR (400 MHz, $CDCl_3$)



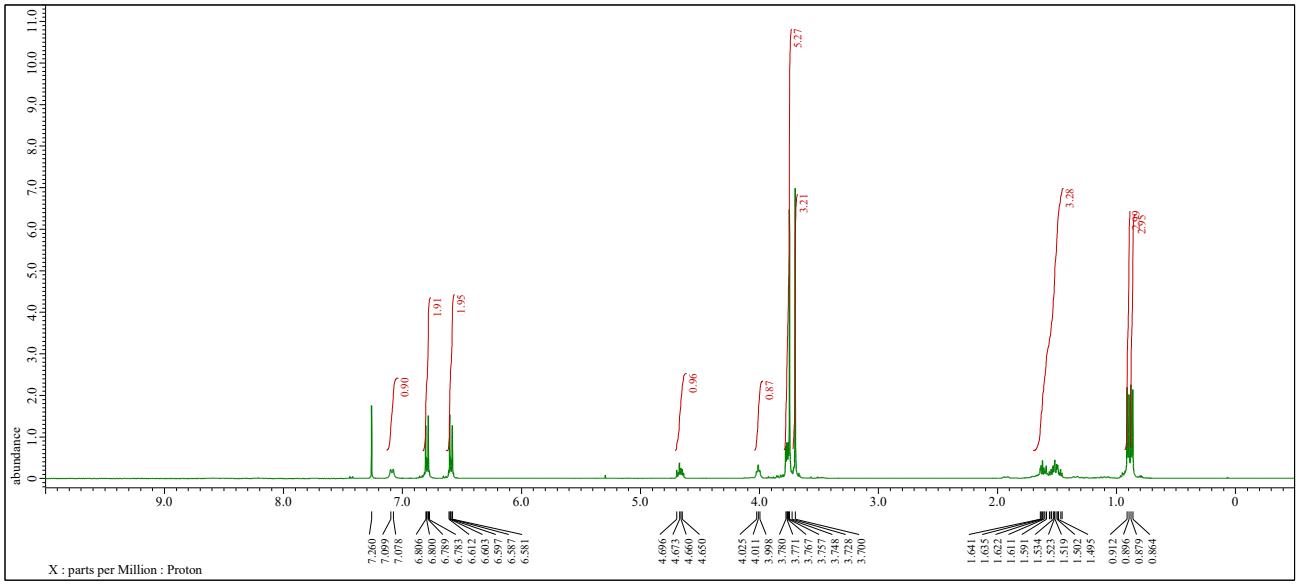
^{13}C NMR (101 MHz, $CDCl_3$)



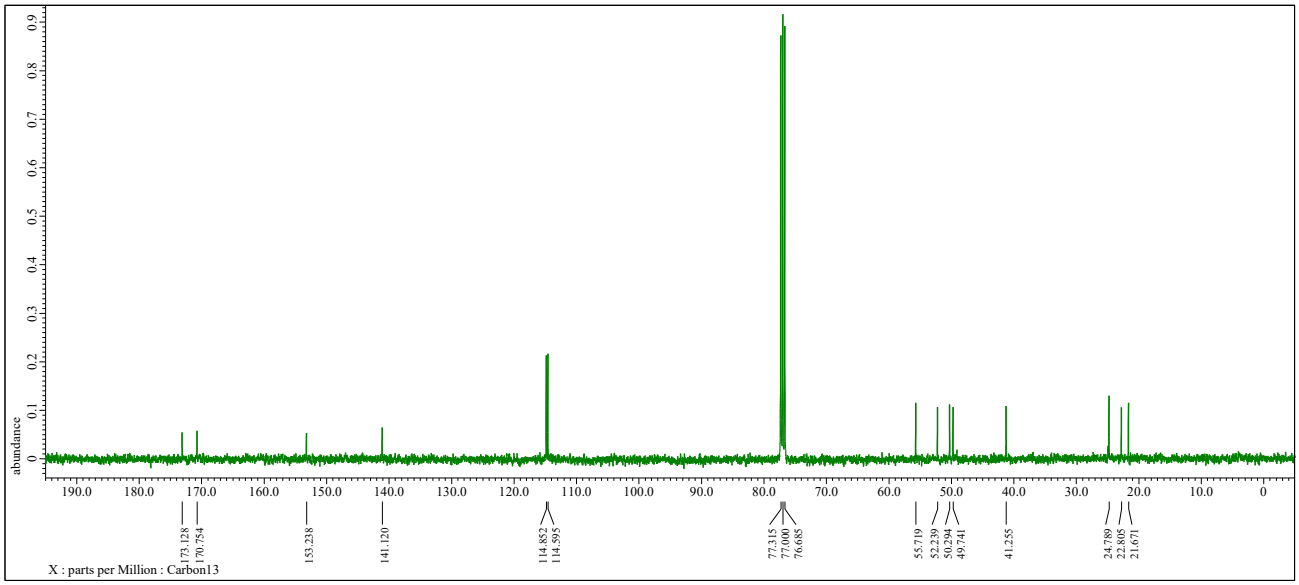
1n



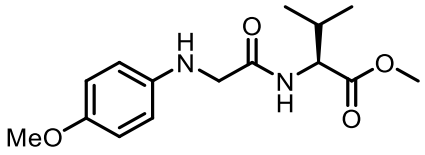
^{1}H NMR (400 MHz, $CDCl_3$)



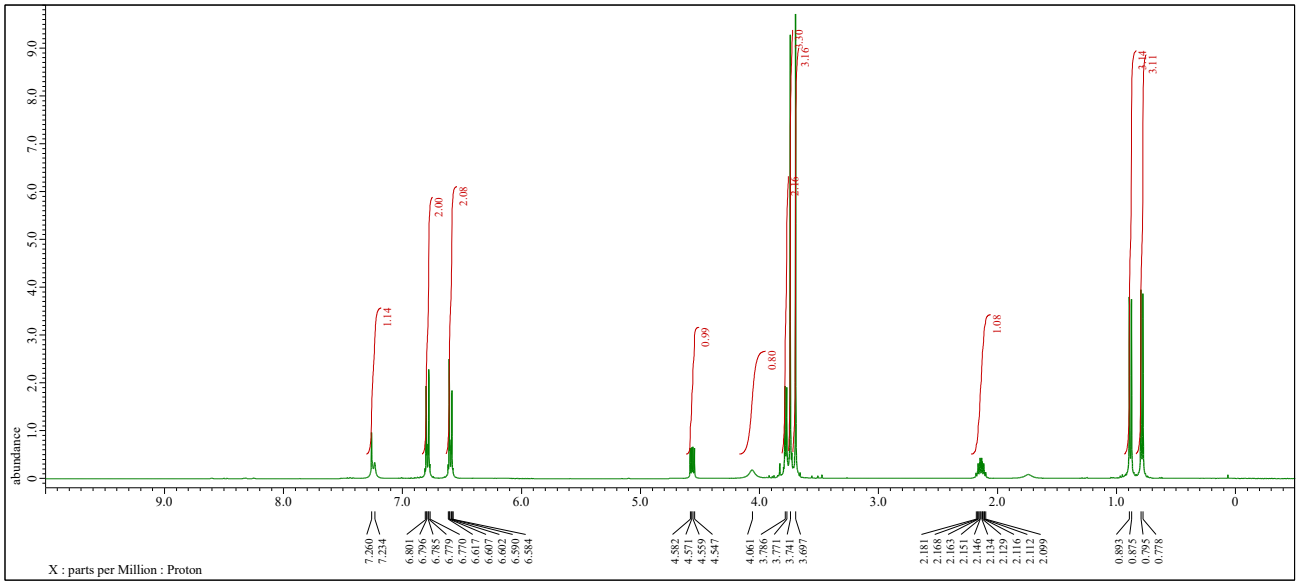
^{13}C NMR (101 MHz, $CDCl_3$)



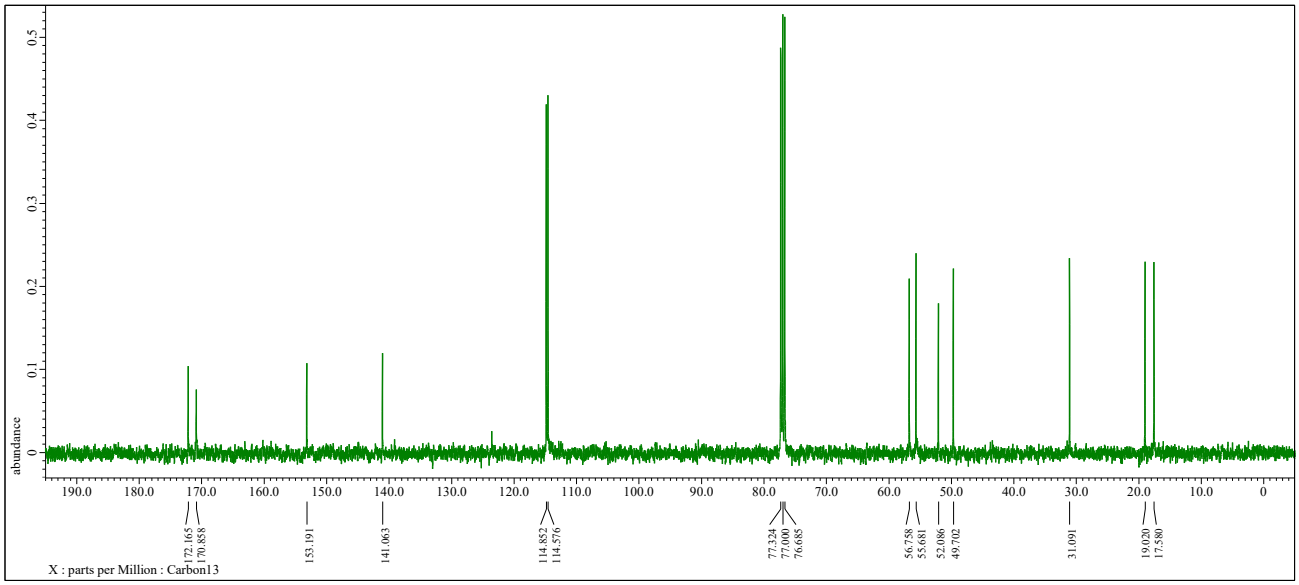
1o



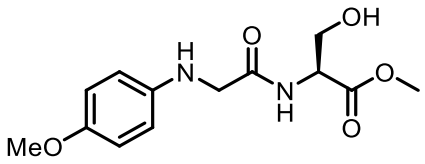
^{1}H NMR (400 MHz, $CDCl_3$)



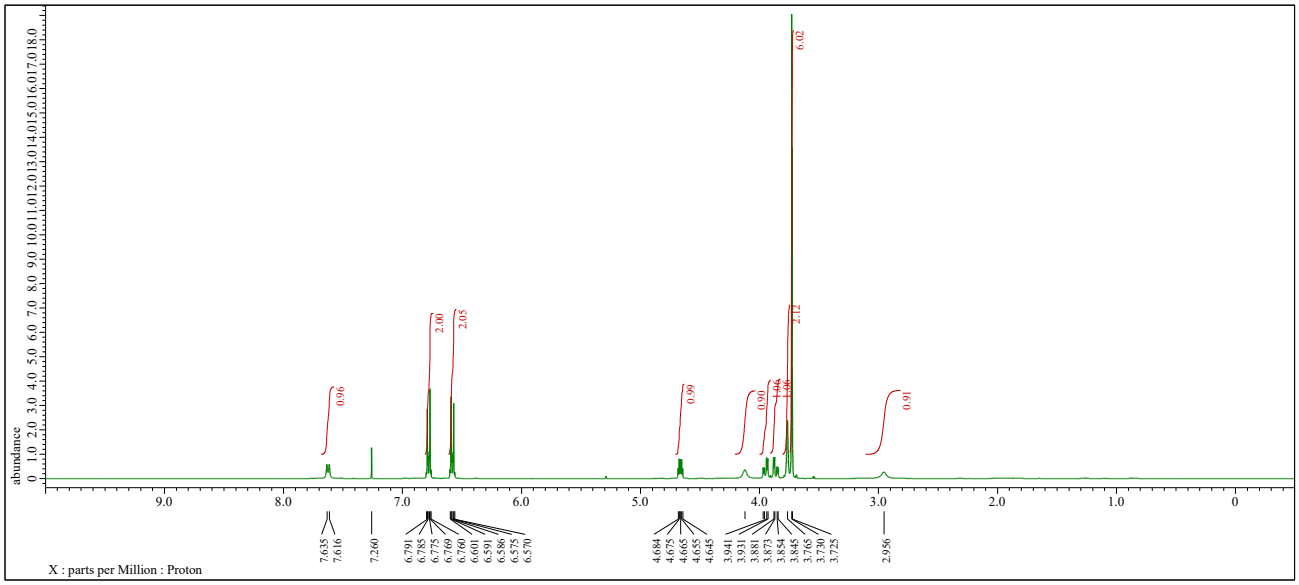
^{13}C NMR (101 MHz, $CDCl_3$)



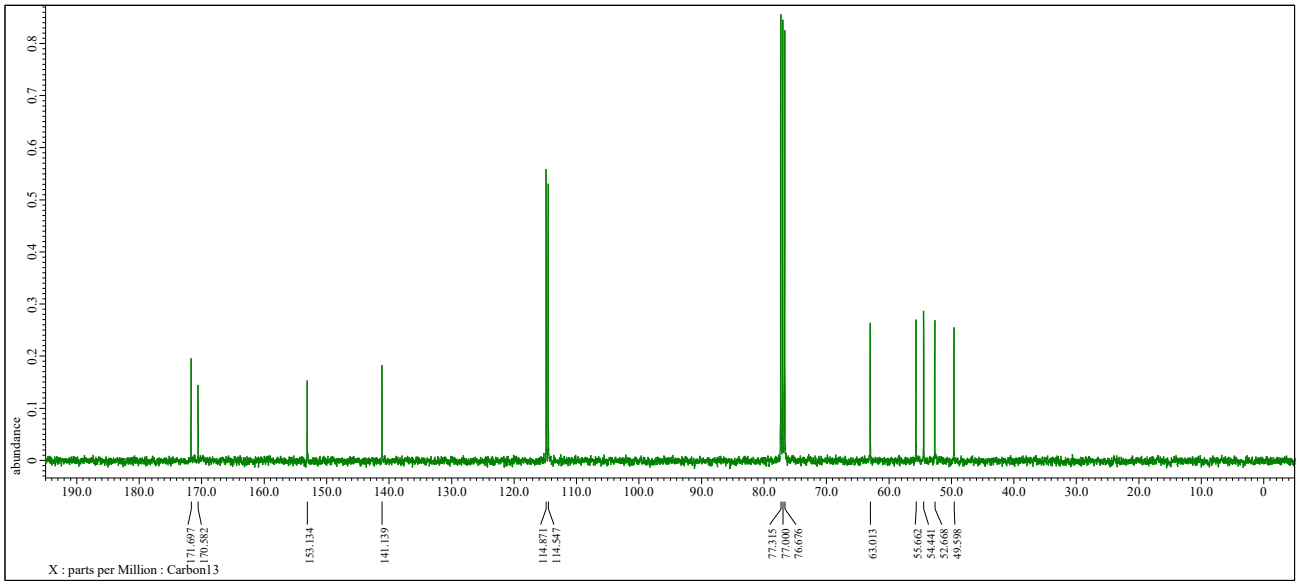
1p



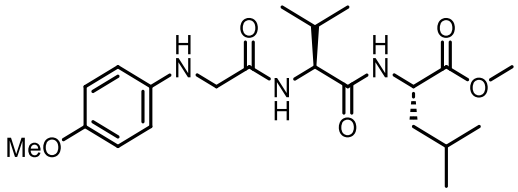
^{1}H NMR (400 MHz, $CDCl_3$)



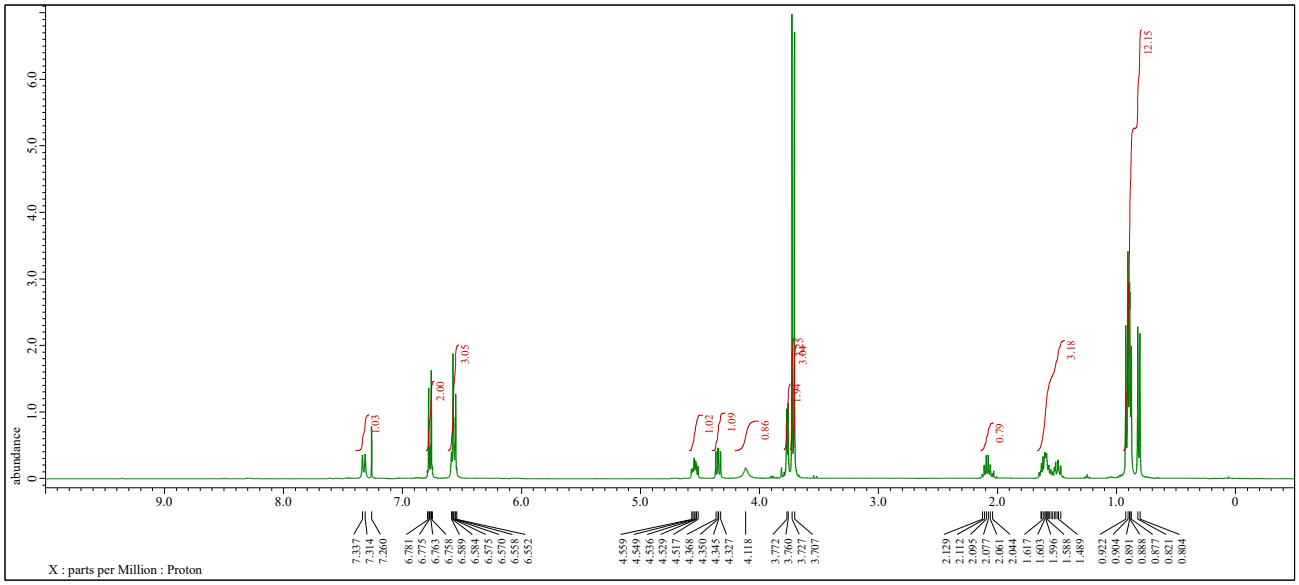
^{13}C NMR (101 MHz, $CDCl_3$)



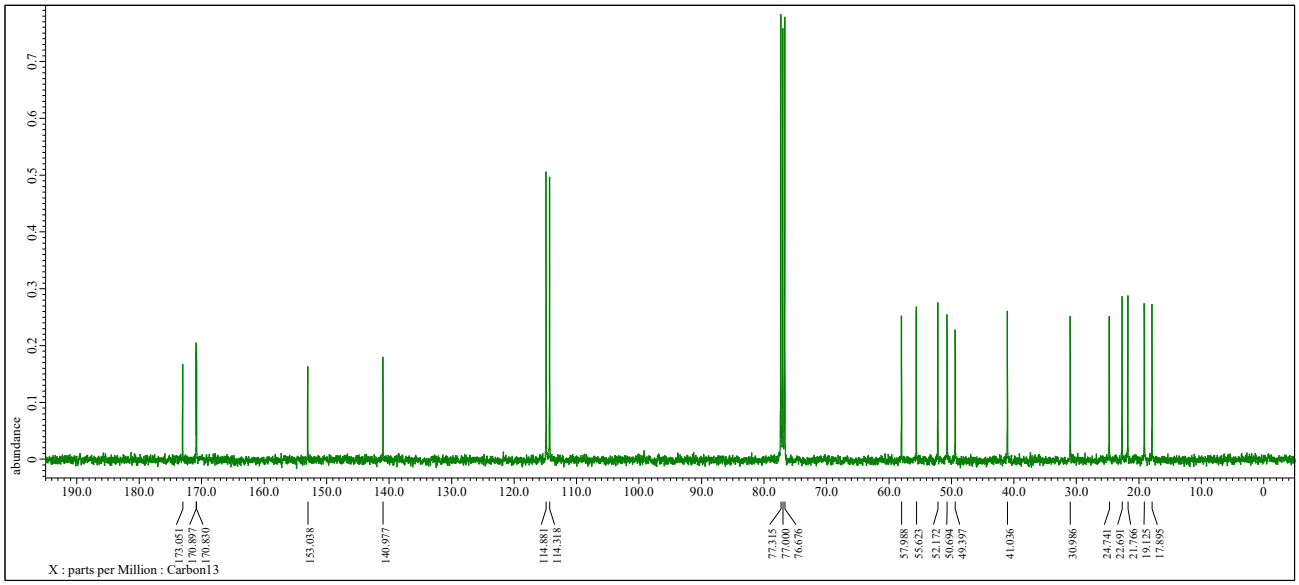
1r



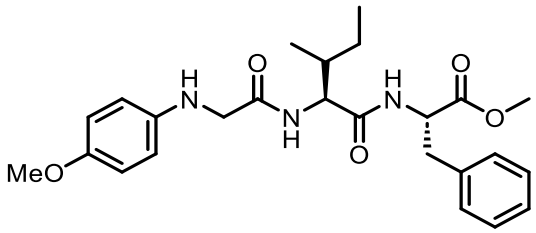
^{1}H NMR (400 MHz, $CDCl_3$)



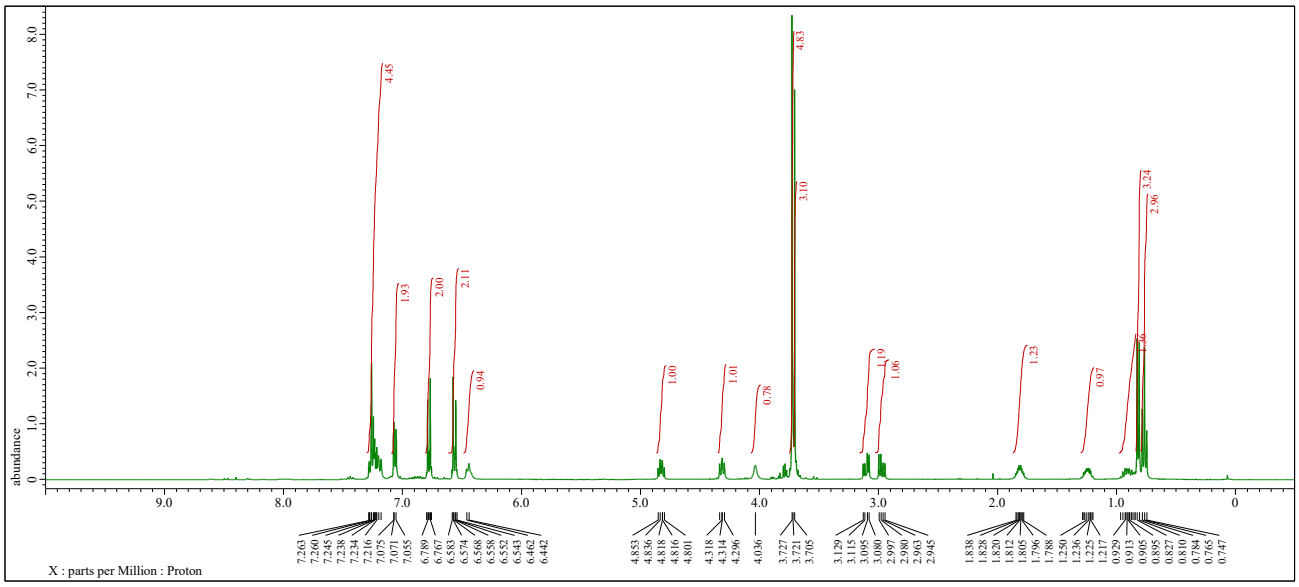
^{13}C NMR (101 MHz, $CDCl_3$)



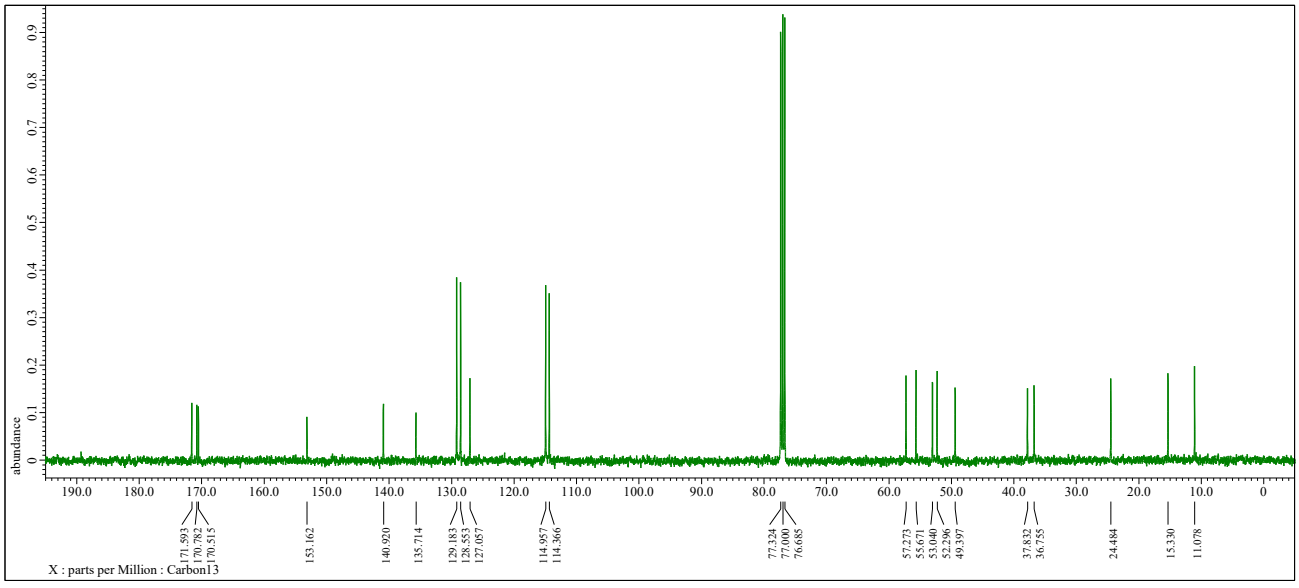
1s



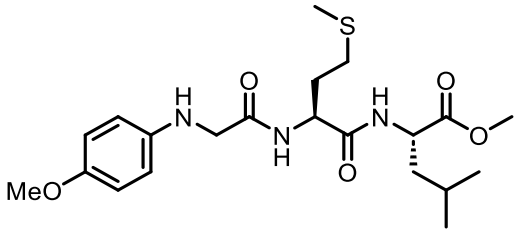
^{1}H NMR (400 MHz, $CDCl_3$)



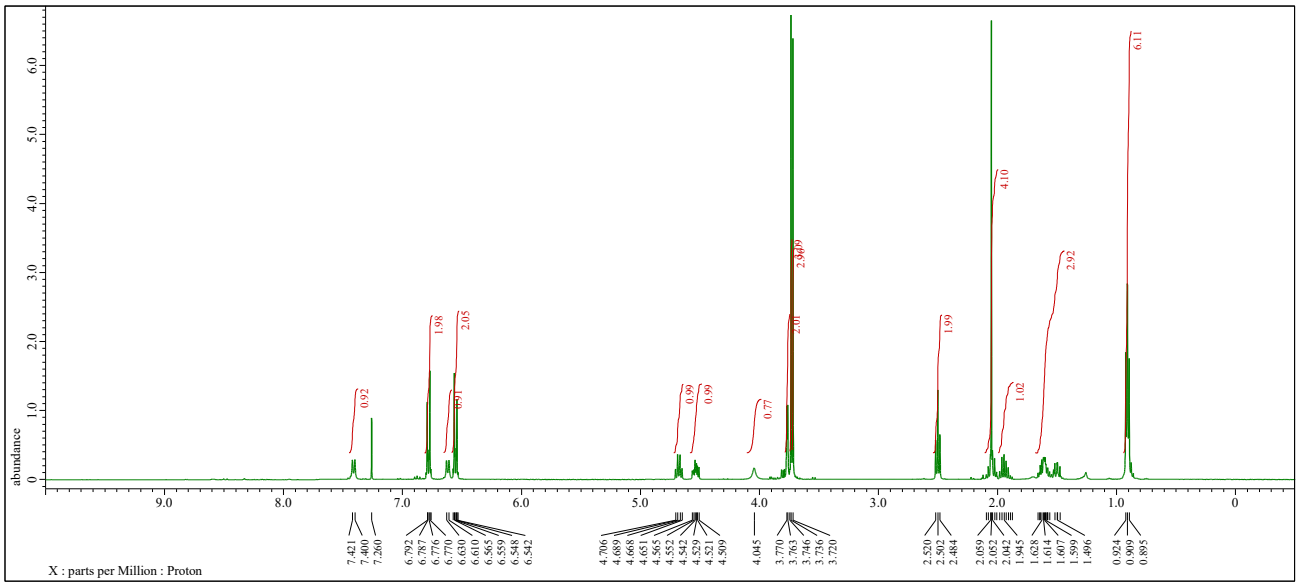
^{13}C NMR (101 MHz, $CDCl_3$)



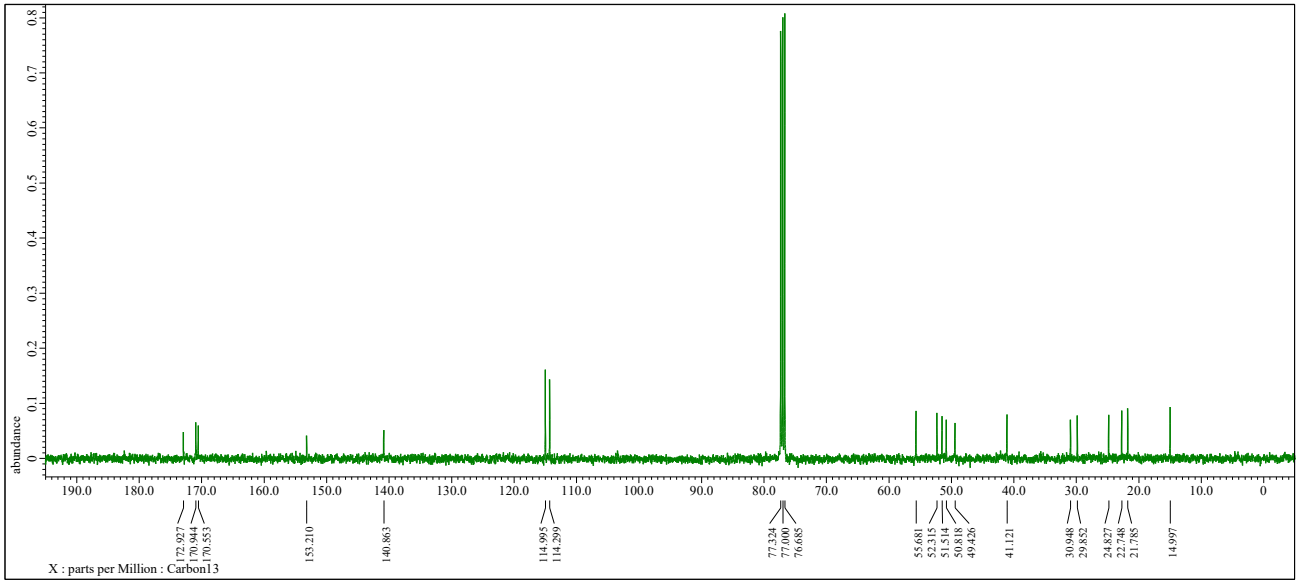
1t



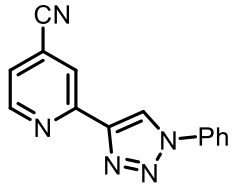
^{1}H NMR (400 MHz, $CDCl_3$)



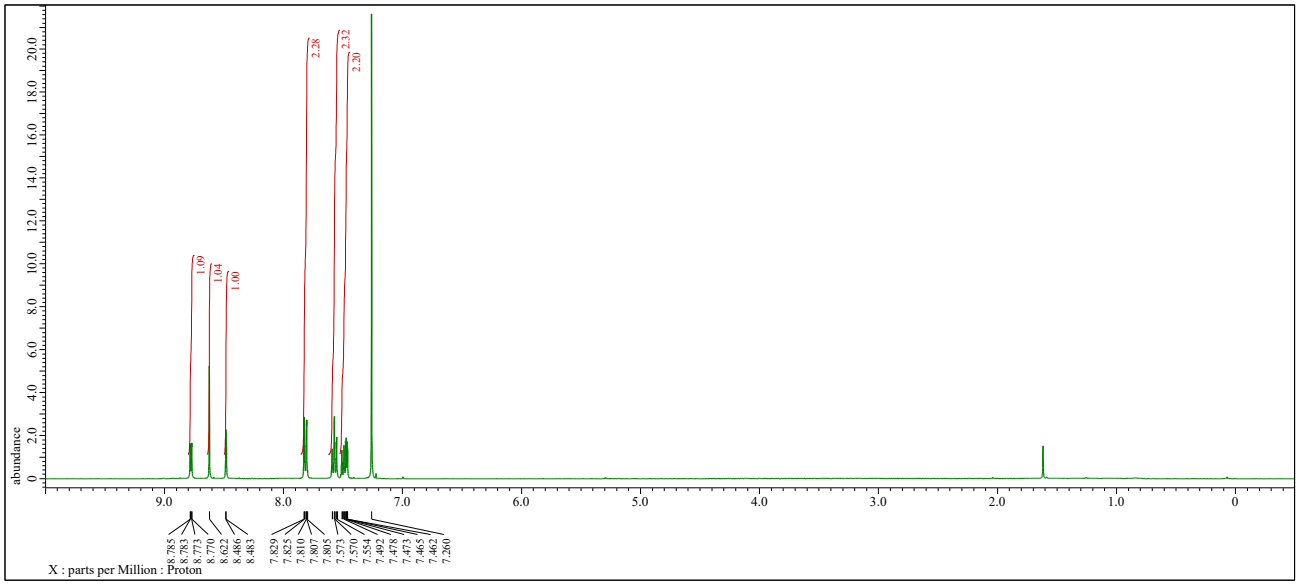
^{13}C NMR (101 MHz, $CDCl_3$)



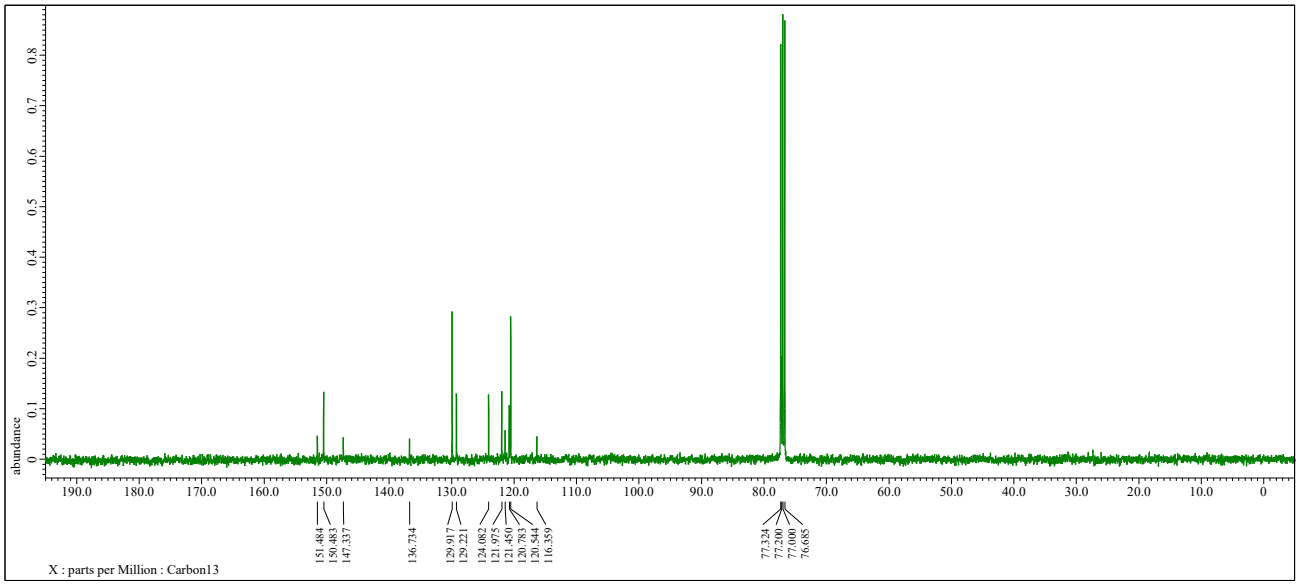
2d



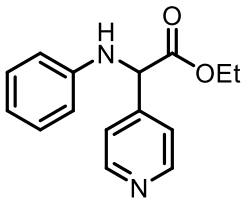
^{1}H NMR (400 MHz, $CDCl_3$)



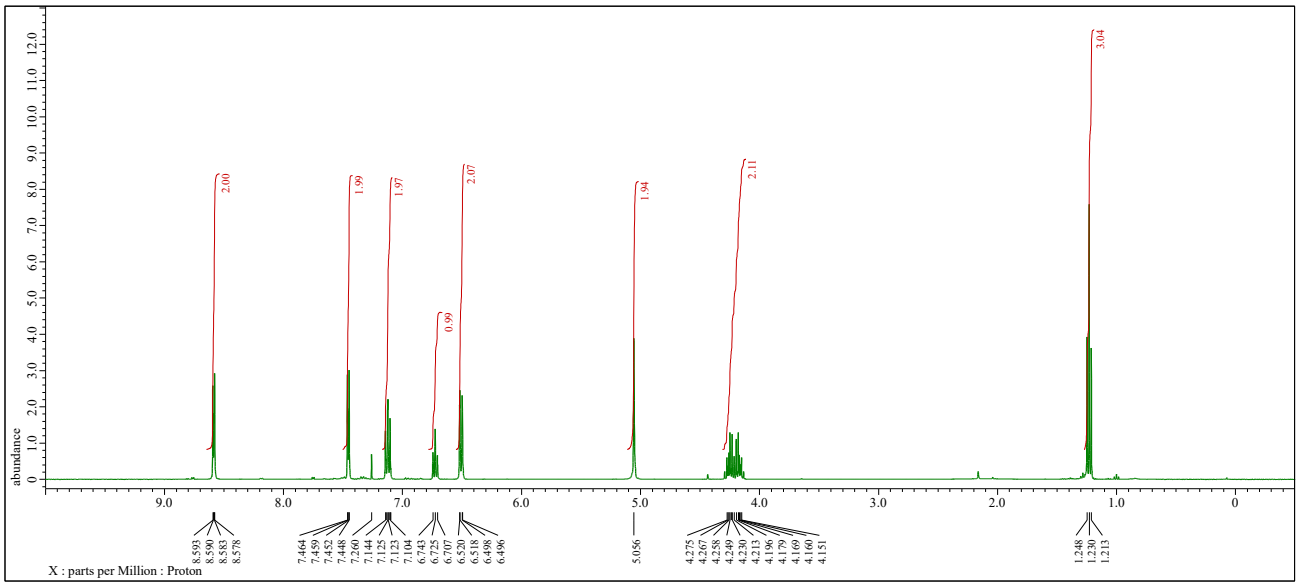
^{13}C NMR (101 MHz, $CDCl_3$)



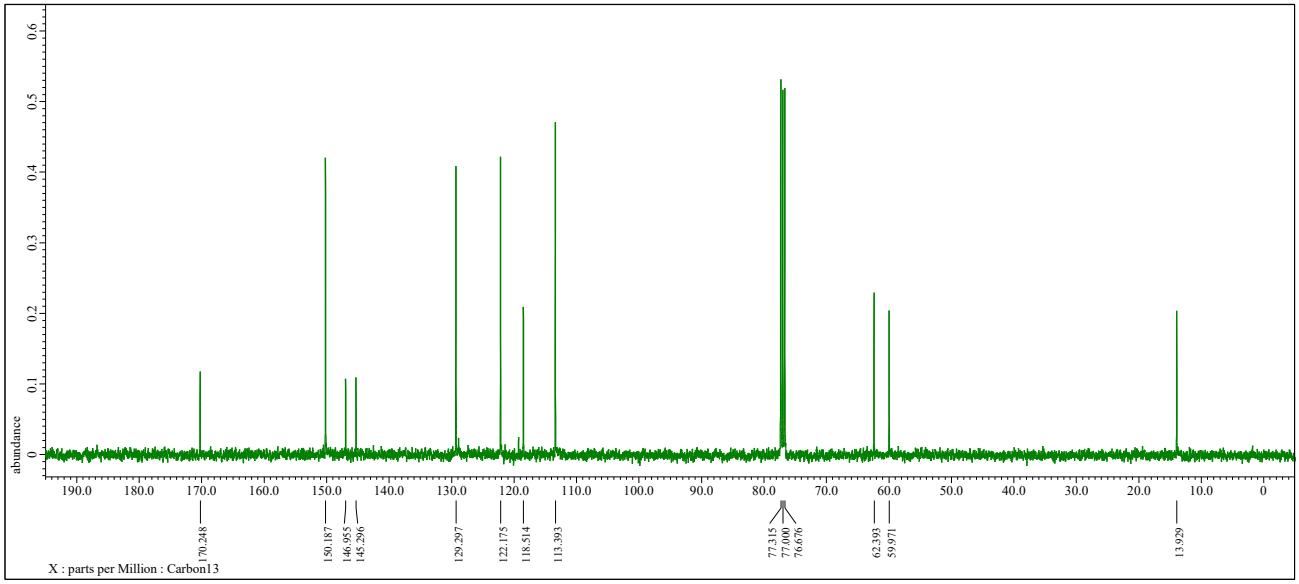
3a



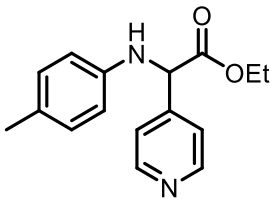
^{1}H NMR (400 MHz, $CDCl_3$)



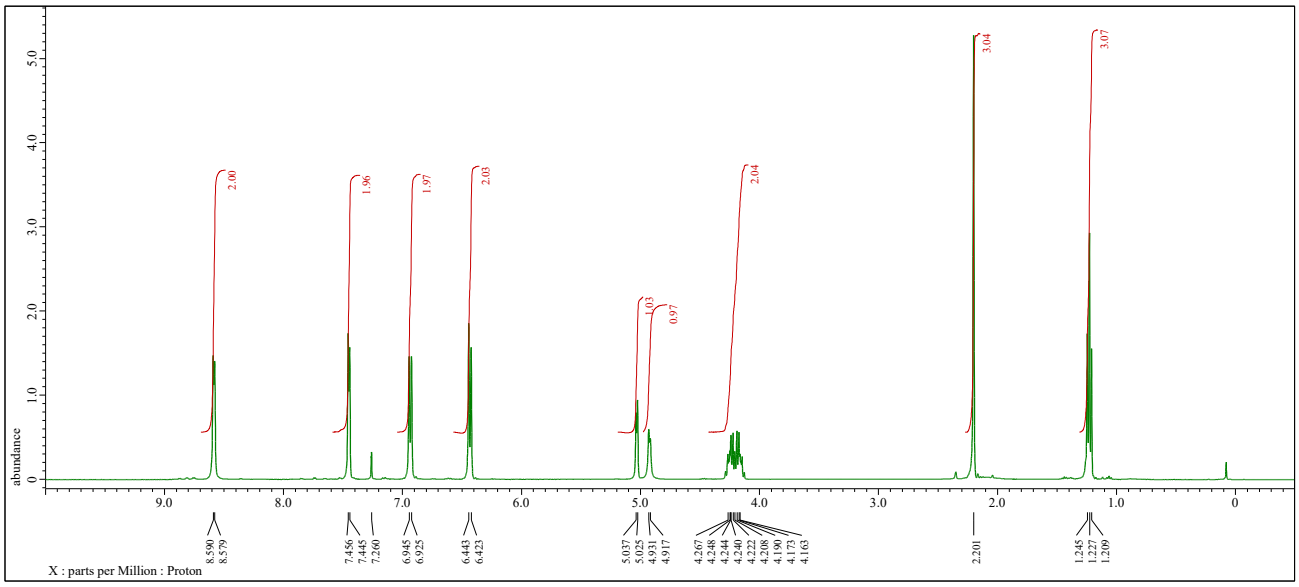
^{13}C NMR (101 MHz, $CDCl_3$)



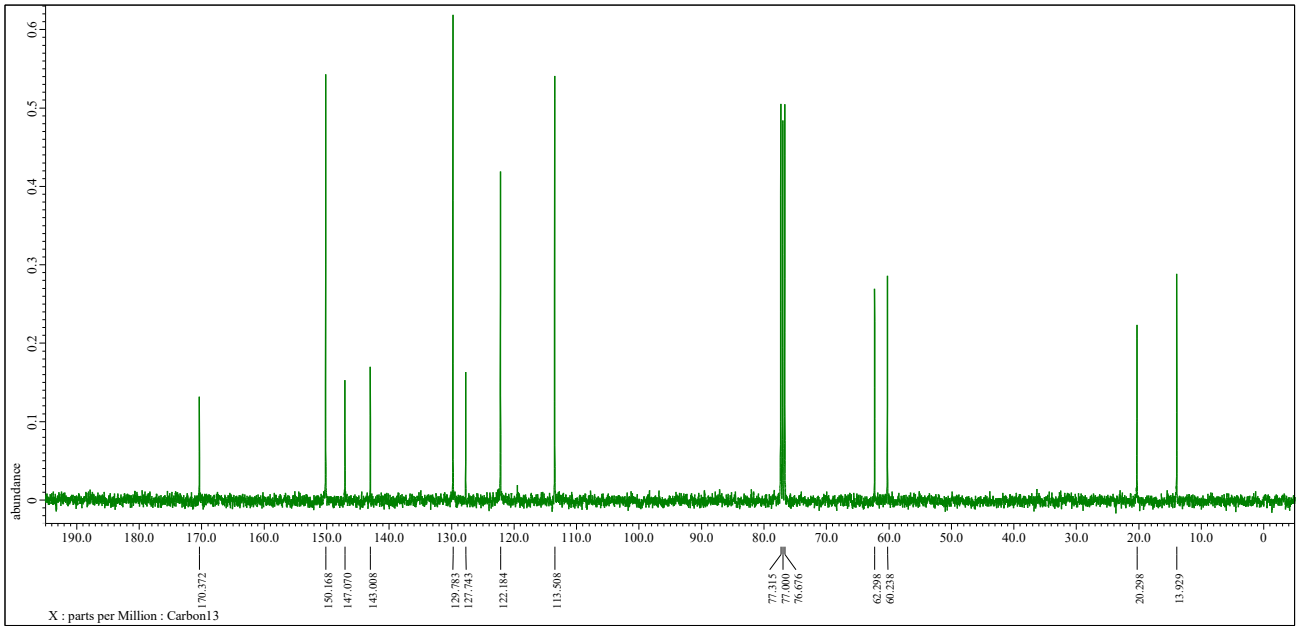
3b



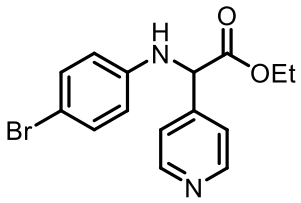
^{1}H NMR (400 MHz, $CDCl_3$)



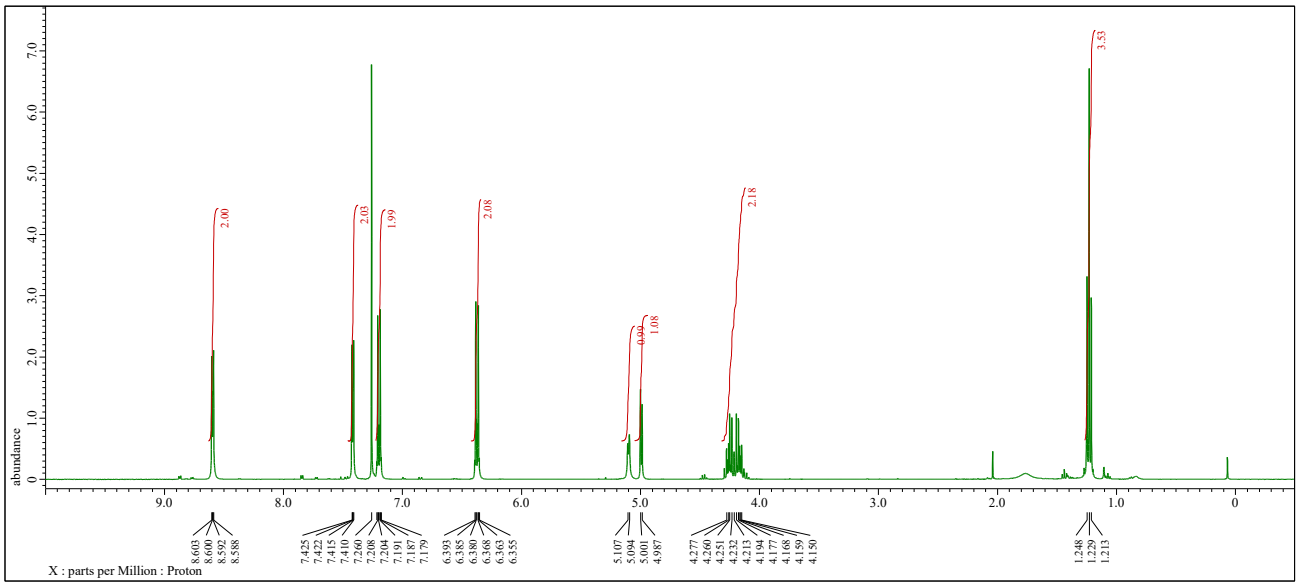
^{13}C NMR (101 MHz, $CDCl_3$)



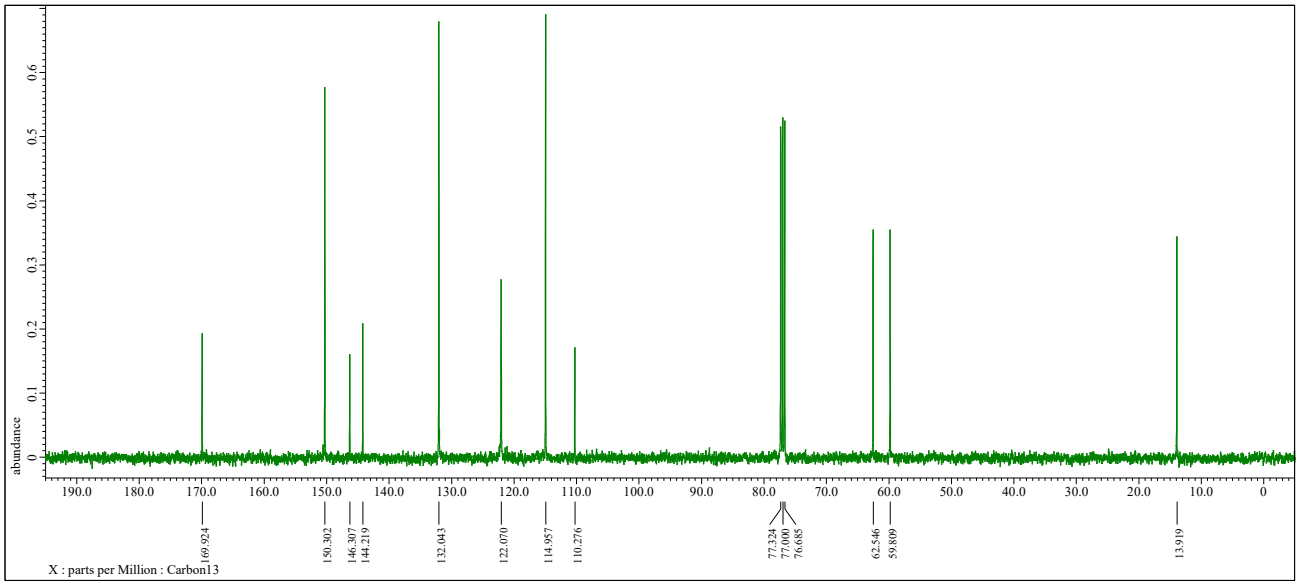
3c



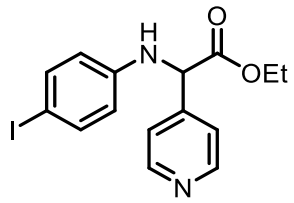
^{1}H NMR (400 MHz, $CDCl_3$)



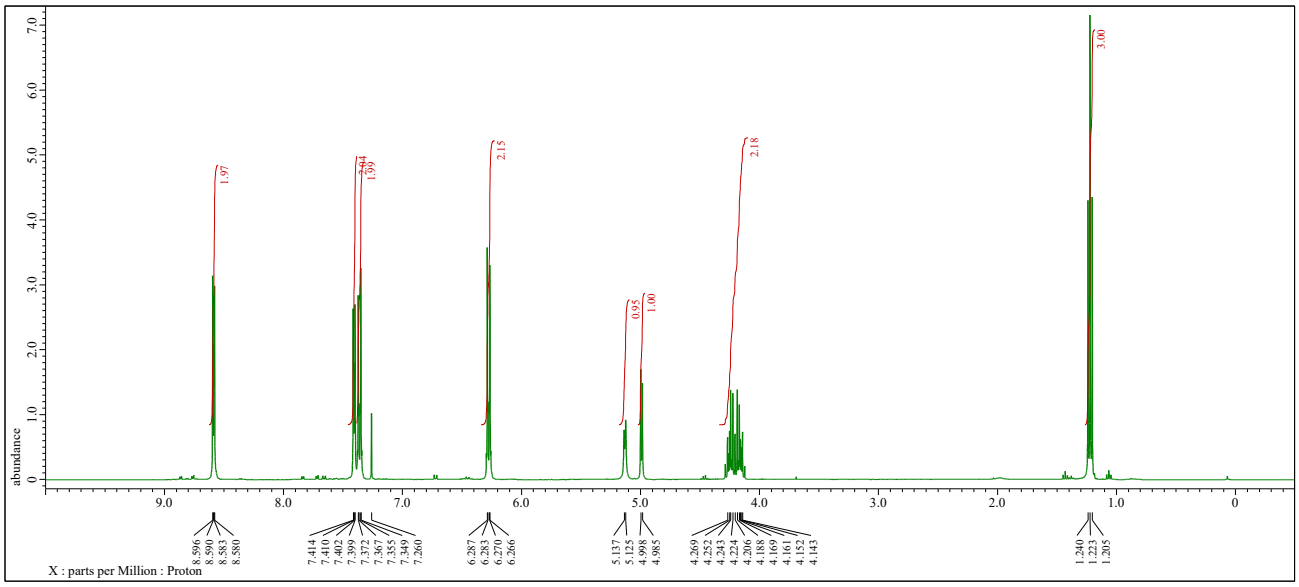
^{13}C NMR (101 MHz, $CDCl_3$)



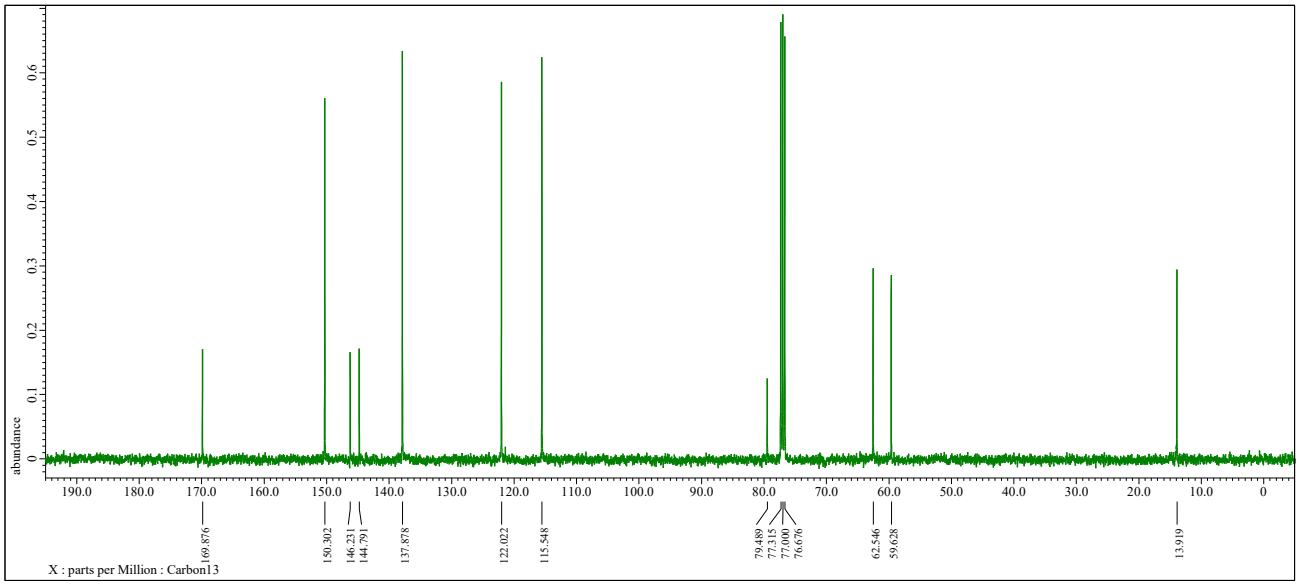
3d



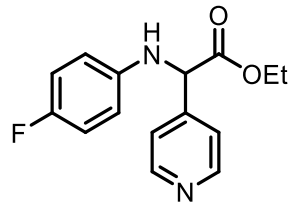
^{1}H NMR (400 MHz, $CDCl_3$)



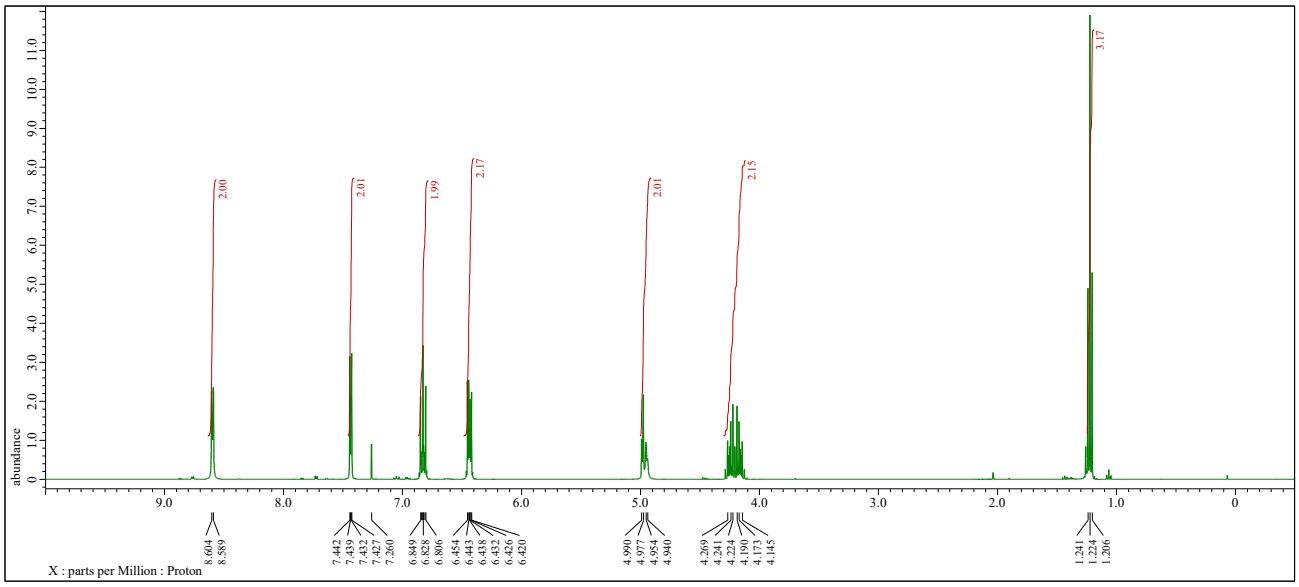
^{13}C NMR (101 MHz, $CDCl_3$)



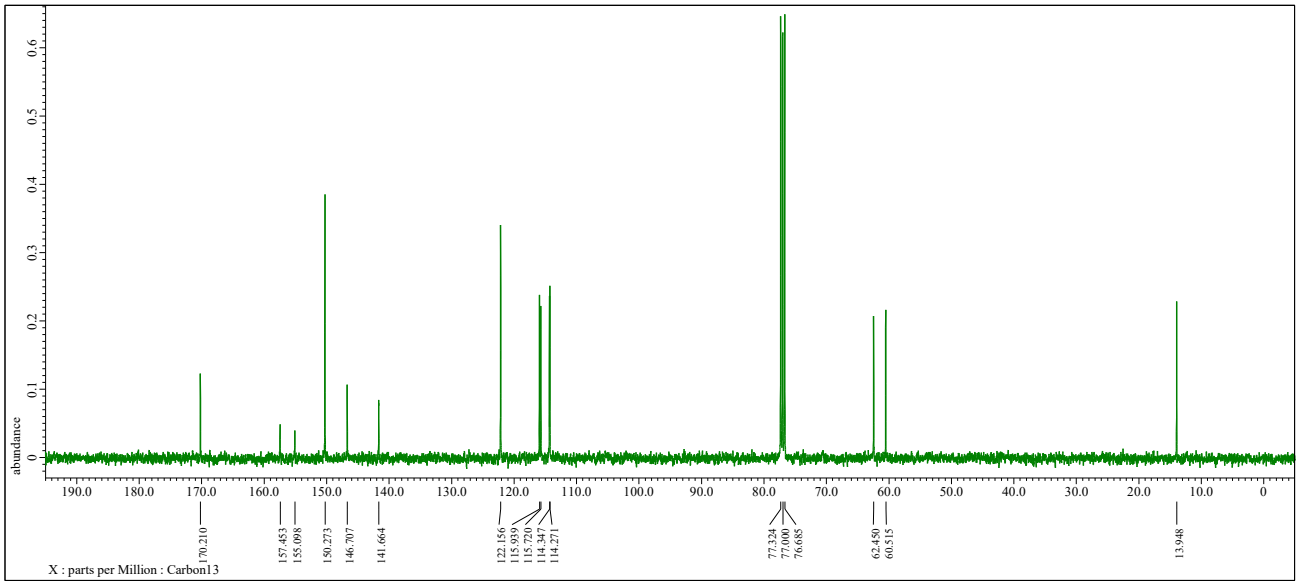
3e



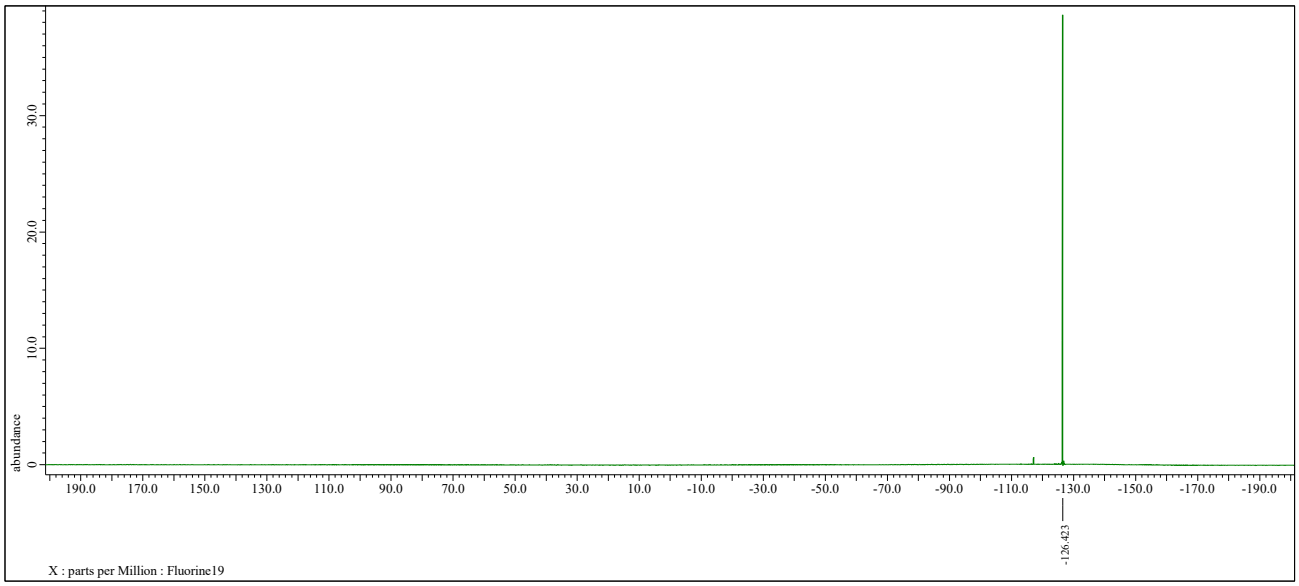
^{1}H NMR (400 MHz, $CDCl_3$)



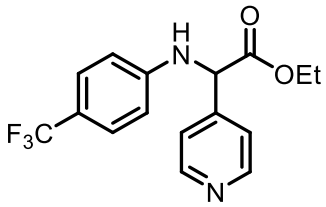
^{13}C NMR (101 MHz, $CDCl_3$)



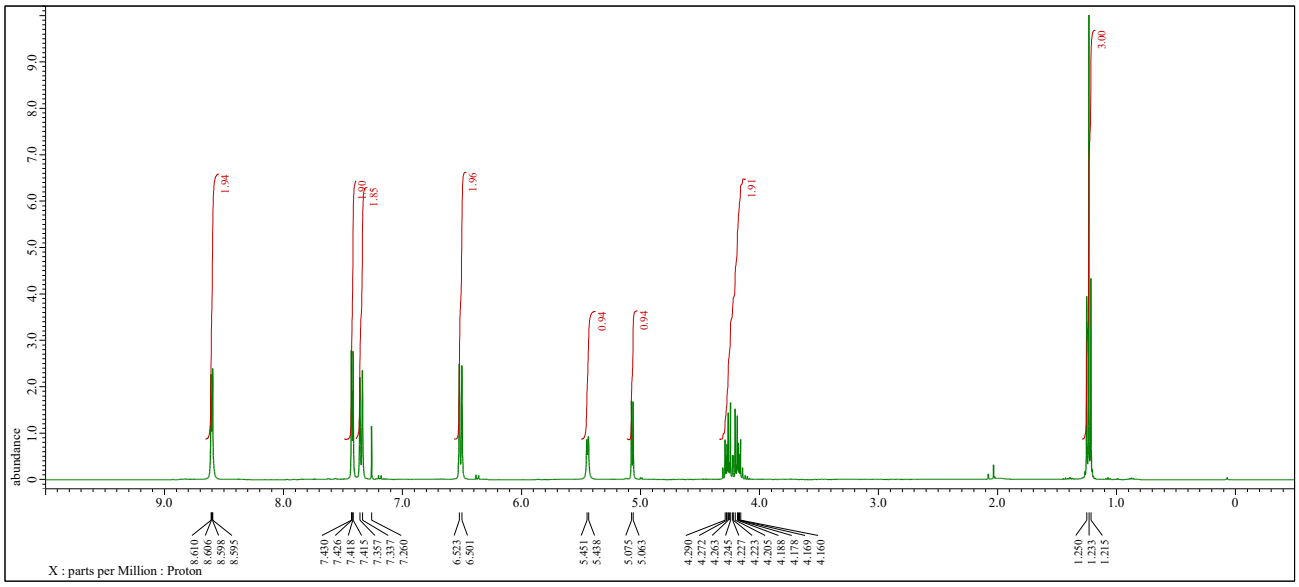
^{19}F NMR (376 MHz, $CDCl_3$)



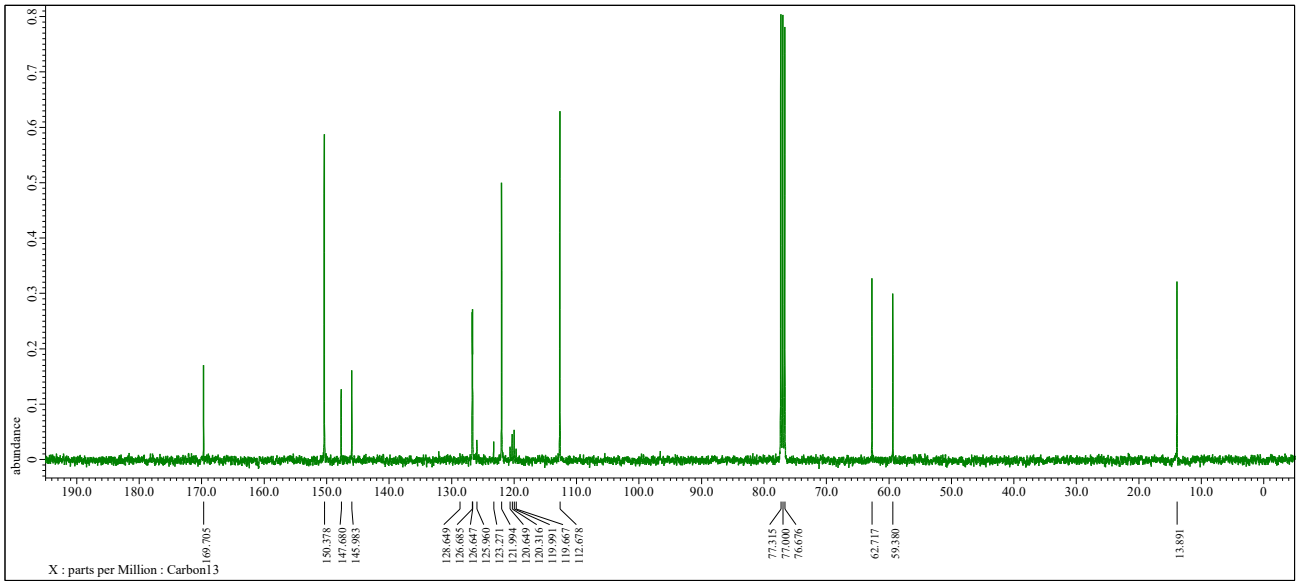
3f



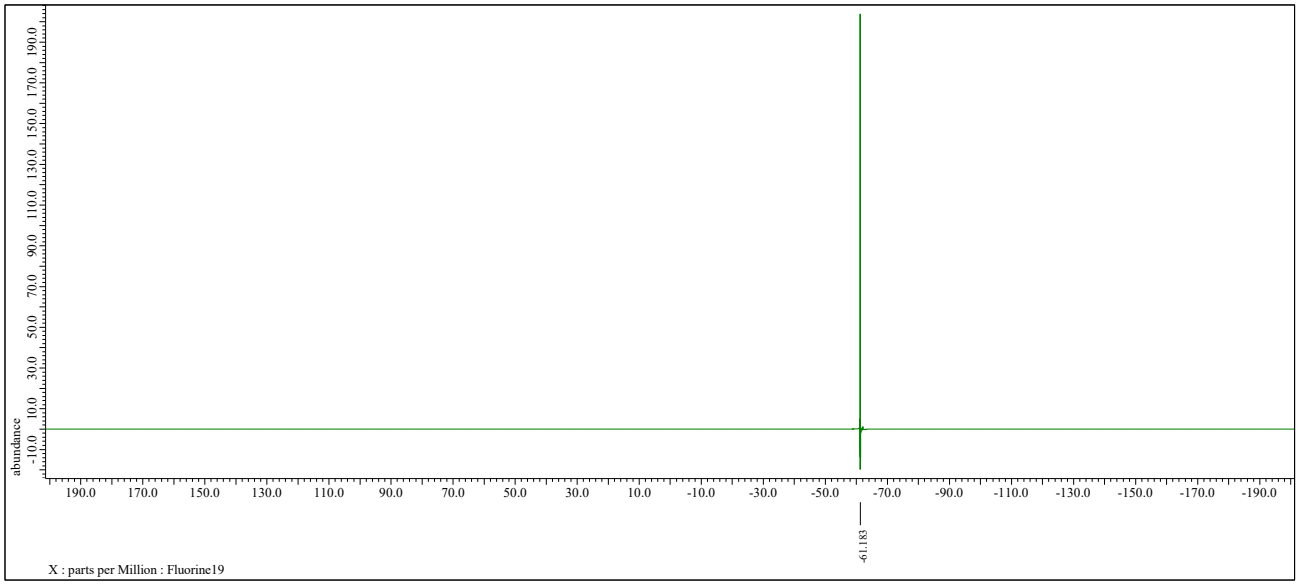
^{1}H NMR (400 MHz, $CDCl_3$)



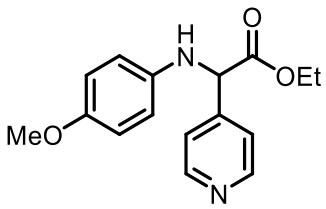
^{13}C NMR (101 MHz, $CDCl_3$)



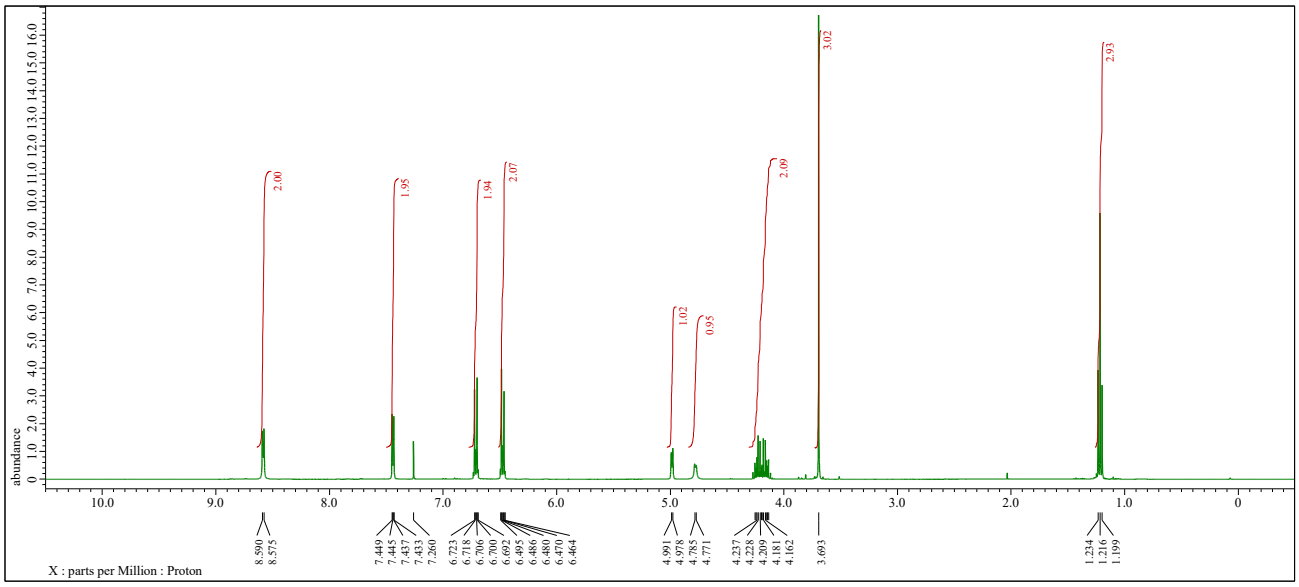
^{19}F NMR (376 MHz, $CDCl_3$)



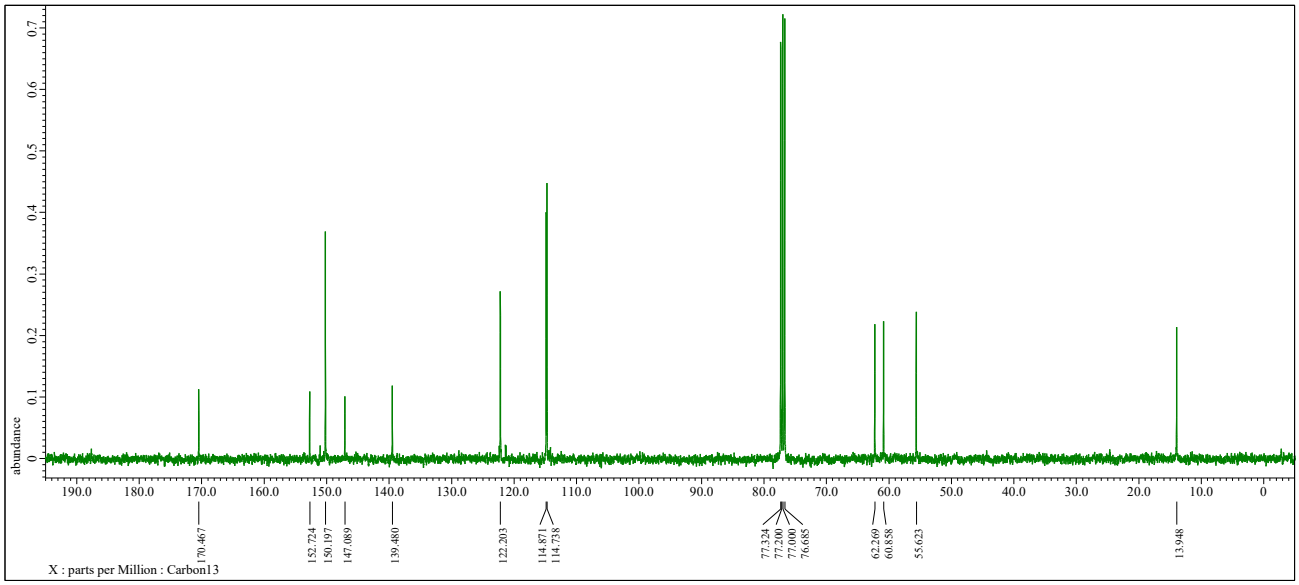
3g



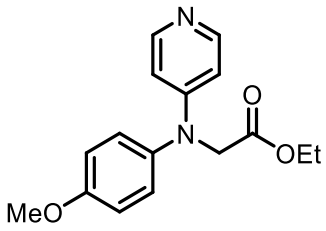
^{1}H NMR (400 MHz, $CDCl_3$)



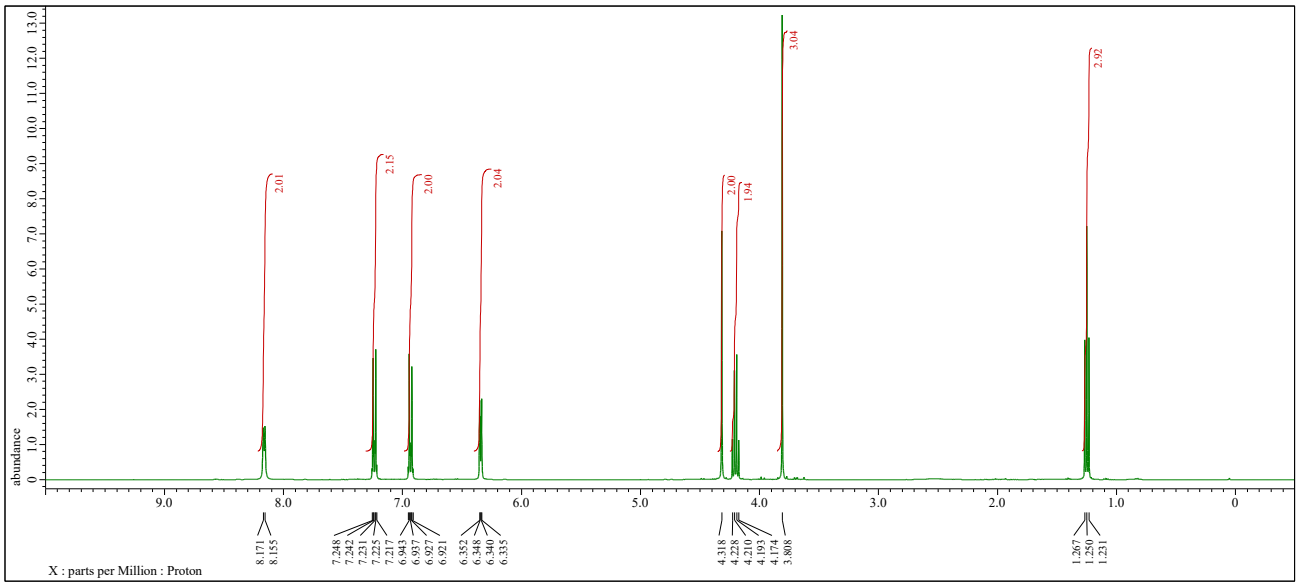
^{13}C NMR (101 MHz, $CDCl_3$)



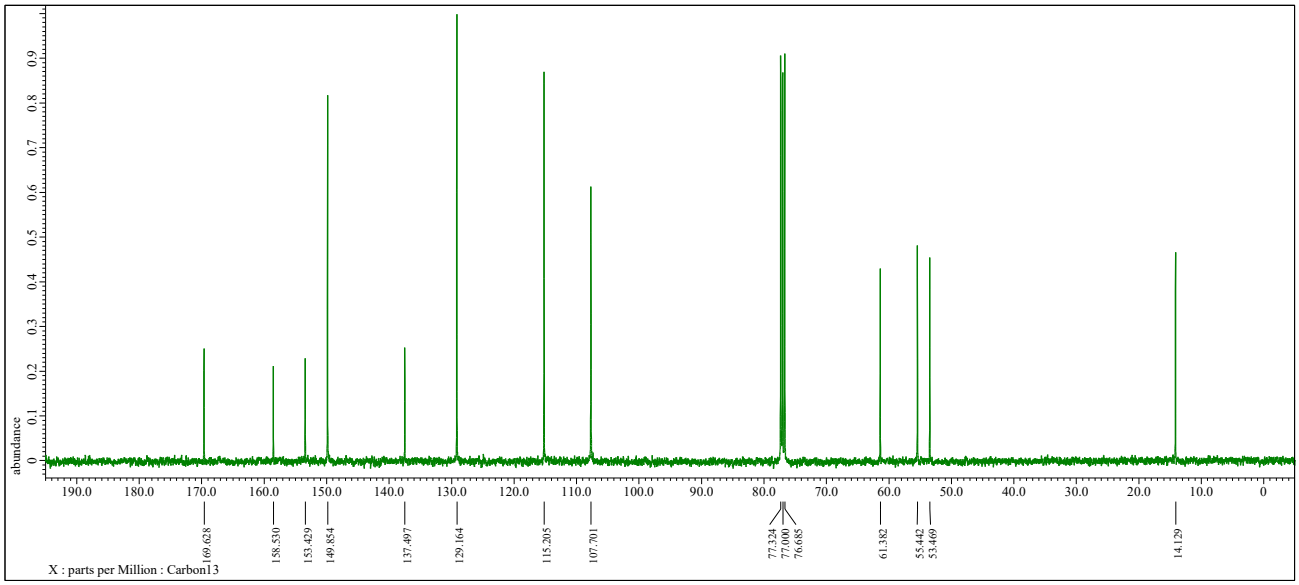
3g'



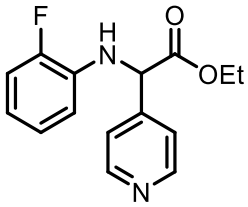
^{1}H NMR (400 MHz, $CDCl_3$)



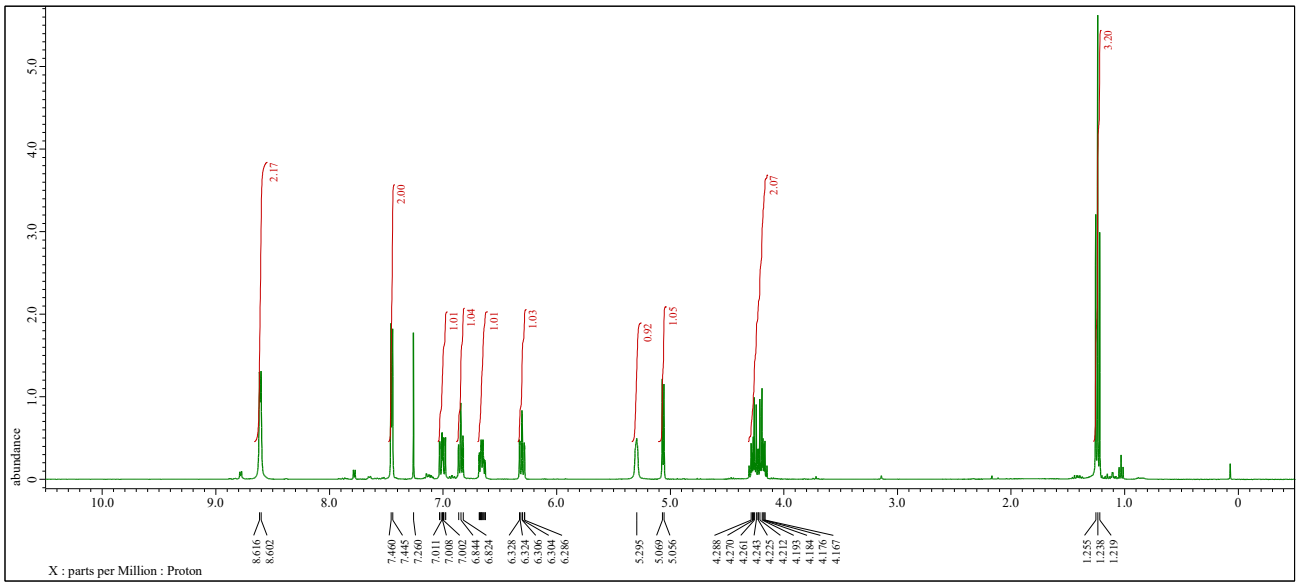
^{13}C NMR (101 MHz, $CDCl_3$)



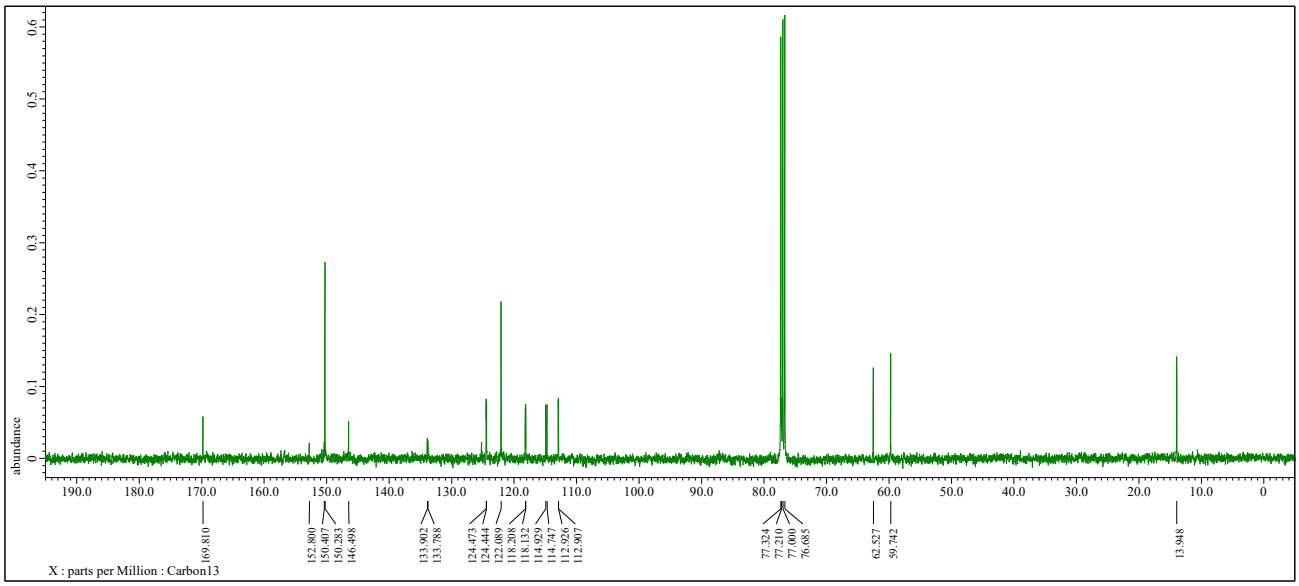
3h



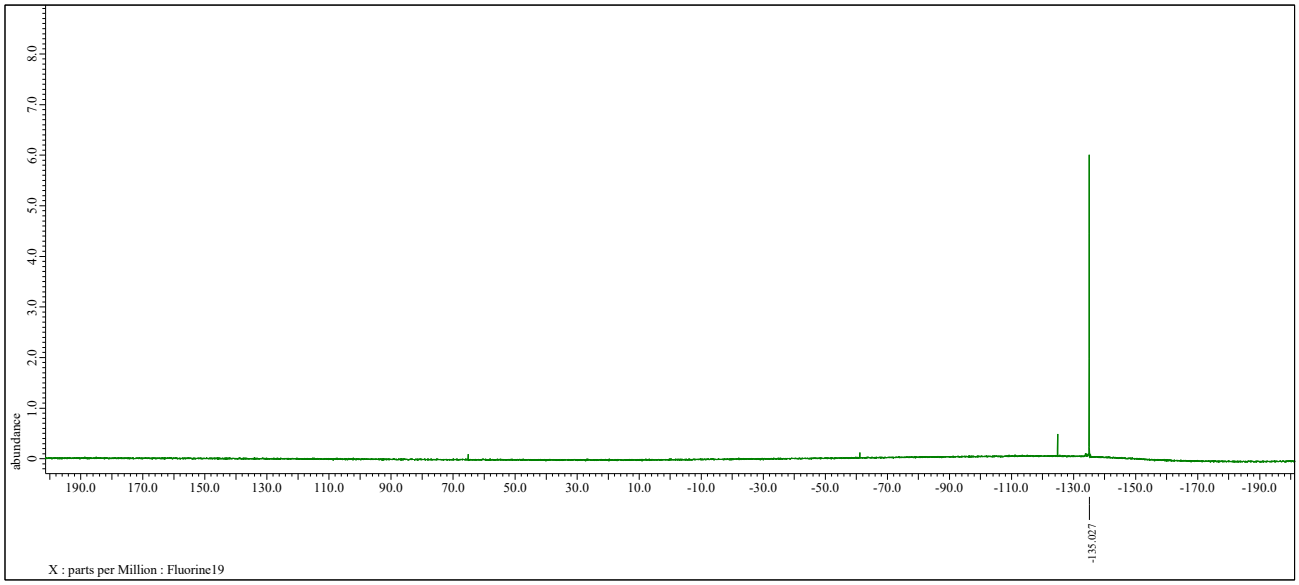
^{1}H NMR (400 MHz, $CDCl_3$)



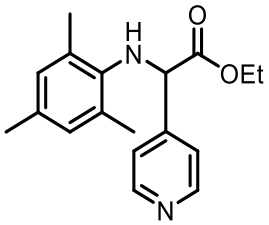
^{13}C NMR (101 MHz, $CDCl_3$)



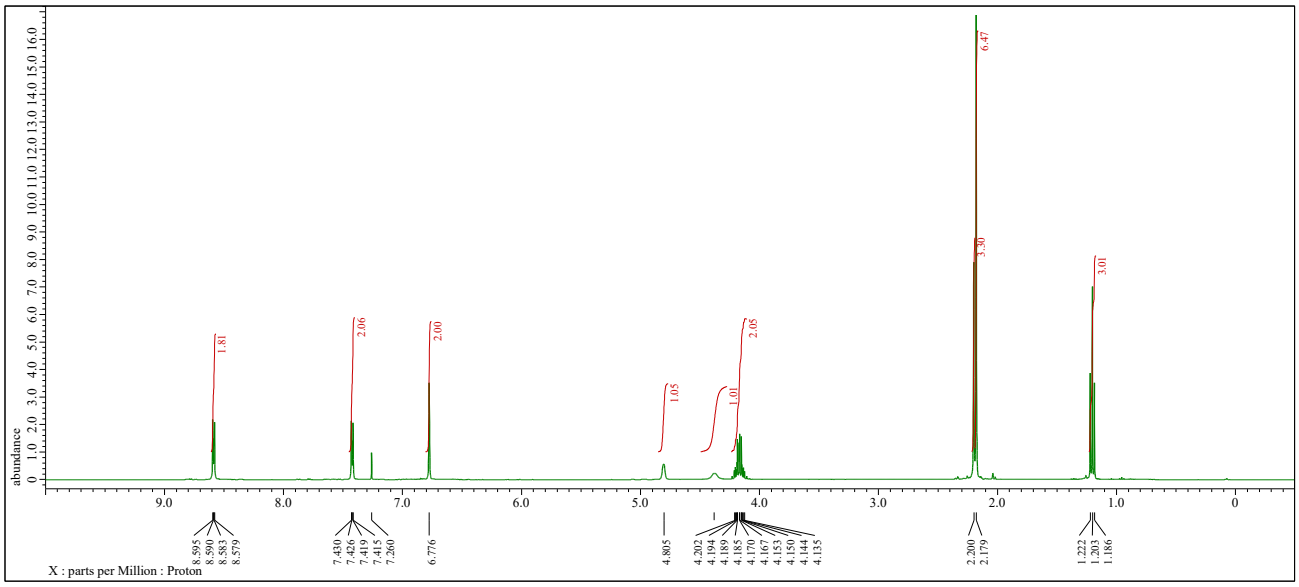
^{19}F NMR (376 MHz, $CDCl_3$)



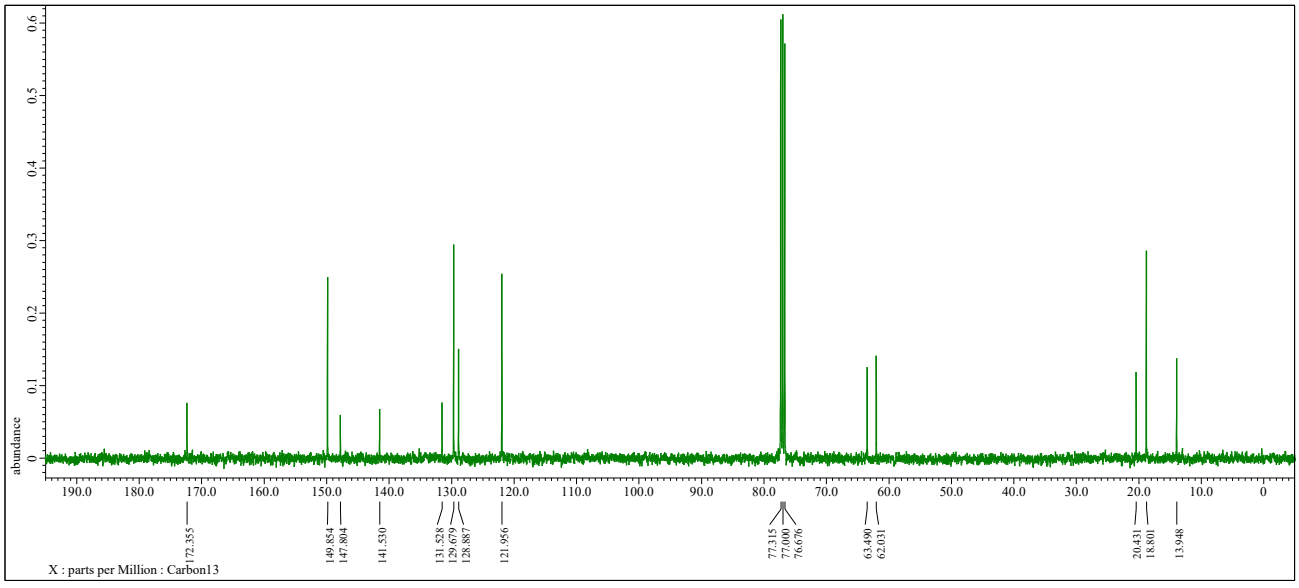
3i



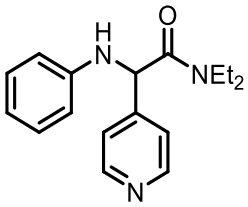
^{1}H NMR (400 MHz, $CDCl_3$)



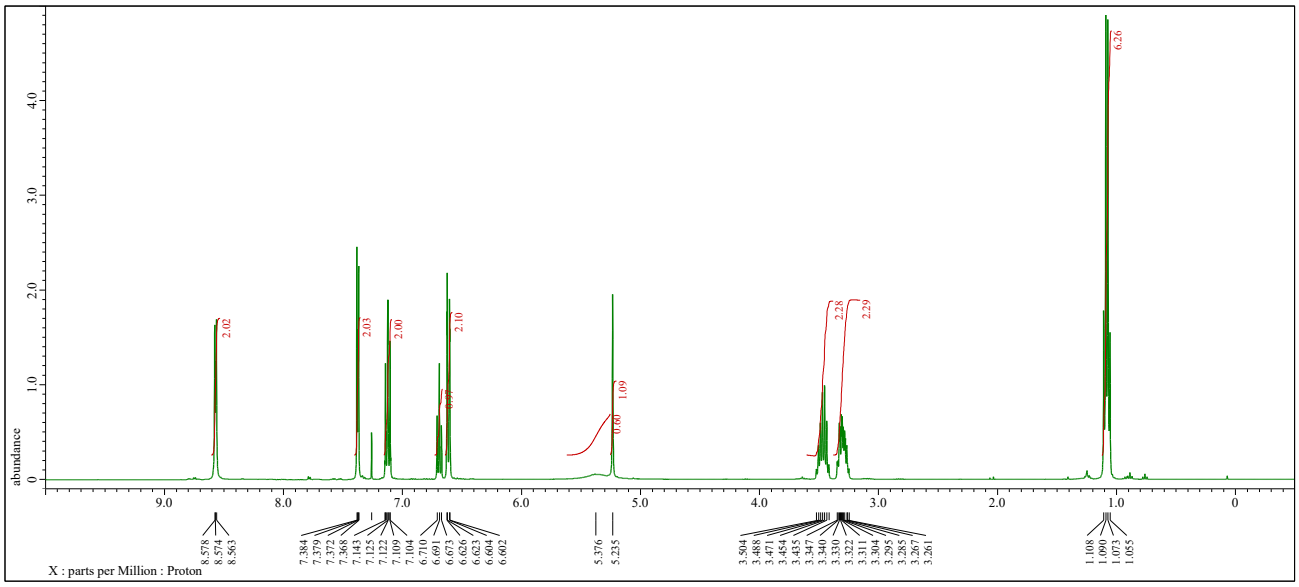
^{13}C NMR (101 MHz, $CDCl_3$)



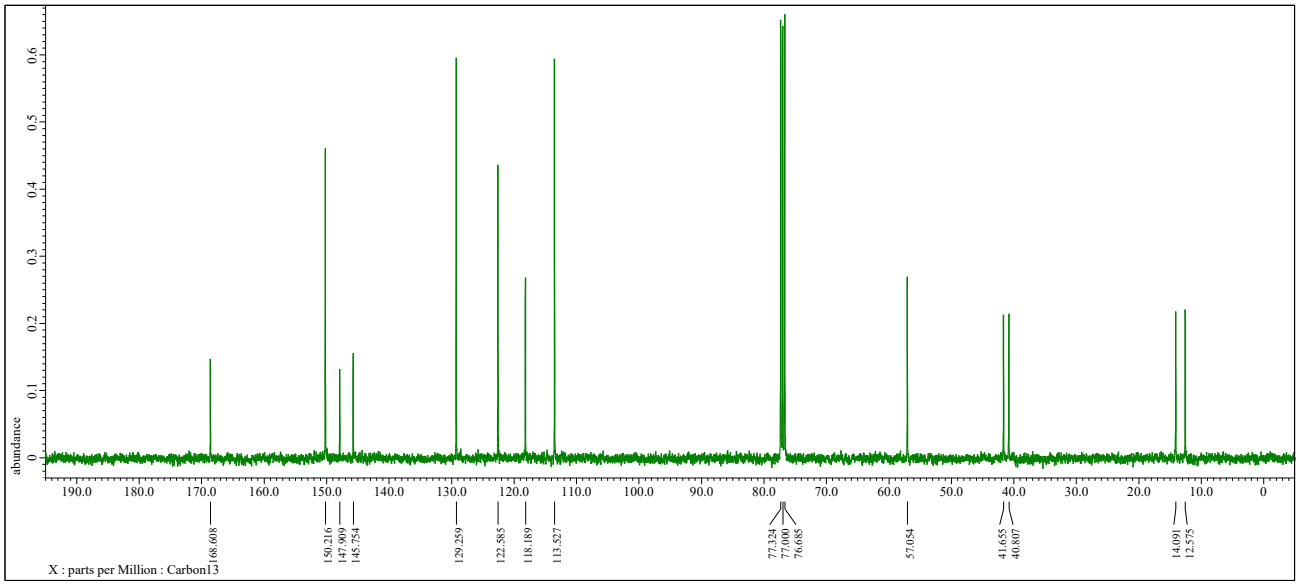
3j



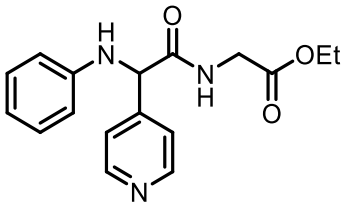
^{1}H NMR (400 MHz, $CDCl_3$)



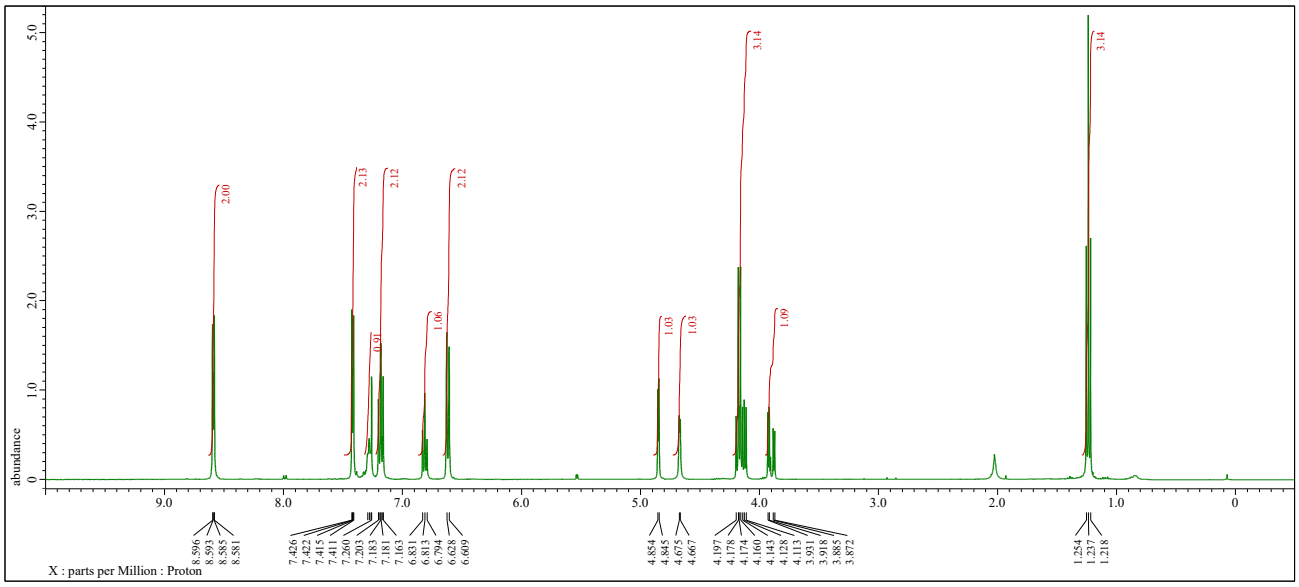
^{13}C NMR (101 MHz, $CDCl_3$)



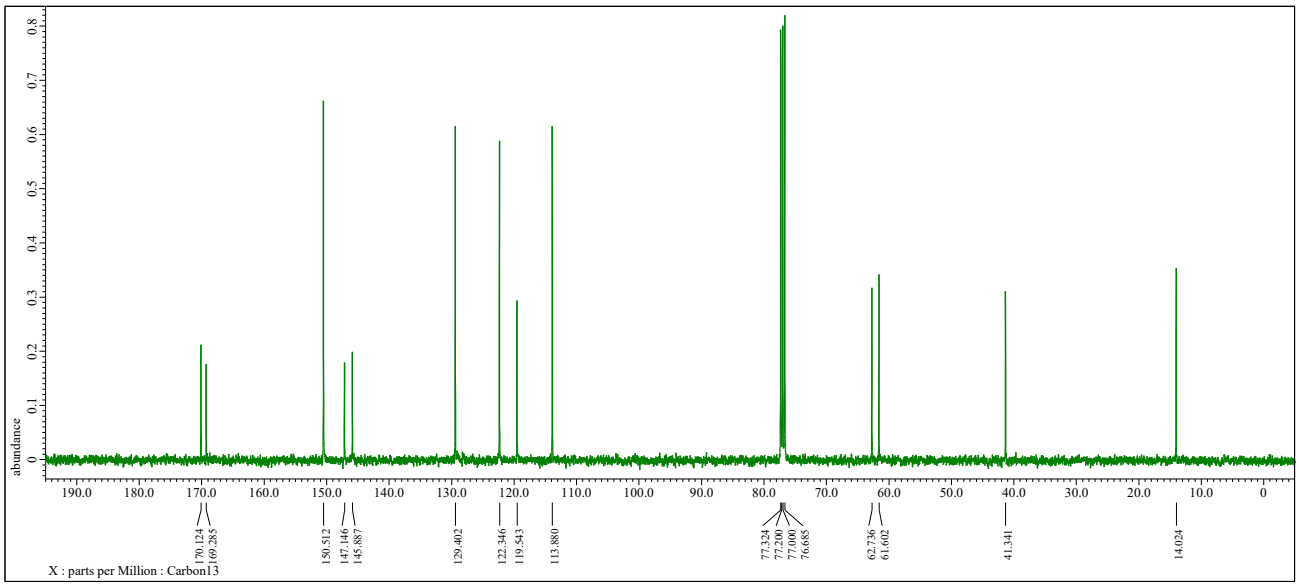
3k



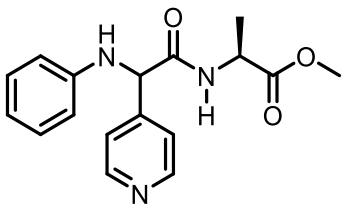
^{1}H NMR (400 MHz, $CDCl_3$)



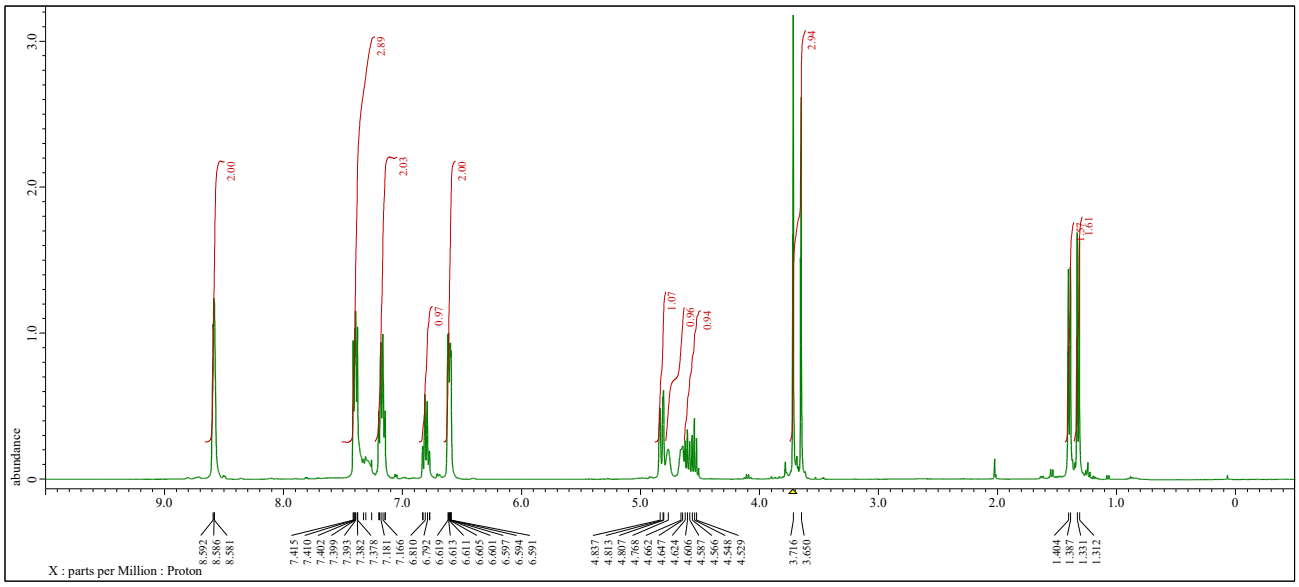
^{13}C NMR (101 MHz, $CDCl_3$)



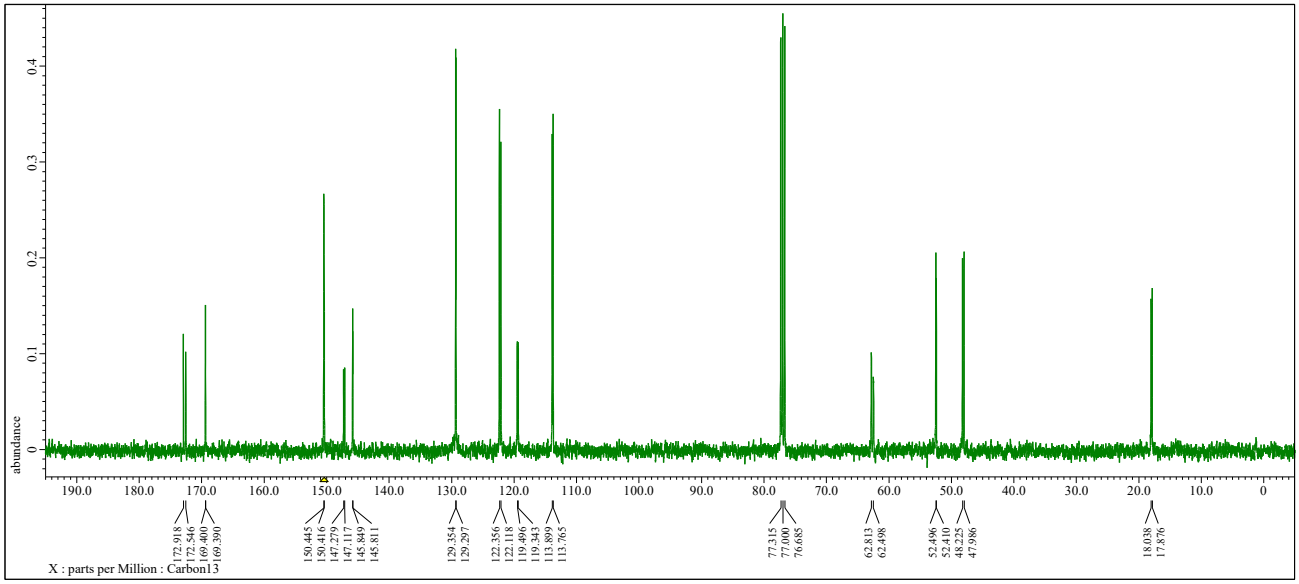
3l



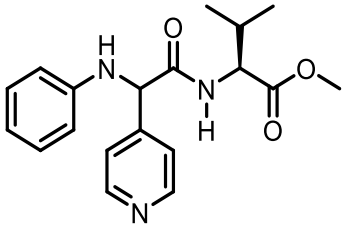
^{1}H NMR (400 MHz, $CDCl_3$)



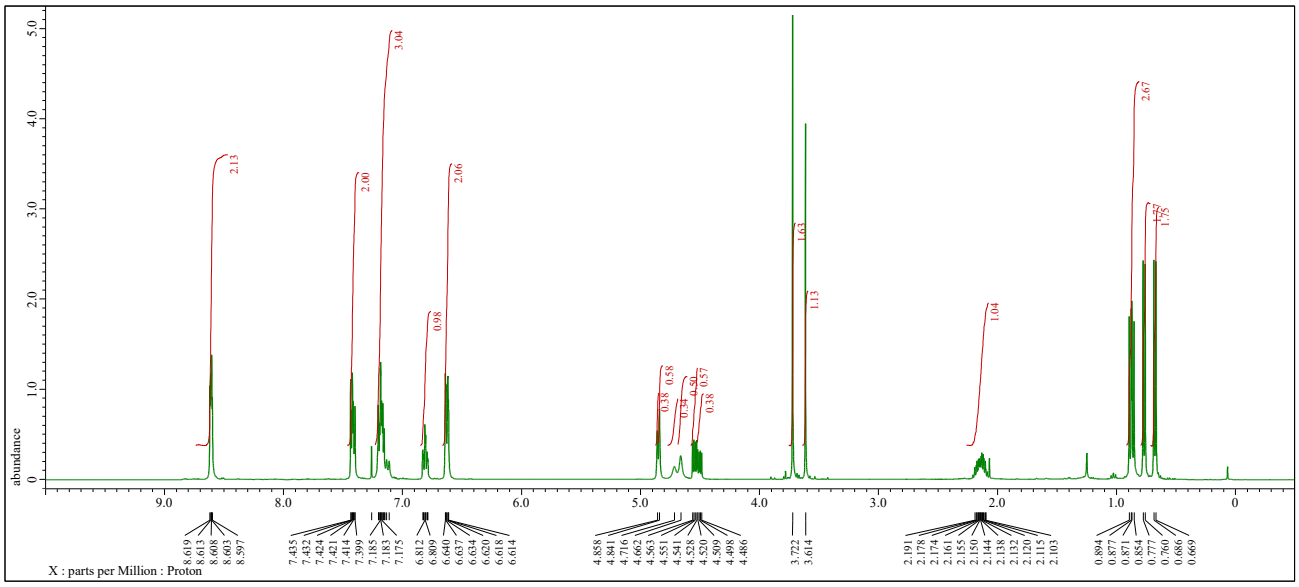
^{13}C NMR (101 MHz, $CDCl_3$)



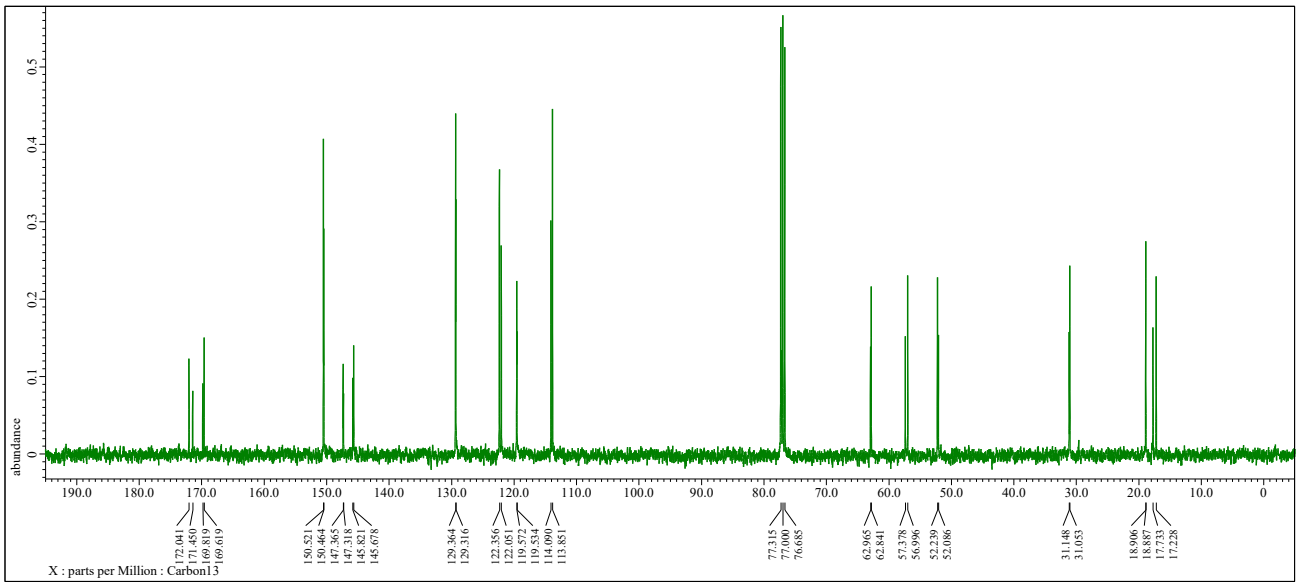
3m



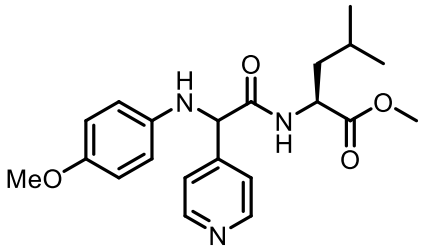
^{1}H NMR (400 MHz, $CDCl_3$)



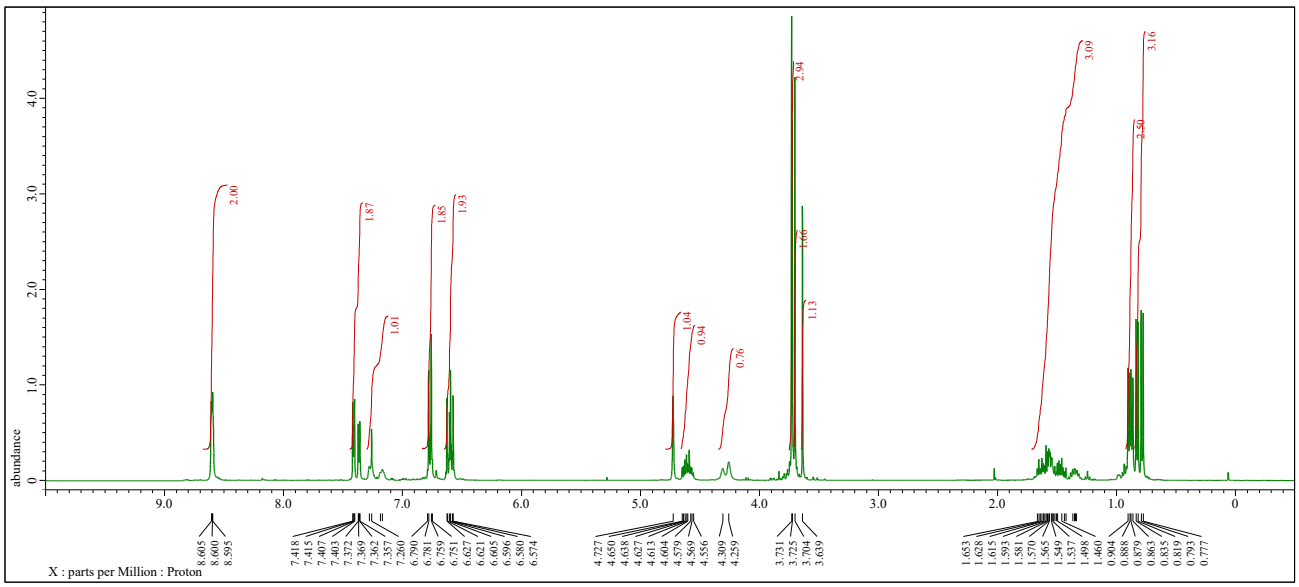
^{13}C NMR (101 MHz, $CDCl_3$)



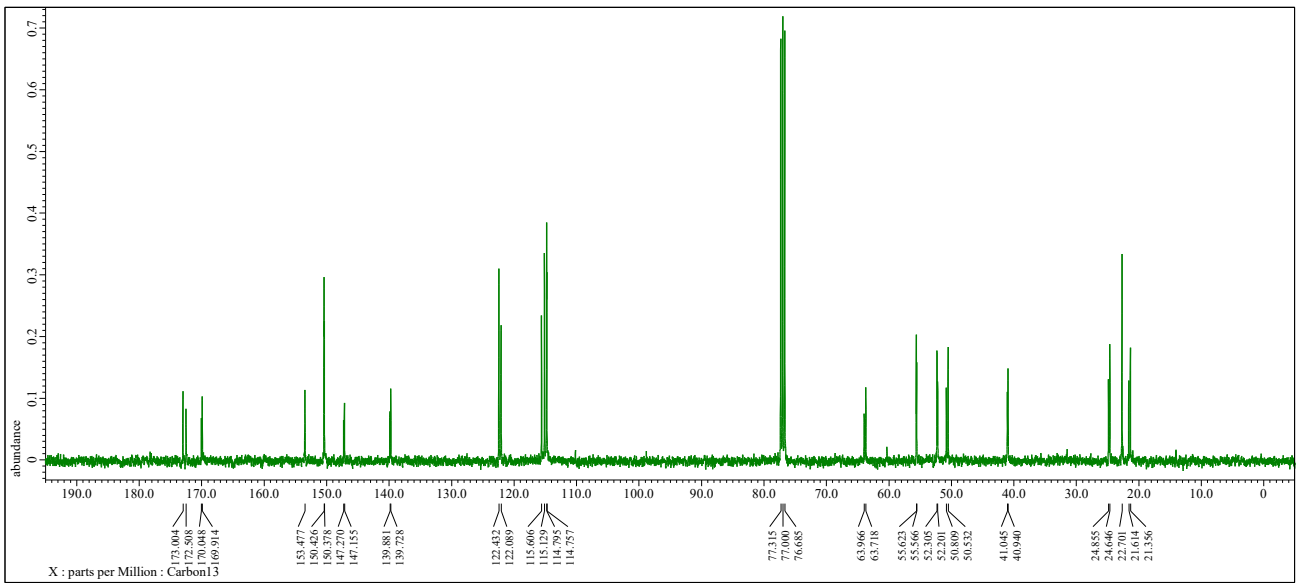
3n



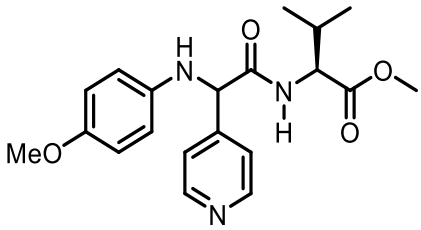
^{1}H NMR (400 MHz, $CDCl_3$)



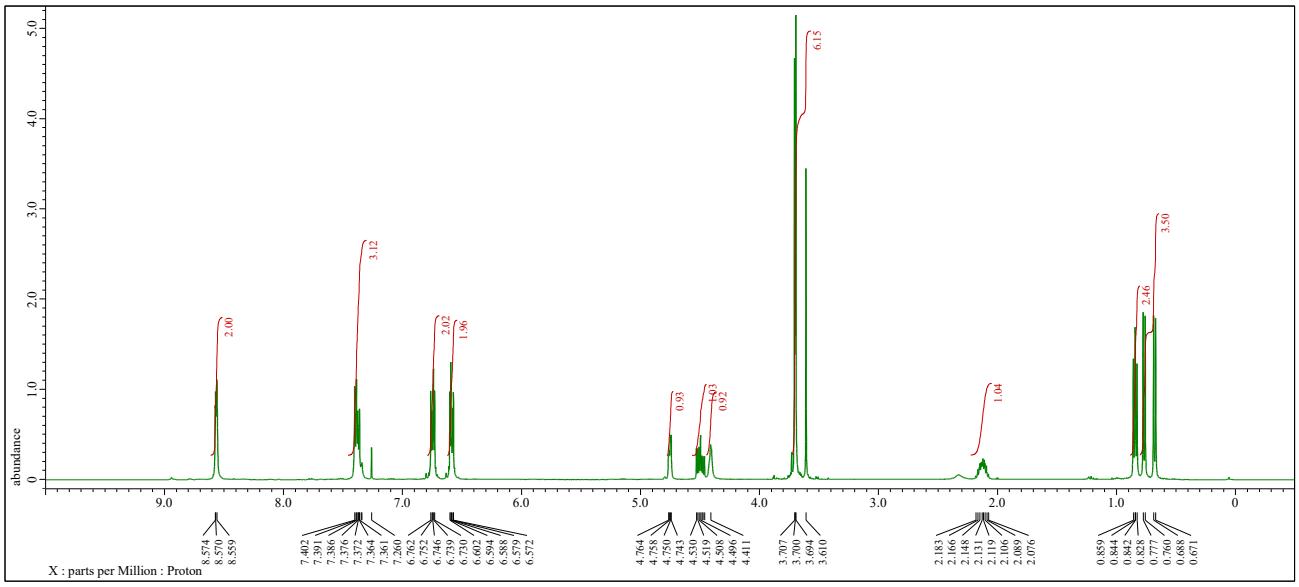
^{13}C NMR (101 MHz, $CDCl_3$)



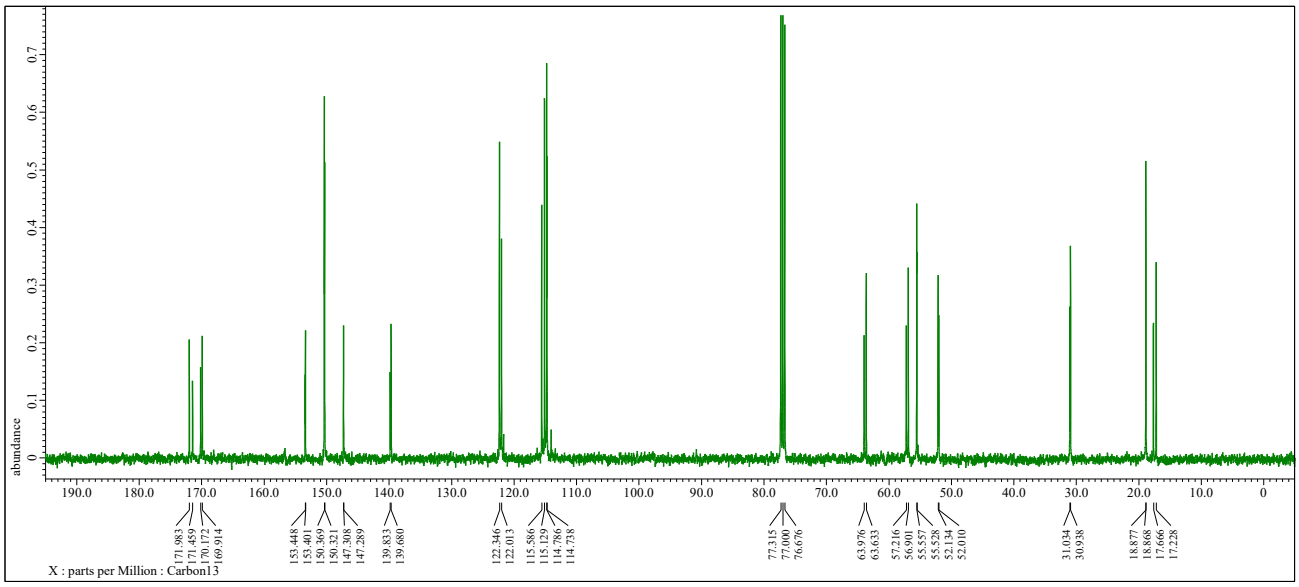
3o



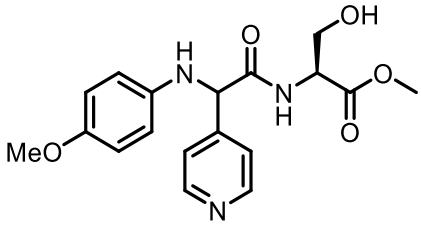
^{1}H NMR (400 MHz, $CDCl_3$)



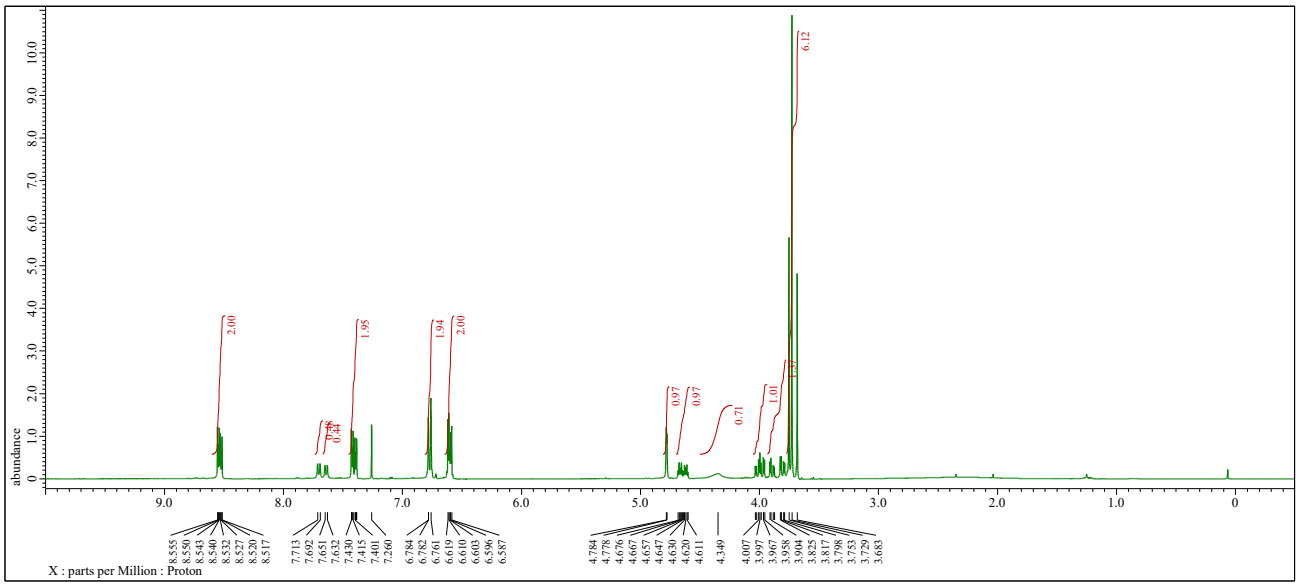
^{13}C NMR (101 MHz, $CDCl_3$)



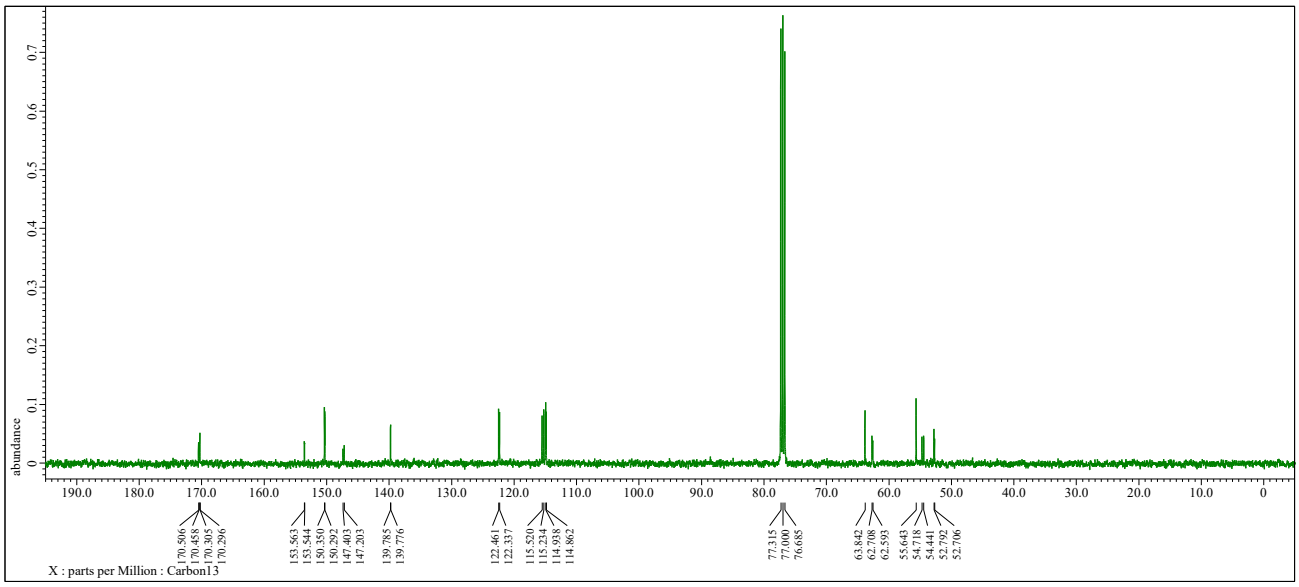
3p



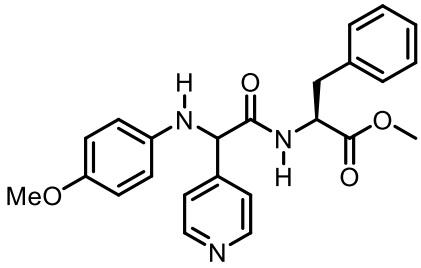
^{1}H NMR (400 MHz, $CDCl_3$)



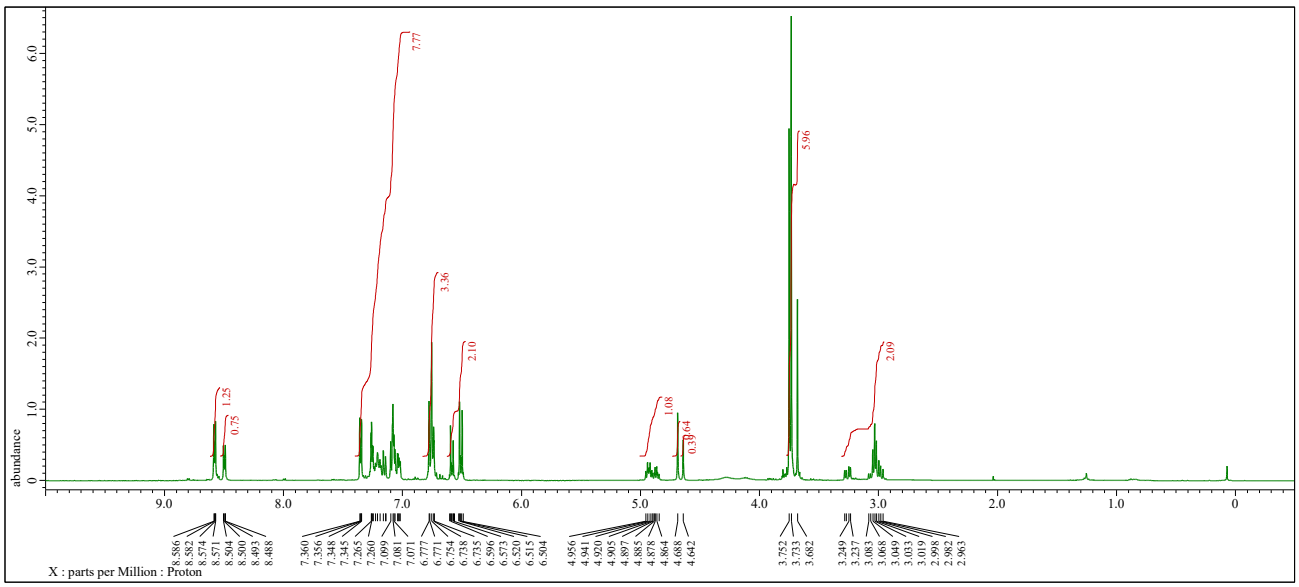
^{13}C NMR (101 MHz, $CDCl_3$)



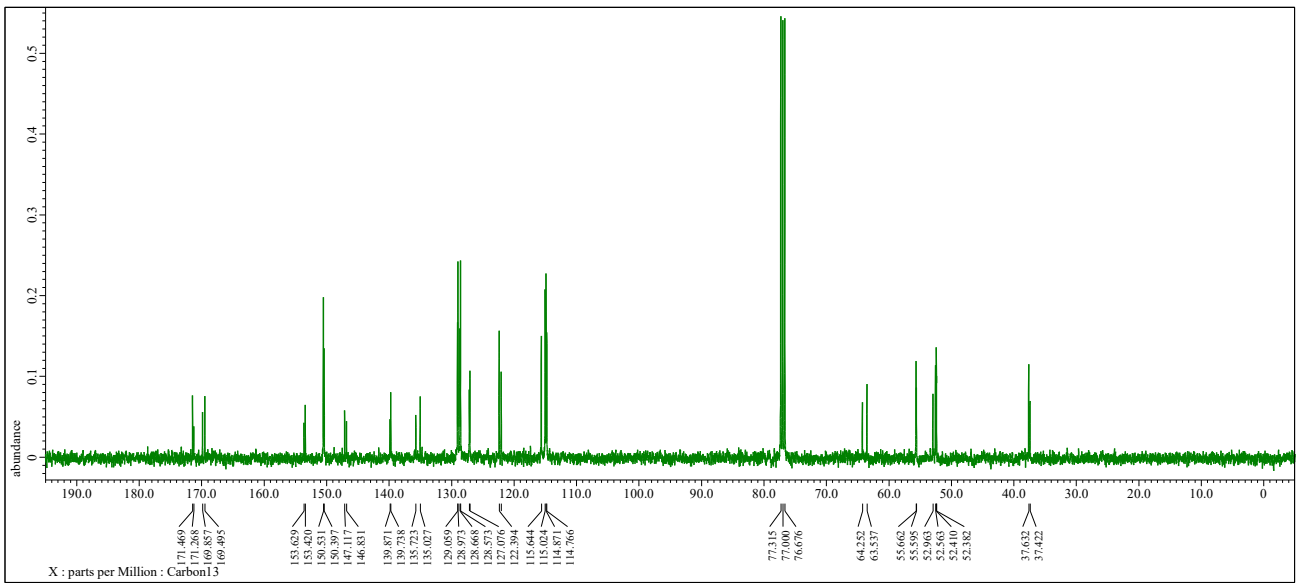
3q



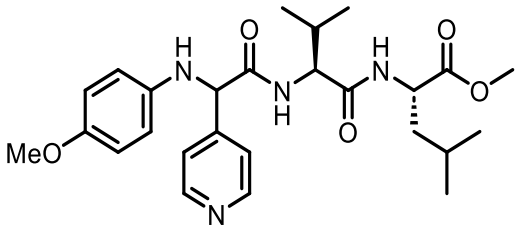
^{1}H NMR (400 MHz, $CDCl_3$)



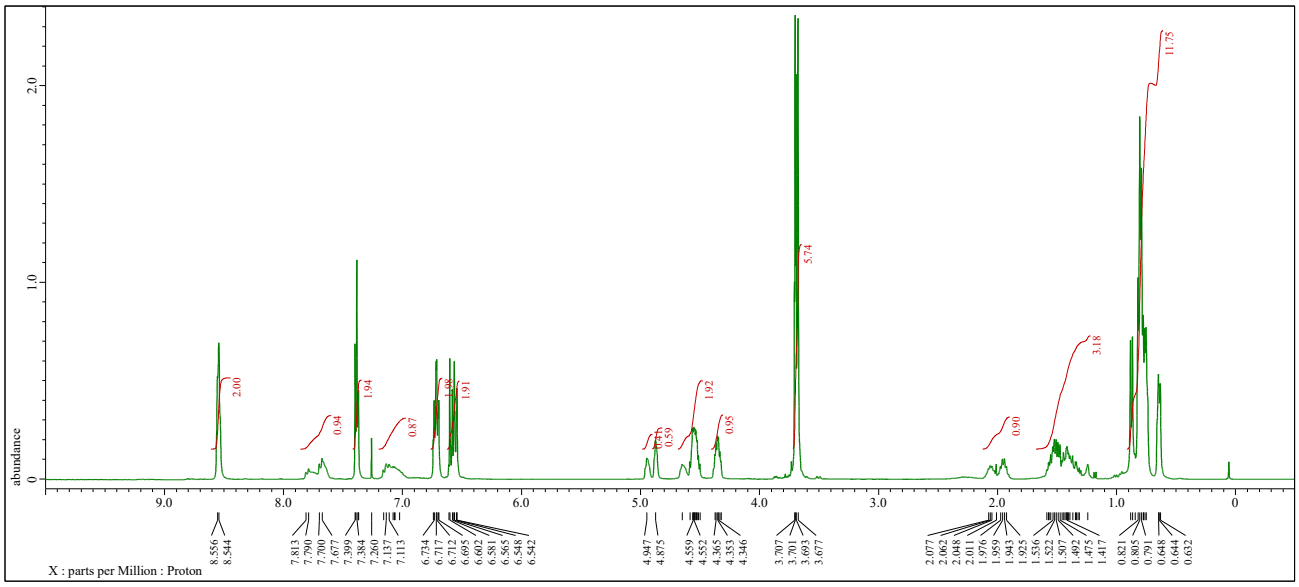
^{13}C NMR (101 MHz, $CDCl_3$)



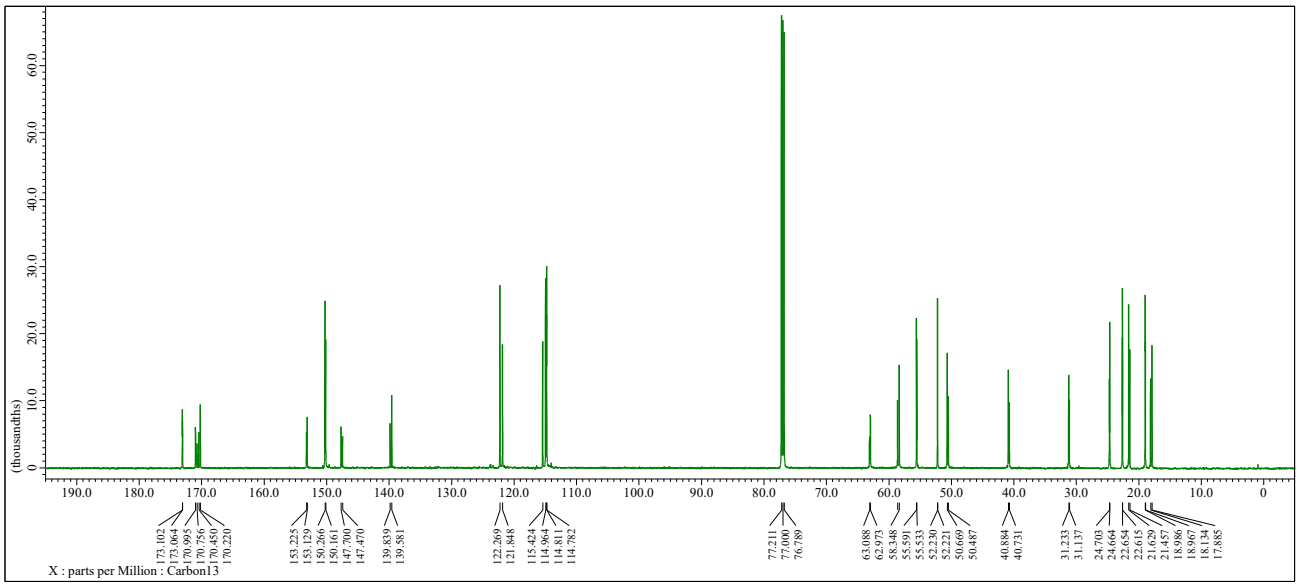
3r



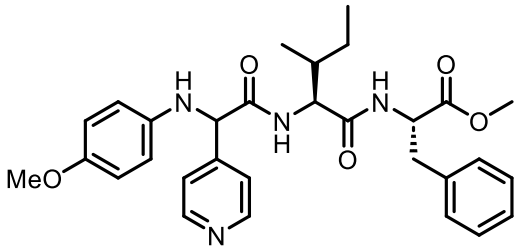
^{1}H NMR (400 MHz, $CDCl_3$)



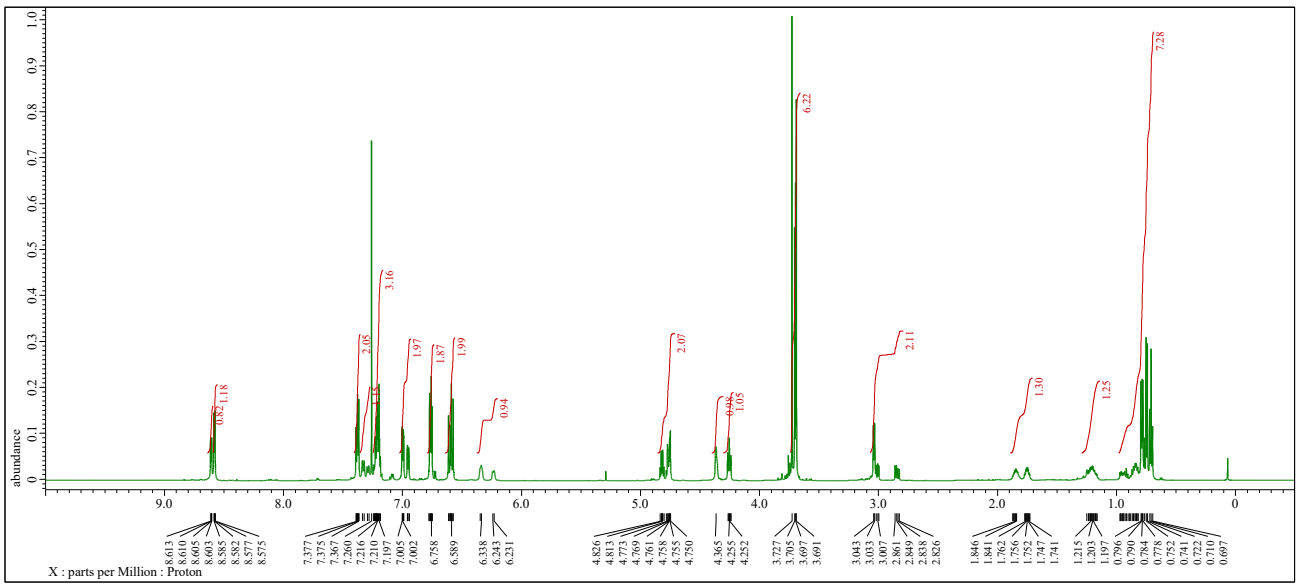
^{13}C NMR (151 MHz, $CDCl_3$)



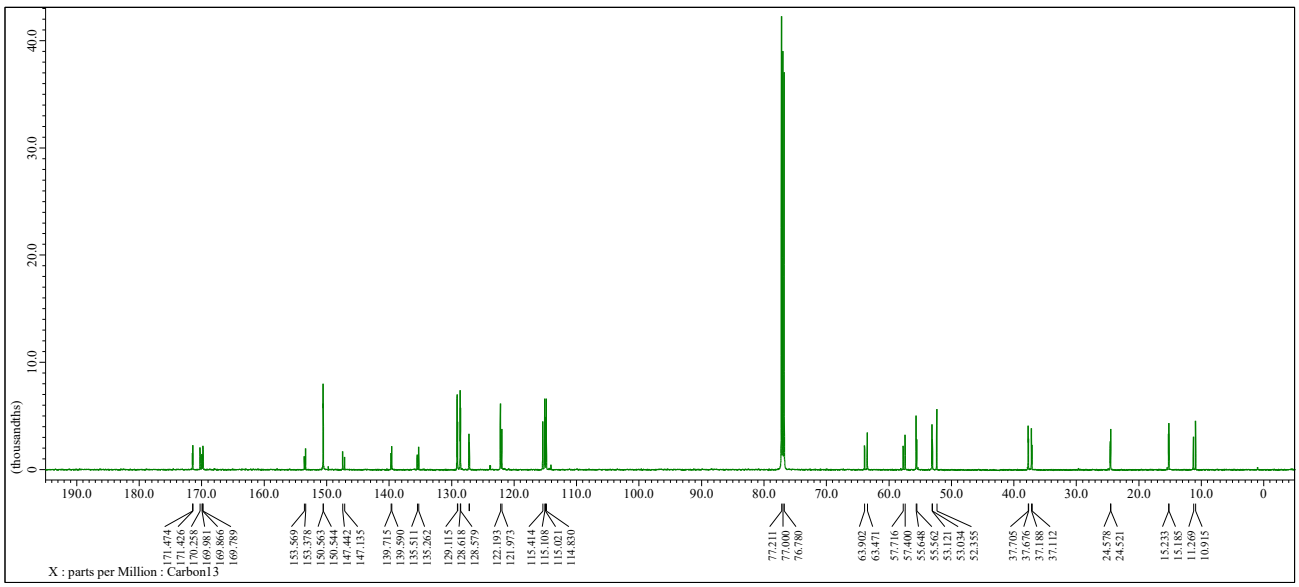
3s



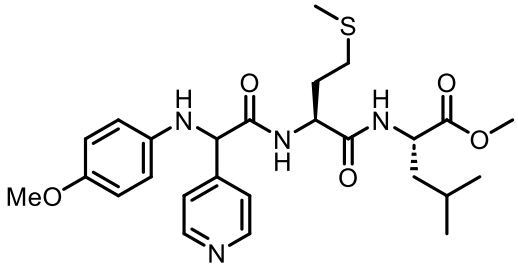
^{1}H NMR (600 MHz, $CDCl_3$)



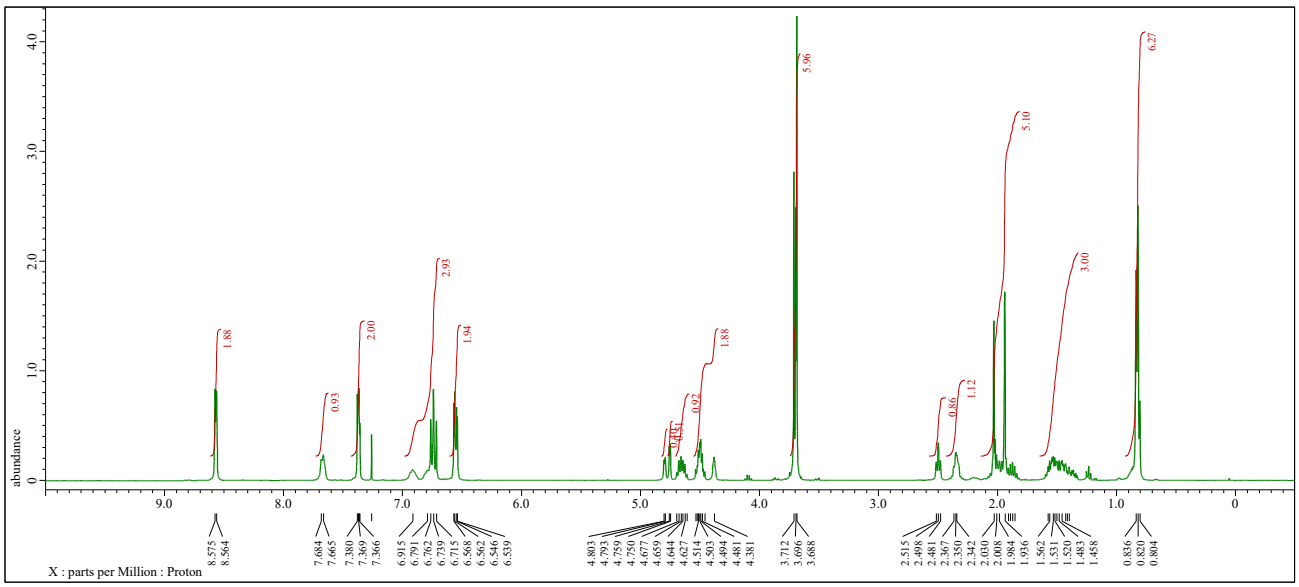
^{13}C NMR (151 MHz, $CDCl_3$)



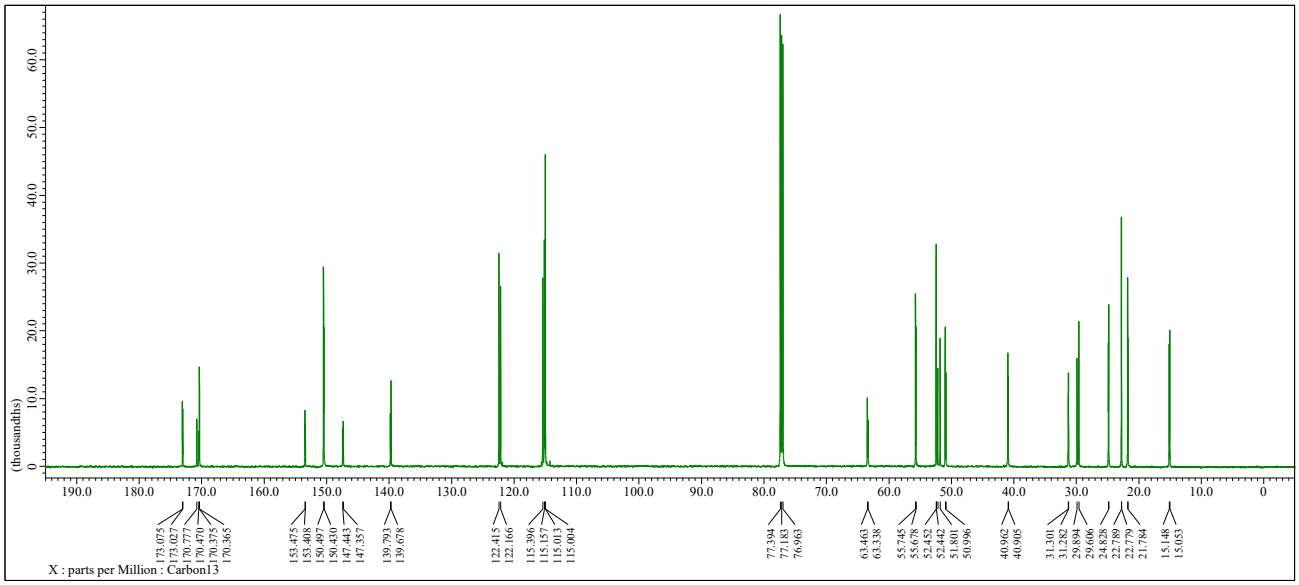
3t



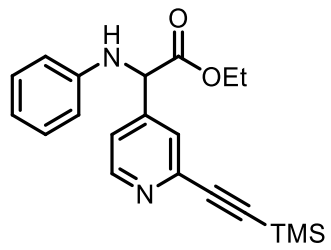
^{1}H NMR (400 MHz, $CDCl_3$)



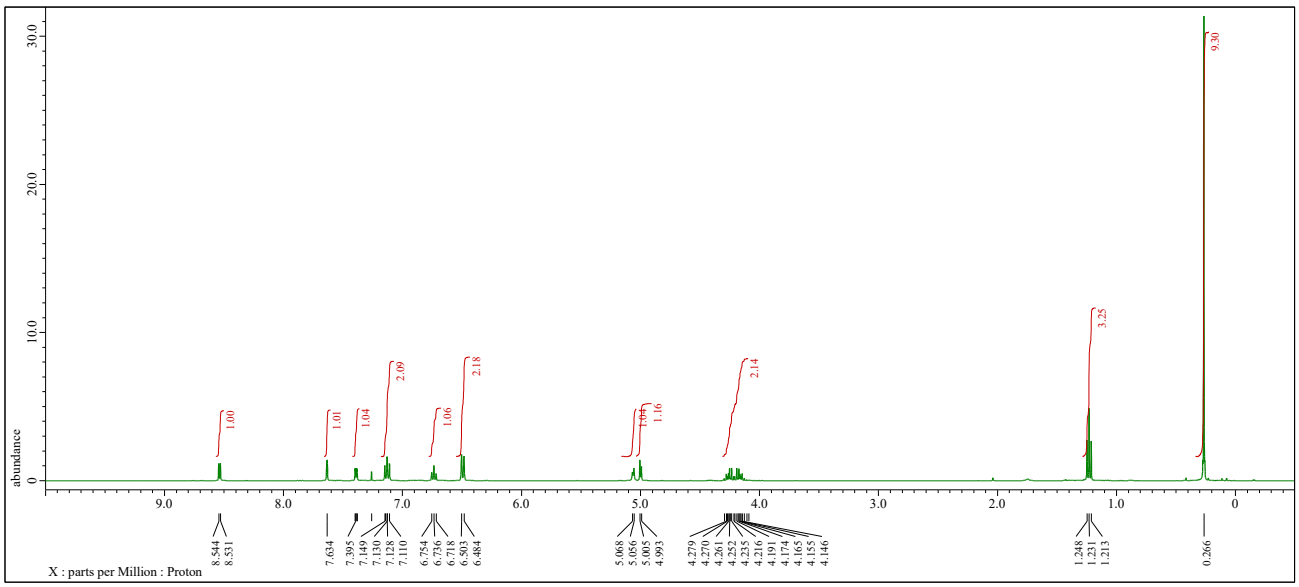
^{13}C NMR (151 MHz, $CDCl_3$)



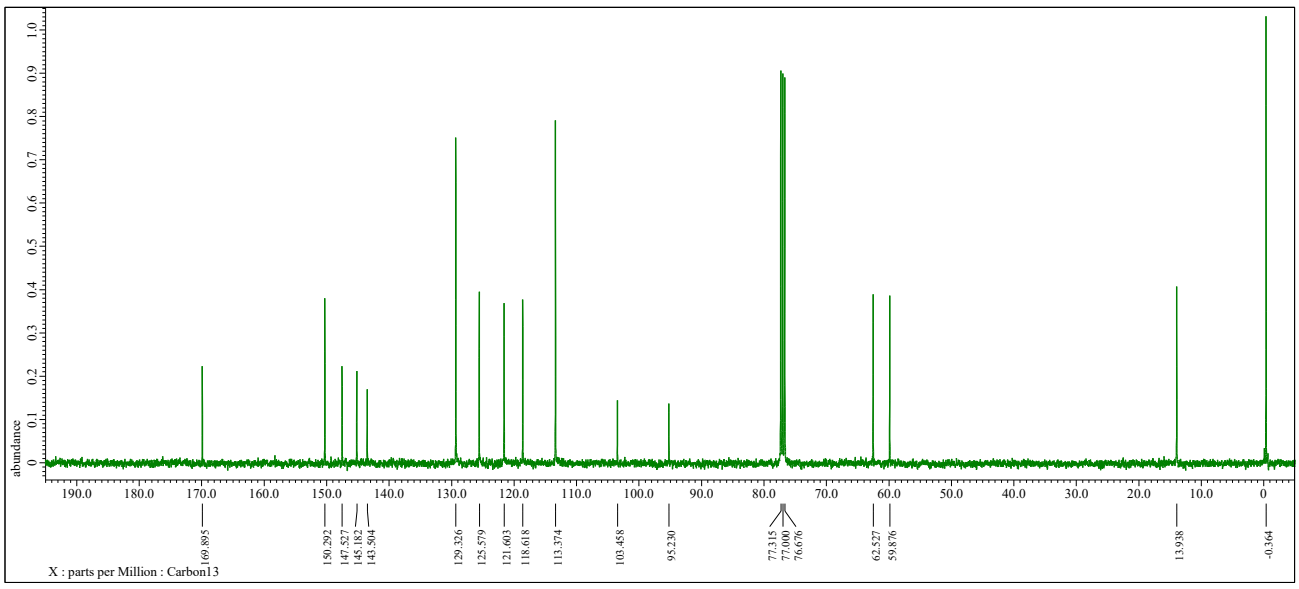
3u



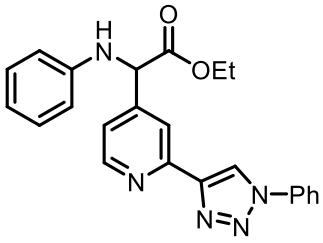
^{1}H NMR (400 MHz, $CDCl_3$)



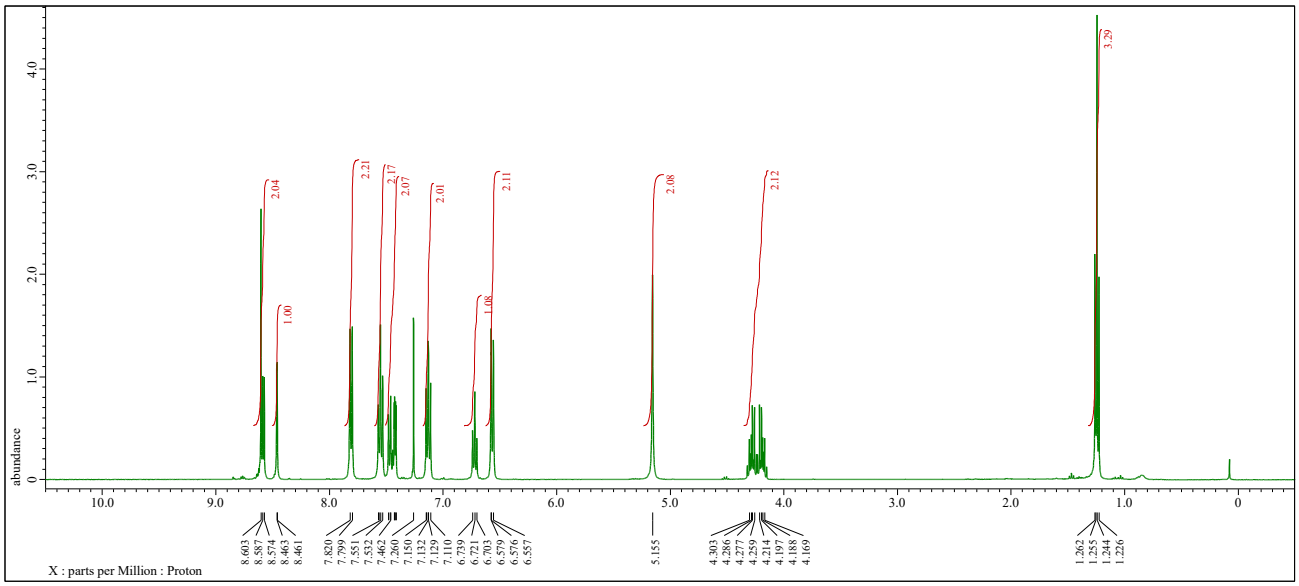
^{13}C NMR (101 MHz, $CDCl_3$)



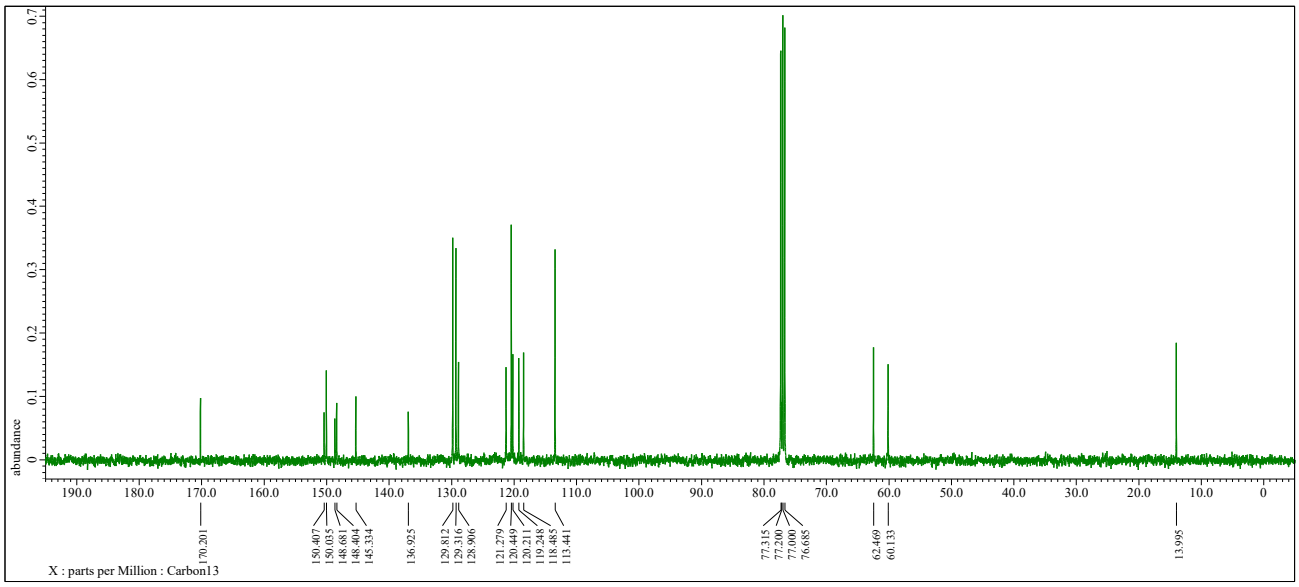
3v



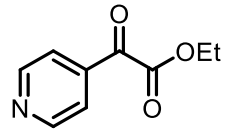
^{1}H NMR (400 MHz, $CDCl_3$)



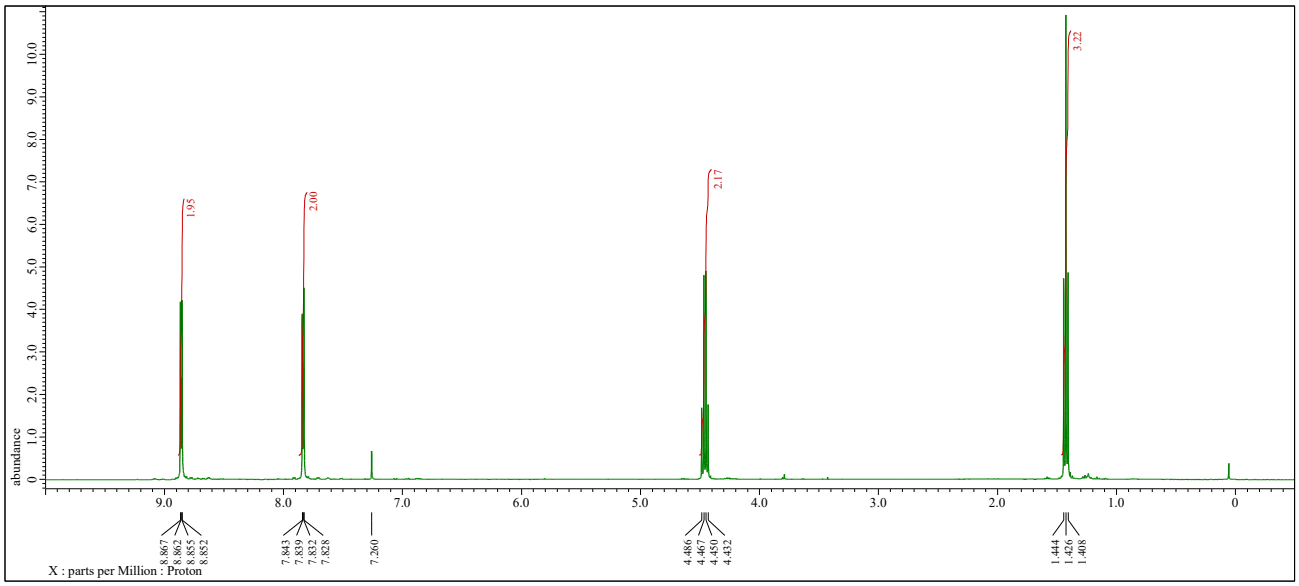
^{13}C NMR (101 MHz, $CDCl_3$)



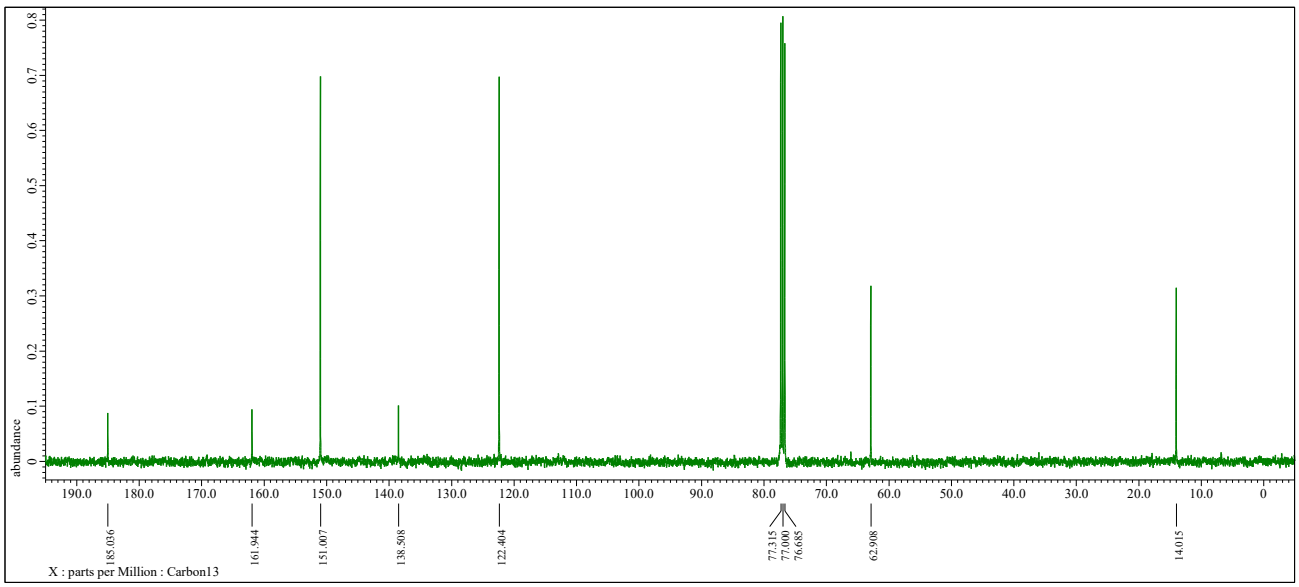
4a



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



^{13}C NMR (101 MHz, $CDCl_3$)



8. References

1) L. Yang, Q. J. Wu, J. Zhao, T. Shen, X. Huang and Z. Liu, *Org. Lett.,* 2021, **23**, 3207-3210.
2) Y. Miyake, Y. Itoh, Y. Suzuma, H. Kodama, T. Kurohara, Y. Yamashita, R. Narozny, Y. Hanatani, S. Uchida and T. Suzuki, *ACS Catal.,* 2020, **10**, 5383-5392.
3) C. Wang, M. Guo, R. Qi, Q. Shang, Q. Liu, S. Wang, L. Zhao, R. Wang and Z. Xu, *Angew. Chem. Int. Ed.,* 2018, **57**, 15841-15846.
4) T. Jiang, X. Yang, X. Yang, M. Yuan, T. Zhang, H. Zhang and M. Li, *Org. Biomol. Chem.*, 2016, **14**, 5272-5281.
5) X. Cui, H. Zhang, H. Zhang, Y. Wang, J. Qu and Y. Kang, *Org. Lett.,* 2023, **25**, 7198–7203.
6) W. Li, D. Wang, X. Liang, Z. Jin, S. Zhou, G. Chen and Y. Pan, *Org. Lett.,* 2022, **24**, 3086–3091.
7) R. Rohlmann, T. Stopka, H. Richter and O. G. Mancheño, *J. Org. Chem.,* 2013, **78**, 6050-6064.
8) N, Wang, Z. Chi, X. Wang, Z. Gao, S. Li and G. Li, *Org. Lett.,* 2022, **24**, 3657-3662.
9) F. Zhao, Q. Yang, J. Zhang, W. Shi, H. Hu, F. Liang, W. Wei and S. Zhou, *Org. Lett.,* 2018, **20***,* 7753-7757.
10) R. Wang, J. Wang, Y. Zhang, B. Wang, Y. Xia, F. Xue, W. Jin and C. Liu, *Adv. Synth. Catal.,* 2023, **365**, 900-905.
11) C. Wang, Y. Yu, W. Liu and W. Duan, *Org. Lett.,* 2019, **21**, 9147-9152.
12) T. Inokuma, Y. Suzuki, T. Sakaeda and Y. Takemoto, *Chem. Asian J.,* 2011, **6**, 2902-2906.
13) G. M. Sheldrick, University of Göttingen: Göttingen, Germany, **2014**.
14) G. M. Sheldrick, *Acta Crystallogr., Sect. A,* 2008, **64**, 112.
15) O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Crystallogr.,* 2009, **42**, 339.