Supplementary Information

Photo-driven reduction/cyclization of nitroarenes via electron donor-acceptor complexes: a novel acquisition for *N*-heterocycles

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I. General Information

^{1}H NMR, ^{13}C NMR spectra were recorded on a Bruker AV 600 or AV 400 NMR spectrometer. Chemical shifts were reported in parts per million (ppm) and calibrated using residual undeuterated solvent as an internal reference ($CDCl_3$: 7.26 ppm ^{1}H NMR, 77.0 ppm ^{13}C NMR; DMSO-*d6*: 2.50 ppm ^{1}H NMR, 39.6 ppm ^{13}C NMR). All high-resolution mass spectra (HRMS) were obtained on an Agilent 6545 LC/Q-TOF spectrometer. The UV-Vis measurements were carried out using a UV-Vis spectrophotometer (ULN 2209003, MAPADA P6). The thin layer chromatography (TLC) was performed using glass plates covered with SiO_2. Visualization was achieved by short wave (254 nm) ultraviolet light. Unless otherwise indicated, all reactions were carried out under air atmosphere at room temperature with magnetic stirring. All reagents were purchased from commercial source and without prior purification. Flash column chromatography was performed on silica gel (200-300 mesh) and the elution was performed with petroleum ether/ethyl acetate. The experiments were conducted in sealed 10 mL or 20 mL Schlenk tube.

Photochemical reactions were performed with a 100 W 390 nm LED purchased from Shanghai 3S Technology Co., Ltd (https://www.3s-tech.net/en/#).

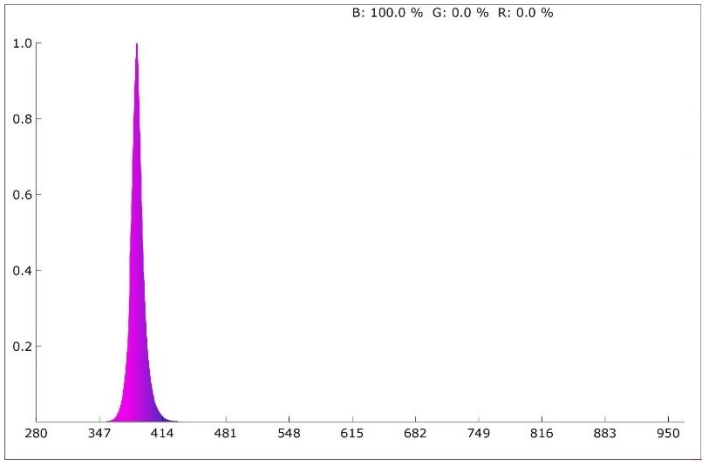
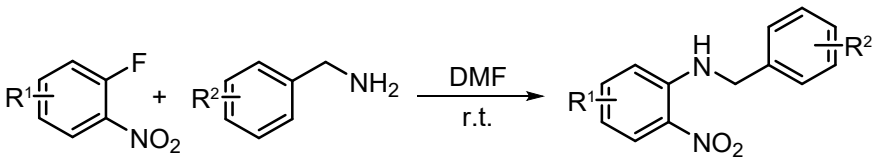


Figure S1. Emission spectrum of 100 W 390 nm LED strips. The maximum emission occurs at approximately 390 nm.

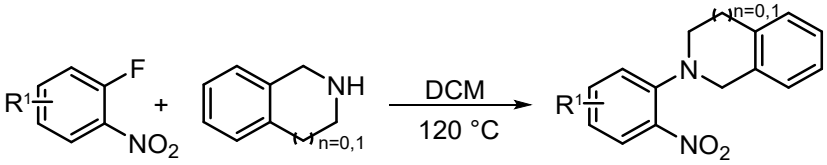
II. Preparation of Substrate

Synthesis of *N*-benzyl-2-nitroaniline derivatives



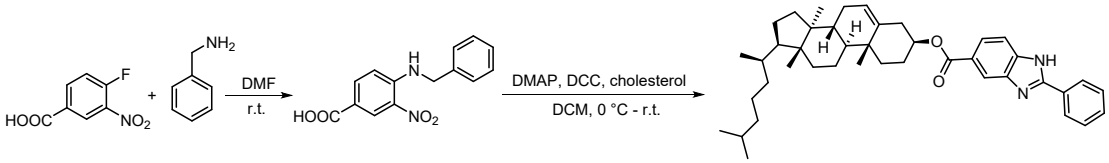
Prepared following a modified literature procedure.[1] To a suspension of 2-fluoronitroaniline (5 mmol, 1.0 equiv.) in DMF (10 mL), benzylamine (5 mmol, 1.0 equiv.) was added dropwise at room temperature. Stir the reaction mixture continuously until starting material is consumed as monitored by TLC. After that, the mixture was poured into H_2O and extracted with EtOAc. The organic layer was then washed with aqueous LiCl, dried over Na_2SO_4 and evaporated under reduced pressure to obtain the corresponding product **S1**-**S20**.

Synthesis of 2-(2-nitrophenyl)-1,2,3,4-tetrahydroisoquinoline derivatives



Prepared following a modified literature procedure.[2] Dissolve 2-fluoronitroaniline (5 mmol, 1.0 equiv.) in DCM (10 mL). Amine (15 mmol, 3.0 equiv.) was added dropwise at room temperature. The mixture was heated to reflux with 120 °C and stirred for 1 h. After that, the reaction mixture cooled to room temperature was diluted with H_2O and DCM. The organic layer was then dried over Na_2SO_4 and evaporated under reduced pressure to obtain the corresponding product **S21**-**S24**.

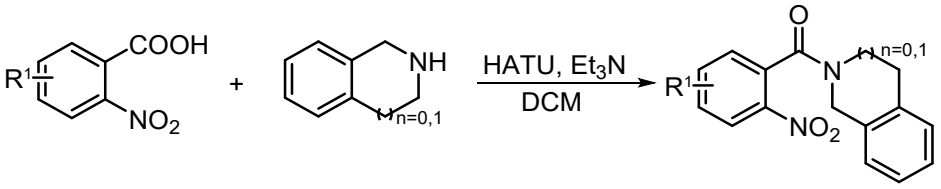
Synthesis of cholesterol derivatives S26



Prepared following modified literature procedures.[1,3] To a suspension of 4-fluoro-3-nitrobenzoic acid (5 mmol, 1.0 equiv.) in DMF (10 mL), benzylamine (5 mmol, 1.0 equiv.) was added dropwise at room temperature. Stir the reaction mixture continuously until starting material is consumed as monitored by TLC. After that, the mixture was poured into H_2O and extracted with EtOAc. The organic layer was then washed with aqueous LiCl, dried over Na_2SO_4 and evaporated under reduced pressure to obtain 4-(benzylamino)-3-nitrobenzoic acid. After that, to a solution of acid (4.0 mmol, 1.0 equiv), cholesterol (4.0 mmol, 1.0 equiv), DCC (8 mmol, 2.0 equiv.), DMAP (0.32 mmol, 8 mol%) was added in DCM at room temperature for 12 h. Then the reaction mixture was diluted with H_2O and DCM. The organic layer was then dried over Na_2SO_4 and evaporated under reduced pressure to obtain the corresponding product

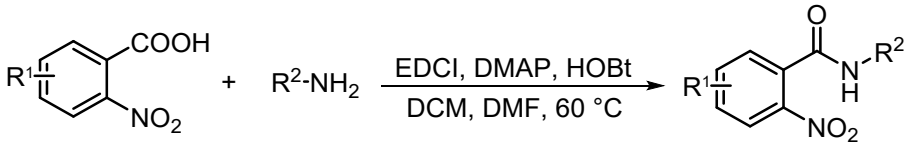
S26.

Synthesis of (3,4-dihydroisoquinolin-2(1*H*)-yl)(2-nitrophenyl)methanone derivatives



Prepared following a modified literature procedure.[4] To the solution of 2-nitrobenzoic acid (5 mmol, 1.0 equiv.) in DCM (10 mL), HATU (6 mmol, 1.2 equiv.) and Et_3N (10 mmol, 2.0 equiv.) were added at room temperature. 15 min later, 1,2,3,4-tetrahydroisoquinoline derivatives (5.5 mmol, 1.1 equiv.) were added dropwise. Stir the reaction mixture continuously until starting material is consumed as monitored by TLC. After the completion of the reaction, the organic layer was washed with saturated NH_4Cl solution, 1 M NaOH solution, saturated NaCl solution, and then dried over Na_2SO_4. The organic solvent was evaporated under reduced pressure. Purification by column chromatography on silica gel to obtain the corresponding product **S27**-**S29**.

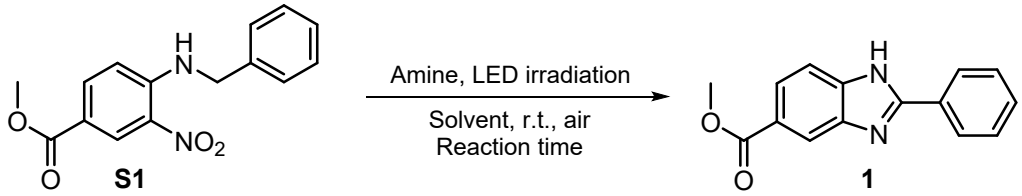
Synthesis of *N*- substituted 2-nitrobenzamide derivatives



Prepared following a modified literature procedure.[5] To the solution of 2-nitrobenzoic acid (5 mmol, 1.0 equiv.) in DCM: DMF (25:1), EDCI (5.5 mmol, 1.1 equiv.), HOBt (5.5 mmol, 1.1 equiv.) and DMAP (0.25 mmol, 0.05 equiv.) were added at room temperature. Then amine (10 mmol, 2.0 equiv.) was added dropwise. The mixture was heated to reflux with 60 °C and stirred for 4 h. After that, the reaction mixture was poured into H_2O and extracted with DCM. The organic layer was washed with saturated NaCl solution, dried over Na_2SO_4 and evaporated under reduced pressure. Purification by column chromatography on silica gel to obtain the corresponding product **S30**-**S53**.

III. Optimization of the reaction conditions

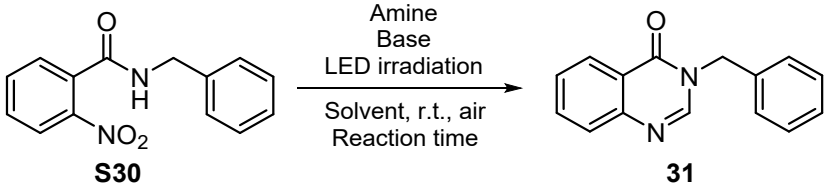
Table S1. Selected reaction optimization for benzimidazoles and polycyclic quinazolinones derivatives[a,b]



Entry	Amine	Solvent	Light source	Time (h)	Yield (%)[b]
1	Piperazine	DMSO	390 nm LED	48	75
2[c]	Piperazine	DMSO	390 nm LED	48	34
3[d]	Piperazine	DMSO	390 nm LED	48	51
4[e]	Piperazine	DMSO	390 nm LED	48	74
5	TMEDA	DMSO	390 nm LED	48	40
6	HTMP	DMSO	390 nm LED	48	48
7	DIPEA	DMSO	390 nm LED	48	n.d.
8	Piperazine	DMSO	370 nm LED	48	69
9	Piperazine	DMSO	455 nm LED	48	65
10	Piperazine	DMF	390 nm LED	48	68
11	Piperazine	MeCN	390 nm LED	48	12
12	Piperazine	THF	390 nm LED	48	45
13	Piperazine	DCE	390 nm LED	48	n.d.
14	Piperazine	H_2O	390 nm LED	48	n.d.
15	Piperazine	Diox	390 nm LED	48	n.d.
16	Piperazine	*i*-PrOH	390 nm LED	48	n.d.
17	Piperazine	MeOH	390 nm LED	48	n.d.
18	Piperazine	EA	390 nm LED	48	n.d.
19	Piperazine	Acetone	390 nm LED	48	61
20	Piperazine	Ethyl formate	390 nm LED	48	n.d.
21	Piperazine	DMSO	390 nm LED	12	45
22	Piperazine	DMSO	390 nm LED	36	63
23	None	DMSO	390 nm LED	48	Trace
24[f]	Piperazine	DMSO	390 nm LED	48	73
25[g]	Piperazine	DMSO	In dark	48	n.d.

[a] Conditions: **S1** (0.3 mmol), amine (2.0 equiv.), DMSO (0.1 M), room temperature, air atmosphere, 48 h under 390 nm irradiation. [b] Isolated yields. [c] Piperazine (1.0 equiv.). [d] Piperazine (1.5 equiv.) [e] Piperazine (3.0 equiv.) [f] Nitrogen atmosphere. [g] The tube was wrapped with tin foil to ensure that the reaction was performed in darkness while keeping all other variables constant.

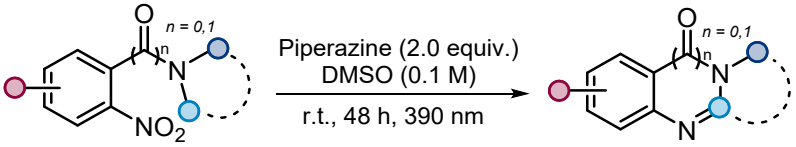
Table S2. Selected reaction optimization for quinazolin-4(3*H*)-one derivatives[a,b]



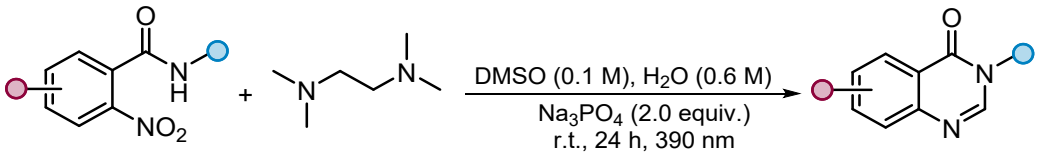
Entry	Amine	Base	Solvent	Light source	Time (h)	Yield (%)[b]
1	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	86
2[c]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	43
3[d]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	62
4[e]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	84
5	DIPEA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	41
6	DBU	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	n.d.
7[f]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	52
8[g]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	79
9[h]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	84
10	TMEDA	K_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	78
11	TMEDA	Cs_2CO_3	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	85
12	TMEDA	K_2CO_3	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	67
13	TMEDA	Na_2CO_3	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	42
14	TMEDA	*t*-BuOK	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	n.d.
15	TMEDA	Na_3PO_4	DMSO	390 nm LED	24	64
16	TMEDA	Na_3PO_4	DMF	390 nm LED	24	62
17	TMEDA	Na_3PO_4	MeCN	390 nm LED	24	59
18	TMEDA	Na_3PO_4	THF	390 nm LED	24	37
19	TMEDA	Na_3PO_4	H_2O	390 nm LED	24	n.d.
20	TMEDA	Na_3PO_4	Acetone	390 nm LED	24	61
21	TMEDA	Na_3PO_4	EA	390 nm LED	24	53
22	TMEDA	Na_3PO_4	DCM	390 nm LED	24	43
23	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	12	59
24	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	370 nm LED	24	74
25	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	455 nm LED	24	n.d.
26	TMEDA	None	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	Trace
27	None	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	n.d.
28[i]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	390 nm LED	24	82
29[j]	TMEDA	Na_3PO_4	DMSO/H_2O (3 mL/0.5 mL)	In dark	24	n.d.

[a] Conditions: **S30** (0.3 mmol), amine (2.0 equiv.), base (2.0 equiv.), DMSO (0.1 M), H_2O (0.6 M), room temperature, air atmosphere, 24 h under 390 nm irradiation. [b] Isolated yields. [c] TMEDA (1.0 equiv.). [d] TMEDA (1.5 equiv.). [e] TMEDA (3.0 equiv.). [f] Na_3PO_4 (1.0 equiv.). [g] Na_3PO_4 (1.5 equiv.) [h] Na_3PO_4 (3.0 equiv.) [i] Nitrogen atmosphere. [j] The tube was wrapped with tin foil to ensure that the reaction was performed in darkness while keeping all other variables constant.

IV. General procedure for cyclization of nitroarenes



Procedure A: To a 10 mL oven-dried Schlenk tube equipped with a magnetic stir bar was added the corresponding nitroarenes (0.3 mmol, 1.0 equiv.), piperazine (0.6 mmol, 2.0 equiv.) and DMSO (3 mL). The resulting solution was stirred under irradiation of a 100 W 390 nm LED for 48 h. After completion of the reaction, the reaction mixture was quenched with H_2O, poured into a separatory funnel, and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified via silica gel chromatography to give the corresponding products **1**-**30**.



Procedure B: To a 10 mL oven-dried Schlenk tube equipped with a magnetic stir bar was added the corresponding nitroarenes (0.3 mmol, 1.0 equiv.), *N,N,N′,N′*-tetramethylethylenediamine (i.e. TMEDA, 0.6 mmol, 2.0 equiv.), Na_3PO_4 (0.6 mmol, 2.0 equiv.), H_2O (0.5 mL) and DMSO (3 mL). The resulting solution was stirred under irradiation of a 100 W 390 nm LED for 24 h. After completion of the reaction, the reaction mixture was quenched with H_2O, poured into a separatory funnel, and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified via silica gel chromatography to give the corresponding products **31**-**54**.

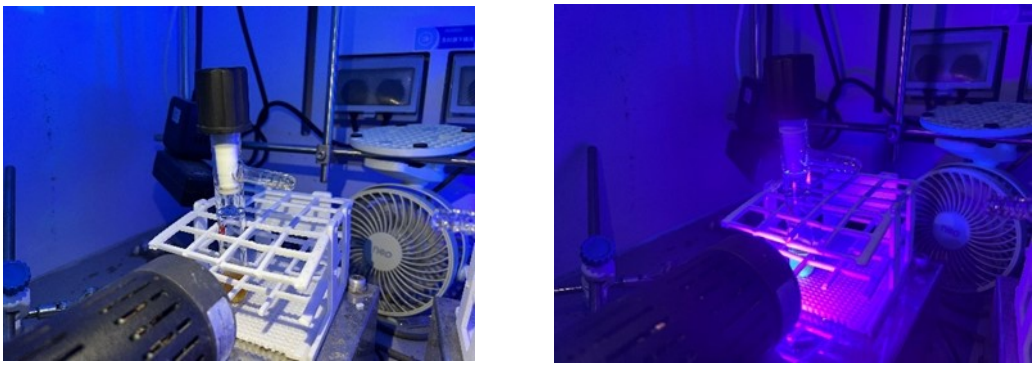
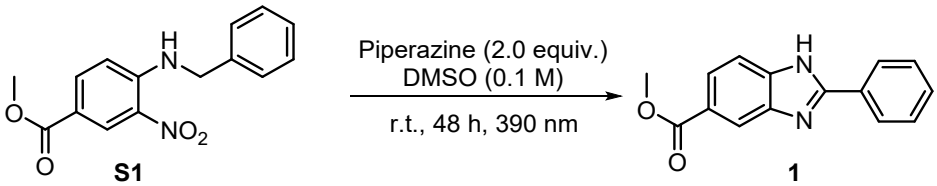


Figure S2. Reaction vessel and reaction set-up (0.3 mmol scale).

V. Application of the methodology

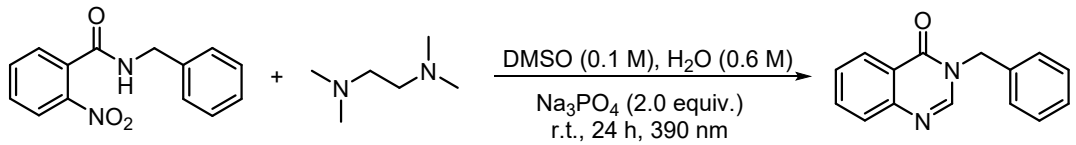
(1) Gram-scale synthesis



S1
5 mmol, 1.43 g

1
60%, 756 mg

To a dry 100 mL round-bottom flask was added methyl 4-(benzylamino)-3-nitrobenzoate (5 mmol, 1.0 equiv.), piperazine (10 mmol, 2.0 equiv.) and 50 mL DMSO under air atmosphere. The resulting solution was stirred under irradiation of 100 W 390 nm LEDs for 48 h. On completion, the reaction mixture was quenched with H_2O, poured into a separatory funnel, and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure. Purification by flash column chromatography gave the compound **1** as yellow solid (756 mg, 60% yield).



S30
5 mmol, 1.28 g

1b
10 mmol, 1.16 g

31
71%, 861 mg

To a dry 100 mL round-bottom flask was added *N*-benzyl-2-nitrobenzamide (5 mmol, 1.0 equiv.), TMEDA (10 mmol, 2.0 equiv.), Na_3PO_4 (10 mmol, 2.0 equiv.), 50 mL DMSO and 8.3 mL H_2O under air atmosphere. The resulting solution was stirred under irradiation of 100 W 390 nm LEDs for 24 h. On completion, the reaction mixture was quenched with H_2O, poured into a separatory funnel, and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure. Purification by flash column chromatography gave the compound **31** as white solid (838 mg, 71% yield).

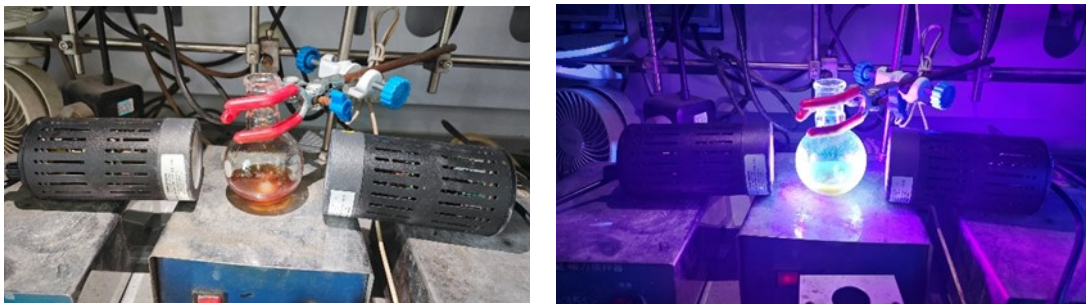
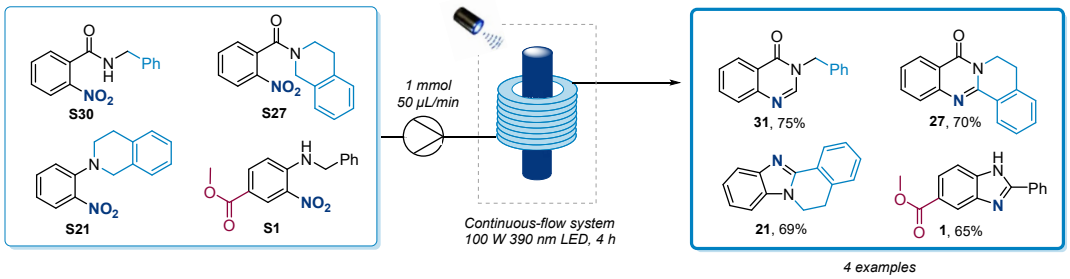


Figure S3. Reaction vessel and reaction set-up (gram scale).

(2) Extend-scale using continuous-flow reactor



To a dry 50 mL round-bottom flask was added *N*-benzyl-2-nitrobenzamide (1 mmol, 1.0 equiv.), TMEDA (2 mmol, 2.0 equiv.), Na_3PO_4 (2 mmol, 2.0 equiv.), 10 mL DMSO and 1.7 mL H_2O. The resulting solution was stirred under air atmosphere, transferred to a 5 mL syringe and then placed on a syringe pump set at a flow rate of 50 μL/min. Later, the mixture was introduced into feeding tubes under irradiation of 100 W 390 nm LEDs. Due to the capacity limitation of the syringe and feeding tubes, the reaction was prepared twice with 5 mL reaction mixture each time, and the total reaction time was 4 h. On completion, the reaction mixture was quenched with H_2O, poured into a separatory funnel, and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure. Purification by flash column chromatography gave the compound **31** (172 mg, 75% yield). Other substrates are similar to the above experimental steps.

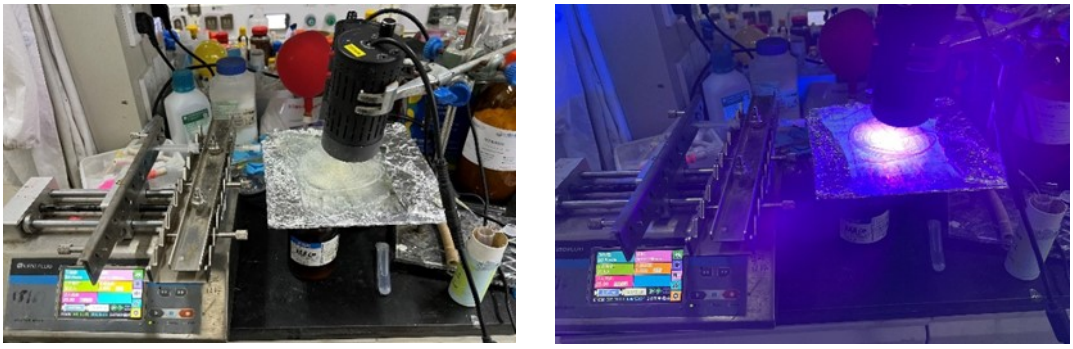
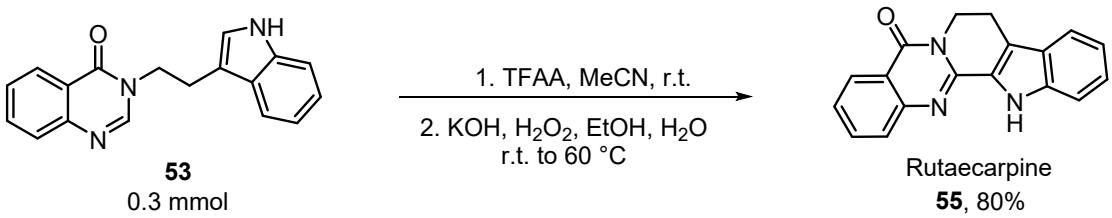


Figure S4. Reaction vessel and reaction set-up (flow chemistry).

(3) Synthesis of drug[6]

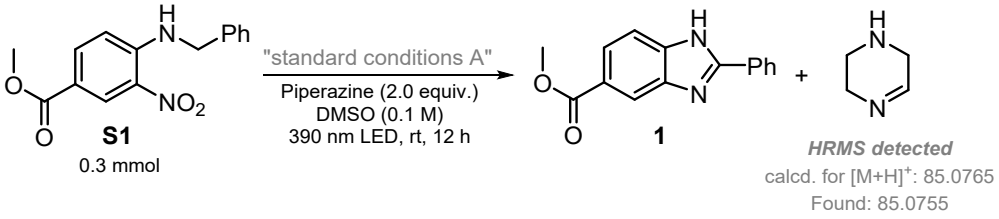


To a dry 25 mL round-bottom flask was added 3-(2-(1*H*-indol-3-yl)ethyl)quinazolin-4(3*H*)-one **53** (0.3 mmol, 1.0 equiv.), TFAA (1.5 mmol, 5.0 equiv.) and 3 mL MeCN under air atmosphere. The reaction mixture was stirred at room temperature for 0.5 h, and solid was filtered in suspension. After then, add

KOH (0.6 mmol, 2.0 equiv.), H_2O_2 (30% in H_2O, 0.75 mL) to a solution of the solid in H_2O/EtOH (1:2, 3 mL). The resulting solution was stirred at room temperature for 0.5 h and proceeded at 60 °C overnight until it was cooled to room temperature and quenched by saturated $NaHCO_3$ solution. The mixture was then extracted with EtOAc. The combined organic layer was washed with brine, dried over Na_2SO_4, filtered and evaporated. Purification by column chromatography gave the product Rutaecarpine **55** as white solid (68.9 mg, 80% yield).

VI. Mechanistic Investigation

(1) HRMS Analysis for Proposed Intermediates



To a 10 mL oven-dried Schlenk tube equipped with a magnetic stir bar was added the corresponding nitroarenes (0.3 mmol, 1.0 equiv.), piperazine (0.6 mmol, 2.0 equiv.) and DMSO (3 mL). The resulting solution was stirred under irradiation of a 100 W 390 nm LED for 12 h. After completion of the reaction, the reaction mixture was detected via HRMS. Evidently, the by-product of dehydrogenated piperazine was detected by HRMS.

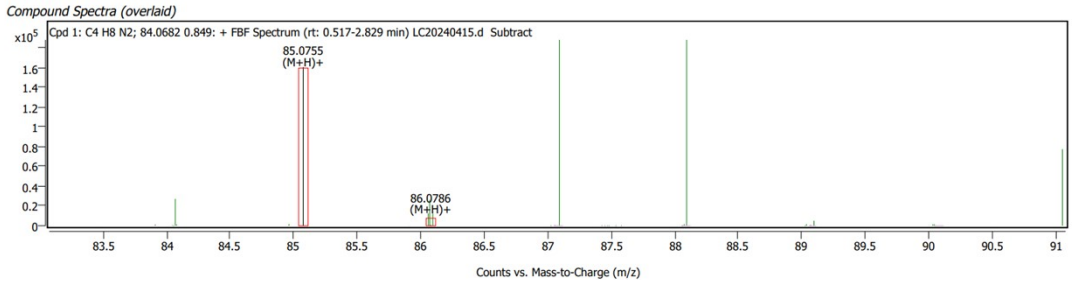
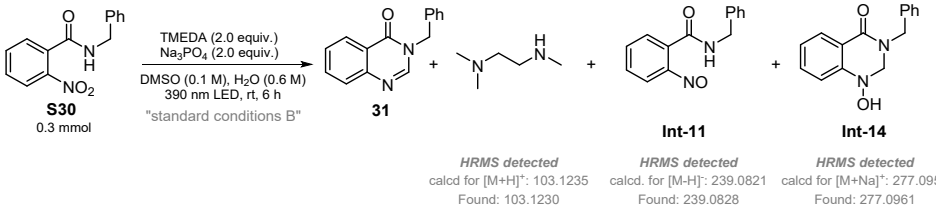


Figure S5. HRMS data of by-product of dehydrogenated piperazine.



To a 10 mL oven-dried Schlenk tube equipped with a magnetic stir bar was added the corresponding nitroarenes (0.3 mmol, 1.0 equiv.), TMEDA (0.6 mmol, 2.0 equiv.), Na_3PO_4 (0.6 mmol, 2.0 equiv.), H_2O (0.5 mL) and DMSO (3 mL). The resulting solution was stirred under irradiation of a 100 W 390 nm LED for 6 h. After completion of the reaction, the reaction mixture was detected via HRMS. Evidently, the proposed intermediates were detected by HRMS.

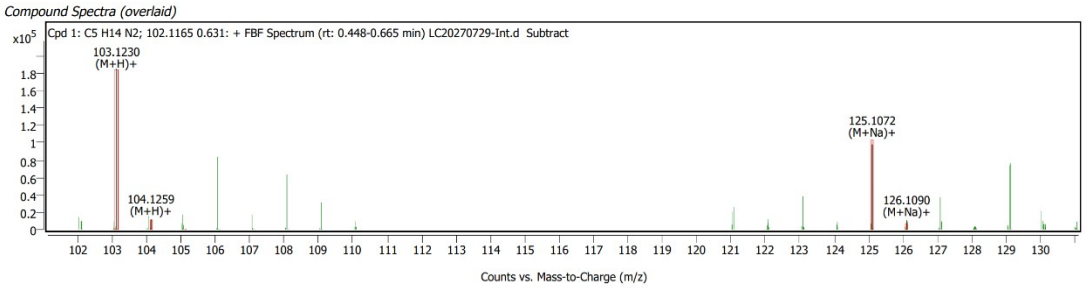


Figure S6. HRMS data of the by-product of TMEDA hydrolysis.

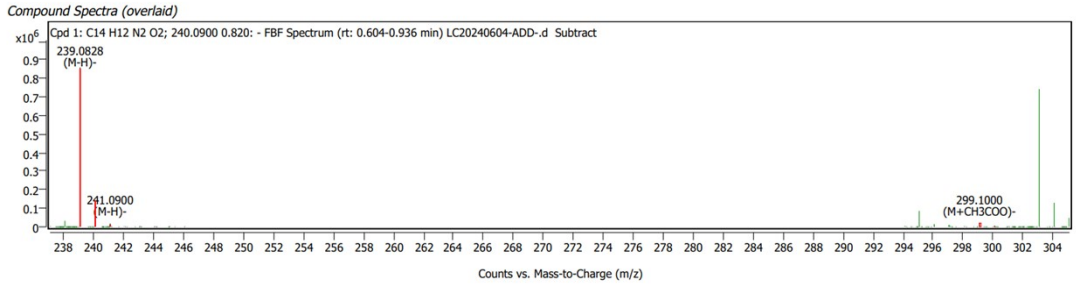


Figure S7. HRMS data of Int-11.

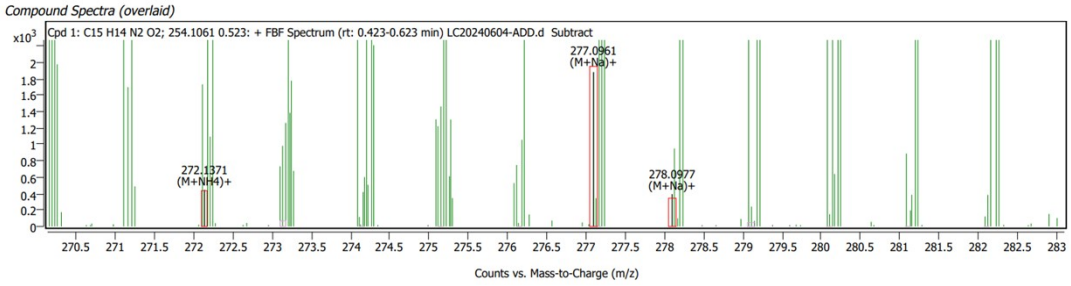


Figure S8. HRMS data of Int-14.

(2) UV-vis spectra

The UV-vis absorption spectrum is an effective means of directly representing the electronic properties of compounds and is often used to detect the presence of electron donor-acceptor (EDA) complexes in photochemical reactions.[7] In this part, UV-vis spectra of **S1**, **1a** and their 1:2 mixture (the molar ratio was in consistence with the reaction mixture) were recorded with a MAPADA P6 spectrophotometer. As shown in Figure S10, the 1:2 mixture of **S1** and **1a** exhibited a bathochromic shift, indicating the occurrence of EDA complexes during the reaction.

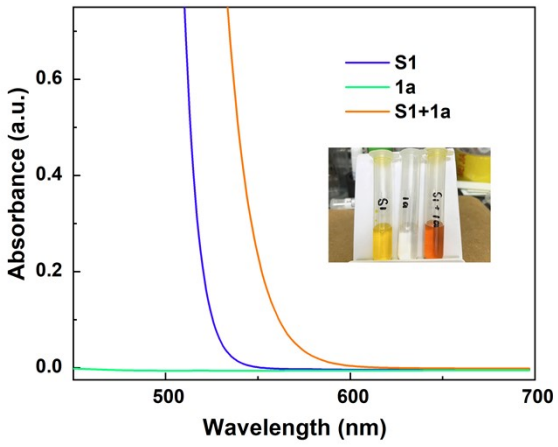


Figure S9. UV/vis absorption spectra of individual reaction components and a combination thereof. All spectra were measured in DMSO with a concentration of 0.1 M **S1**, 0.2 M **1a**.

Next, Absorption spectra of individual reaction components (**S30**, **1b**) and mixtures thereof were recorded. A bathochromic shift was observed for a mixture of **S30** and **1b**, which indicated the formation of EDA complexes. Moreover, there was a more pronounced redshift of the mixed solution occurred when Na_3PO_4 was added, implying that the base promoted the formation of EDA complexes between **S30** and **1b**.

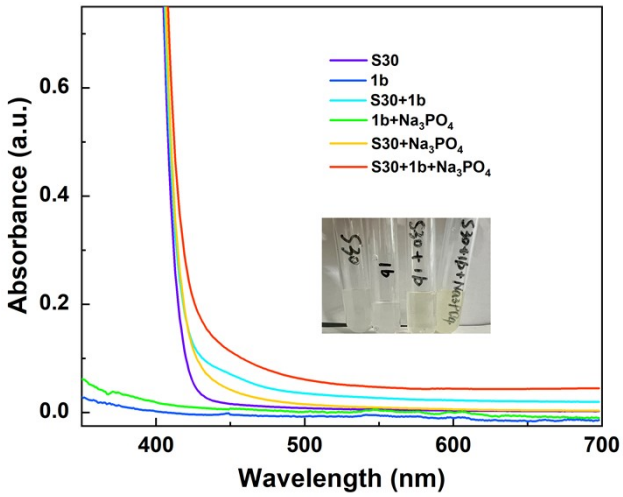
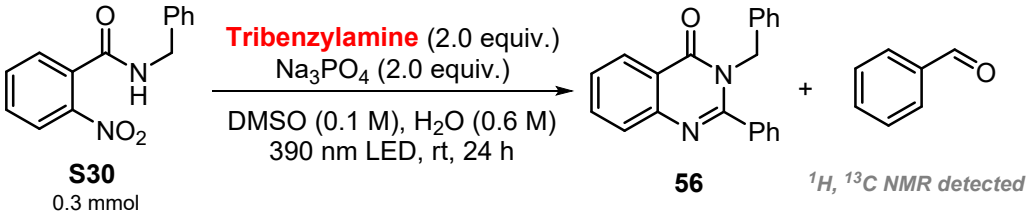
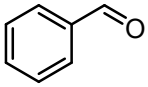


Figure S10. UV/vis absorption spectra of individual reaction components and a combination thereof. All spectra were measured in DMSO with a concentration of 0.1 M **S30**, 0.2 M **1b**, 10 mg Na_3PO_4.

(3) Control experiments

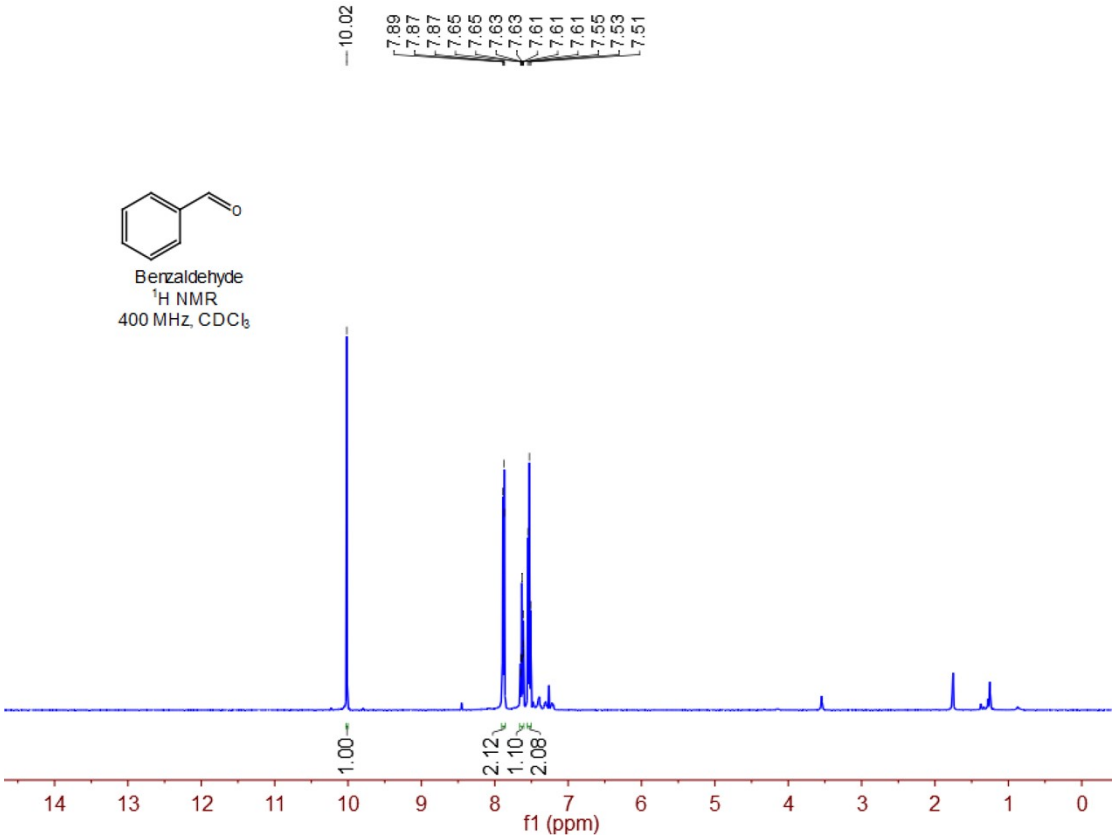


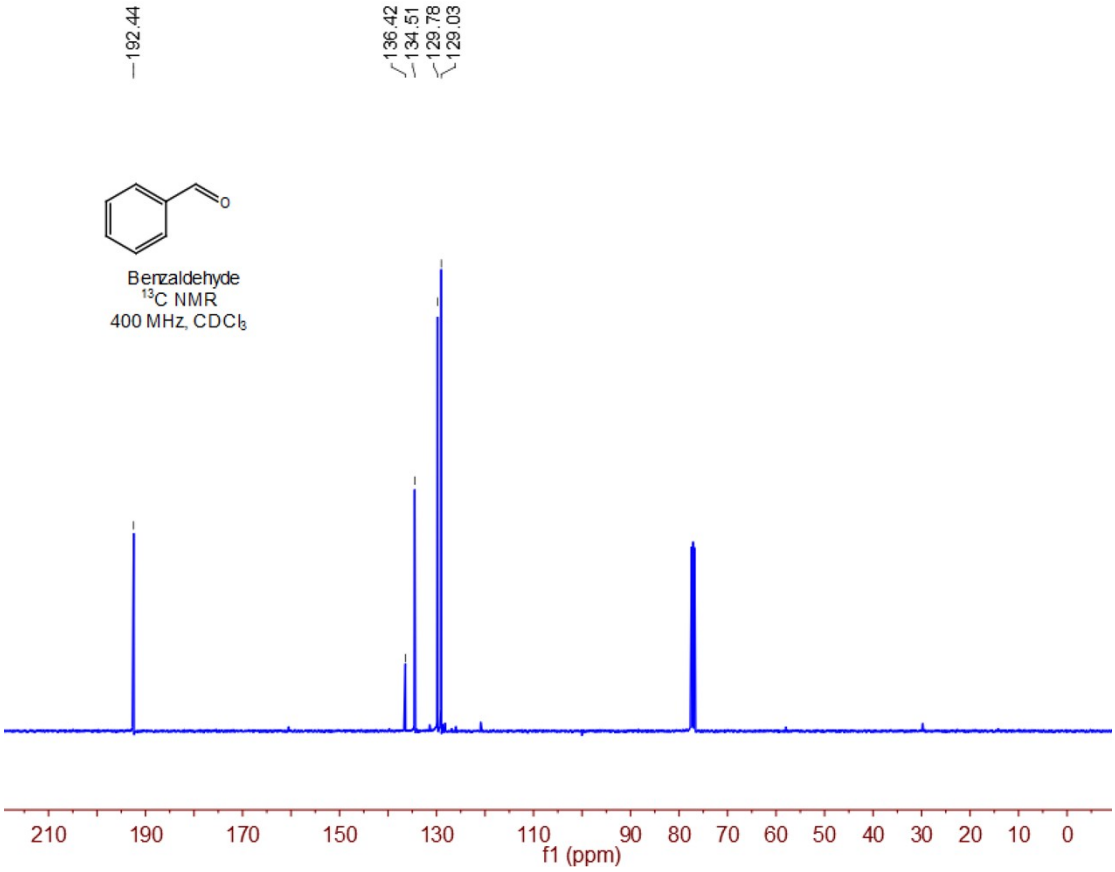
To a 10 mL oven-dried Schlenk tube equipped with a magnetic stir bar was added the corresponding nitroarenes (0.3 mmol, 1.0 equiv.), tribenzylamine (0.6 mmol, 2.0 equiv.), Na_3PO_4 (0.6 mmol, 2.0 equiv.), H_2O (0.5 mL) and DMSO (3 mL). The resulting solution was stirred under irradiation of a 100 W 390 nm LED for 24 h. After completion of the reaction, the reaction mixture was quenched with H_2O, poured into a separatory funnel, and extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified via silica gel chromatography to give the corresponding product **56** and benzaldehyde, proving that amines serve as C1 synthons during the reaction.



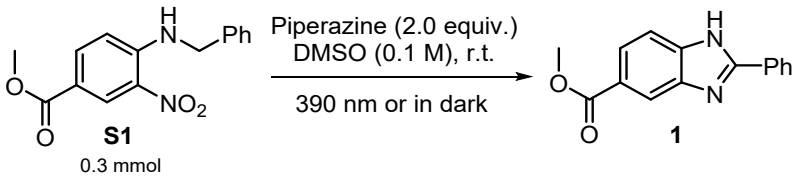
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.02 (s, 1H), 7.90 – 7.86 (m, 2H), 7.66 – 7.60 (m, 1H), 7.53 (t, J = 7.5 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 192.44, 136.42, 134.51, 129.78, 129.03.





(4) Light on/off experiments



Five parallel reactions were performed between methyl 4-(benzylamino)-3-nitrobenzoate **S1** (0.3 mmol, 1.0 equiv.), piperazine **1a** (0.6 mmol, 2.0 equiv.) according to the procedure A. The yield of **1** was recorded at specified time intervals. The light irradiation was represented by the white area, while the blue area indicates the duration in darkness.

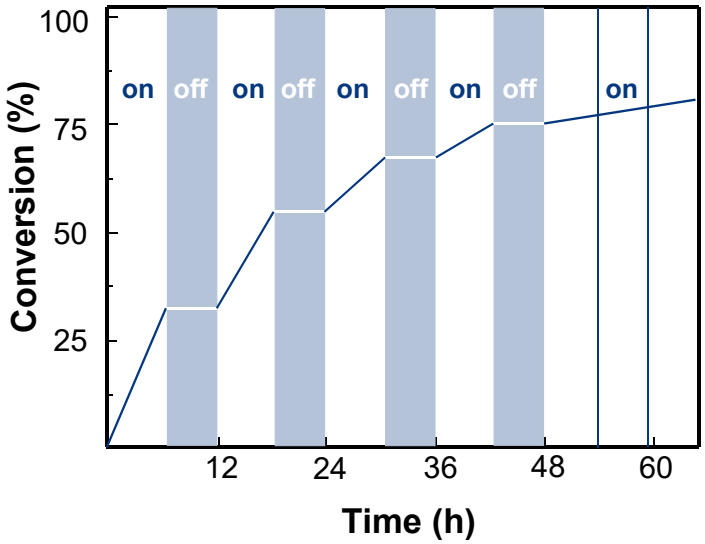
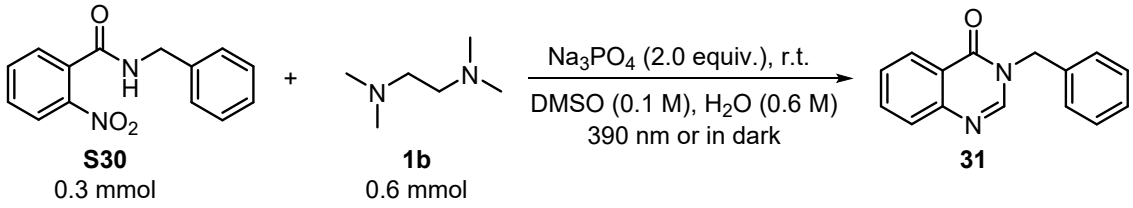


Figure S11. Light on/off experiments of **1**.



Five parallel reactions were performed between *N*-benzyl-2-nitrobenzamide **S30** (0.3 mmol, 1.0 equiv.), TMEDA **1b** (0.6 mmol, 2.0 equiv.) according to the procedure B. The yield of **31** was recorded at specified time intervals. The light irradiation was represented by the white area, while the red area indicates the duration in darkness.

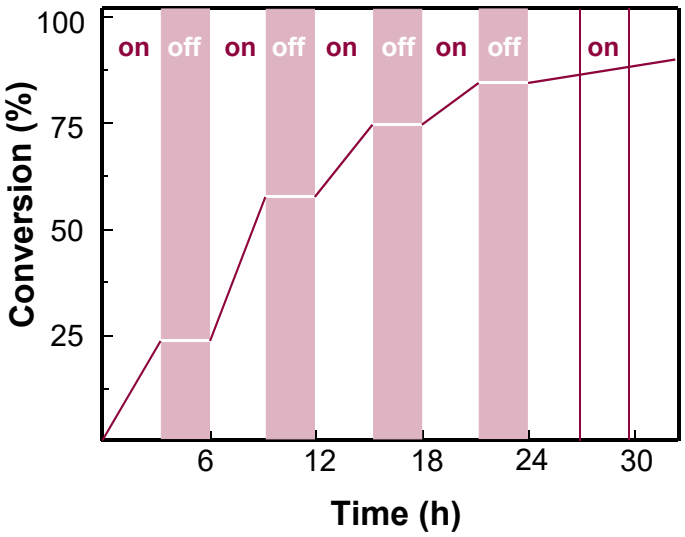


Figure S12. Light on/off experiments of **31**.

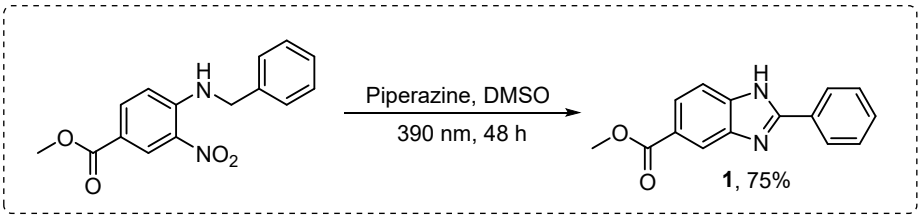
(5) Calculations of green chemistry metrics

In recent years, the importance of sustainability has been steadily increasing. EcoScale is a semi-quantitative tool for selecting green reagents based on economic and ecological parameters. In this part, we selected some reported strategies as control groups, and systematically evaluated the EcoScales of our strategy and control groups in terms of six parameters including yield, price of reaction components, safety, technical setup, temperature/time, workup and purification. Our strategy received EcoScale scores of 66.5 and 72, which is deemed acceptable regarding sustainability.

EcoScale = 100 - sum of individual penalties

Score on Eco Scale: > 75, Excellent; > 50, Acceptable; < 50, Inadequate

Table S3. Calculation of Ecoscale score for this work (Conditions A)



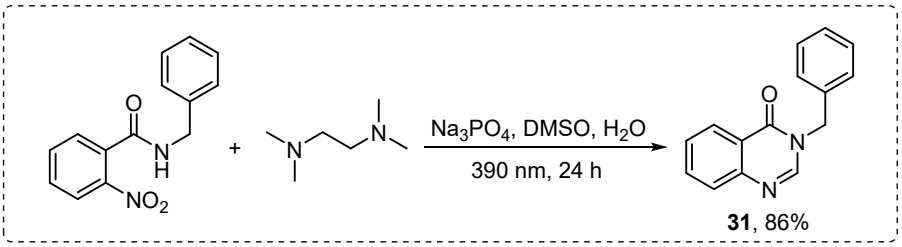
A. Calculation of Penalty Points:

Parameters		Penalty Points
1. Yield:	(100- % of yield)/2 = (100-75)/2	**12.5**
2. Price of reaction components (To obtain 10 mmol of end product, **1**)		
a. methyl 4-fluoro-3-nitrobenzoate = 13.3 mmol = 2.65 g = USD 1.0		
b. benzylamine = 13.3 mmol = 1.42 g = USD 0.2		
c. piperazine = 26.6 mmol = 2.29 g = USD 0.18		
Total cost of synthesis of **1** = (1.0 + 0.2 + 0.18) = USD 1.38		
Thus inexpensive, since (total cost of synthesis of 10 mmol of **1**) < $10:		**0**
3. Safety		
Piperazine (T)		**5**
4. Technical Setup		
Photochemical activation		**2**
5. Temperature/time		
Room temperature, 48 h		**1**
6. Workup and purification		
Liquid-liquid extraction		**3**
Classical chromatography		**10**
	Total penalty points:	**33.5**

B. Ecoscale calculation:

EcoScale score: (100-33.5) = **66.5 (> 50; it is an acceptable synthesis)**

Table S4. Calculation of Ecoscale score for this work (Conditions B)



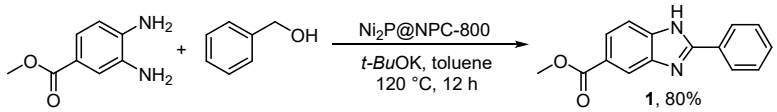
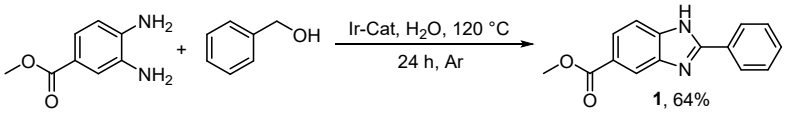
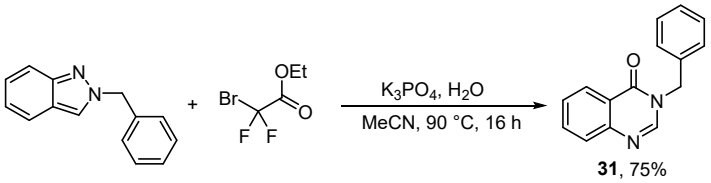
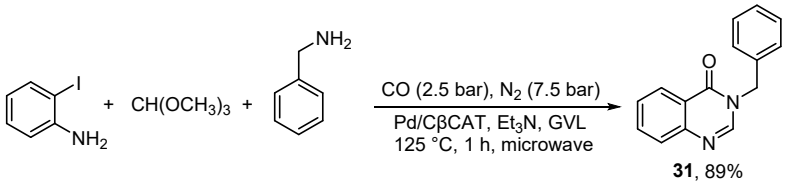
A. Calculation of Penalty Points:

Parameters		Penalty Points
1. Yield:	(100- % of yield)/2 = (100-86)/2	**7**
2. Price of reaction components (To obtain 10 mmol of end product, **31**) **a.** 2-nitrobenzoic acid = 11.6 mmol = 1.94 g = USD 0.14 **b.** benzylamine = 23.2 mmol = 2.48 g = USD 0.35 **c.** EDCI = 12.76 mmol = 2.40 g = USD 0.43 **d.** HOBt = 12.76 mmol = 1.72 g = USD 1.08 **e.** DMAP = 0.58 mmol = 0.071 g = USD 0.004 **f.** TMEDA = 23.2 mmol = 2.7 g = USD 0.6 **g.** Na_3PO_4 = 23.2 mmol = 3.8 g = USD 0.19		
Total cost of synthesis of **31** = (0.14 + 0.35 + 0.43 + 1.08 + 0.004 + 0.6 + 0.19) = USD 2.79 Thus inexpensive, since (total cost of synthesis of 10 mmol of **31**) < $10:		**0**
3. Safety DMAP (T)		**5**
4. Technical Setup Room temperature, 24 h		**2**
5. Temperature/time Heating (120 °C), 24 h		**1**
6. Workup and purification Liquid-liquid extraction Classical chromatography		**3** **10**
	Total penalty points:	**28**

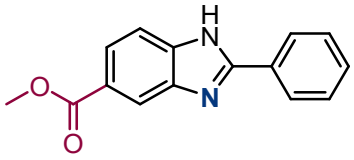
B. Ecoscale calculation:

EcoScale score: (100-28) = 72 **(> 50; it is an acceptable synthesis)**

Table S5. Calculation of Ecoscale score for control groups[8-11]

Number	Strategy	EcoScale
I[8]		50
II[9]		55
III[10]		66.5
IV[11]		68.5

VII. Analytic Data of Products (reactions was conducted at 0.3 mmol scale).



1

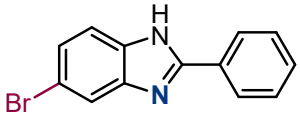
methyl 2-phenyl-1*H*-benzo[*d*]imidazole-5-carboxylate

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a yellow solid (57 mg, 75%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.29 (s, 1H), 8.22 – 8.20 (m, 3H), 7.85 (d, *J* = 8.2 Hz, 1H), 7.68 (s, 1H), 7.61 – 7.52 (m, 3H), 3.88 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 166.85, 154.87, 147.26, 143.49, 138.64, 130.59, 129.62, 129.17, 126.87, 123.84, 123.52, 112.77, 111.47, 52.12.

(Known compound: *ChemistrySelect*, 2021, **6**, 8080-8084).



2

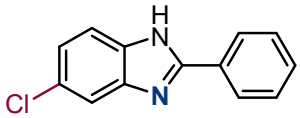
5-bromo-2-phenyl-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (55 mg, 68%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.13 (s, 1H), 8.17 (d, *J* = 6.9 Hz, 2H), 7.79 (s, 1H), 7.58 – 7.50 (m, 4H), 7.34 (dd, *J* = 8.5, 1.7 Hz, 1H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 152.54, 144.48, 130.34, 129.71, 129.12, 126.68, 125.07, 117.99, 114.33.

(Known compound: *Synlett.*, 2019, **30**, 319-324).



3

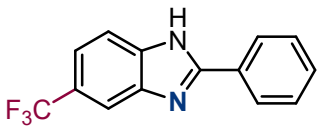
5-chloro-2-phenyl-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (44 mg, 64%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.13 (s, 1H), 8.19 (d, *J* = 7.0 Hz, 2H), 7.77 – 7.47 (m, 5H), 7.23 (d, *J* = 8.2 Hz, 1H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 152.79, 130.28, 129.79, 129.09, 126.67, 122.64.

(Known compound: *Green Chem.*, 2019, **21**, 6154-6160).



4

2-phenyl-5-(trifluoromethyl)-1*H*-benzo[*d*]imidazole

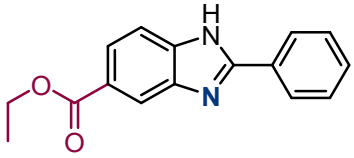
The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a yellow solid (56 mg, 72%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.38 (s, 1H), 8.24 – 8.21 (m, 2H), 8.03 – 7.78 (m, 2H), 7.62 – 7.53 (m, 4H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 154.36, 131.02, 129.89, 129.54, 127.26, 126.88, 124.18, 123.17 (C-F, J = 31.5 Hz), 119.37.

^{19}F NMR (376 MHz, DMSO-*d6*) δ -58.87.

(Known compound: *Molecular Catalysis.*, 2024, **561**, 114159-114168).



5

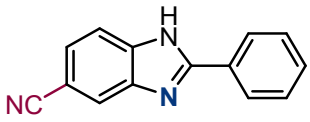
ethyl 2-phenyl-1*H*-benzo[*d*]imidazole-5-carboxylate

The product was purified by column chromatography on silica gel (eluent: 2:1 petroleum ether: ethyl acetate) as a yellow solid (59 mg, 74%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.27 (s, 1H), 8.28 (s, 1H), 8.20 (d, J = 7.3 Hz, 2H), 7.85 (dd, J = 15.8, 8.3 Hz, 1H), 7.75 (d, J = 7.9 Hz, 1H), 7.63 – 7.56 (m, 3H), 4.33 (q, J = 6.8 Hz, 2H), 1.35 (t, J = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 166.35, 153.50, 143.50, 138.60, 130.51, 129.63, 129.17, 126.83, 123.77, 122.91, 118.76, 111.45, 60.61, 14.36.

(Known compound: *Eur. J. Inorg*., 2021, **25**, 2493-2498).



6

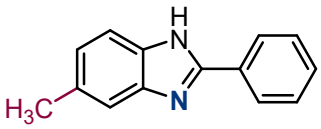
2-phenyl-1*H*-benzo[*d*]imidazole-5-carbonitrile

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (47 mg, 72%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.48 (s, 1H), 8.22 – 8.14 (m, 3H), 7.75 (d, J = 7.7 Hz, 1H), 7.61 – 7.53 (m, 4H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 154.41, 130.85, 129.35, 129.21, 126.99, 125.80, 120.12, 104.08.

(Known compound: *Synlett*., 2019, **30**, 319-324).



7

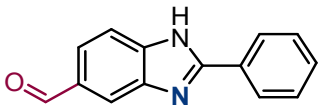
5-methyl-2-phenyl-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a yellow solid (15 mg, 24%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 12.81 (s, 1H), 8.16 (d, *J* = 7.4 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 2H), 7.49 (d, *J* = 6.4 Hz, 2H), 7.38 (s, 1H), 7.03 (d, *J* = 8.1 Hz, 1H), 2.43 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 151.32, 131.77, 130.72, 130.13, 129.37, 126.75, 124.04, 116.15, 21.81.

(Known compound: *Molecular Catalysis.*, 2024, **561**, 114159-114168).



8

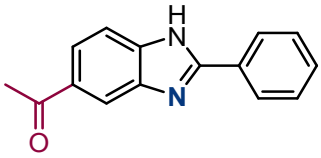
2-phenyl-1*H*-benzo[*d*]imidazole-5-carbaldehyde

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (42 mg, 63%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.46 (s, 1H), 10.08 – 10.06 (m, 1H), 8.23 – 8.18 (m, 3H), 7.78 – 7.59 (m, 4H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 192.51, 154.35, 131.31, 130.63, 129.46, 129.10, 126.88, 123.01.

(Known compound: *J. Med. Chem.*, 1996, **39**, 992-998).



9

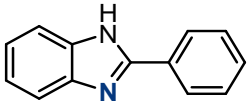
1-(2-phenyl-1*H*-benzo[*d*]imidazol-5-yl)ethan-1-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (45 mg, 66%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (s, 1H), 8.14 (d, *J* = 6.6 Hz, 2H), 7.90 (d, *J* = 8.4 Hz, 1H), 7.62 (d, *J* = 8.4 Hz, 1H), 7.44 (d, *J* = 6.5 Hz, 3H), 2.63 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 198.43, 154.47, 145.92, 142.83, 132.39, 131.00, 129.24, 128.91, 127.01, 123.72, 116.25, 115.23, 26.87.

(Known compound: *J. Org. Chem.*, 2009, **74**, 7974-7977).



10

2-phenyl-1*H*-benzo[*d*]imidazole

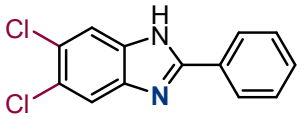
The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (20 mg, 35%).

^{1}H NMR (400 MHz, DMSO-*d6*) 12.96 (s, 1H), 8.24 (d, *J* = 7.3 Hz, 2H), 7.64 (dd, *J* = 5.8, 3.2 Hz, 2H),

7.56 (t, *J* = 7.5 Hz, 2H), 7.49 (t, *J* = 7.3 Hz, 1H), 7.25 – 7.21 (m, 2H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 151.36, 139.80, 130.29, 129.93, 129.05, 126.56, 122.22, 115.41.

(Known compound: *Molecular Catalysis.*, 2024, **561**, 114159-114168).



11

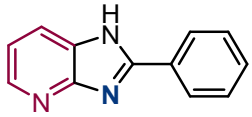
5,6-dichloro-2-phenyl-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (54 mg, 69%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.25 (s, 1H), 8.17 (d, *J* = 7.0 Hz, 2H), 7.93 (s, 1H), 7.75 (s, 1H), 7.58 – 7.53 (m, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 154.27, 143.98, 130.97, 129.75, 129.49, 127.19, 124.81, 120.43, 113.14.

(Known compound: *Green Chem.*, 2021, **23**, 9439-9446).



12

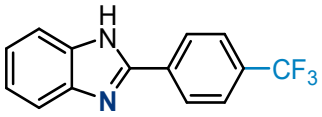
2-phenyl-1*H*-imidazo[*4,5-b*]pyridine

The product was purified by column chromatography on silica gel (eluent: 2:1 petroleum ether: ethyl acetate) as a yellow solid (41 mg, 71%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.78 (s, 1H), 8.65 (d, *J* = 4.0 Hz, 1H), 8.54 (d, *J* = 6.9 Hz, 2H), 8.32 (d, *J* = 7.5 Hz, 1H), 7.89 – 7.81 (m, 3H), 7.55 – 7.53 (m, 1H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 152.77, 143.88, 131.25, 130.58, 129.72, 129.08, 128.25, 127.51, 126.80, 118.15.

(Known compound: *J. Org. Chem.*, 2011, **76**, 9577-9583).



13

2-(4-(trifluoromethyl)phenyl)-1*H*-benzo[*d*]imidazole

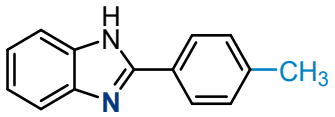
The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (44 mg, 56%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.18 (s, 1H), 8.39 (d, *J* = 8.0 Hz, 2H), 7.93 (d, *J* = 8.0 Hz, 2H), 7.71 (d, *J* = 7.2 Hz, 1H), 7.58 (d, *J* = 7.2 Hz, 1H), 7.29 – 7.21 (m, 2H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 149.72, 143.79, 135.17, 134.04, 130.18 (C-F, *J* = 31.7 Hz), 127.14, 126.07 (C-F, *J* = 3.9 Hz), 125.57 (C-F, *J* = 270.5 Hz), 123.29, 122.16, 119.34, 111.74.

^{19}F NMR (376 MHz, DMSO-*d6*) δ -61.18.

(Known compound: *Chem. Commun.*, 2019, **55**, 5958-5961).



14

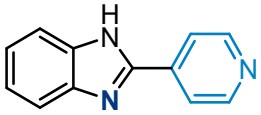
2-(*p*-tolyl)-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (27 mg, 43%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 12.82 (s, 1H), 8.07 (d, *J* = 8.2 Hz, 2H), 7.65 – 7.50 (m, 2H), 7.36 (d, *J* = 8.0 Hz, 2H), 7.19 – 7.18 (m, 2H), 2.38 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 156.58, 149.03, 144.76, 140.15, 134.72, 132.66, 131.59, 127.52, 126.76, 123.91, 116.39, 26.20.

(Known compound: *Adv. Synth. Catal*., 2017, **359**, 3332-3340).



15

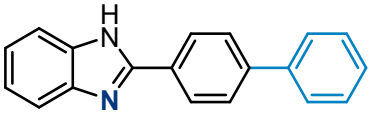
2-(pyridin-4-yl)-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (36 mg, 62%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.31 (s, 1H), 8.77 (d, *J* = 3.3 Hz, 2H), 8.11 (d, *J* = 5.3 Hz, 2H), 7.68 (s, 2H), 7.29 – 7.27 (m, 2H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 150.96, 149.22, 138.52, 137.59, 123.41, 120.80.

(Known compound: *RSC Adv.*, 2024, **14**, 6906-6916).



16

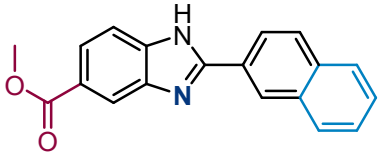
2-([1,1'-biphenyl]-4-yl)-1*H*-benzo[*d*]imidazole

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (63 mg, 78%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 12.93 (s, 1H), 8.22 (d, *J* = 7.4 Hz, 2H), 7.82 (d, *J* = 7.4 Hz, 2H), 7.72 (d, *J* = 6.9 Hz, 2H), 7.56 (s, 2H), 7.45 (t, *J* = 6.3 Hz, 2H), 7.36 (d, *J* = 6.6 Hz, 1H), 7.17 (s, 2H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 151.00, 141.37, 139.34, 129.22, 129.13, 128.00, 127.24, 127.09, 126.79, 122.23, 119.12, 111.71.

(Known compound: *RSC Adv.*, 2019, **9**, 753-760).



17

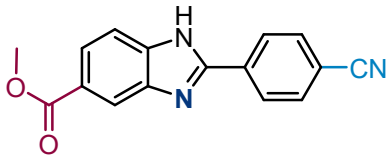
methyl 2-(naphthalen-2-yl)-1*H*-benzo[*d*]imidazole-5-carboxylate

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (67 mg, 74%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 9.05 (d, *J* = 8.2 Hz, 1H), 8.31 (s, 1H), 8.14 (d, *J* = 8.1 Hz, 1H), 8.06 (d, *J* = 7.3 Hz, 2H), 7.92 (d, *J* = 8.3 Hz, 1H), 7.77 (d, *J* = 8.4 Hz, 1H), 7.74 – 7.58 (m, 3H), 3.90 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 166.87, 154.02, 133.68, 130.83, 130.50, 128.58, 128.41, 127.40, 126.95, 126.57, 126.07, 125.36, 123.60, 123.46, 52.13.

HRMS: $C_{19}H_{15}N_2O_2$ $[M+H]^+$; calculated: 303.1133, found: 303.1133.



18

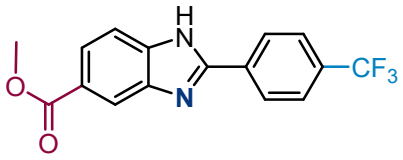
methyl 2-(4-cyanophenyl)-1*H*-benzo[*d*]imidazole-5-carboxylate

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (58 mg, 70%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.54 (s, 1H), 8.35 (d, *J* = 8.2 Hz, 2H), 8.29 – 8.16 (m, 1H), 8.05 (d, *J* = 8.0 Hz, 2H), 7.88 – 7.67 (m, 2H), 3.88 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 166.66, 151.67, 144.01, 138.64, 133.69, 133.14, 127.42, 124.52, 123.21, 118.58, 112.57, 112.56, 111.92, 52.18.

HRMS: $C_{17}H_{11}N_3O_2$ $[M+H]^+$; calculated: 278.0929, found: 278.0918.



19

methyl 2-(4-(trifluoromethyl)phenyl)-1*H*-benzo[*d*]imidazole-5-carboxylate

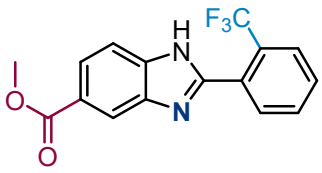
The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (65 mg, 68%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.48 (s, 1H), 8.39 (d, *J* = 8.1 Hz, 2H), 8.29 – 8.13 (m, 1H), 7.94 (d, *J* = 8.2 Hz, 2H), 7.88 – 7.65 (m, 2H), 3.88 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 166.73, 151.86, 143.34, 138.65, 133.38, 128.17 (C-F, *J* = 271.0 Hz), 127.47, 126.08 (C-F, *J* = 5.0 Hz), 124.23, 123.73, 120.97, 113.40, 111.81, 52.10.

^{19}F NMR (376 MHz, DMSO-*d6*) δ -61.32.

HRMS: $C_{16}H_{10}F_3N_2O_2$ $[M-H]^-$; calculated: 319.0695, found: 319.0701.



20

methyl 2-(2-(trifluoromethyl)phenyl)-1*H*-benzo[*d*]imidazole-5-carboxylate

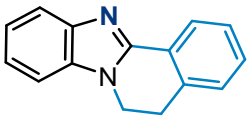
The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (65 mg, 66%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 13.19 (s, 1H), 8.31 – 8.18 (m, 1H), 7.97 (d, *J* = 7.7 Hz, 1H), 7.90 – 7.84 (m, 3H), 7.82 – 7.79 (m, 1H), 7.79 – 7.67 (m 1H), 3.88 (s, 3H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 166.77, 151.63, 146.85, 143.09, 138.01, 134.31, 132.55, 132.26, 130.67, 129.66, 128.43 (C-F, *J* = 31.0 Hz), 126.82 (C-F, *J* = 5.0 Hz), 125.09 (C-F, *J* = 272.0 Hz), 113.41, 111.74, 52.08.

^{19}F NMR (376 MHz, DMSO-*d6*) δ -57.07.

HRMS: $C_{16}H_{12}F_3N_2O_2$ $[M+H]^+$; calculated: 321.0851, found: 321.0847.



21

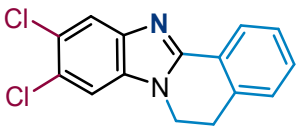
5,6-dihydrobenzo[4,5]imidazo[2,1-*a*]isoquinoline

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (50 mg, 76%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 – 8.29 (m, 1H), 7.85 – 7.81 (m, 1H), 7.43 – 7.38 (m, 2H), 7.37 – 7.34 (m, 1H), 7.33 – 7.28 (m, 3H), 4.31 (t, *J* = 6.9 Hz, 2H), 3.27 (t, *J* = 6.8 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 149.11, 143.84, 134.65, 134.31, 130.22, 128.12, 127.78, 126.63, 125.70, 122.74, 122.53, 119.76, 109.10, 40.44, 28.27.

(Known compound: *J. Org. Chem.*, 2020, **85**, 1991-2009).



22

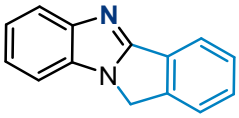
9,10-dichloro-5,6-dihydrobenzo[4,5]imidazo[2,1-*a*]isoquinoline

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (67 mg, 78%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 – 8.21 (m, 1H), 7.84 (s, 1H), 7.42 – 7.40 (m, 3H), 7.32 – 7.30 (m, 1H), 4.26 (t, *J* = 6.9 Hz, 2H), 3.28 (t, *J* = 6.8 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 150.98, 143.21, 134.25, 133.97, 130.91, 128.24, 127.96, 126.62, 126.45, 125.93, 125.90, 120.79, 110.52, 40.75, 28.07.

(Known compound: *Org. Lett.*, 2022, **24**, 8703-8708).



23

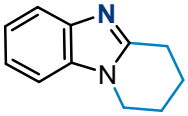
11*H*-benzo[4,5]imidazo[2,1-*a*]isoindole

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (44 mg, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 (d, *J* = 7.3 Hz, 1H), 7.86 – 7.83 (m, 1H), 7.57 (d, *J* = 7.2 Hz, 1H), 7.52 – 7.48 (m, 2H), 7.47 – 7.42 (m, 1H), 7.30 – 7.27 (m, 2H), 5.05 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 158.51, 148.22, 143.58, 132.71, 129.67, 129.39, 128.89, 123.93, 122.84, 122.36, 122.27, 120.58, 109.45, 47.39.

(Known compound: *Org. Biomol. Chem.*, 2010, **8**, 841-845).



24

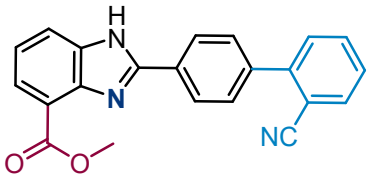
1,2,3,4-tetrahydrobenzo[4,5]imidazo[1,2-a]pyridine

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (31 mg, 61%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.3 Hz, 1H), 7.28 (d, *J* = 8.2 Hz, 1H), 7.24 – 7.20 (m, 2H), 4.07 (t, *J* = 5.9 Hz, 2H), 3.09 (t, *J* = 6.1 Hz, 2H), 2.15 – 2.11 (m, 2H), 2.04 – 2.00 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 151.66, 142.73, 134.56, 122.10, 121.67, 118.85, 108.71, 42.45, 25.44, 22.68, 20.77.

(Known compound: *Org. Lett.*, 2022, **24**, 8703-8708).



25

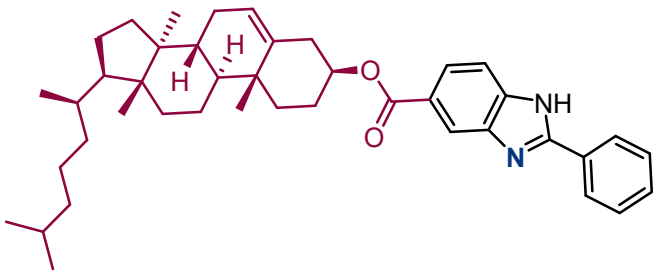
methyl 2-(2'-cyano-[1,1'-biphenyl]-4-yl)-1*H*-benzo[*d*]imidazole-4-carboxylate

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a yellow solid (86 mg, 81%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (d, *J* = 8.2 Hz, 2H), 8.07 (d, *J* = 8.0 Hz, 1H), 7.95 (d, *J* = 7.7 Hz, 1H), 7.83 (d, *J* = 7.7 Hz, 1H), 7.76 (d, *J* = 8.2 Hz, 2H), 7.71 (t, *J* = 7.7 Hz, 1H), 7.60 (d, *J* = 7.6 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 1H), 7.37 (t, *J* = 7.9 Hz, 1H), 4.06 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 167.05, 151.82, 144.63, 144.32, 140.22, 135.05, 133.91, 133.02, 130.02, 129.58, 129.46, 128.13, 127.17, 125.12, 125.00, 122.26, 118.52, 113.49, 111.22, 52.33.

HRMS: $C_{22}H_{16}N_3O_2$ $[M+H]^+$; calculated: 354.1242, found: 354.1244.



26

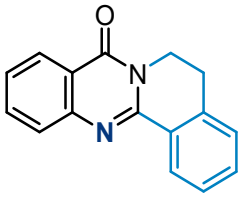
(3*S*,8*R*,9*S*,10*R*,13*R*,14*S*,17*R*)-10,13,14-trimethyl-17-((*R*)-6-methylheptan-2-yl)-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1*H*-cyclopenta[*a*]phenanthren-3-yl 2-phenyl-1*H*-benzo[*d*]imidazole-5-carboxylate

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a yellow solid (128 mg, 69%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (s, 1H), 8.16 (s, 2H), 7.98 (d, *J* = 8.4 Hz, 1H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.43 (s, 3H), 5.39 (d, *J* = 3.6 Hz, 1H), 4.90 – 4.83 (m, 1H), 2.46 (d, *J* = 7.2 Hz, 2H), 2.00 (t, *J* = 13.3 Hz, 3H), 1.92 (s, 1H), 1.89 – 1.77 (m, 1H), 1.76 – 1.60 (m, 2H), 1.58 – 1.49 (m, 4H), 1.46 (s, 2H), 1.35 – 1.33 (m, 2H), 1.25 (s, 2H), 1.24 – 1.18 (m, 2H), 1.14 (s, 2H), 1.10 (d, *J* = 11.1 Hz, 2H), 1.06 (s, 3H), 1.03 – 0.97 (m, 3H), 0.92 (d, *J* = 6.3 Hz, 3H), 0.87 (d, *J* = 6.5 Hz, 6H), 0.69 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 166.48, 153.72, 146.09, 139.73, 131.12, 129.22, 128.44, 127.25, 125.92, 124.82, 122.88, 112.17, 74.88, 56.81, 56.26, 50.16, 42.42, 39.84, 39.61, 38.36, 37.14, 36.75, 36.29, 35.89, 32.03, 31.97, 28.33, 28.10, 28.02, 24.38, 23.95, 22.91, 22.65, 21.15, 19.48, 18.82, 11.96.

HRMS: $C_{41}H_{55}N_2O_2$ [M-H] $^-$; calculated: 605.4107, found: 605.4128.



27

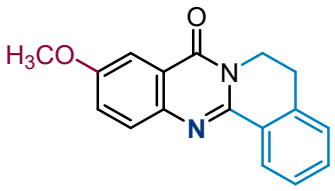
5,6-dihydro-8*H*-isoquinolino[1,2-*b*]quinazolin-8-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (57 mg, 75%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, *J* = 7.4 Hz, 1H), 8.32 (d, *J* = 7.9 Hz, 1H), 7.82 (d, *J* = 8.0 Hz, 1H), 7.78 – 7.74(m, 1H), 7.51 – 7.43 (m, 3H), 7.30 (d, *J* = 7.1 Hz, 1H), 4.43 (t, *J* = 6.4 Hz, 2H), 3.11 (t, *J* = 6.4 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.70, 149.59, 147.59, 137.19, 134.41, 131.97, 129.38, 128.24, 127.78, 127.62, 127.52, 126.97, 126.72, 120.74, 39.73, 27.54.

(Known compound: *J. Org. Chem.*, 2023, **88**, 1061-1074).



28

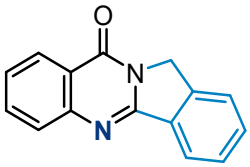
10-methoxy-5,6-dihydro-8*H*-isoquinolino[1,2-*b*]quinazolin-8-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (58 mg, 70%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (d, *J* = 7.2 Hz, 1H), 7.71 (d, *J* = 8.9 Hz, 1H), 7.67 (d, *J* = 2.9 Hz, 1H), 7.48 – 7.40 (m, 2H), 7.35 (dd, *J* = 8.9, 3.0 Hz, 1H), 7.28 (d, *J* = 6.9 Hz, 1H), 4.46 – 4.38 (m, 2H), 3.93 (s, 3H), 3.10 (t, *J* = 6.4 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.55, 158.38, 147.48, 142.47, 136.77, 131.43, 129.70, 129.27, 127.77, 127.68, 127.55, 124.76, 121.52, 106.22, 55.93, 39.83, 27.58.

(Known compound: *RSC Adv.*, 2020, **10**, 44382-44386).



29

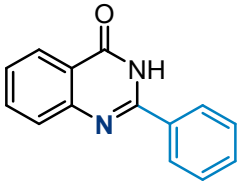
isoindolo[1,2-*b*]quinazolin-10(12*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (50 mg, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (d, *J* = 7.9 Hz, 1H), 8.21 (d, *J* = 7.3 Hz, 1H), 7.85 (d, *J* = 8.0 Hz, 1H), 7.79 (t, *J* = 7.5 Hz, 1H), 7.67 – 7.58 (m, 3H), 7.50 (t, *J* = 7.4 Hz, 1H), 5.16 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.65, 155.08, 149.34, 139.75, 134.40, 132.66, 132.51, 129.03, 127.36, 126.60, 126.55, 123.78, 123.58, 120.65, 49.94.

(Known compound: *J. Org. Chem.*, 2024, **89**, 4395-4405).



30

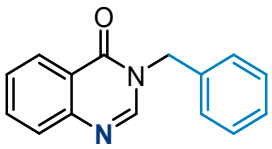
2-phenylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (27 mg, 41%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 12.55 (s, 1H), 8.17 (t, *J* = 8.7 Hz, 3H), 7.84 (t, *J* = 7.4 Hz, 1H), 7.75 (d, *J* = 8.0 Hz, 1H), 7.59 – 7.51 (m, 4H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 162.32, 152.39, 148.82, 134.71, 132.80, 131.49, 128.70, 127.85, 127.60, 126.69, 125.94, 121.07.

(Known compound: *Chem. Commun.*, 2024, **60**, 6043-6046).



31

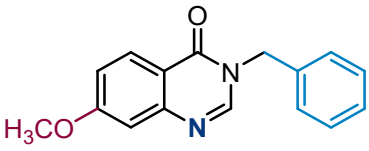
3-benzylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (61 mg, 86%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 8.0 Hz, 1H), 8.12 (s, 1H), 7.77 – 7.70 (m, 2H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.36 – 7.30 (m, 5H), 5.20 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.09, 147.97, 146.41, 135.74, 134.40, 129.09, 128.38, 128.07, 127.51, 127.47, 126.95, 122.23, 49.68.

(Known compound: *Org. Biomol. Chem.*, 2020, **18**, 5726-5733).



32

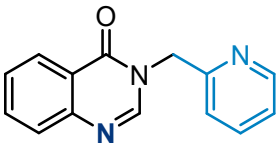
3-benzyl-7-methoxyquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (66 mg, 83%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.69 (d, *J* = 2.9 Hz, 1H), 7.64 (d, *J* = 8.9 Hz, 1H), 7.36 – 7.33 (m, 5H), 7.32 – 7.30 (m, 1H), 5.21 (s, 2H), 3.91 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.99, 158.89, 144.26, 142.57, 135.83, 129.07, 129.02, 128.35, 128.06, 124.66, 123.07, 106.27, 55.90, 49.78.

(Known compound: *J. Org. Chem.*, 2022, **87**, 9864-9874).



33

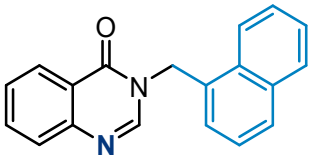
3-(pyridin-2-ylmethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 4:1 petroleum ether: ethyl acetate) as a yellow solid (60 mg, 85%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 (d, *J* = 4.1 Hz, 1H), 8.33 (s, 1H), 8.29 (d, *J* = 8.0 Hz, 1H), 7.77 – 7.71 (m, 2H), 7.67 (t, *J* = 7.6 Hz, 1H), 7.49 (t, *J* = 7.1 Hz, 1H), 7.42 (d, *J* = 7.7 Hz, 1H), 7.22 – 7.19 (m, 1H), 5.28 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.13, 154.98, 149.80, 148.30, 147.08, 137.11, 134.37, 127.64, 127.30, 126.84, 123.18, 123.02, 122.23, 51.24.

(Known compound: *J. Org. Chem.*, 2020, **85,** 7378-7385).



34

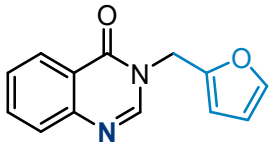
3-(naphthalen-1-ylmethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 4:1 petroleum ether: ethyl acetate) as a white solid (72 mg, 84%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (d, *J* = 8.0 Hz, 1H), 8.02 (d, *J* = 9.7 Hz, 2H), 7.89 (t, *J* = 9.4 Hz, 2H), 7.77 (t, *J* = 7.0 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.59 – 7.52 (m, 3H), 7.46 (t, *J* = 7.6 Hz, 1H), 7.39 (d, *J* = 6.9 Hz, 1H), 5.70 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.09, 147.67, 145.97, 134.51, 134.02, 131.07, 130.78, 129.58, 129.07, 127.56, 127.46, 127.26, 127.22, 127.12, 126.43, 125.43, 123.01, 121.99, 46.84.

(Known compound: *Org. Lett.*, 2020, **22**, 2522-2526).



35

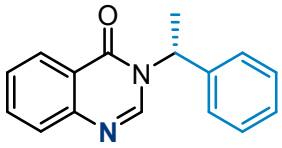
3-(furan-2-ylmethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 4:1 petroleum ether: ethyl acetate) as a white solid (54 mg, 79%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (d, *J* = 8.0 Hz, 1H), 8.17 (s, 1H), 7.76 – 7.68 (m, 2H), 7.49 (t, *J* = 7.4 Hz, 1H), 7.37 (s, 1H), 6.46 (d, *J* = 3.2 Hz, 1H), 6.35 – 6.33 (m, 1H), 5.18 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.71, 148.46, 147.96, 146.08, 143.24, 134.41, 127.53, 127.43, 126.88, 122.17, 110.84, 110.05, 42.18.

(Known compound: *J. Org. Chem.*, 2022, **87**, 9864-9874).



36

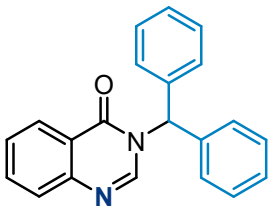
(*R*)-3-(1-phenylethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (60 mg, 80%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 8.0 Hz, 1H), 7.94 (s, 1H), 7.77 – 7.73 (m, 1H), 7.68 (d, *J* = 7.7 Hz, 1H), 7.53 – 7.49 (m, 1H), 7.39 – 7.37 (m, 4H), 7.34 – 7.30 (m, 1H), 6.37 (q, *J* = 7.2 Hz, 1H), 1.85 (d, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.86, 147.57, 144.55, 139.48, 134.35, 129.14, 128.40, 127.44, 127.38, 127.35, 127.09, 121.93, 51.86, 19.29.

(Known compound: *Tetrahedron Lett.*, 2014, **55**, 6004-6006).



37

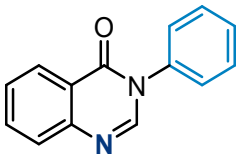
3-benzhydrylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (72 mg, 77%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.99 (s, 1H), 7.78 – 7.74 (m, 1H), 7.72 - 7.70 (m, 1H), 7.53 – 7.49 (m, 1H), 7.47 (s, 1H), 7.40 – 7.34 (m, 6H), 7.24 – 7.22 (m, 4H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.92, 147.60, 145.46, 138.05, 134.46, 129.09, 128.60, 128.40, 127.50, 127.42, 127.17, 121.87, 60.78.

(Known compound: *Org. Lett.*, 2020, **22**, 2522-2526).



38

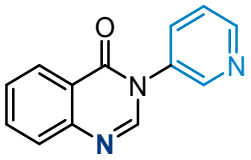
3-phenylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (50 mg, 75%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (dd, *J* = 0.8, 0.8 Hz, 1H), 8.13 (s, 1H), 7.83 – 7.76 (m, 2H), 7.57 – 7.53 (m, 3H), 7.51 – 7.47 (m, 1H), 7.44 – 7.42 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.80, 147.89, 146.16, 137.55, 134.66, 129.72, 129.19, 127.73, 127.62, 127.26, 127.07, 122.44.

(Known compound: *Angew. Chem. Int. Ed.*, 2014, **53**, 1420-1424).



39

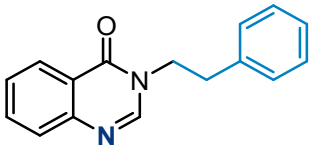
3-(pyridin-3-yl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a yellow solid (52 mg, 78%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.72 – 8.69 (m, 2H), 8.32 (d, *J* = 7.9 Hz, 1H), 8.08 (s, 1H), 7.84 – 7.74 (m, 3H), 7.54 (t, *J* = 7.5 Hz, 1H), 7.50 – 7.47 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.54, 150.13, 147.75, 147.54, 145.08, 134.94, 134.79, 134.19, 127.99, 127.77, 127.16, 123.99, 122.06.

(Known compound: *Org. Lett.*, 2012, **14**, 1150-1153).



40

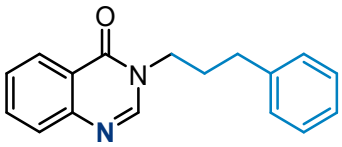
3-phenethylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (64 mg, 85%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.77 (t, *J* = 7.6 Hz, 1H), 7.74 – 7.64 (m, 2H), 7.53 (t, *J* = 7.5 Hz, 1H), 7.32 – 7.25 (m, 3H), 7.18 (d, *J* = 6.8 Hz, 2H), 4.23 (t, *J* = 7.1 Hz, 2H), 3.12 (t, *J* = 7.0 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.06, 148.11, 146.50, 137.45, 134.23, 128.93, 128.92, 127.48, 127.26, 127.09, 126.69, 122.11, 48.92, 35.18.

(Known compound: *J. Org. Chem*., 2020, **85**, 7378-7385).



41

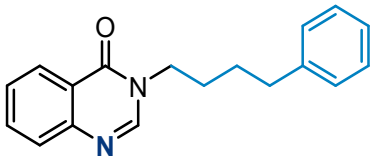
3-(3-phenylpropyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (66 mg, 83%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (d, *J* = 7.9 Hz, 1H), 7.95 (s, 1H), 7.76 – 7.67 (m, 2H), 7.49 (t, *J* = 7.3 Hz, 1H), 7.31 – 7.26 (m, 2H), 7.20 – 7.17 (m, 3H), 4.00 (t, *J* = 7.3 Hz, 2H), 2.72 (t, *J* = 7.6 Hz, 2H), 2.20 – 2.11 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.04, 148.06, 146.51, 140.33, 134.15, 128.57, 128.27, 127.39, 127.24, 126.65, 126.25, 122.13, 46.59, 32.71, 30.36.

(Known compound: *J. Org. Chem.*, 2022, **87**, 9864-9874).



42

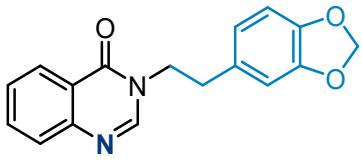
3-(4-phenylbutyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (69 mg, 83%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 9.0 Hz, 1H), 8.00 (s, 1H), 7.77 – 7.69 (m, 2H), 7.52 – 7.48 (m, 1H), 7.27 (t, *J* = 7.3 Hz, 2H), 7.22 – 7.13 (m, 3H), 4.00 (t, *J* = 7.2 Hz, 2H), 2.67 (t, *J* = 7.5 Hz, 2H), 1.88 – 1.80 (m, 2H), 1.75 – 1.68 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.05, 148.05, 146.55, 141.63, 134.22, 128.46, 128.43, 127.40, 127.31, 126.75, 126.03, 122.19, 46.90, 35.45, 29.02, 28.46.

HRMS: $C_{18}H_{17}N_2O$ [M-H] $^-$; calculated: 277.1341, found: 277.1342.



43

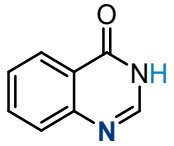
3-(2-(benzo[*d*][1,3]dioxol-5-yl)ethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (76 mg, 86%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (dd, *J* = 8.0, 1.1 Hz, 1H), 7.77 – 7.73 (m, 1H), 7.67 (d, *J* = 8.3 Hz, 2H), 7.51 (t, *J* = 7.5 Hz, 1H), 6.70 (d, *J* = 7.9 Hz, 1H), 6.66 (d, *J* = 1.4 Hz, 1H), 6.56 (dd, *J* = 7.9, 1.5 Hz, 1H), 5.93 (s, 2H), 4.17 (t, *J* = 6.9 Hz, 2H), 3.01 (t, *J* = 6.9 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.06, 148.08, 148.07, 146.65, 146.55, 134.30, 131.07, 127.47, 127.31, 126.72, 122.09, 122.02, 109.13, 108.67, 101.09, 49.12, 34.85.

(Known compound: *Synthetic Commun*., 2011, **42**, 341-349).



44

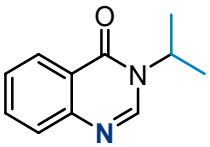
quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (25 mg, 57%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 12.23 (s, 1H), 8.12 (dd, *J* = 1.6, 1.2 Hz, 1H), 8.09 (s, 1H), 7.79 (t, *J* = 8.0 Hz, 1H), 7.65 (d, *J* = 8.4 Hz, 1H), 7.51 (t, *J* = 7.6, 1H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 160.85, 148.80, 145.48, 134.36, 127.25, 126.79, 125.91, 122.71.

(Known compound: *Org. Biomol. Chem.,* 2020, **18,** 5726-5733).



45

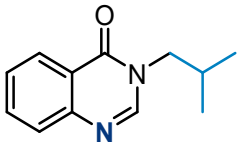
3-isopropylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (42 mg, 73%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (d, *J* = 8.0 Hz, 1H), 8.10 (s, 1H), 7.74 – 7.66 (m, 2H), 7.46 (t, *J* = 7.4 Hz, 1H), 5.20 – 5.14 (m, 1H), 1.47 (d, *J* = 6.9 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.66, 147.53, 143.60, 134.13, 127.26, 127.17, 126.89, 121.96, 46.08, 22.01.

(Known compound: *Tetrahedron Lett*., 2013, **54**, 3518-3521).



46

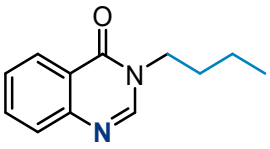
3-isobutylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a yellow solid (46 mg, 76%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 8.0 Hz, 1H), 8.00 (s, 1H), 7.77 – 7.70 (m, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 3.81 (d, *J* = 7.4 Hz, 2H), 2.26 – 2.16 (m, 1H), 0.98 (d, *J* = 6.7 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.28, 148.08, 147.00, 134.23, 127.44, 127.30, 126.86, 122.24, 54.22, 28.23, 19.99.

(Known compound: *Tetrahedron*., 2013, **69**, 1705-1711).



47

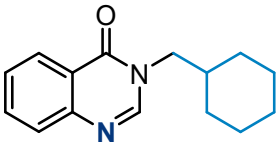
3-butylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a yellow solid (45 mg, 74%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (d, *J* = 7.9 Hz, 1H), 8.02 (s, 1H), 7.75 – 7.68 (m, 2H), 7.48 (t, *J* = 8.0 Hz, 1H), 3.99 (t, *J* = 7.3 Hz, 2H), 1.80 – 1.73 (m, 2H), 1.45 – 1.35 (m, 2H), 0.96 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.08, 148.09, 146.65, 134.17, 127.39, 127.26, 126.74, 122.23, 46.86, 31.47, 19.94, 13.68.

(Known compound: *Tetrahedron Lett.*, 2014, **55**, 6004-6006).



48

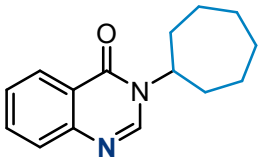
3-(cyclohexylmethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a yellow solid (58 mg, 80%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (d, *J* = 8.0 Hz, 1H), 7.96 (s, 1H), 7.75 – 7.67 (m, 2H), 7.47 (t, *J* = 7.4 Hz, 1H), 3.80 (d, *J* = 7.2 Hz, 2H), 1.88 – 1.83 (m, 1H), 1.71 – 1.69 (m, 5H), 1.21 – 1.13 (m, 3H), 1.04 – 0.96 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.26, 148.08, 147.02, 134.14, 127.39, 127.20, 126.78, 122.21, 53.10, 37.25, 30.64, 26.22, 25.61.

(Known compound: *J. Org. Chem.*, 2022, **87**, 9864-9874).



49

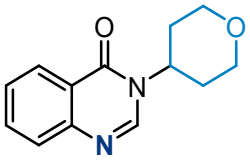
3-cycloheptylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a yellow solid (61 mg, 84%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (d, *J* = 8.0 Hz, 1H), 8.11 (s, 1H), 7.76 – 7.68 (m, 2H), 7.51 – 7.47 (m, 1H), 4.96 – 4.89 (m, 1H), 2.08 – 2.01 (m, 2H), 1.93 – 1.81 (m, 4H), 1.74 – 1.71 (m, 2H), 1.66 – 1.58 (m, 4H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.40, 147.49, 144.48, 134.14, 127.24, 127.20, 127.00, 122.03, 55.72, 35.15, 27.36, 25.34.

(Known compound: *Tetrahedron Lett.*, 2014, **55**, 6004-6006).



50

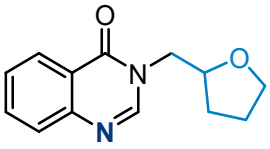
3-(tetrahydro-2*H*-pyran-4-yl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 3:1 petroleum ether: ethyl acetate) as a white solid (57 mg, 83%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (dd, *J* = 8.0, 1.2 Hz, 1H), 8.13 (s, 1H), 7.68 – 7.70 (m, 2H), 7.52 – 7.48 (m, 1H), 5.13 – 5.05 (m, 1H), 4.15 (dd, *J* = 11.7, 4.4 Hz, 2H), 3.64 – 3.57 (m, 2H), 2.08 – 1.97 (m, 2H), 1.95 – 1.91 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 160.68, 147.36, 143.45, 134.44, 127.44, 127.39, 127.03, 121.71, 67.44, 50.49, 32.40.

(Known compound: *Org. Lett.*, 2009, **11**, 1421-1424).



51

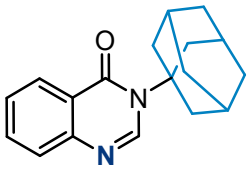
3-((tetrahydrofuran-2-yl)methyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (52 mg, 75%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (dd, *J* = 7.6, 0.8 Hz, 1H), 8.15 (s, 1H), 7.76 – 7.70 (m, 2H), 7.51 – 7.47 (m, 1H), 4.34 (dd, *J* = 13.8, 2.9 Hz, 1H), 4.24 – 4.18 (m, 1H), 3.90 – 3.83 (m, 2H), 3.77 – 3.72 (m, 1H), 2.13 – 2.05 (m, 1H), 1.93 – 1.84 (m, 2H), 1.65 – 1.56 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.34, 148.11, 147.57, 134.29, 127.47, 127.16, 126.81, 122.05, 76.89, 68.25, 49.58, 28.85, 25.87.

(Known compound: *Tetrahedron Lett.*, 2014, **55**, 6004-6006).



52

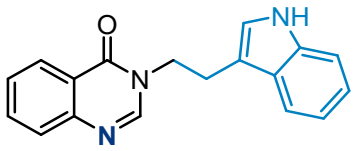
3-(adamantan-1-yl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (58 mg, 69%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, *J* = 9.5 Hz, 2H), 7.72 (t, *J* = 7.0 Hz, 1H), 7.66 (d, *J* = 8.0 Hz, 1H), 7.46 (t, *J* = 7.4 Hz, 1H), 2.45 (s, 6H), 2.27 (s, 3H), 1.83 – 1.75 (m, 6H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 162.04, 146.76, 144.06, 134.03, 126.99, 126.81, 126.61, 123.18, 62.69, 39.96, 36.07, 30.08.

HRMS: $C_{18}H_{21}N_2O$ $[M+H]^+$; calculated: 281.1654, found: 281.1651.



53

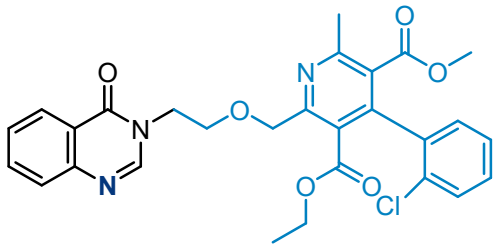
3-(2-(1*H*-indol-3-yl)ethyl)quinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (64 mg, 74%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, *J* = 8.0 Hz, 1H), 8.27 (s, 1H), 7.74 (t, *J* = 7.6 Hz, 1H), 7.65 (d, *J* = 5.9 Hz, 2H), 7.53 – 7.50 (m, 2H), 7.35 (d, *J* = 8.1 Hz, 1H), 7.20 (t, *J* = 7.5 Hz, 1H), 7.13 (t, *J* = 7.4 Hz, 1H), 6.85 (s, 1H), 4.30 (t, *J* = 6.7 Hz, 2H), 3.27 (t, *J* = 6.7 Hz, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 161.17, 148.15, 146.80, 136.52, 134.23, 127.38, 127.21, 126.87, 126.70, 122.86, 122.42, 122.14, 119.79, 118.42, 111.58, 111.29, 47.62, 24.99.

(Known compound: *J. Org. Chem.*, 2020, **85**, 7378-7385).



54

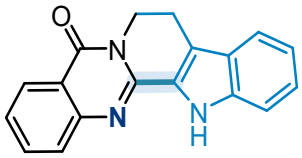
3-ethyl 5-methyl 4-(2-chlorophenyl)-6-methyl-2-((2-(4-oxoquinazolin-3(4*H*)-yl)ethoxy)methyl)pyridine-3,5-dicarboxylate

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a yellow solid (115 mg, 72%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (d, *J* = 8.1 Hz, 1H), 8.05 (s, 1H), 7.73 – 7.65 (m, 2H), 7.47 – 7.43 (m, 1H), 7.38 – 7.36 (m, 1H), 7.31 – 7.27 (m, 1H), 7.25 – 7.22 (m, 1H), 7.14 (dd, *J* = 7.5, 1.7 Hz, 1H), 4.75 (dd, *J* = 33.0, 12.7 Hz, 2H), 4.13 (dd, *J* = 7.8, 4.6 Hz, 2H), 3.93 (q, *J* = 7.1 Hz, 2H), 3.78 (t, *J* = 4.9 Hz, 2H), 3.49 (s, 3H), 2.56 (s, 3H), 0.85 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 167.23, 166.31, 161.05, 156.36, 155.55, 148.07, 147.48, 145.04, 134.87, 134.17, 132.77, 130.18, 129.87, 129.08, 128.38, 127.35, 127.05, 126.57, 126.28, 126.15, 121.99, 73.04, 68.32, 61.41, 52.23, 46.63, 23.18, 13.44.

HRMS: $C_{28}H_{27}ClN_3O_6$ $[M+H]^+$; calculated: 536.1588, found: 536.1589.



55

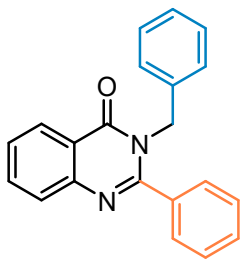
Rutaecarpine

The product was purified by column chromatography on silica gel (eluent: 1:1 petroleum ether: ethyl acetate) as a white solid (69 mg, 80%).

^{1}H NMR (400 MHz, DMSO-*d6*) δ 11.87 (s, 1H), 8.16 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.83 – 7.79 (m, 1H), 7.69 – 7.63 (m, 2H), 7.50 – 7.45 (m, 2H), 7.28 – 7.24 (m, 1H), 7.09 (t, *J* = 7.8 Hz, 1H), 4.45 (t, *J* = 6.9 Hz, 2H), 3.17 (t, *J* = 6.9 Hz, 2H).

^{13}C NMR (100 MHz, DMSO-*d6*) δ 160.68, 147.45, 145.37, 138.74, 134.49, 127.18, 126.67, 126.52, 126.05, 124.97, 124.81, 120.79, 120.03, 119.81, 117.93, 112.64, 40.90, 19.03.

(Known compound: *Org. Chem. Front.*, 2020, **7**, 2499-2504).



56

3-benzyl-2-phenylquinazolin-4(3*H*)-one

The product was purified by column chromatography on silica gel (eluent: 5:1 petroleum ether: ethyl acetate) as a white solid (78 mg, 83%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (d, *J* = 8.3 Hz, 1H), 7.82 – 7.75 (m, 2H), 7.56 – 7.51 (m, 1H), 7.47 (t, *J* = 7.3 Hz, 1H), 7.40 (t, *J* = 7.5 Hz, 2H), 7.36 – 7.32 (m, 2H), 7.25 – 7.16 (m, 3H), 6.93 (dd, *J* = 6.5, 2.9 Hz, 2H), 5.28 (s, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 162.53, 156.44, 147.32, 136.63, 135.32, 134.63, 129.96, 128.66, 128.58, 128.06, 127.66, 127.50, 127.23, 127.17, 127.03, 120.92, 48.87.

(Known compound: *Green Chem.*, 2024, **26**, 4723-4732)

VIII. Supplementary References

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5 Y. Bao, Z. Deng, J. Feng, W. Zhu, J. Li, J. Wan and G. Liu, *Org. Lett.*, 2020, **22**, 6277–6282.

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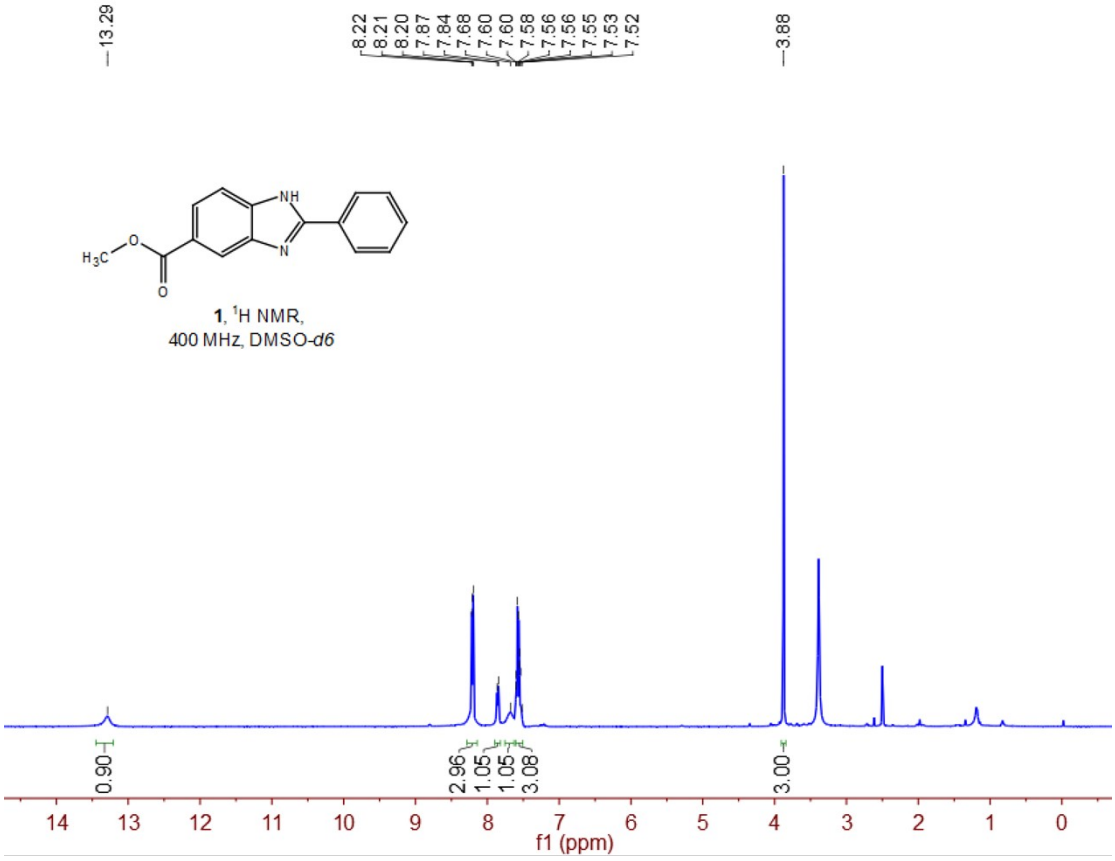
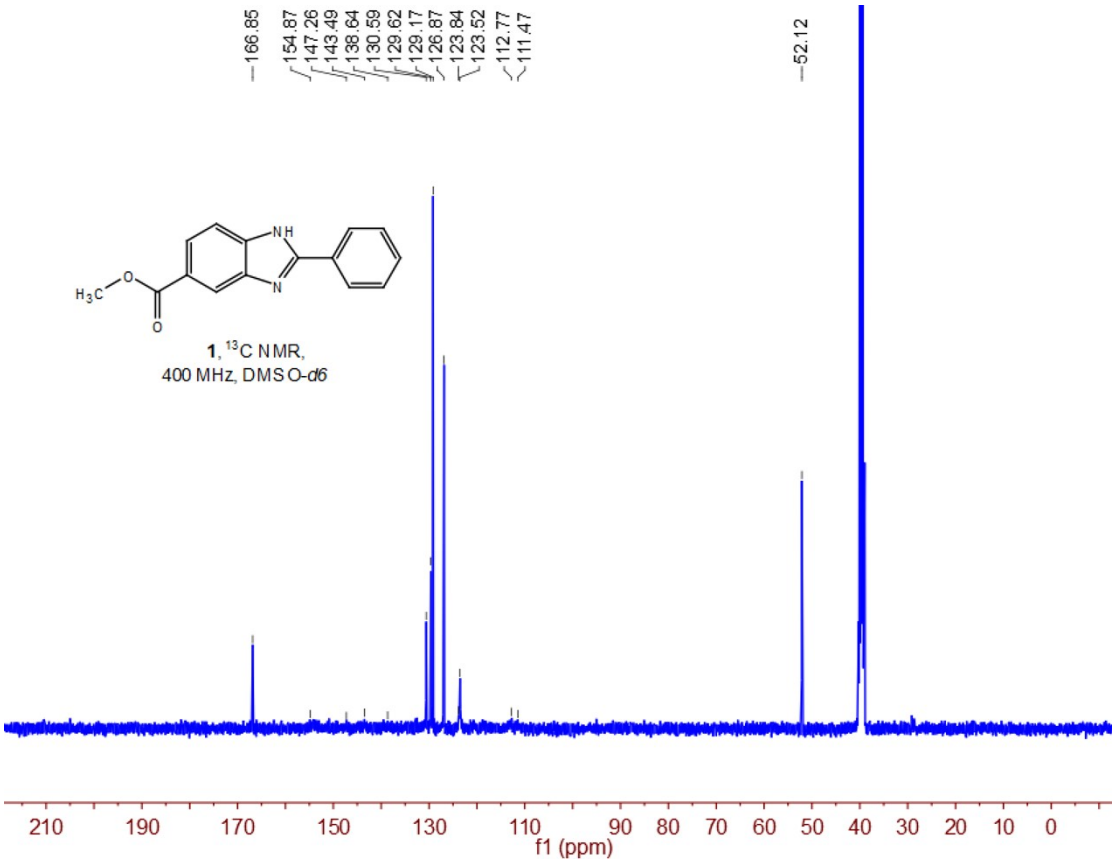
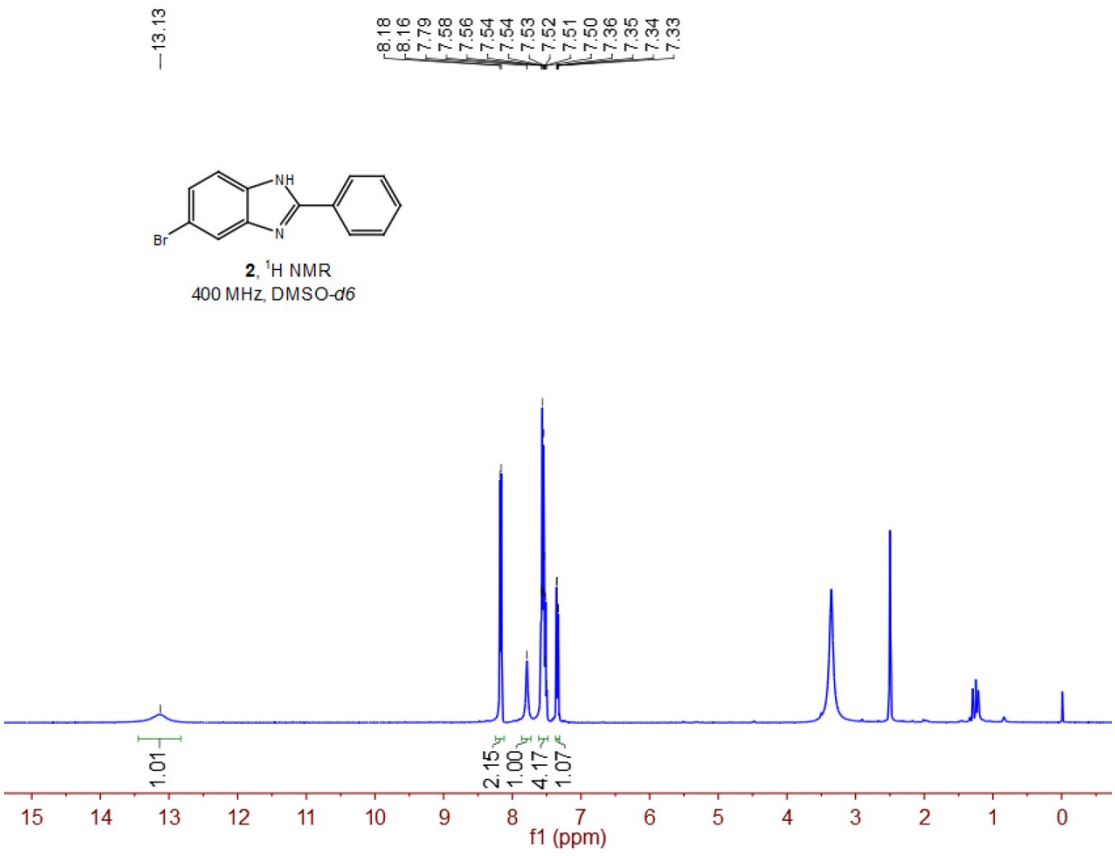
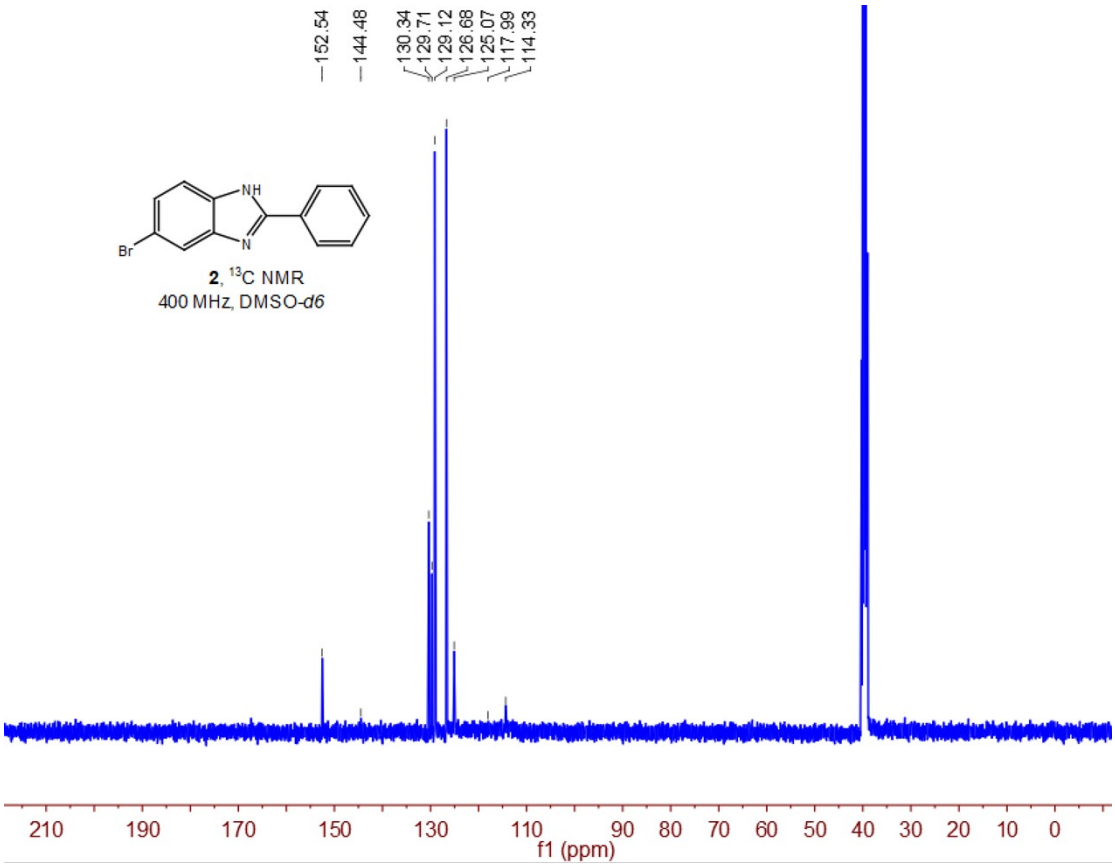
IX. NMR Spectra

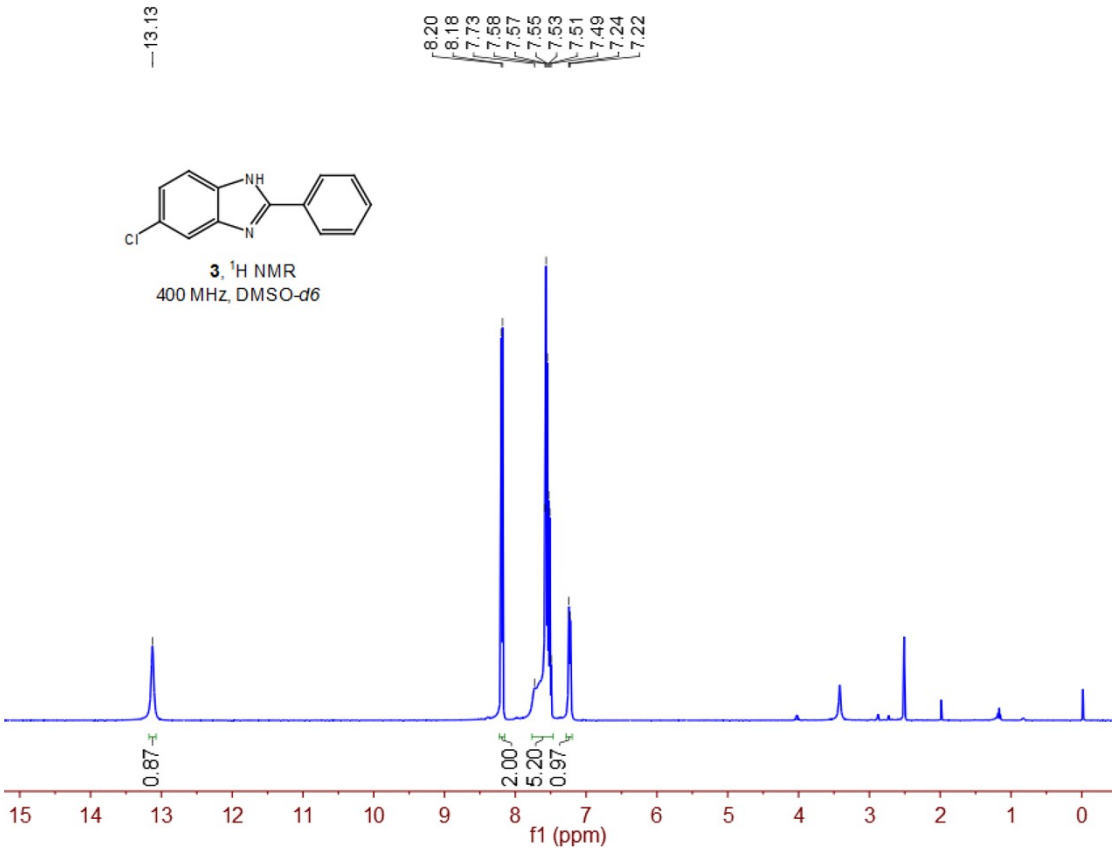


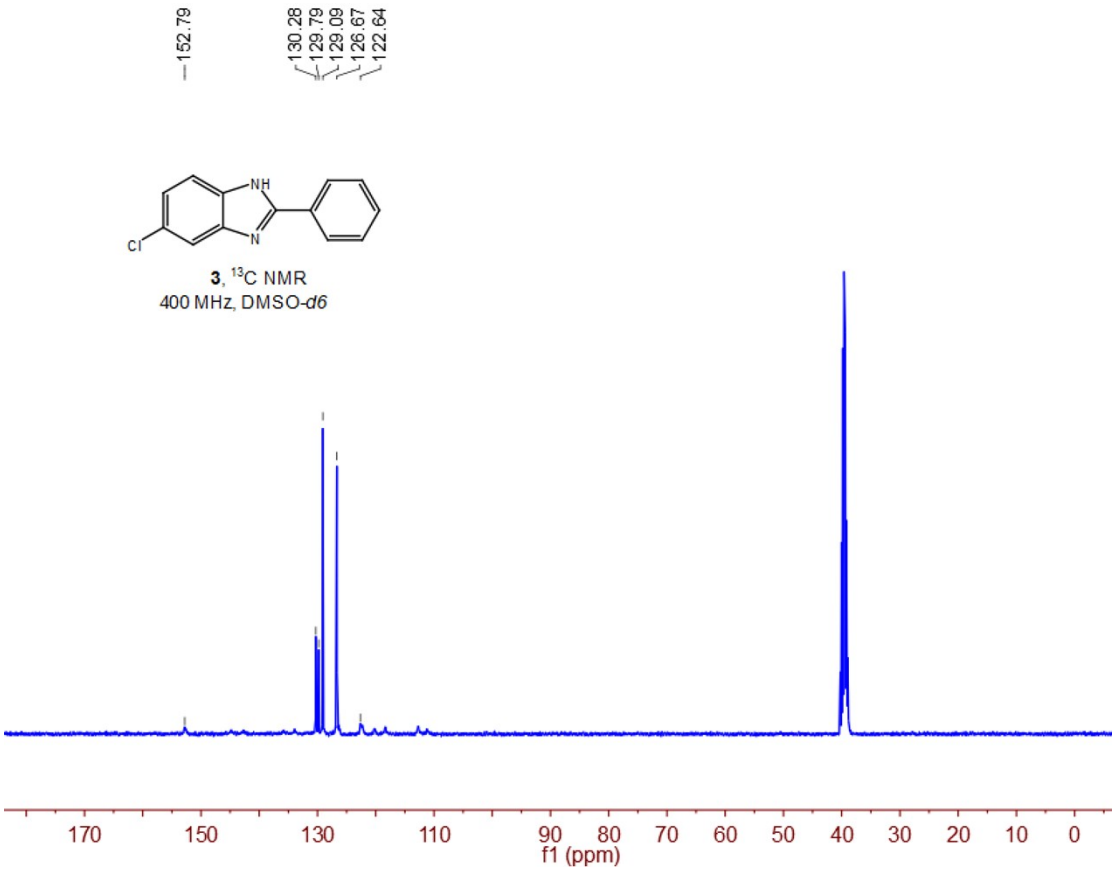
1, ^{1}H NMR,
400 MHz, DMSO-*d6*


166.85
154.87
147.26
143.49
138.64
130.59
129.62
129.17
126.87
123.84
123.52
112.77
111.47
52.12
NH
N
O
O
H3C
1, 13C NMR,
400 MHz, DMSO-d6
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

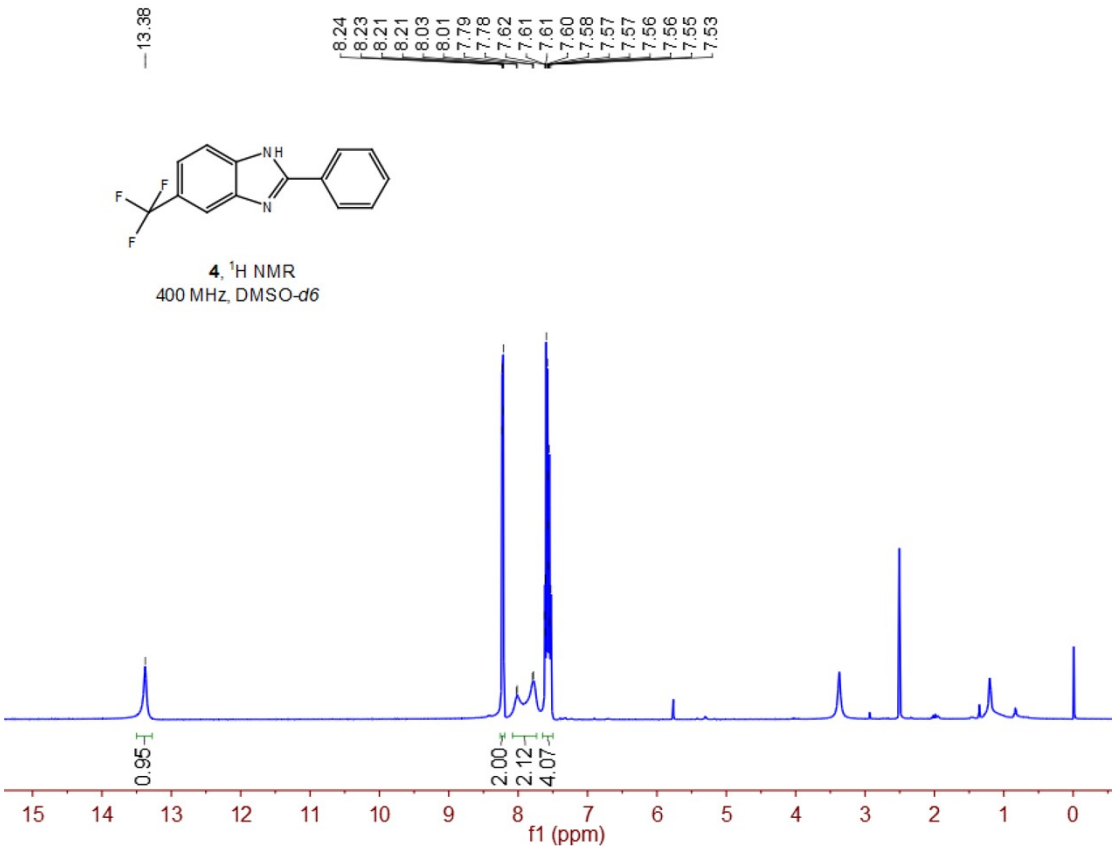

13.13
8.18
8.16
7.79
7.58
7.56
7.54
7.54
7.53
7.52
7.51
7.50
7.36
7.35
7.34
7.33
NH
N
Br
2, 1H NMR
400 MHz, DMSO-d6
1.01
2.15
1.00
4.17
1.07
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
f1 (ppm)


152.54
144.48
130.34
129.71
129.12
126.68
125.07
117.99
114.33
NH
N
Br
2, 13C NMR
400 MHz, DMSO-d6
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

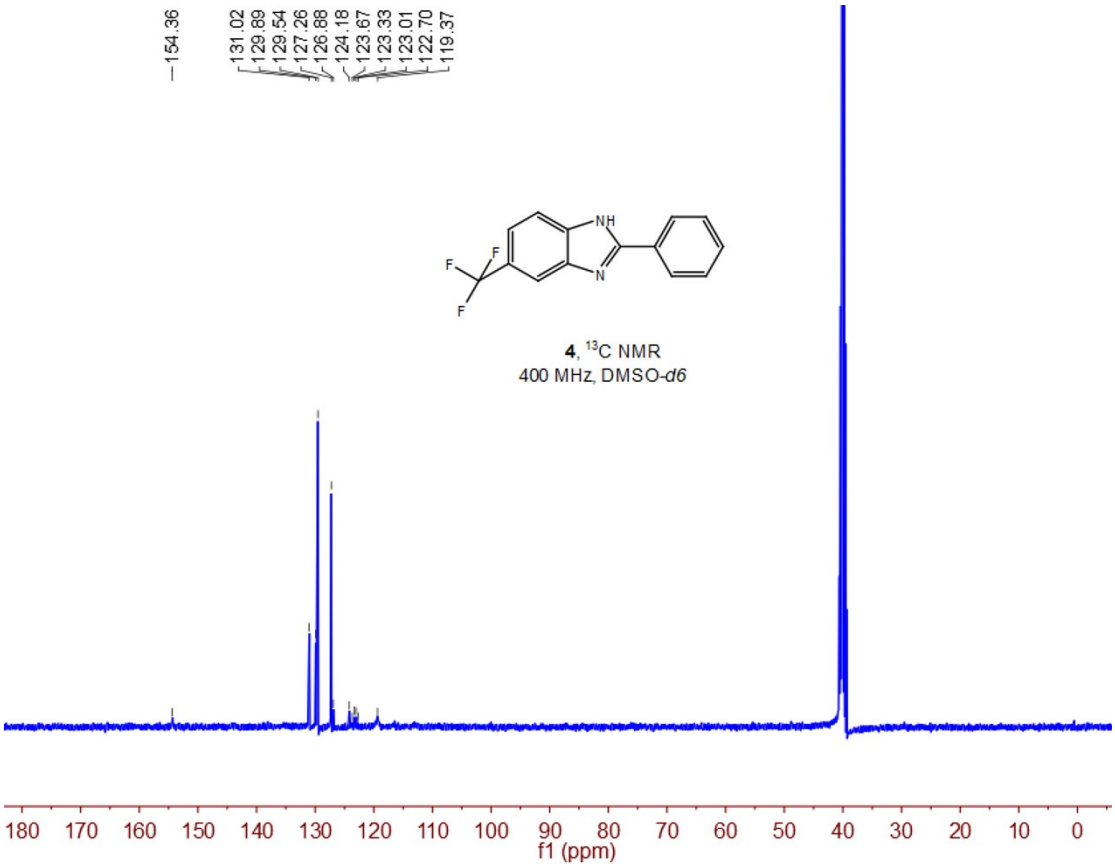

13.13
8.20
8.18
7.73
7.58
7.57
7.55
7.53
7.51
7.49
7.24
7.22
NH
N
Cl
3, 1H NMR
400 MHz, DMSO-d6
0.87
2.00
5.20
0.97
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)



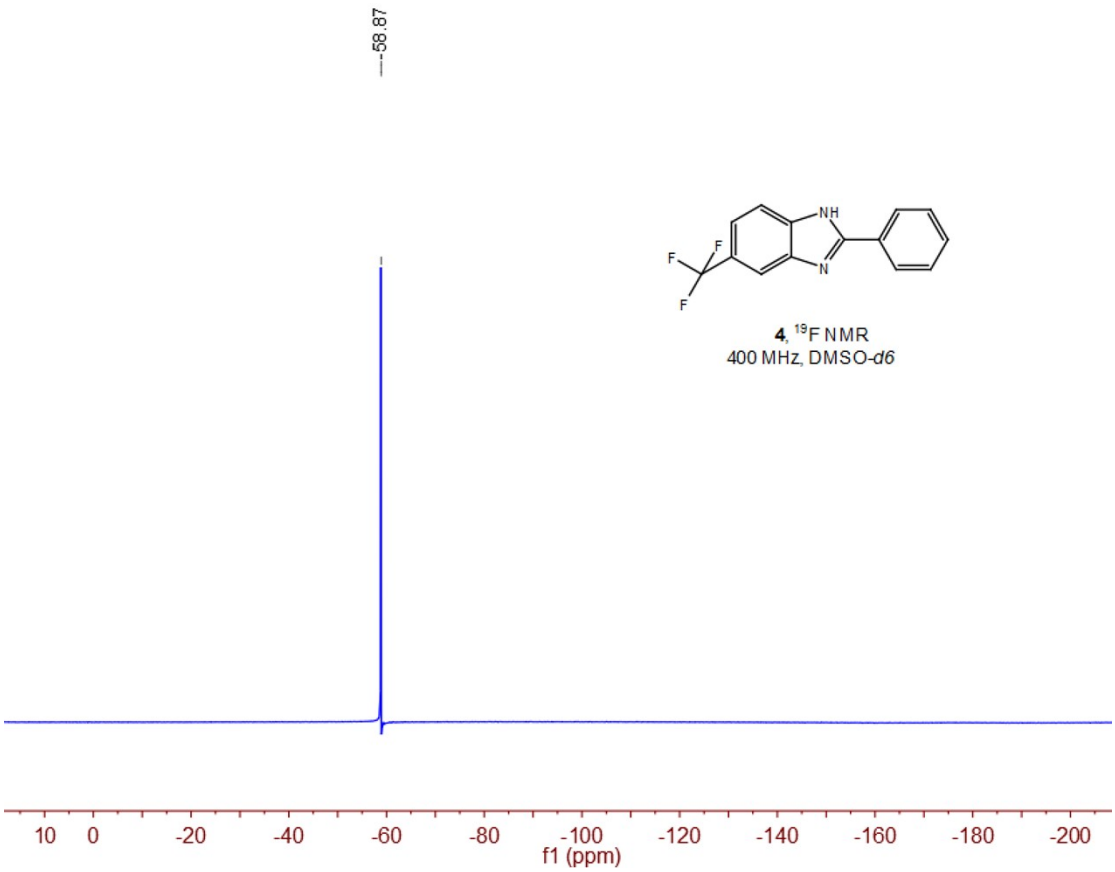
3, ^{13}C NMR
400 MHz, DMSO-*d6*



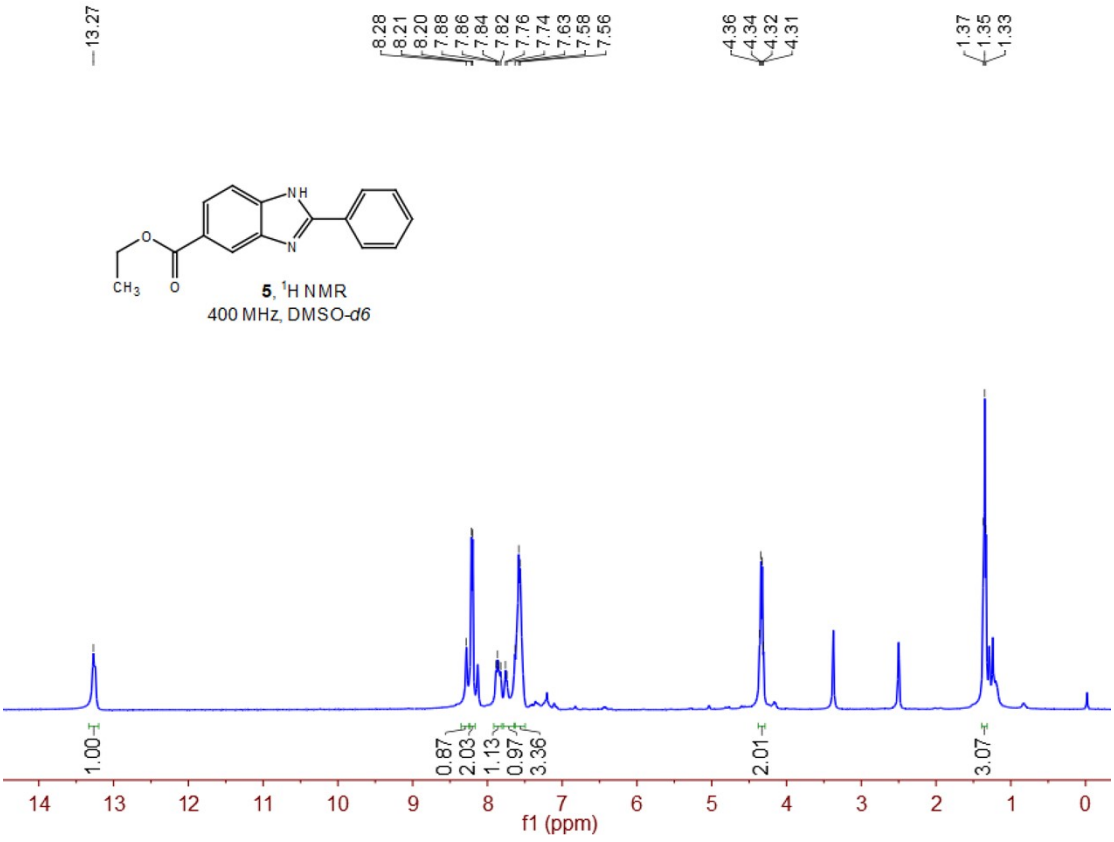
4, ^{1}H NMR
400 MHz, DMSO-*d6*

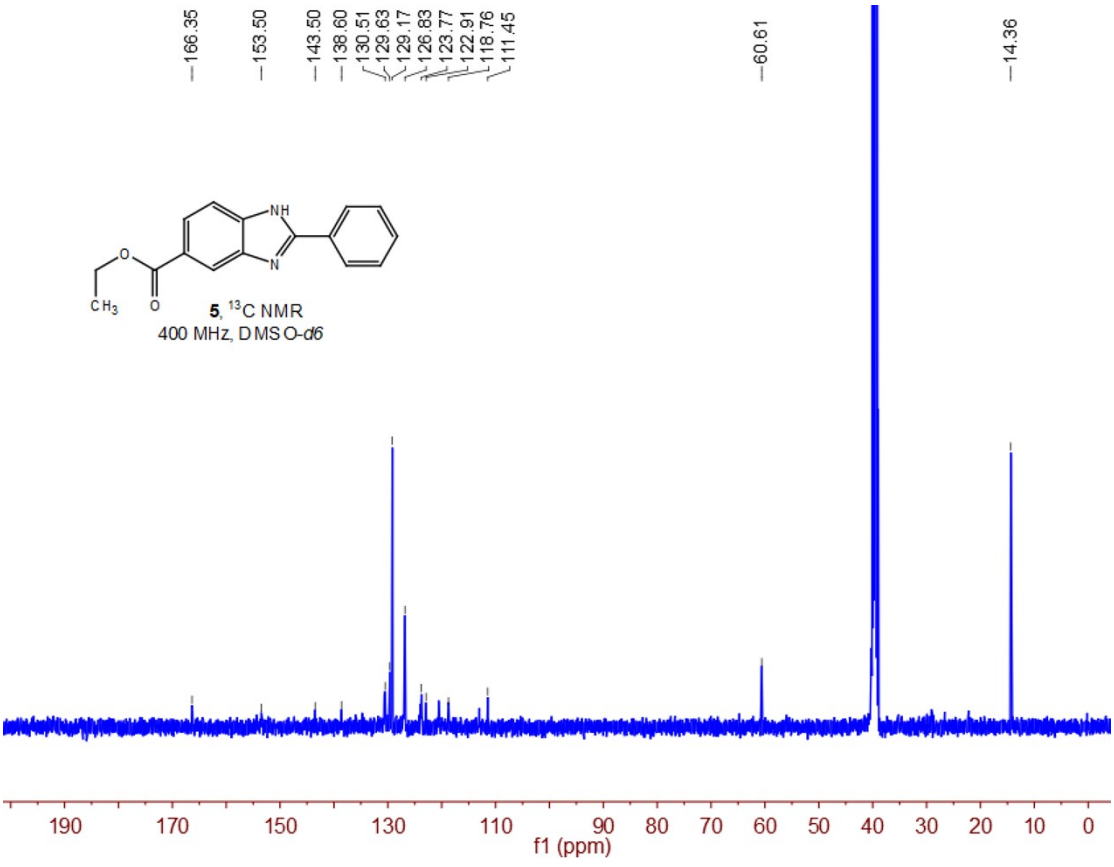


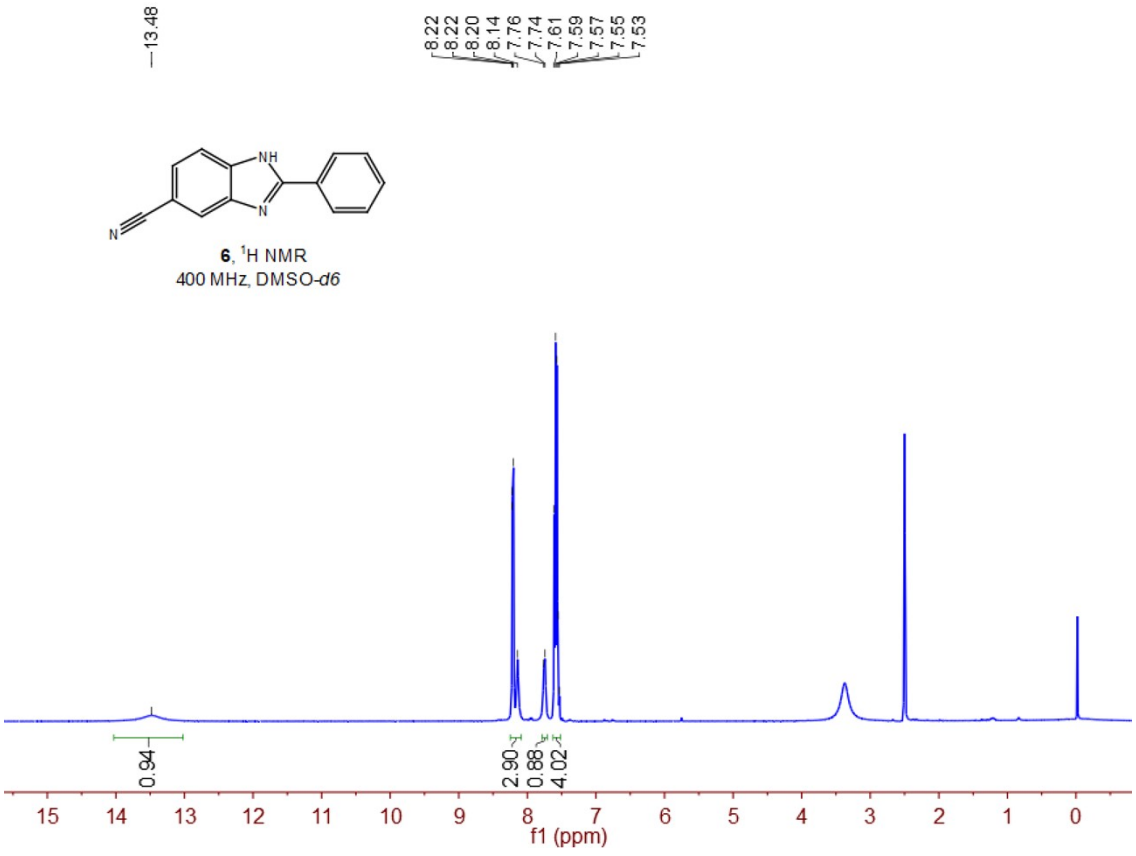
4, ^{13}C NMR
400 MHz, DMSO-*d6*



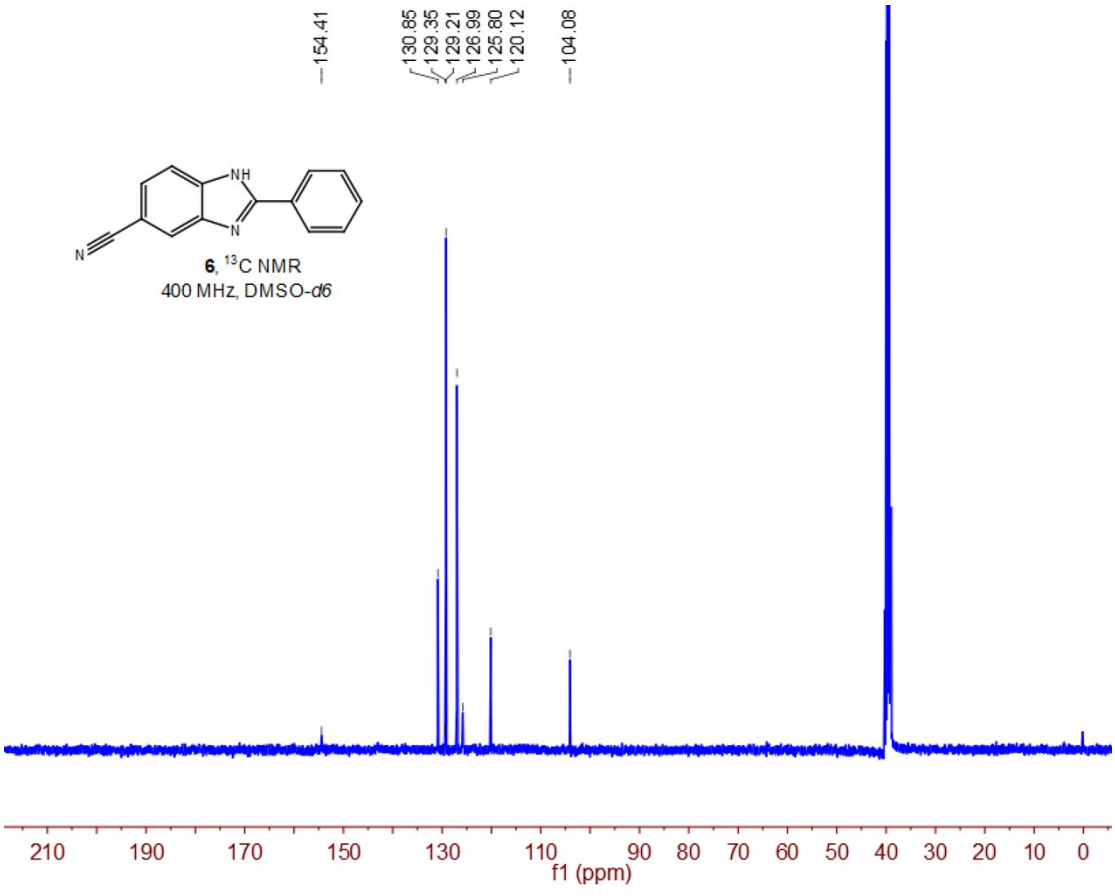
4, ^{19}F NMR
400 MHz, DMSO-*d6*


13.27
8.28
8.21
8.20
7.88
7.86
7.84
7.82
7.76
7.74
7.63
7.58
7.56
4.36
4.34
4.32
4.31
1.37
1.35
1.33
NH
N
O
O
CH3
5, 1H NMR
400 MHz, DMSO-d6
1.00
0.87
2.03
1.13
0.97
3.36
2.01
3.07
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

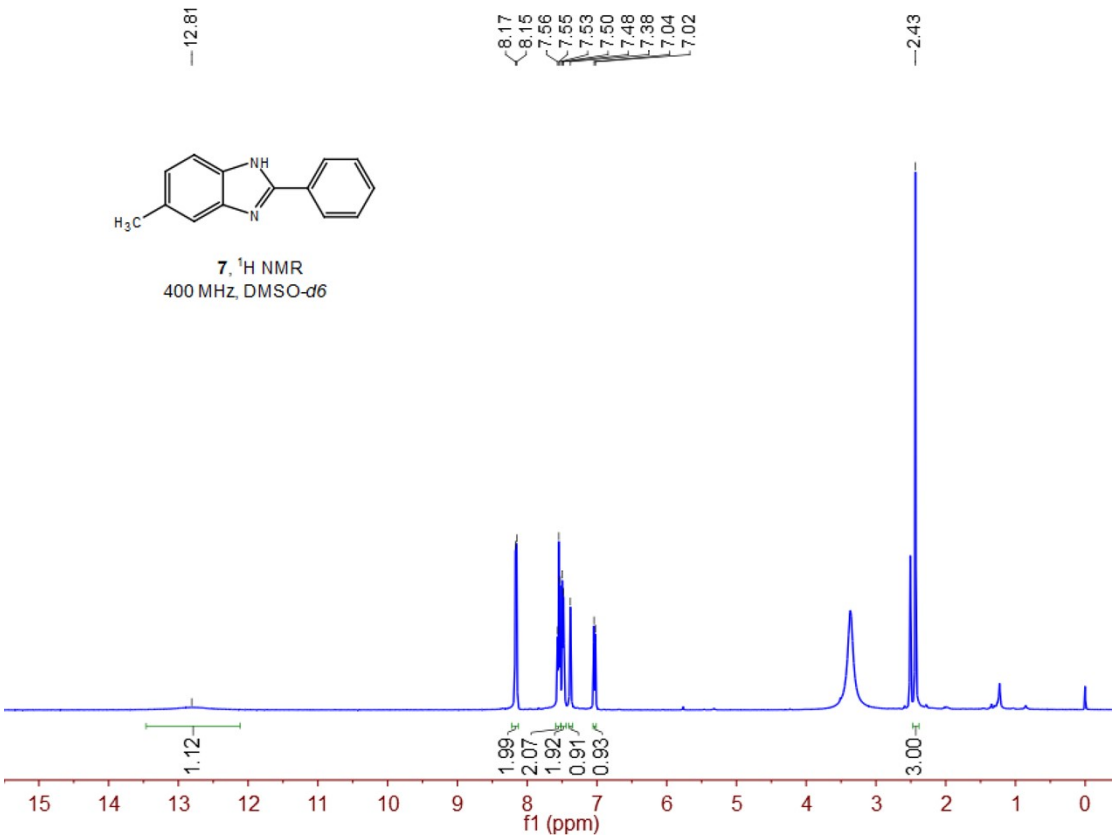

166.35
153.50
143.50
138.60
130.51
129.63
129.17
126.83
123.77
122.91
118.76
111.45
60.61
14.36
NH
N
O
O
CH3
5, 13C NMR
400 MHz, DMSO-d6
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

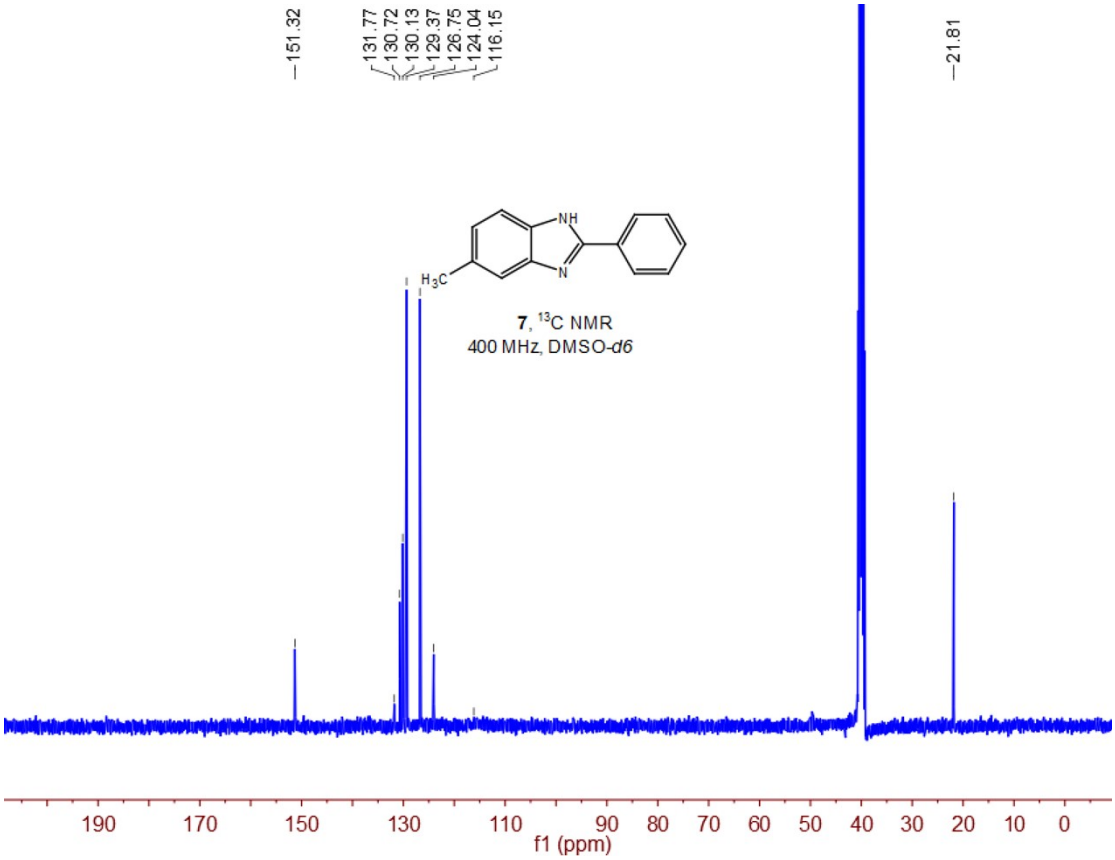


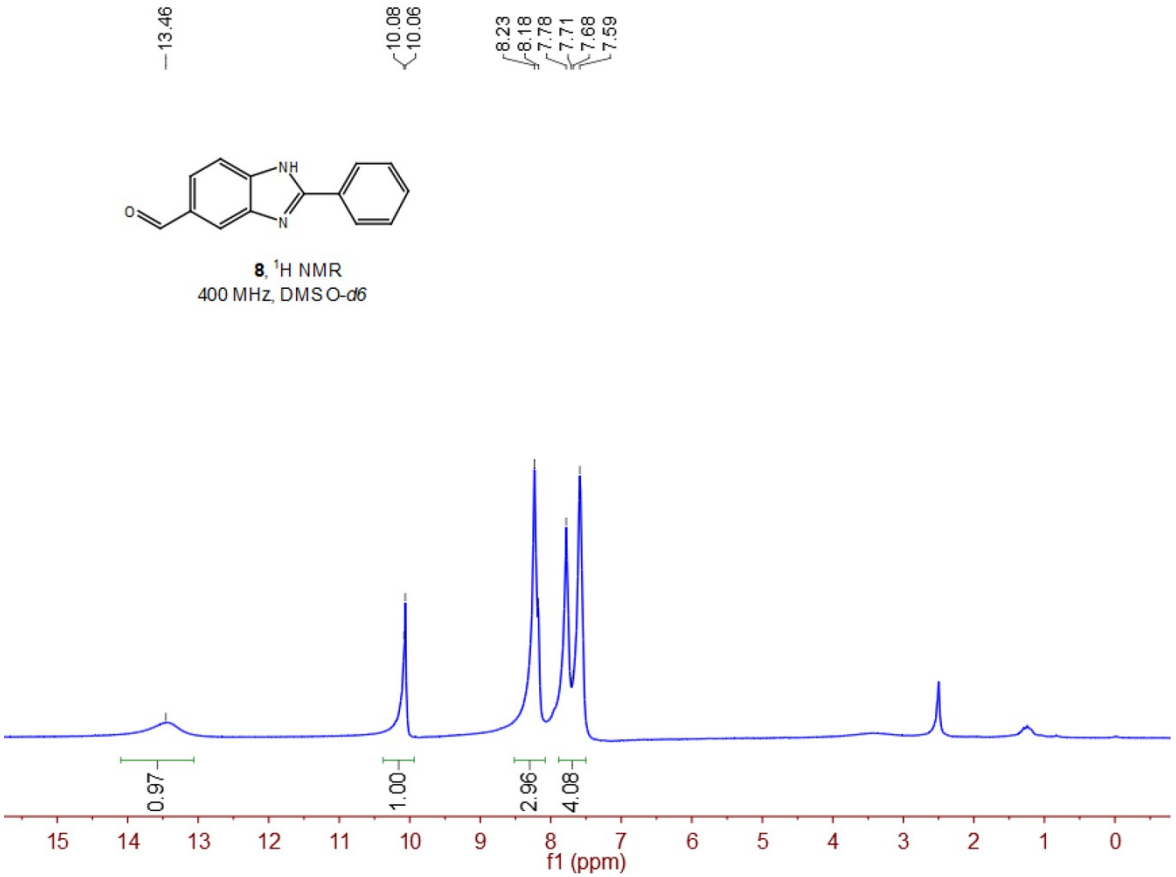
6, ^{1}H NMR
400 MHz, DMSO-*d6*



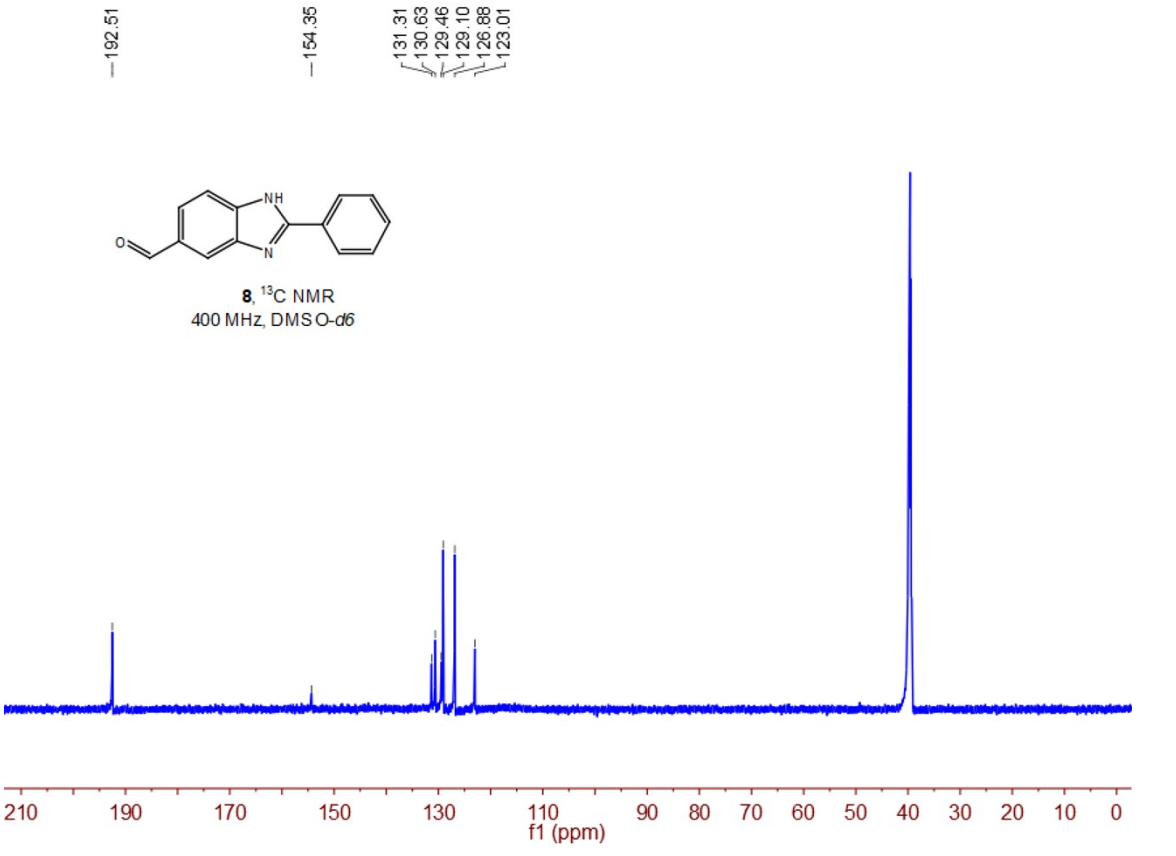
6, ^{13}C NMR
400 MHz, DMSO-*d6*


12.81
8.17
8.15
7.56
7.55
7.53
7.50
7.48
7.38
7.04
7.02
2.43
NH
N
H3C
7, 1H NMR
400 MHz, DMSO-d6
1.12
1.99
2.07
1.92
0.91
0.93
3.00
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

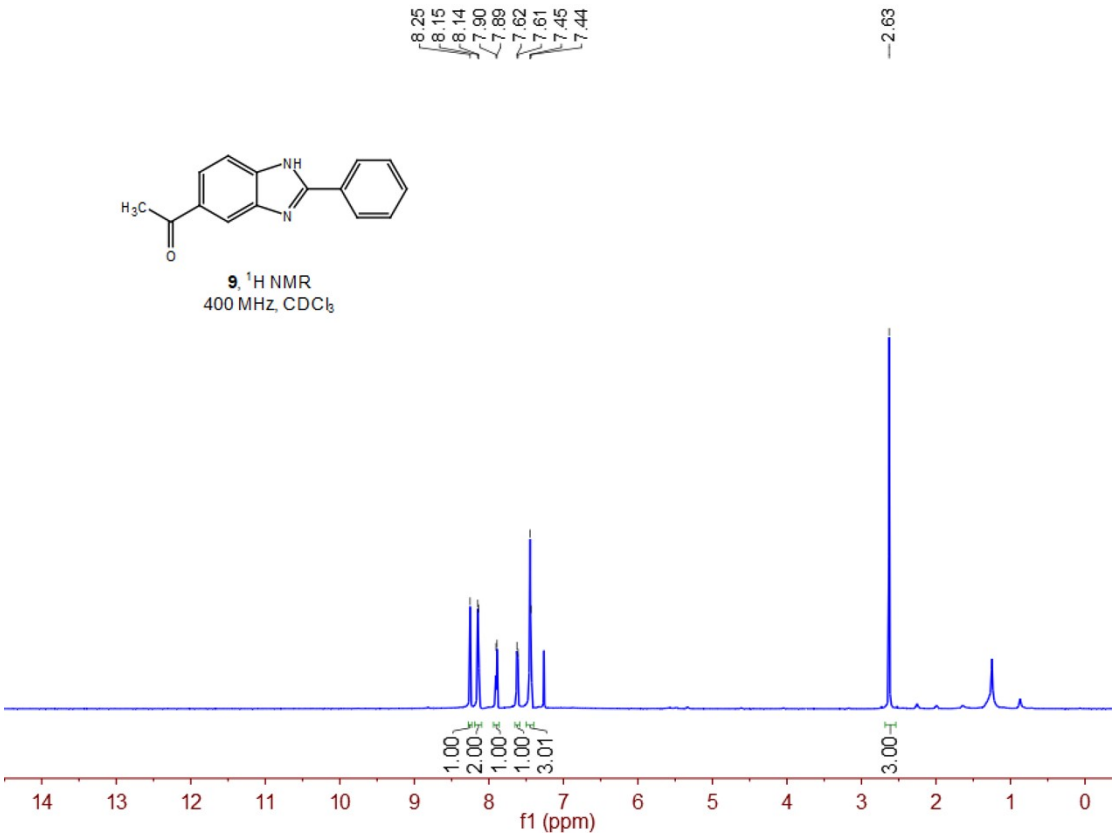

151.32
131.77
130.72
130.13
129.37
126.75
124.04
116.15
21.81
NH
N
H3C
7, 13C NMR
400 MHz, DMSO-d6
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

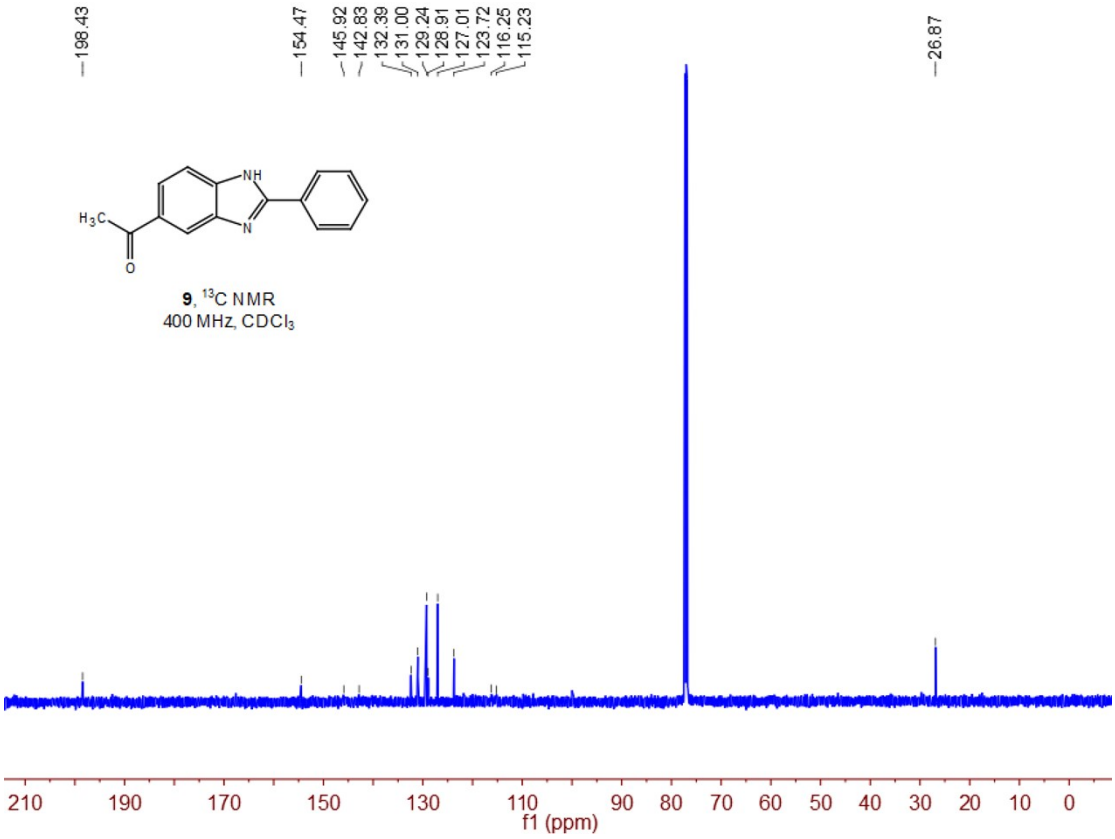


8, ^{1}H NMR
400 MHz, DMSO-*d6*

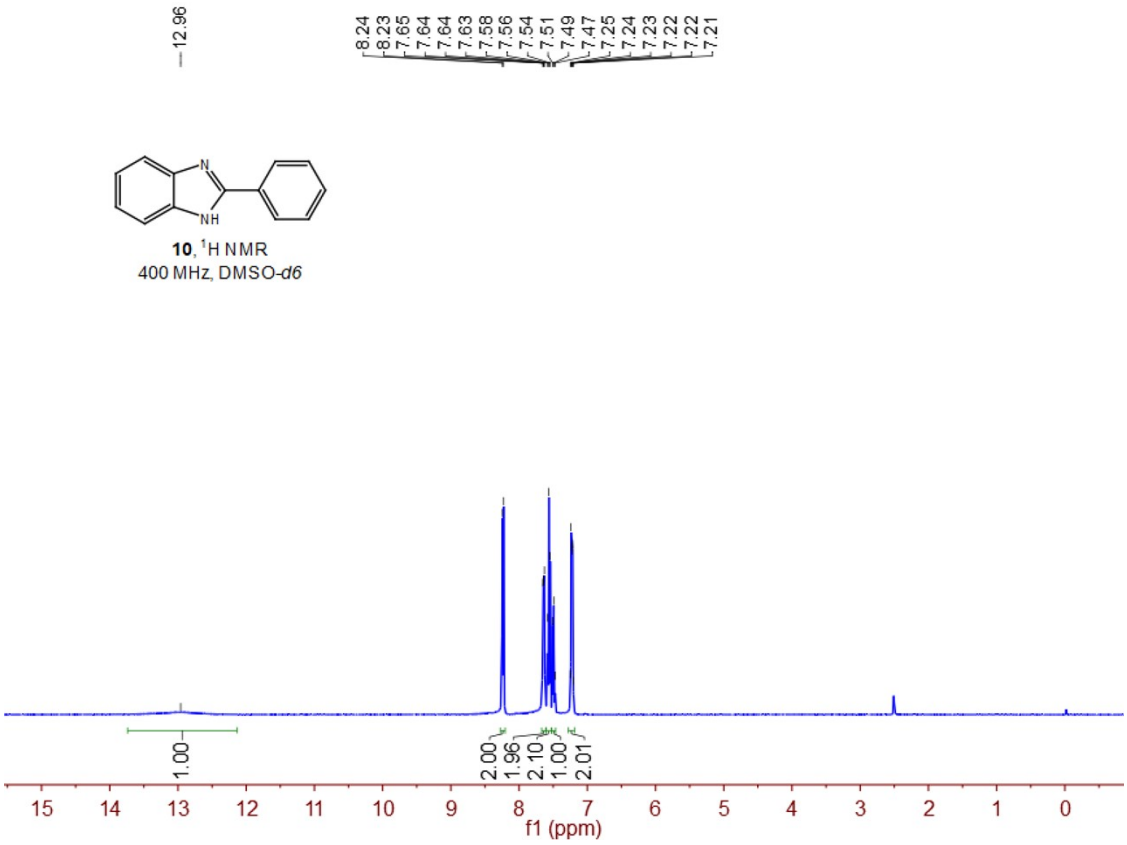


8, ^{13}C NMR
400 MHz, DMSO-*d6*

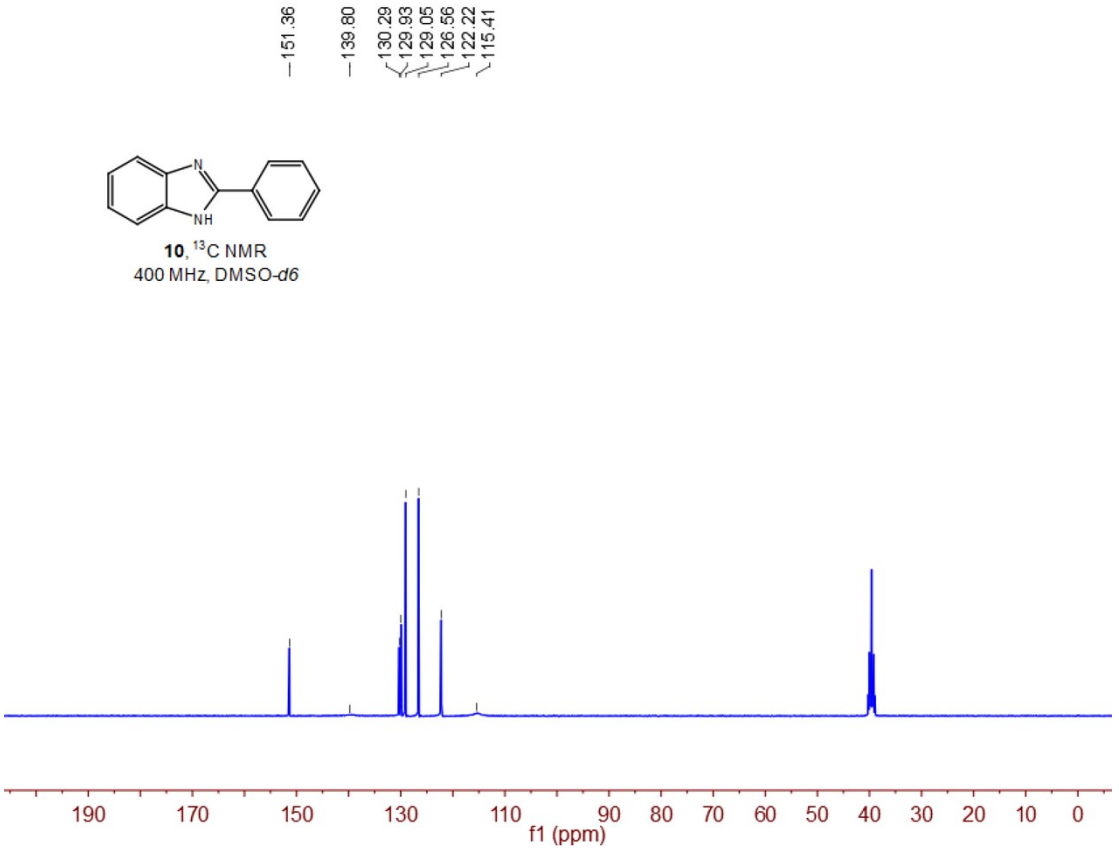

8.25
8.15
8.14
7.90
7.89
7.62
7.61
7.45
7.44
2.63
NH
N
H3C
O
9, 1H NMR
400 MHz, CDCl3
1.00
2.00
1.00
1.00
3.01
3.00
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
f1 (ppm)



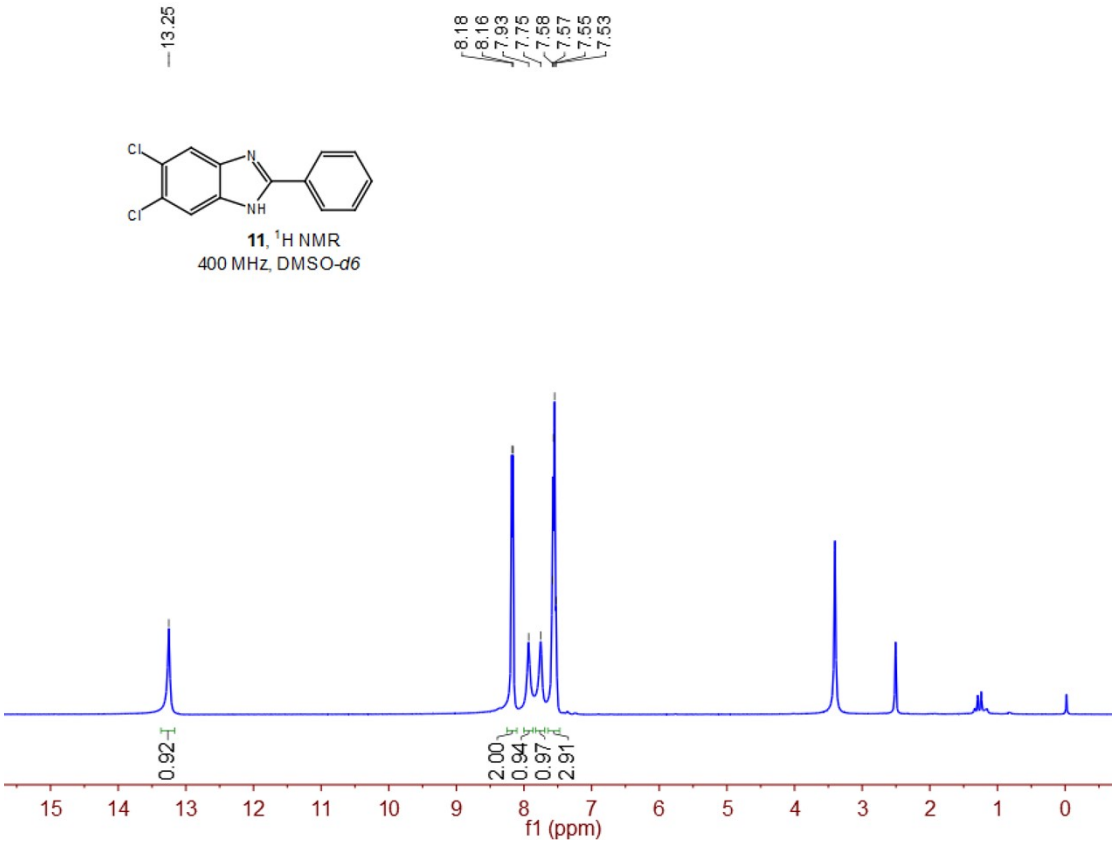
9, ^{13}C NMR
400 MHz, $CDCl_3$



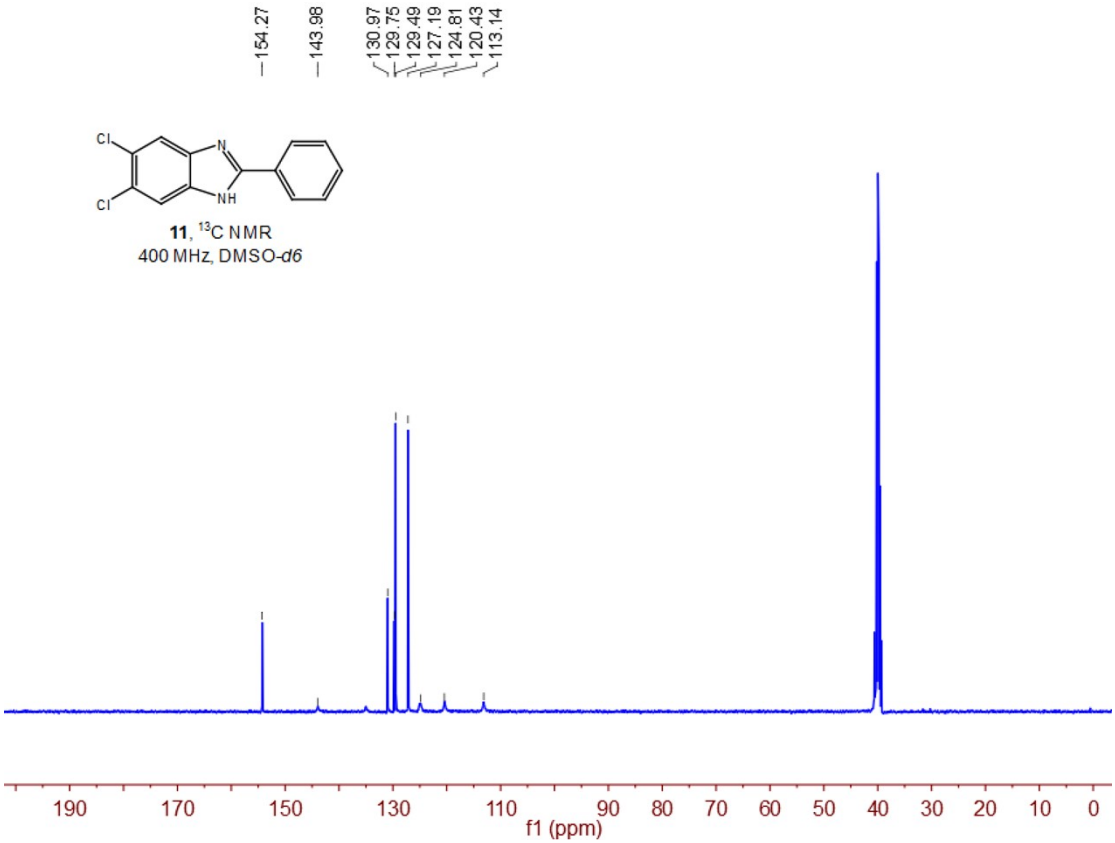
10, ^{1}H NMR
400 MHz, DMSO-*d6*



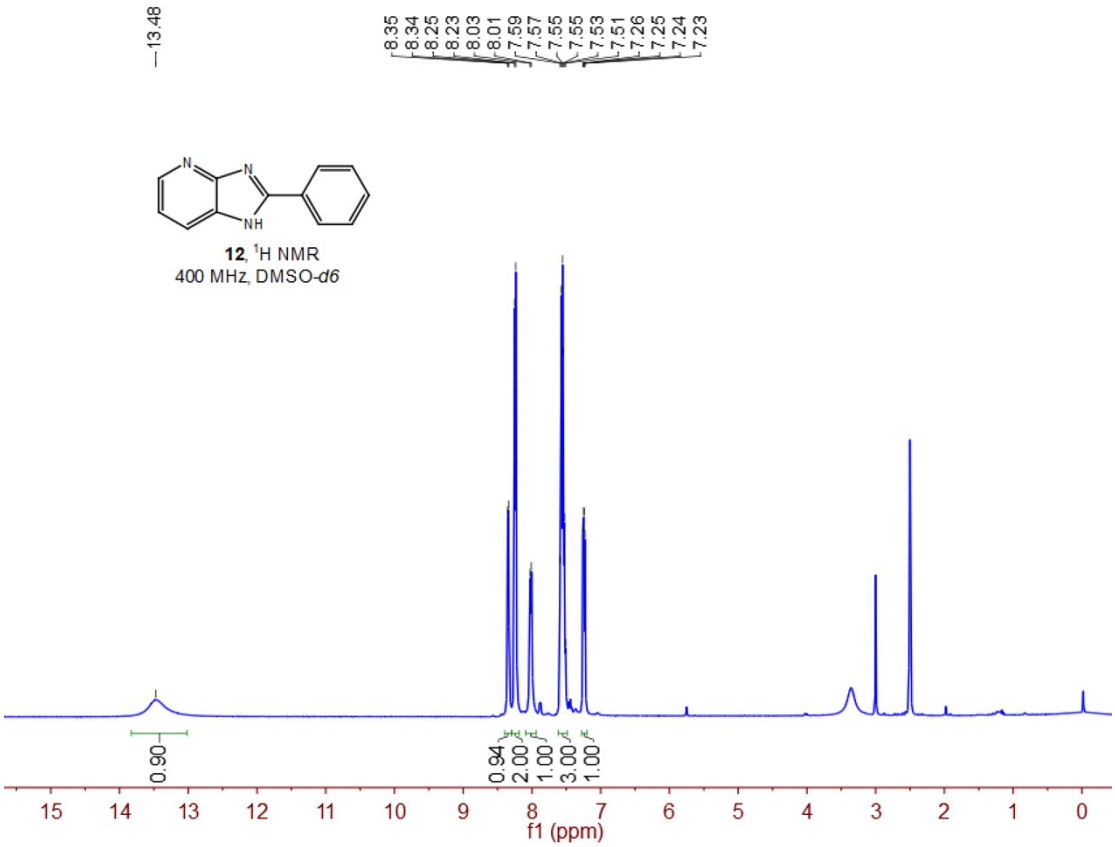
10, ^{13}C NMR
400 MHz, DMSO-*d6*



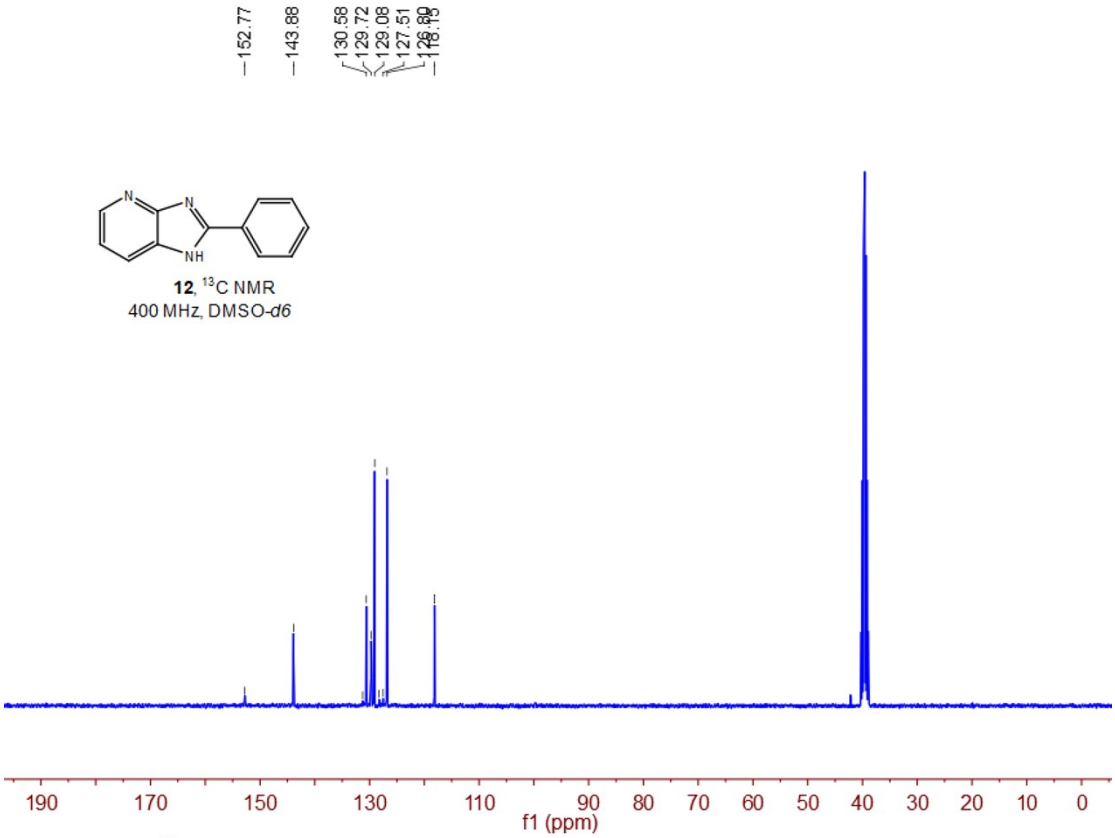
11, ^{1}H NMR
400 MHz, DMSO-*d6*



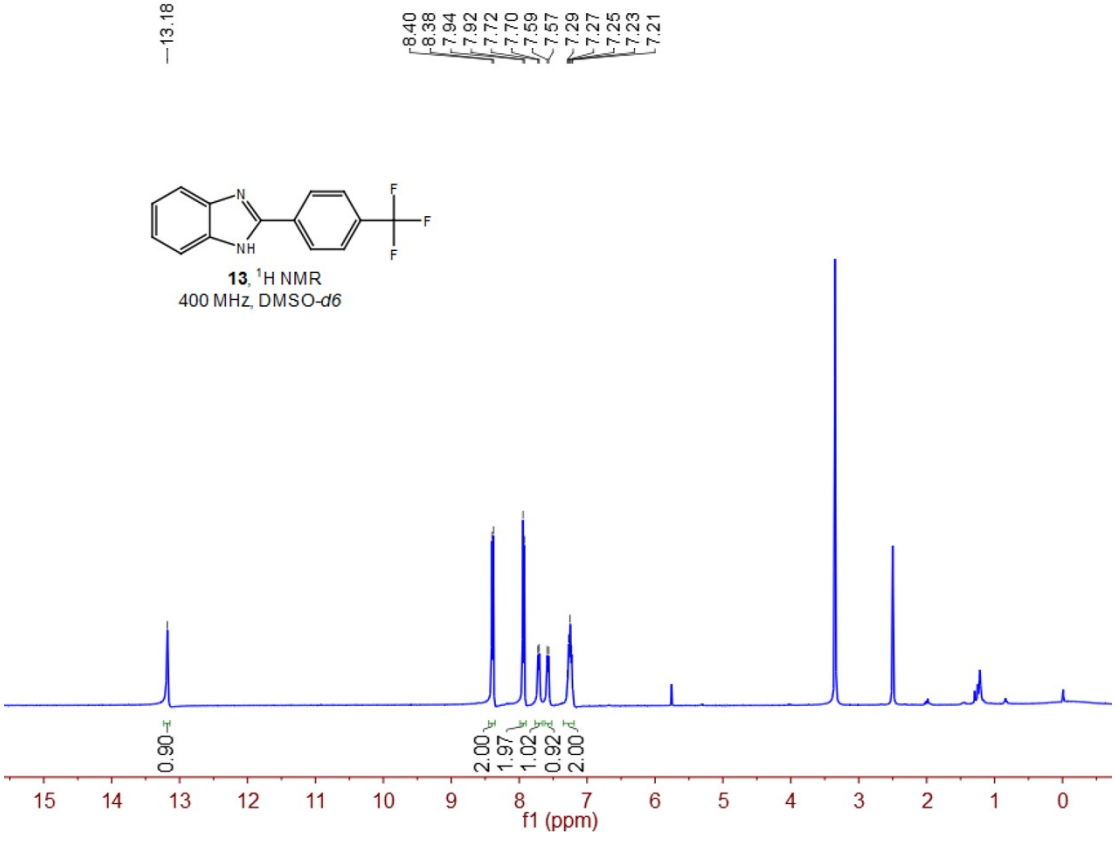
11, ^{13}C NMR
400 MHz, DMSO-*d6*



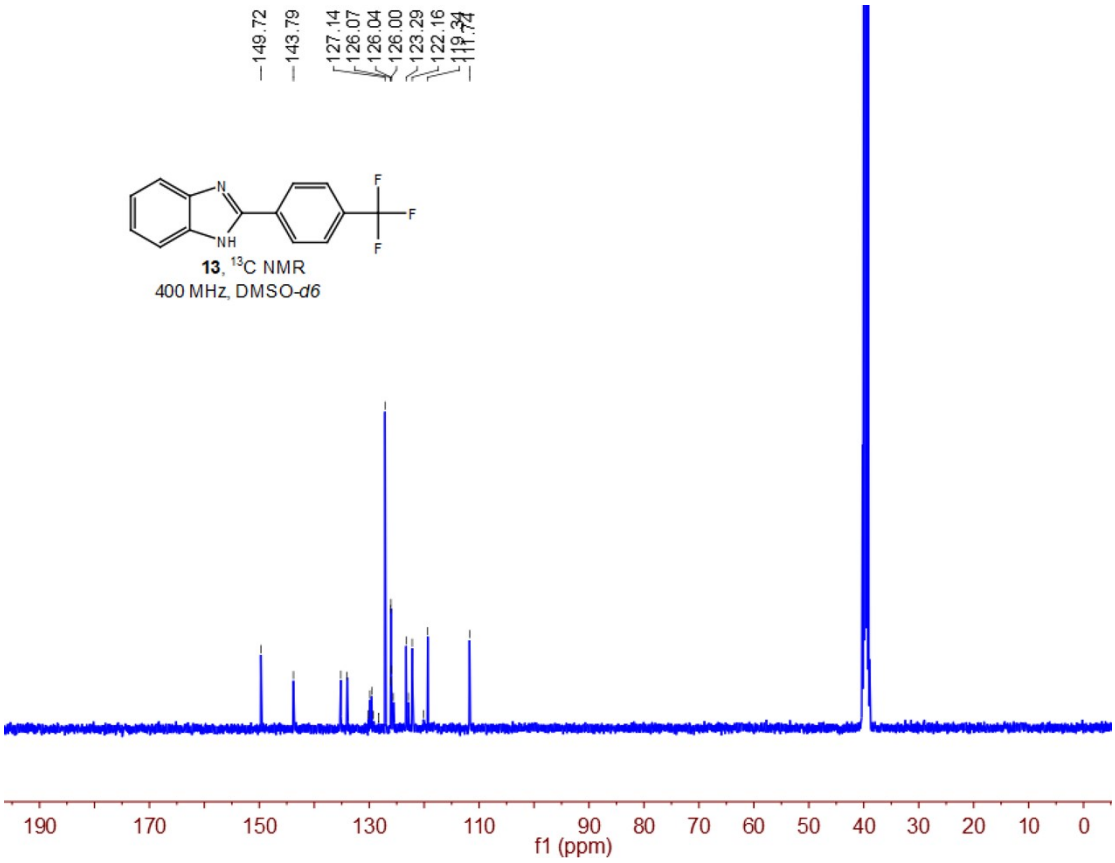
12, ^{1}H NMR
400 MHz, DMSO-*d6*



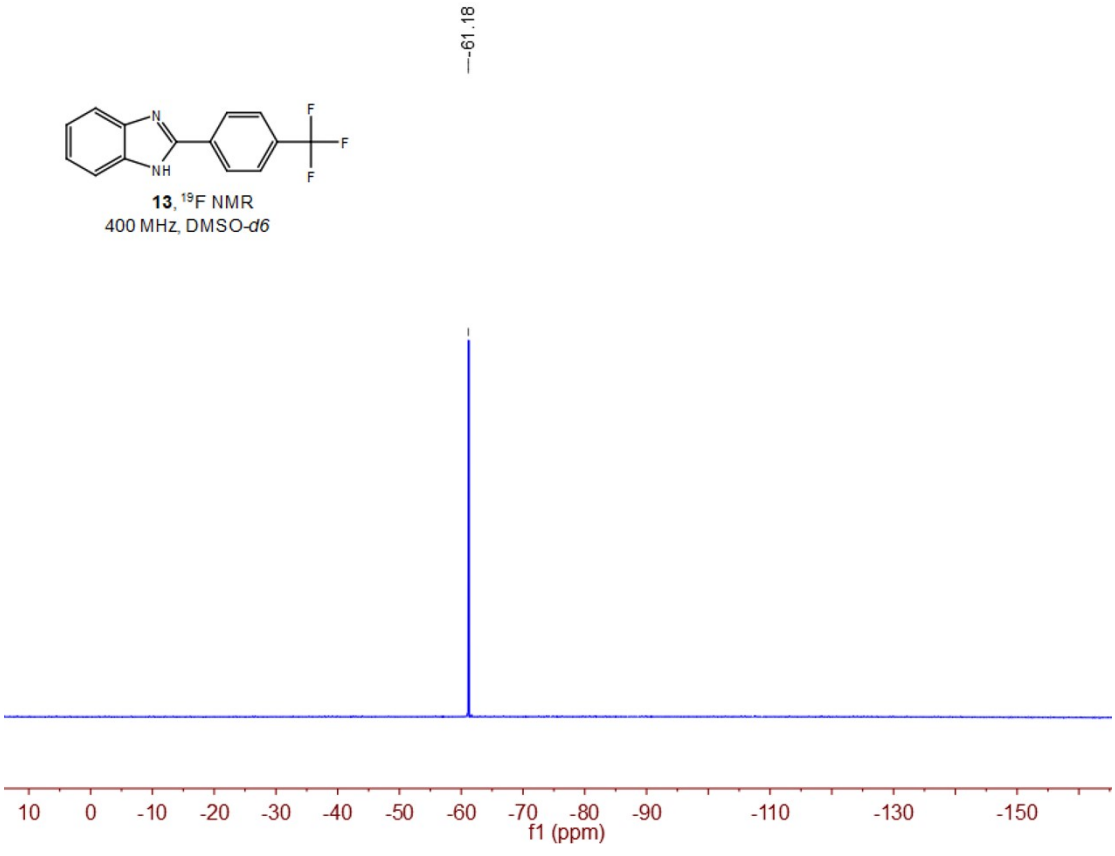
12, ^{13}C NMR
400 MHz, DMSO-*d6*



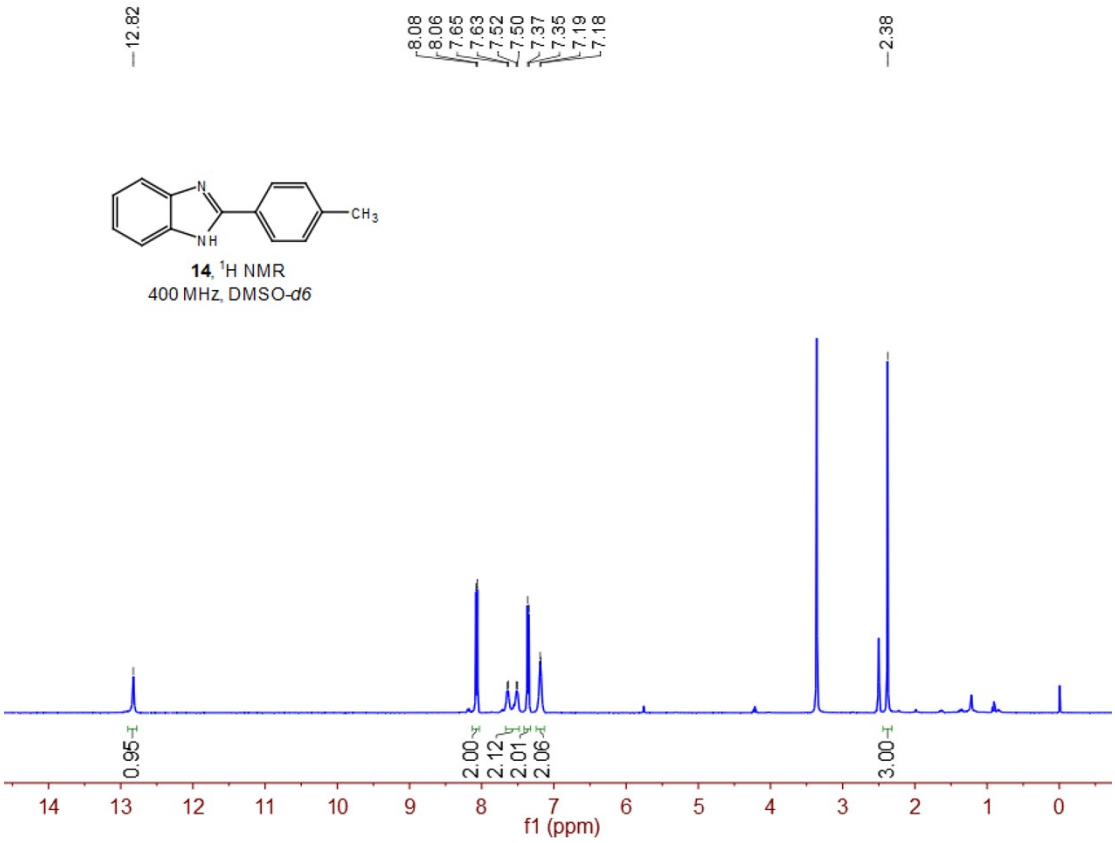
13, ^{1}H NMR
400 MHz, DMSO-*d6*



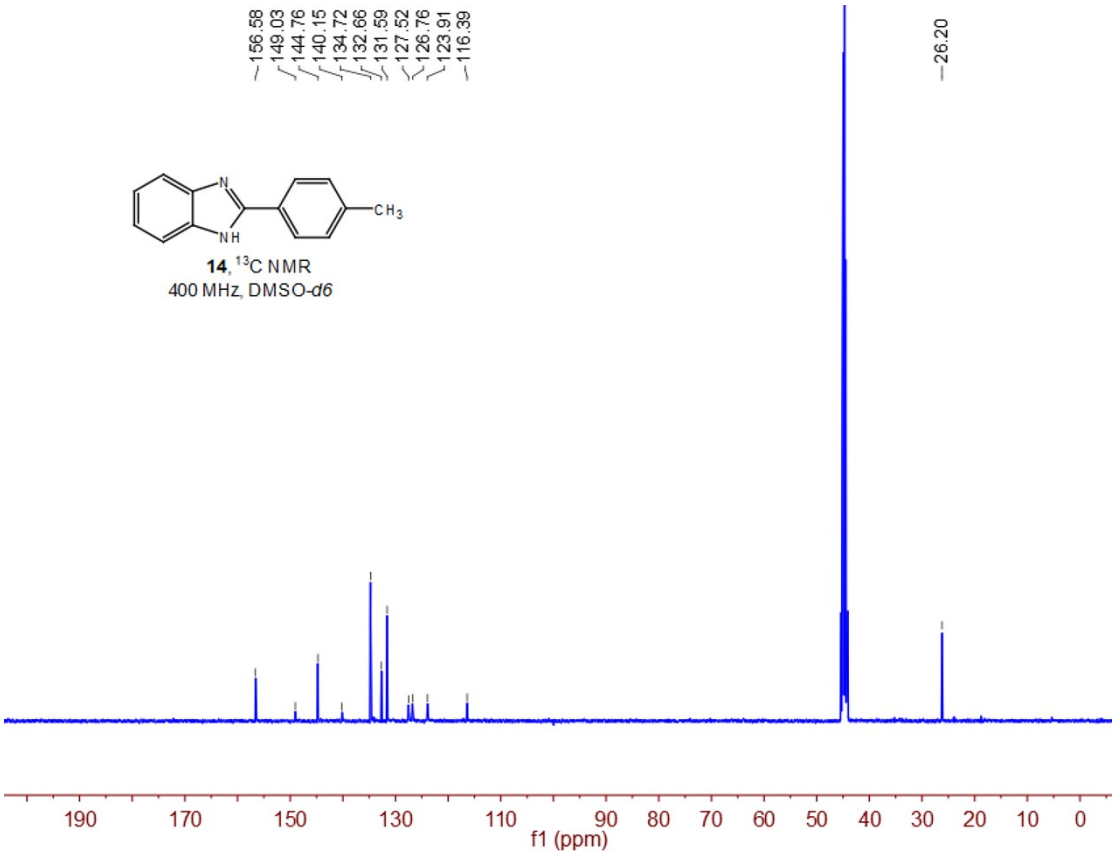
13, ^{13}C NMR
400 MHz, DMSO-*d6*



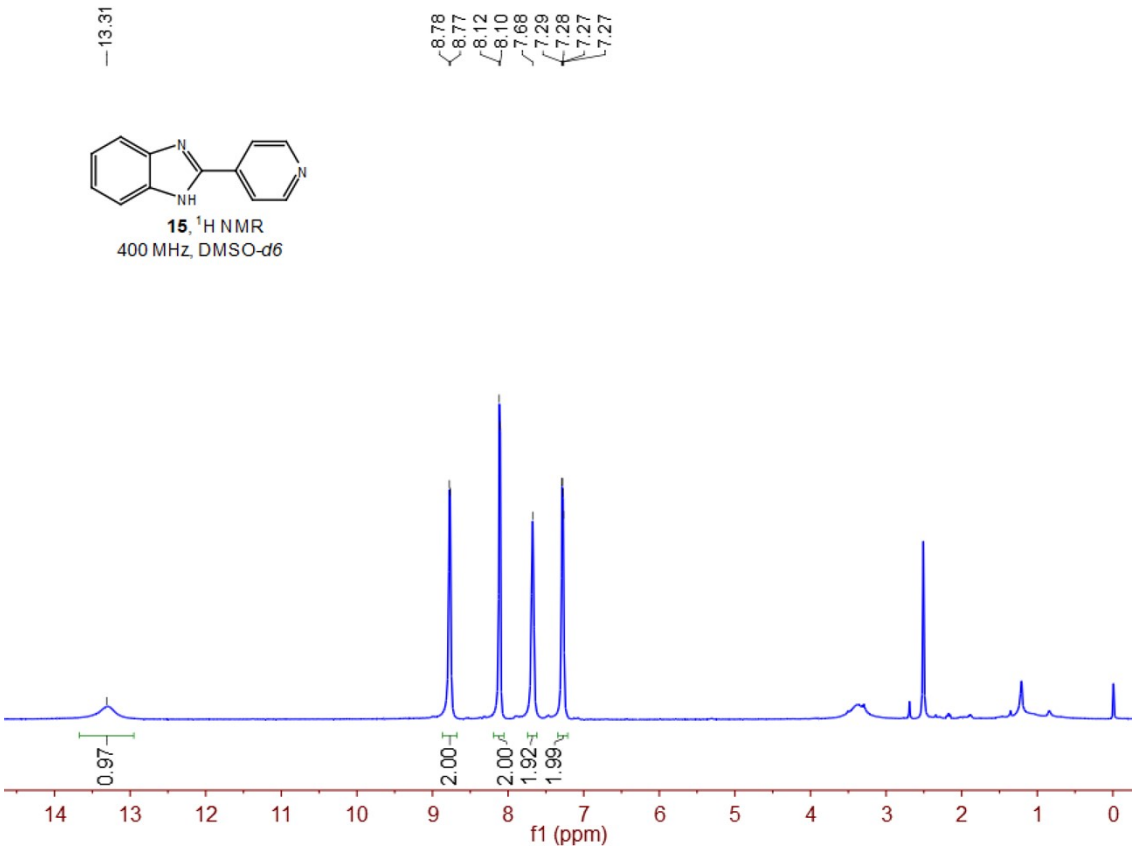
13, ^{19}F NMR
400 MHz, DMSO-*d6*



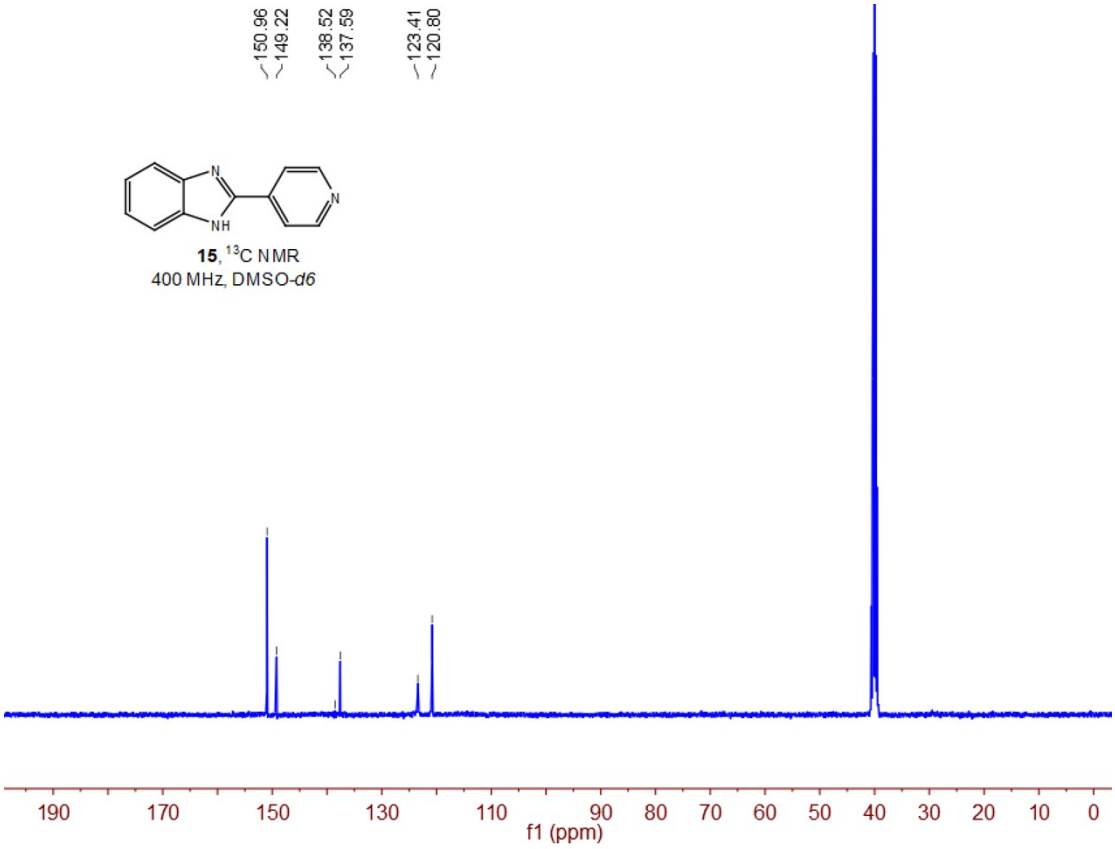
14, ^{1}H NMR
400 MHz, DMSO-*d6*



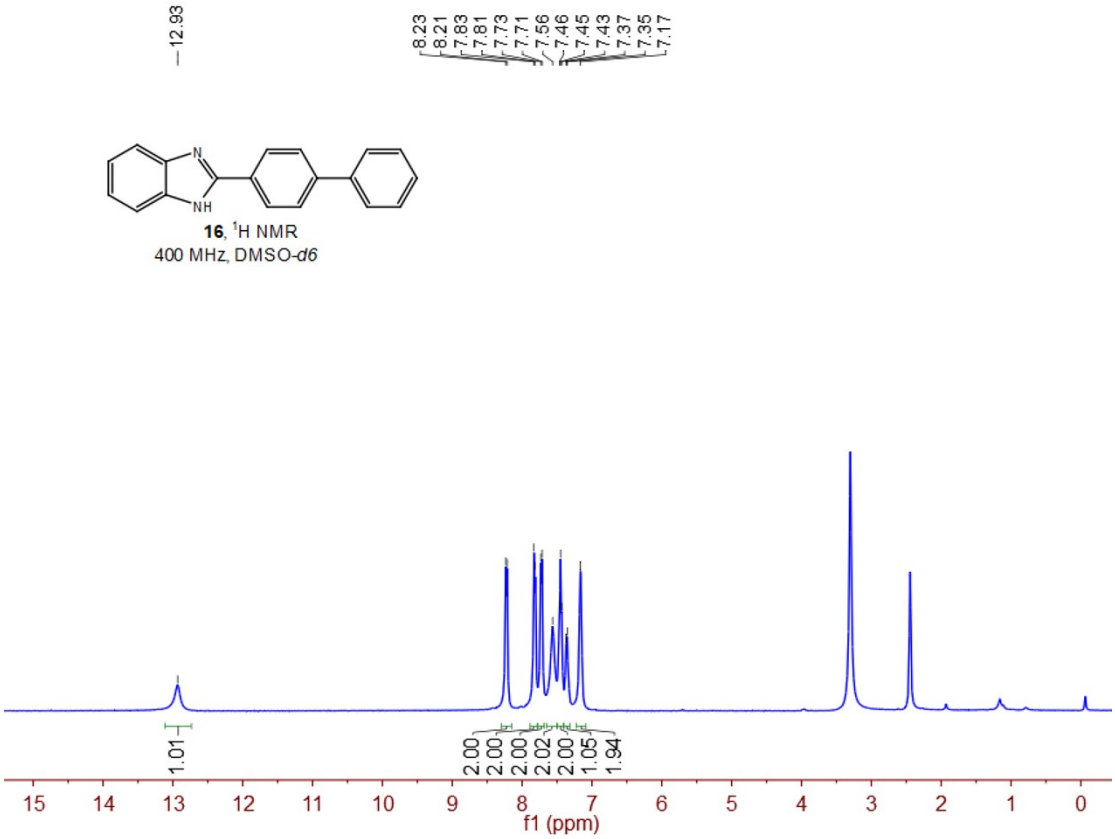
14, ^{13}C NMR
400 MHz, DMSO-*d6*

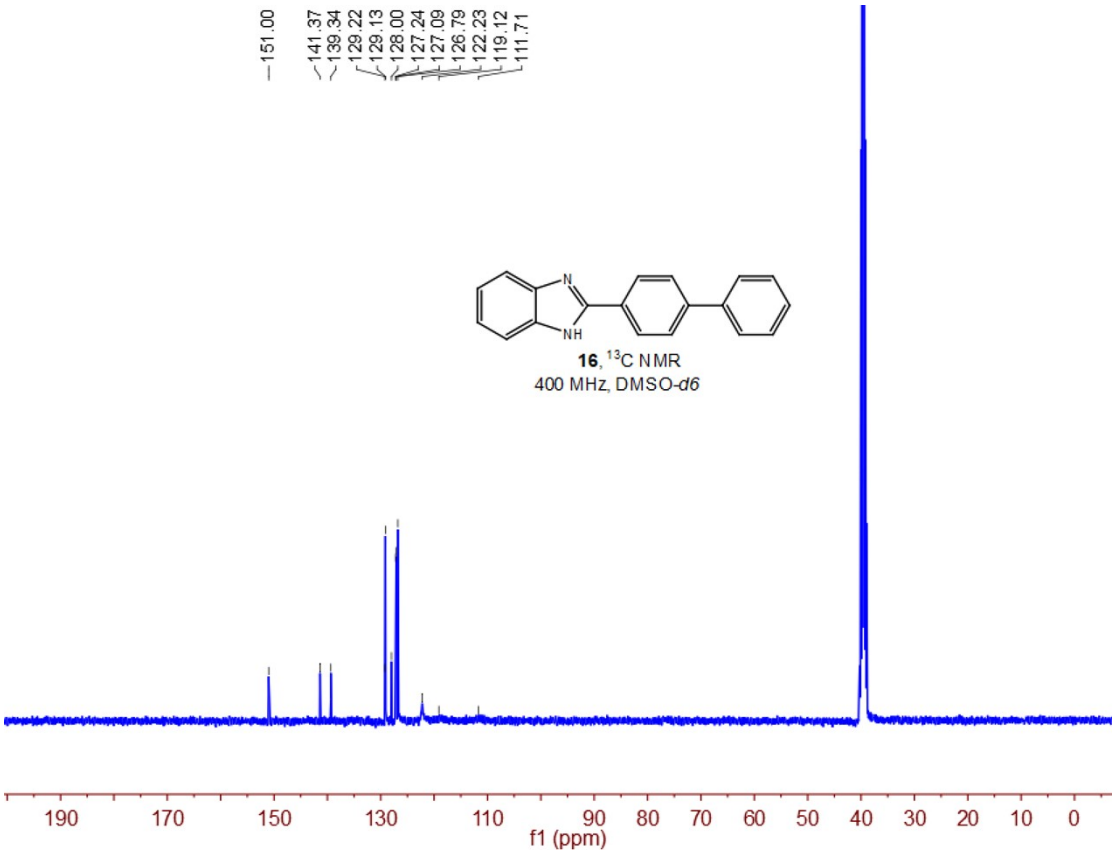


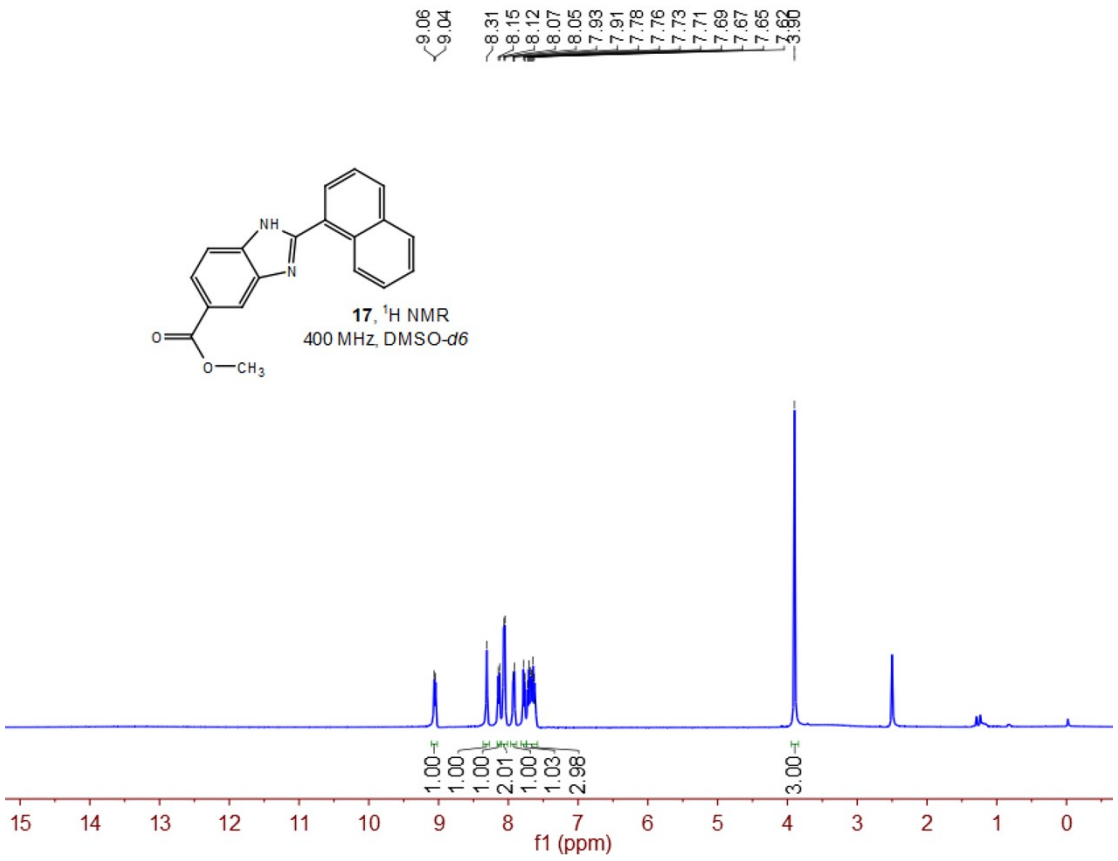
15, ^{1}H NMR
400 MHz, DMSO-*d6*

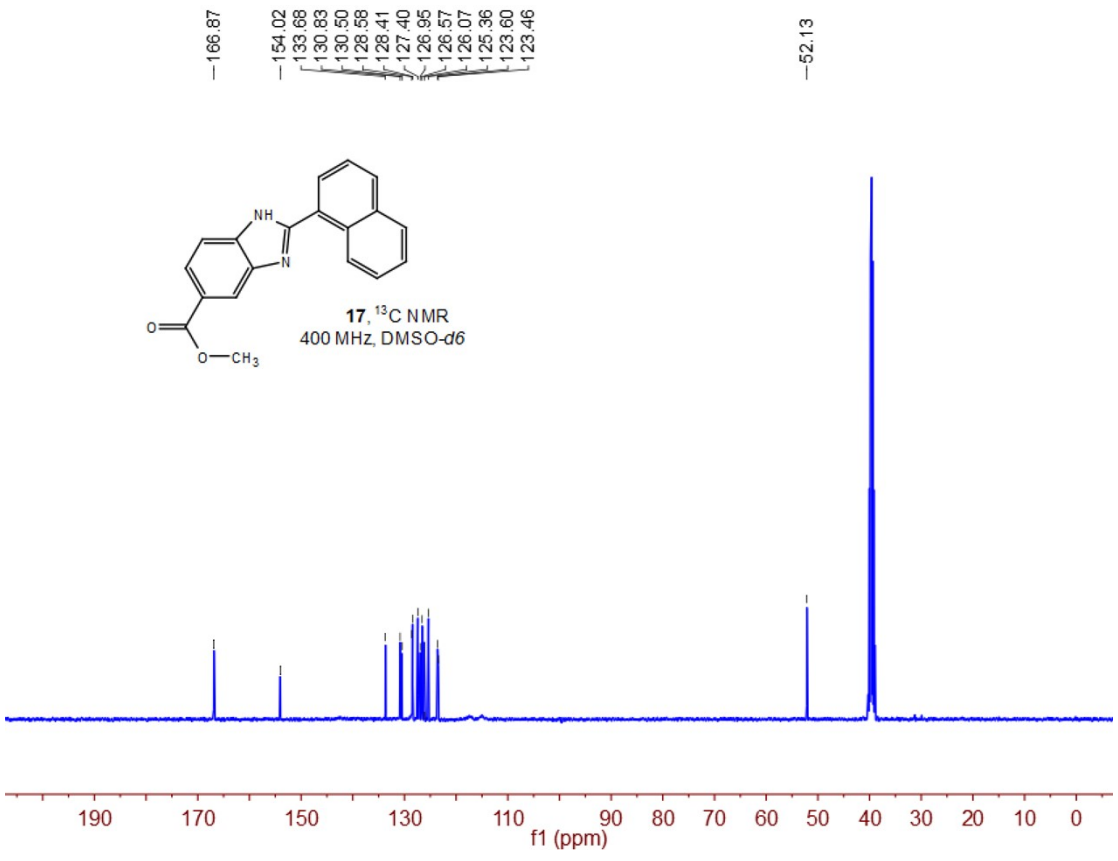


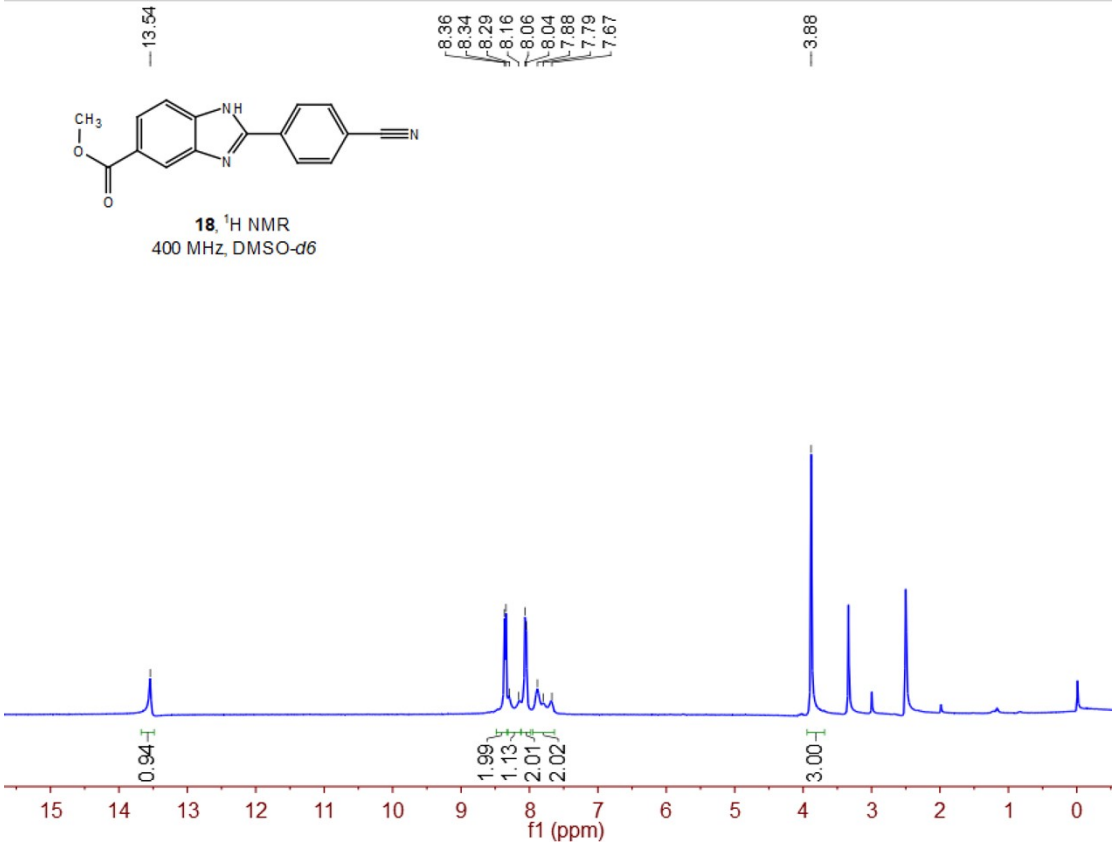
15, ^{13}C NMR
400 MHz, DMSO-*d6*


12.93
8.23
8.21
7.83
7.81
7.73
7.71
7.56
7.46
7.45
7.43
7.37
7.35
7.17
N
NH
16, 1H NMR
400 MHz, DMSO-d6
1.01
2.00
2.00
2.02
2.00
1.05
1.94
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

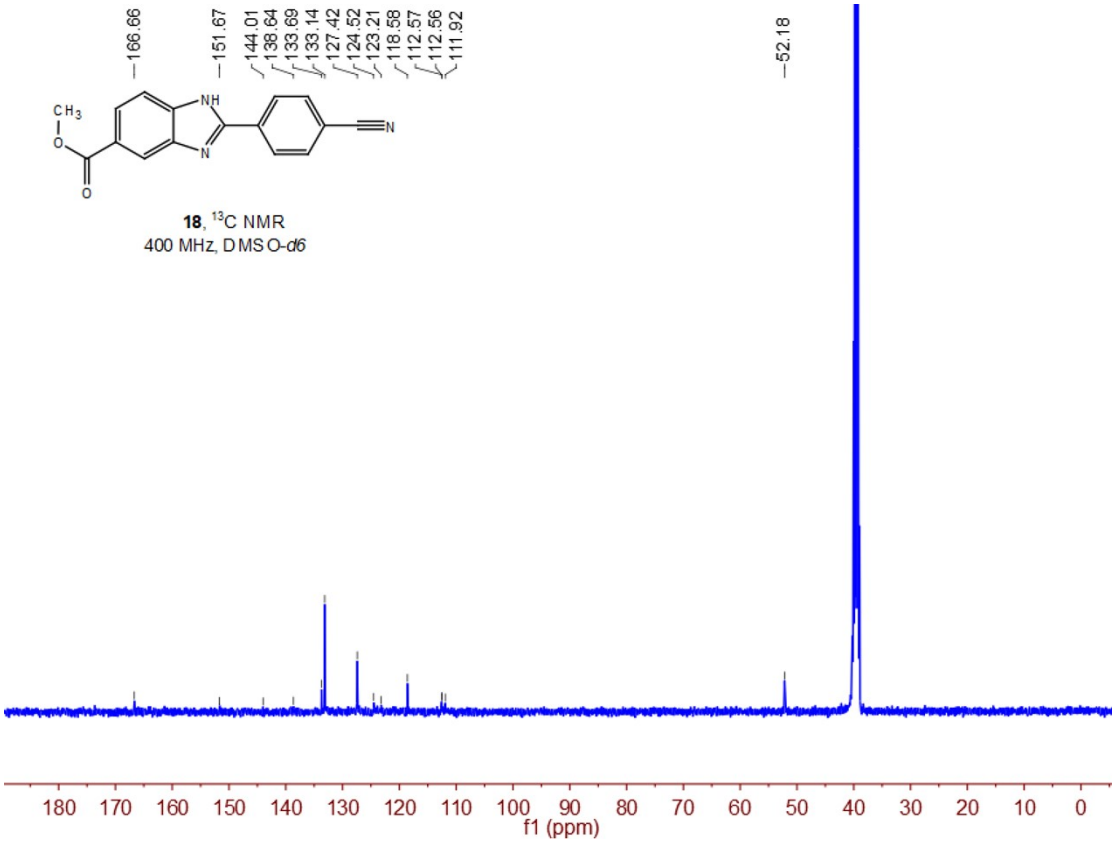

151.00
141.37
139.34
129.22
129.13
128.00
127.24
127.09
126.79
122.23
119.12
111.71
N
NH
16, 13C NMR
400 MHz, DMSO-d6
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


9.06
9.04
8.31
8.15
8.12
8.07
8.05
7.93
7.91
7.78
7.76
7.73
7.71
7.69
7.67
7.65
7.62
7.60
3.90
NH
N
O
O—CH3
17, 1H NMR
400 MHz, DMSO-d6
1.00
1.00
1.00
2.01
1.00
1.03
2.98
3.00
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

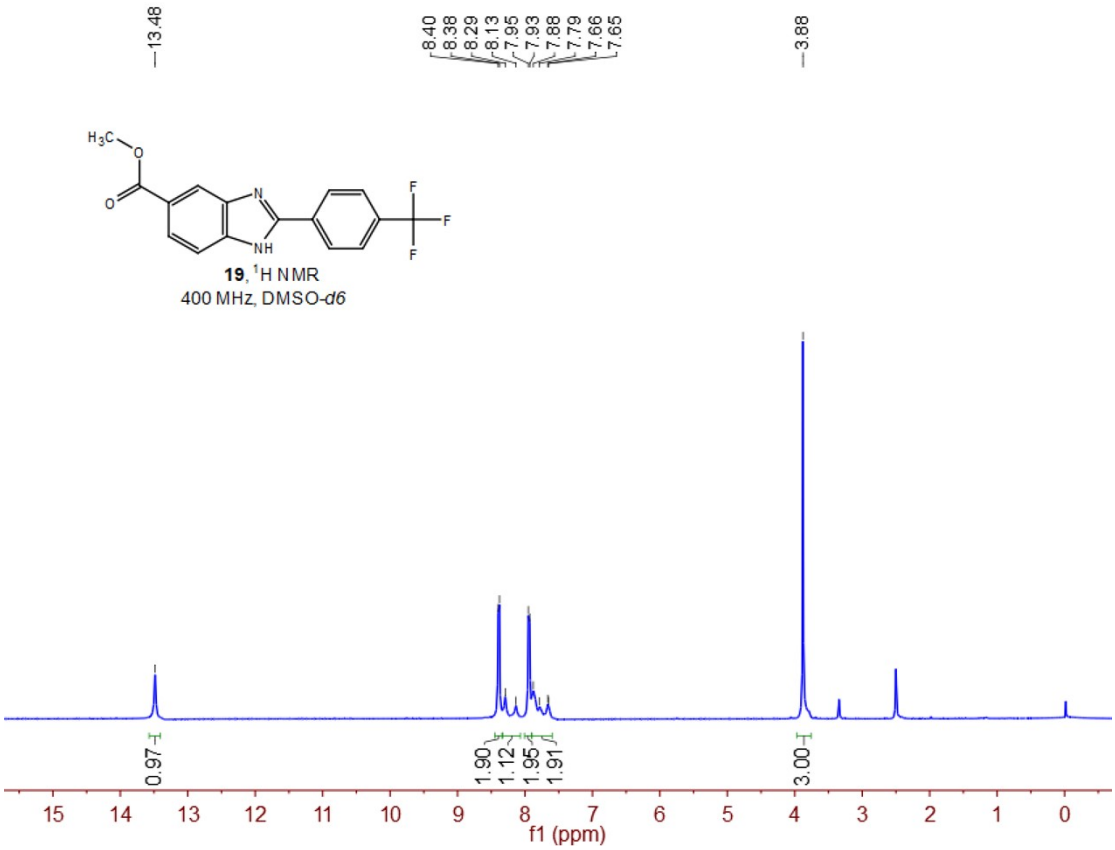

166.87
154.02
133.68
130.83
130.50
128.58
128.41
127.40
126.95
126.57
126.07
125.36
123.60
123.46
52.13
NH
N
O
O—CH3
17, 13C NMR
400 MHz, DMSO-d6
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

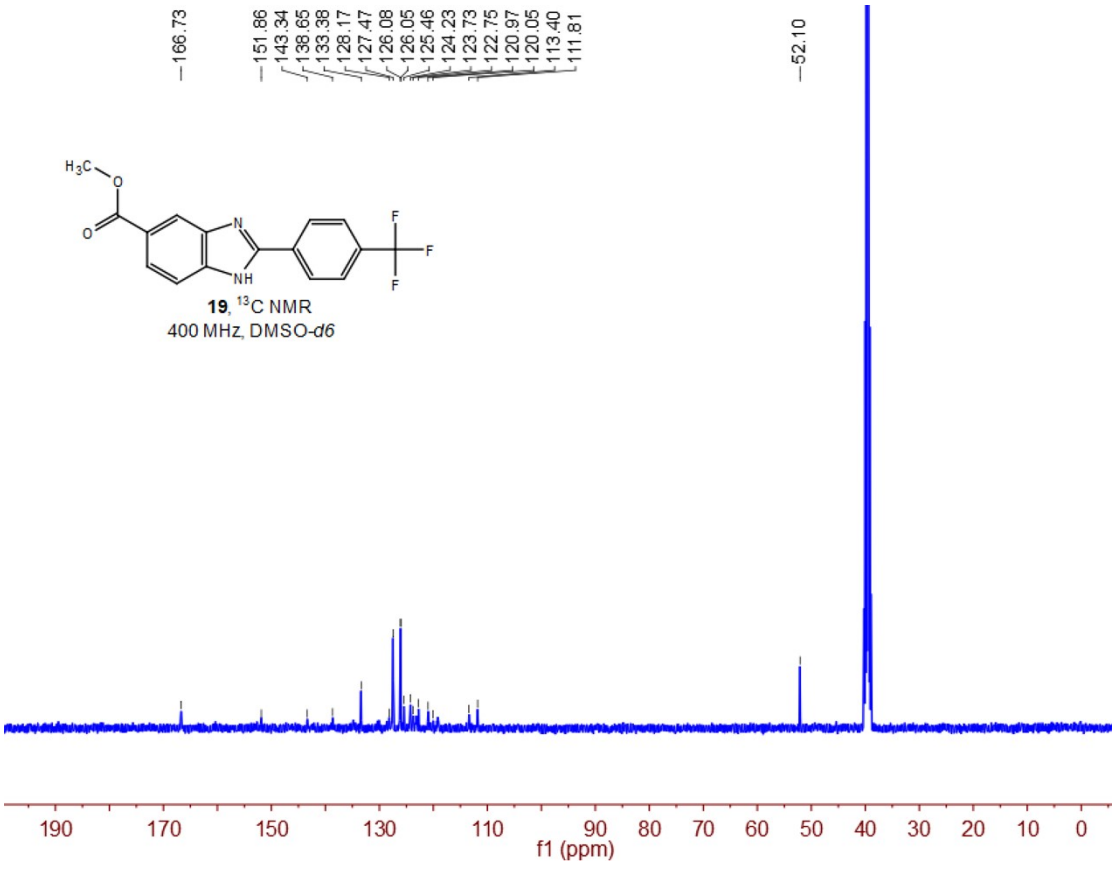


18, ^{1}H NMR
400 MHz, DMSO-*d6*

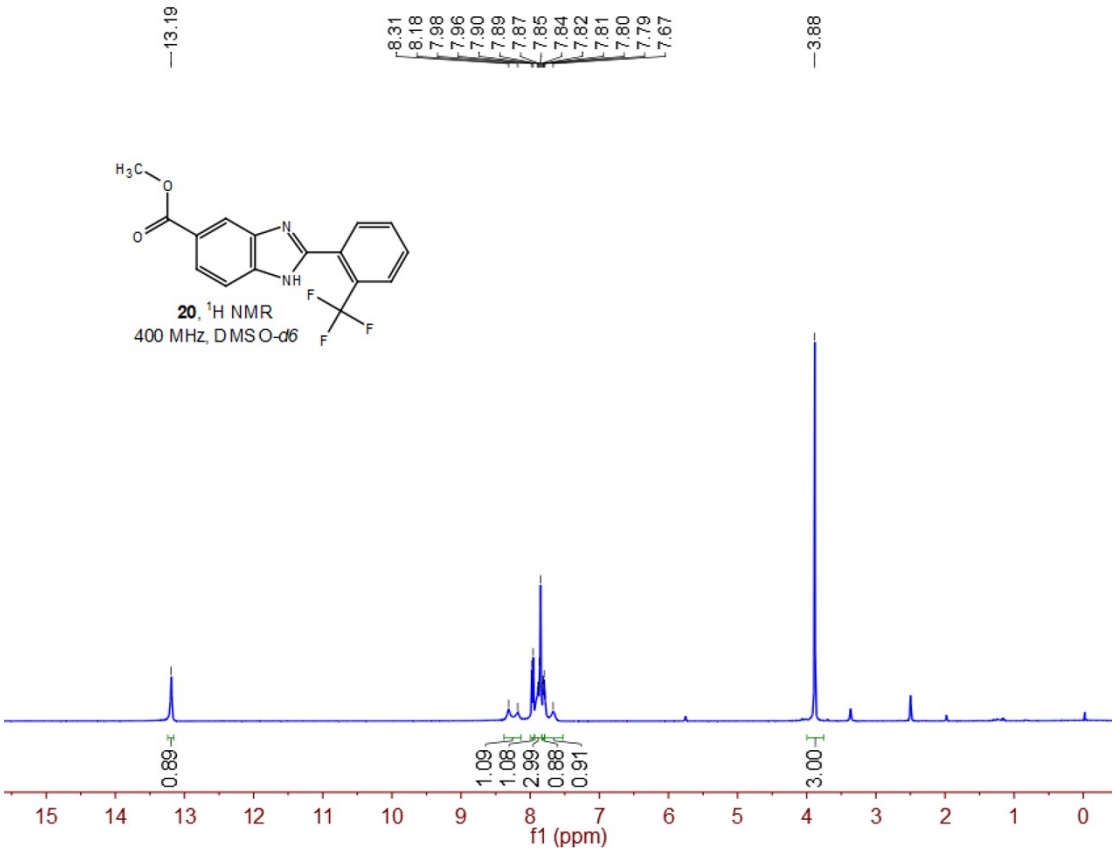


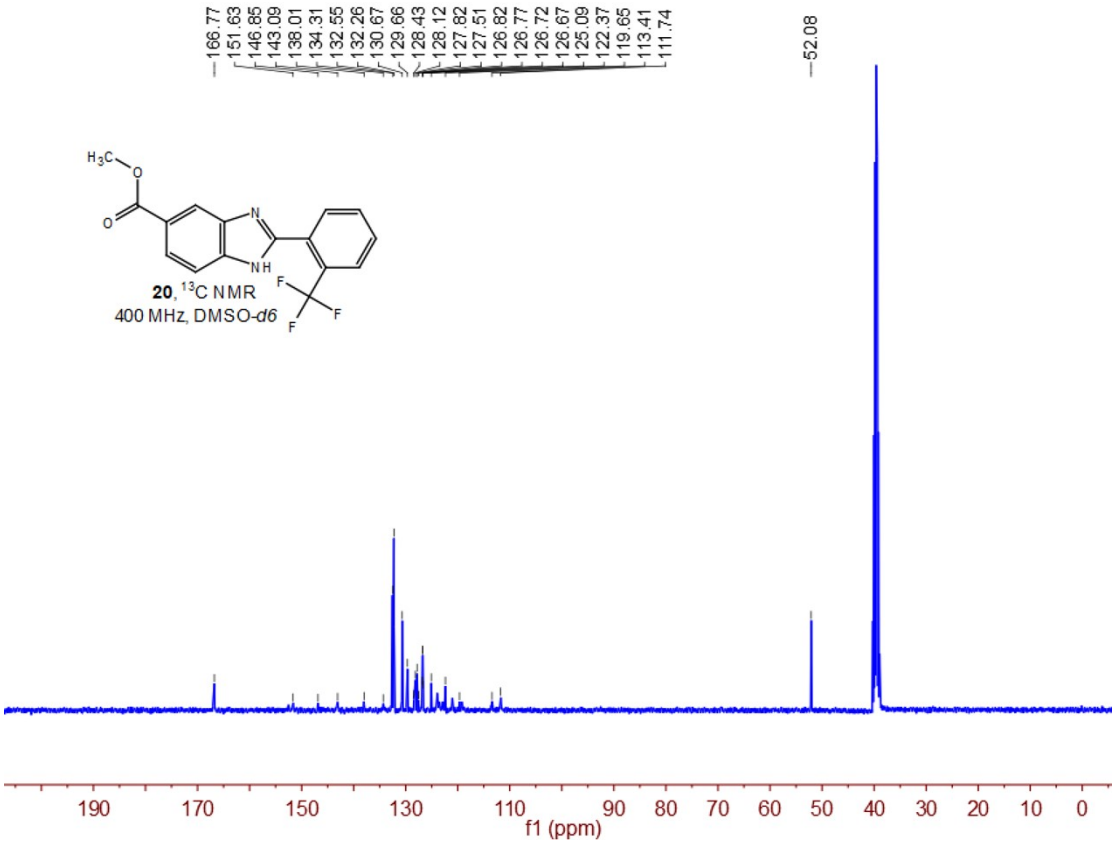
18, ^{13}C NMR
400 MHz, DMSO-*d6*

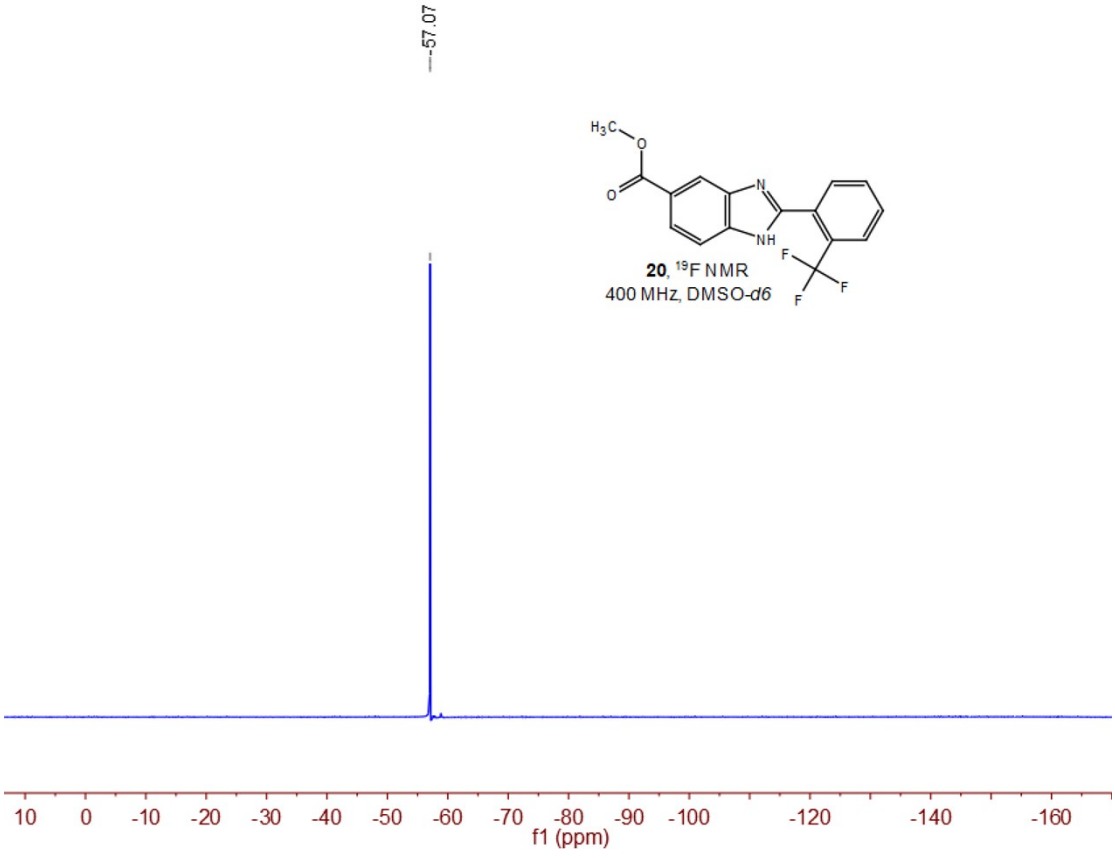

13.48
8.40
8.38
8.29
8.13
7.95
7.93
7.88
7.79
7.66
7.65
3.88
H3C
O
O
N
NH
F
F
F
19, 1H NMR
400 MHz, DMSO-d6
0.97
1.90
1.12
1.95
1.91
3.00
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

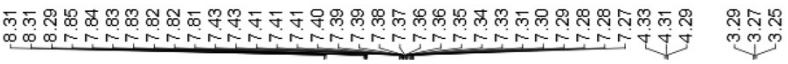

166.73
151.86
143.34
138.65
133.38
128.17
127.47
126.08
126.05
125.46
124.23
123.73
122.75
120.97
120.05
113.40
111.81
52.10
H3C
O
O
N
NH
F
F
F
19, 13C NMR
400 MHz, DMSO-d6
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

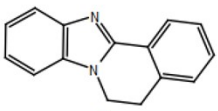

-61.32
19, 19F NMR
400 MHz, DMSO-d6
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160
f1 (ppm)


-13.19
8.31
8.18
7.98
7.96
7.90
7.89
7.87
7.85
7.84
7.82
7.81
7.80
7.79
7.67
-3.88
20, 1H NMR
400 MHz, DMSO-d6
0.89
1.09
1.08
2.99
0.88
0.91
3.00
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

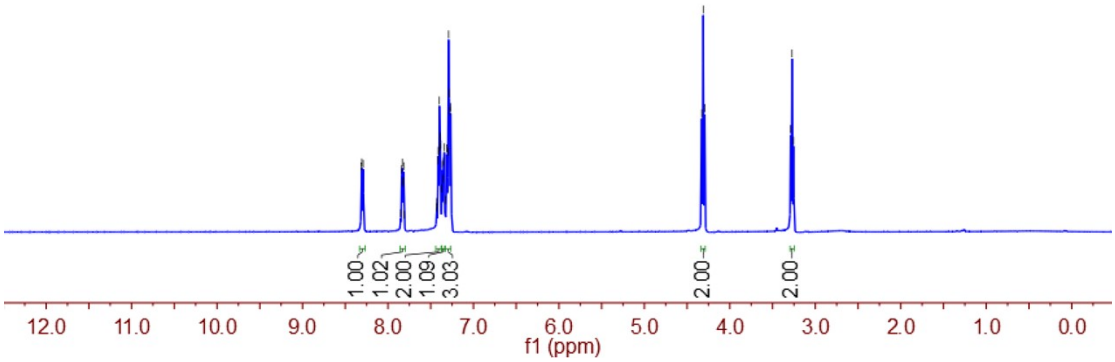

166.77
151.63
146.85
143.09
138.01
134.31
132.55
132.26
130.67
129.66
128.43
128.12
127.82
127.51
126.82
126.77
126.72
126.67
125.09
122.37
119.65
113.41
111.74
52.08
20, 13C NMR
400 MHz, DMSO-d6
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

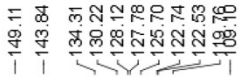

-57.07
20, 19F NMR
400 MHz, DMSO-d6
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
f1 (ppm)

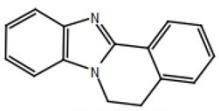




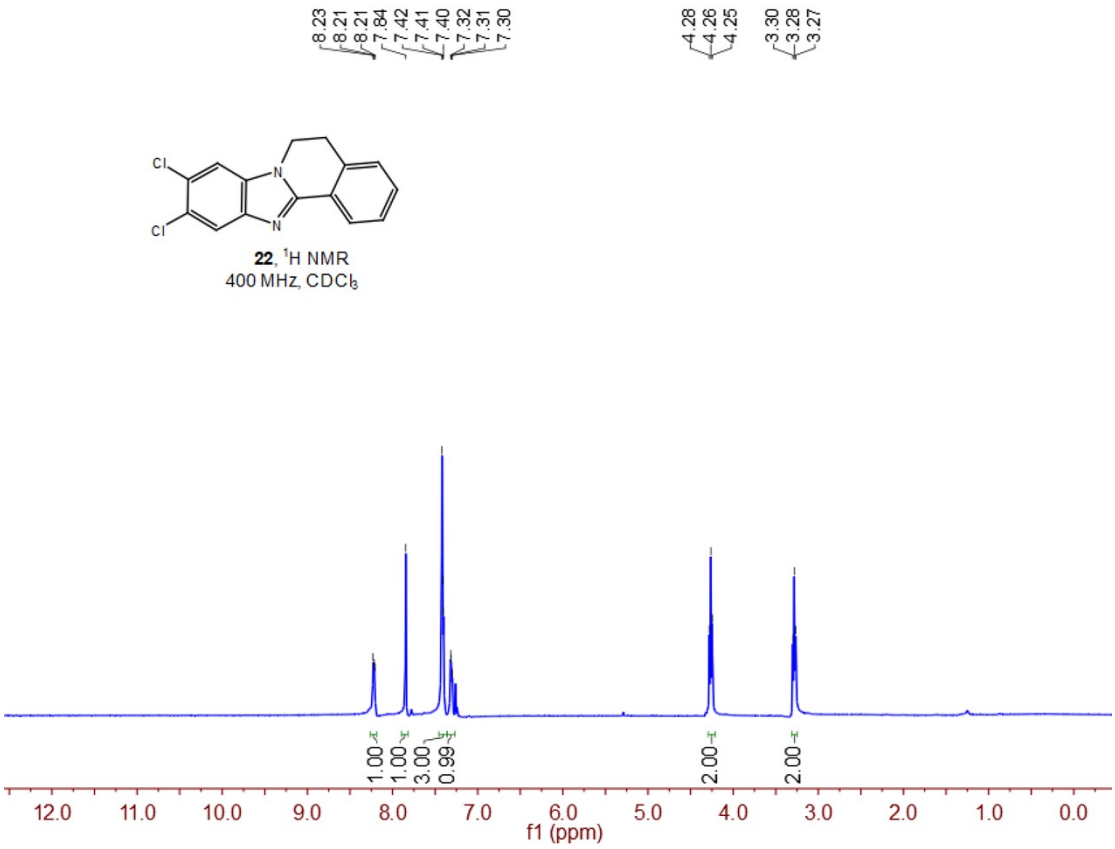
21, ^{1}H NMR
400 MHz, $CDCl_3$



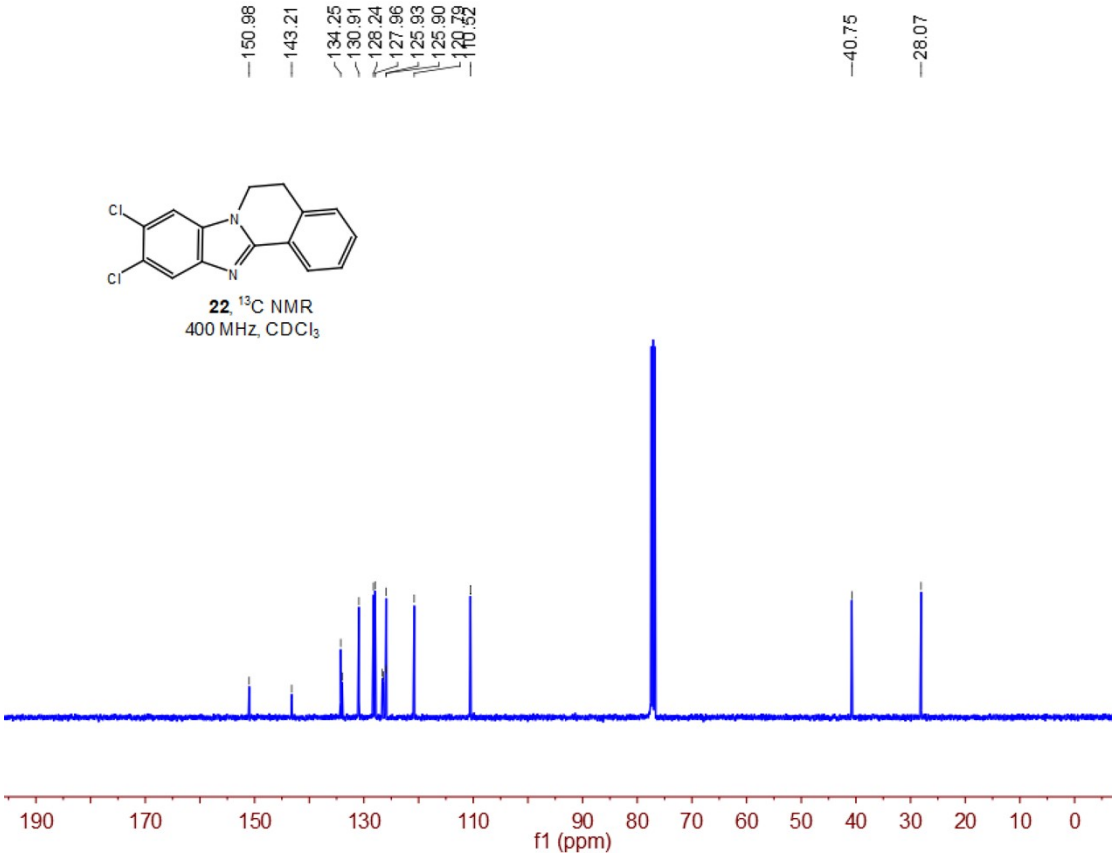




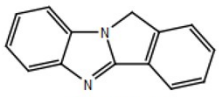
21, ^{13}C NMR
400 MHz, $CDCl_3$



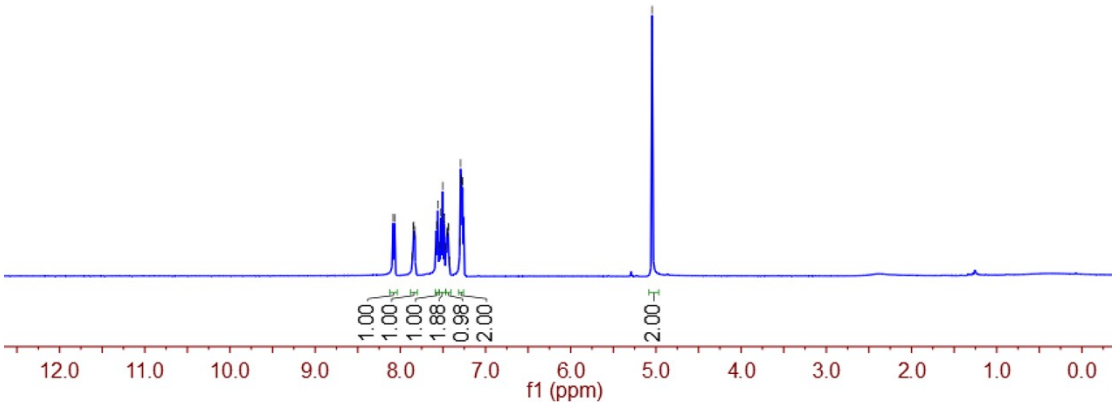
22, ^{1}H NMR
400 MHz, $CDCl_3$

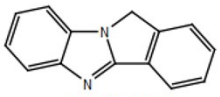


22, ^{13}C NMR
400 MHz, $CDCl_3$

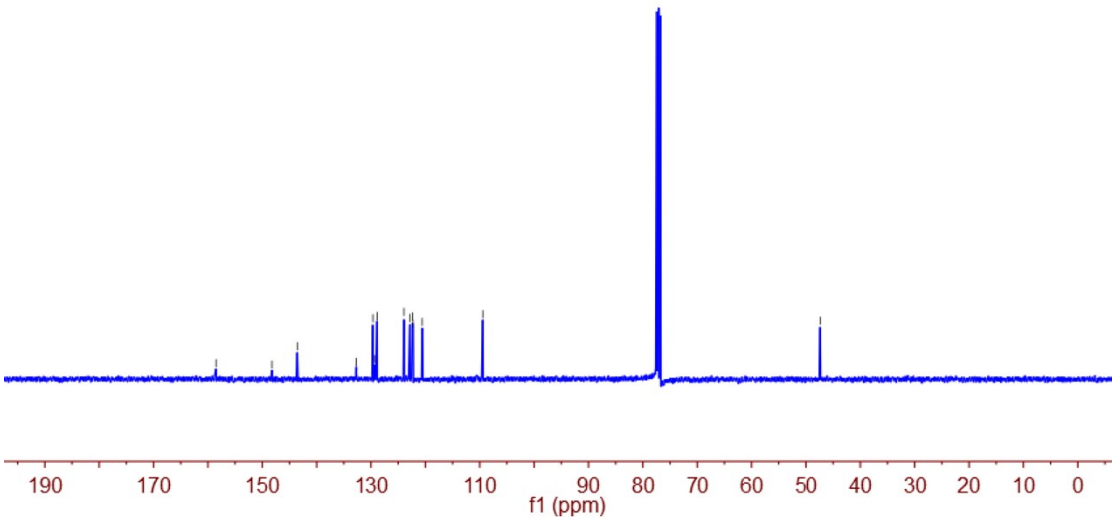


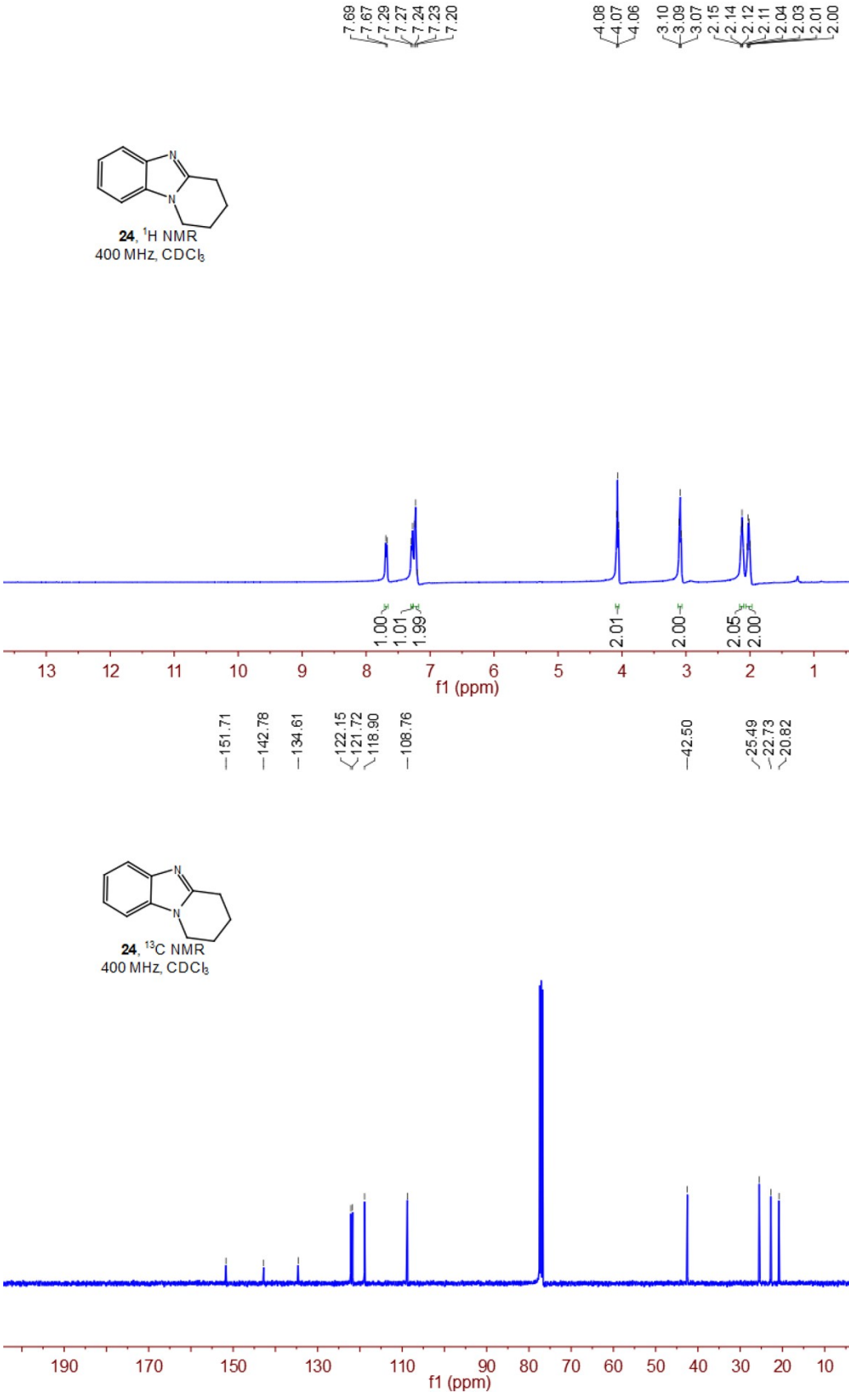
23, ^{1}H NMR
400 MHz, $CDCl_3$

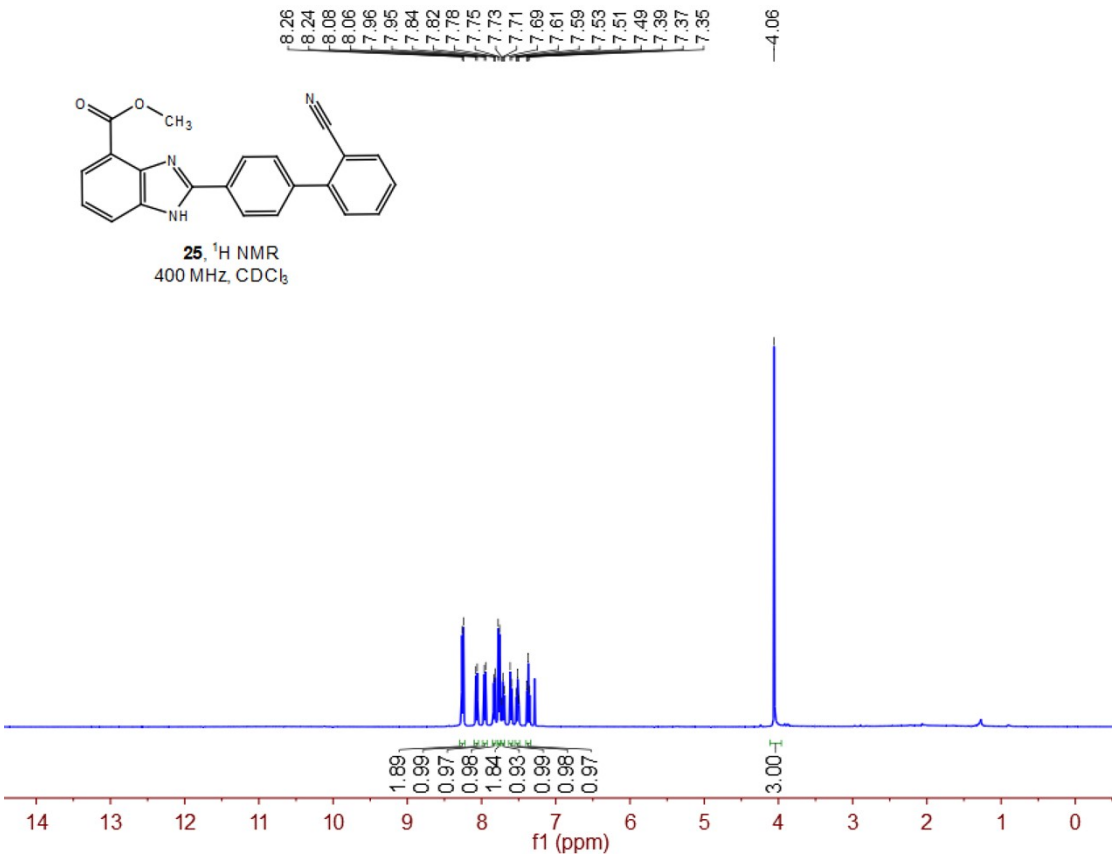




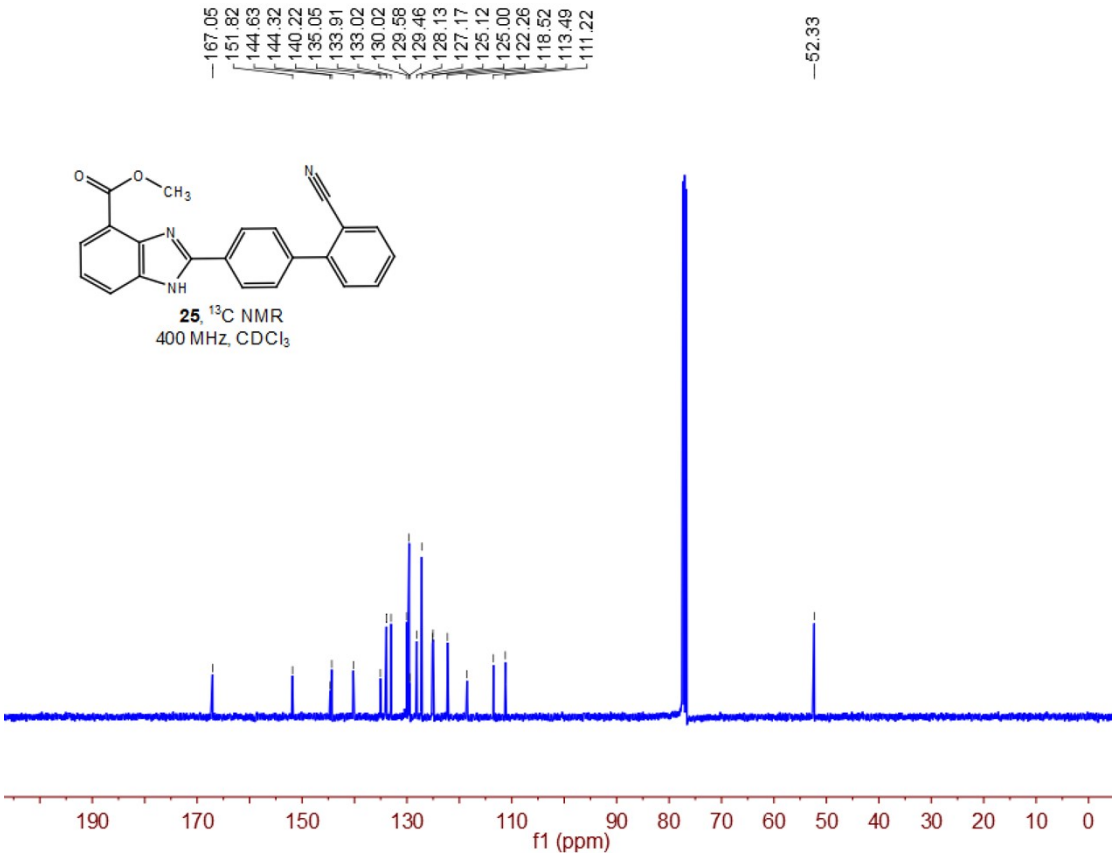
23, ^{13}C NMR
400 MHz, $CDCl_3$



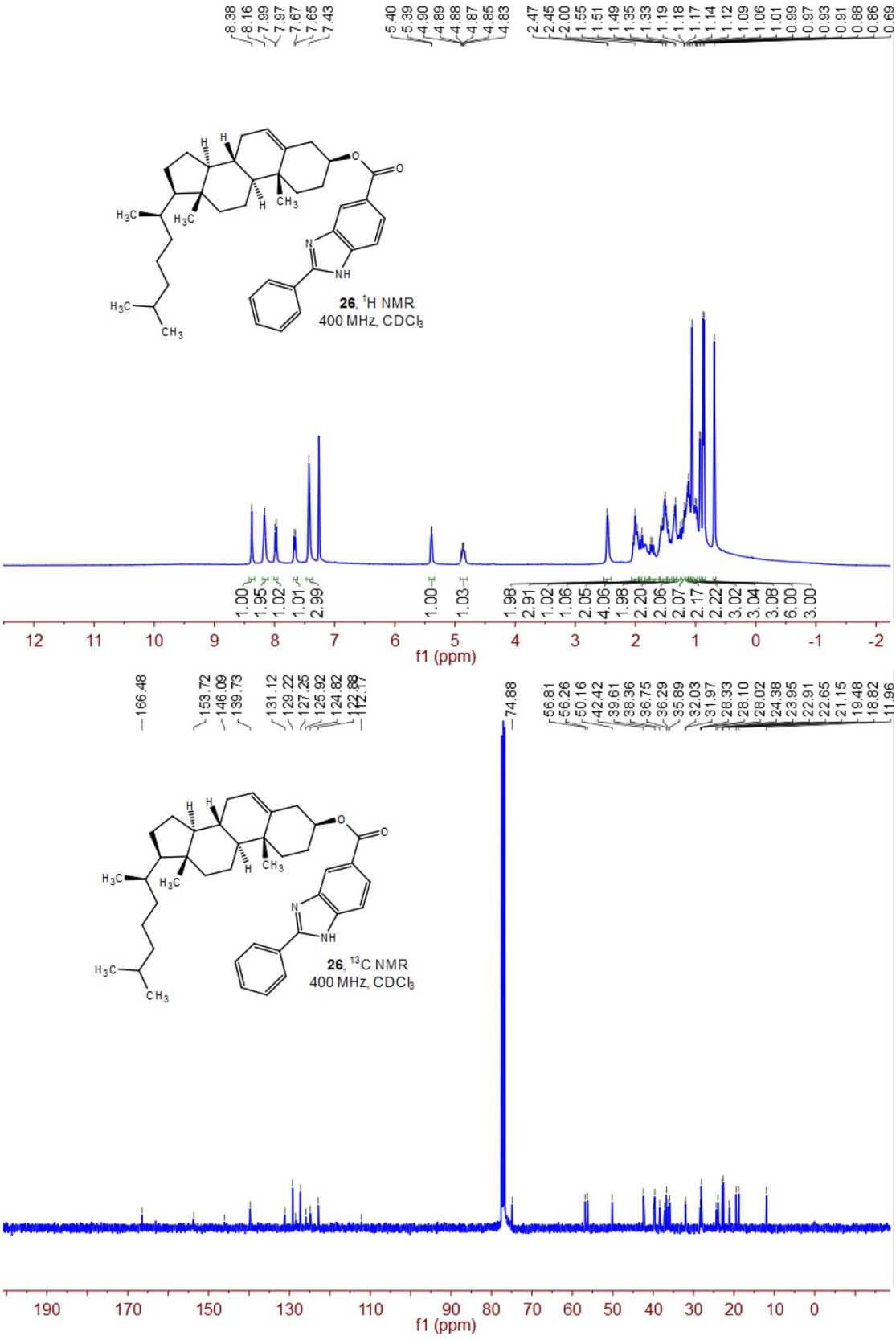

7.69
7.67
7.29
7.27
7.24
7.23
7.20
4.08
4.07
4.06
3.10
3.09
3.07
2.15
2.14
2.12
2.11
2.04
2.03
2.01
2.00
24, 1H NMR
400 MHz, CDCl3
1.00
1.01
1.99
2.01
2.00
2.05
2.00
13
12
11
10
9
8
7
6
5
4
3
2
1
0
f1 (ppm)
151.71
142.78
134.61
122.15
121.72
118.90
108.76
42.50
25.49
22.73
20.82
24, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

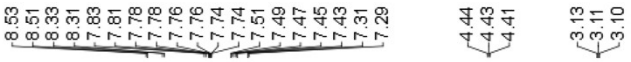


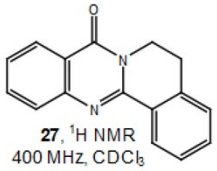
25, ^{1}H NMR
400 MHz, $CDCl_3$



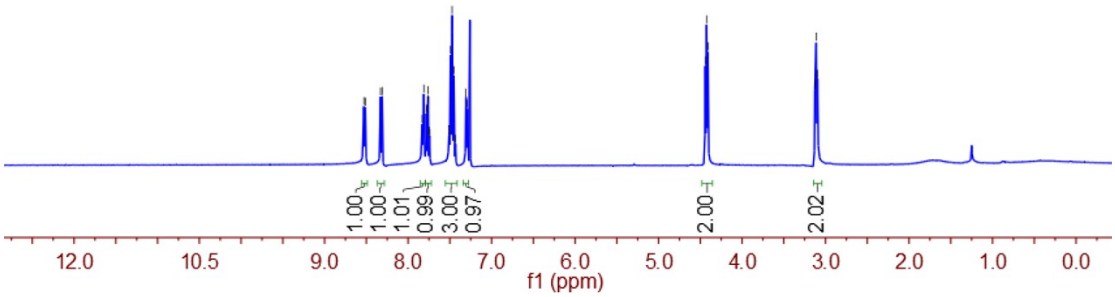
25, ^{13}C NMR
400 MHz, $CDCl_3$

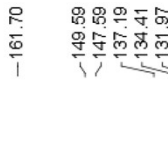

8.38
8.16
7.99
7.97
7.67
7.65
7.43
5.40
5.39
4.90
4.89
4.88
4.87
4.85
4.83
2.47
2.45
2.00
1.55
1.51
1.49
1.35
1.33
1.19
1.18
1.17
1.14
1.12
1.09
1.06
1.01
0.99
0.97
0.93
0.91
0.88
0.86
0.69
26, 1H NMR
400 MHz, CDCl3
1.00
1.95
1.02
1.01
2.99
1.00
1.03
1.98
2.91
1.02
1.06
2.05
4.06
1.98
2.20
2.06
2.07
2.17
2.22
3.02
3.04
3.08
6.00
3.00
f1 (ppm)
166.48
153.72
146.09
139.73
131.12
129.22
127.25
125.92
124.82
74.88
56.81
56.26
50.16
42.42
39.61
38.36
36.75
36.29
35.89
32.03
31.97
28.33
28.10
28.02
24.38
23.95
22.91
22.65
21.15
19.48
18.82
11.96
26, 13C NMR
400 MHz, CDCl3
f1 (ppm)



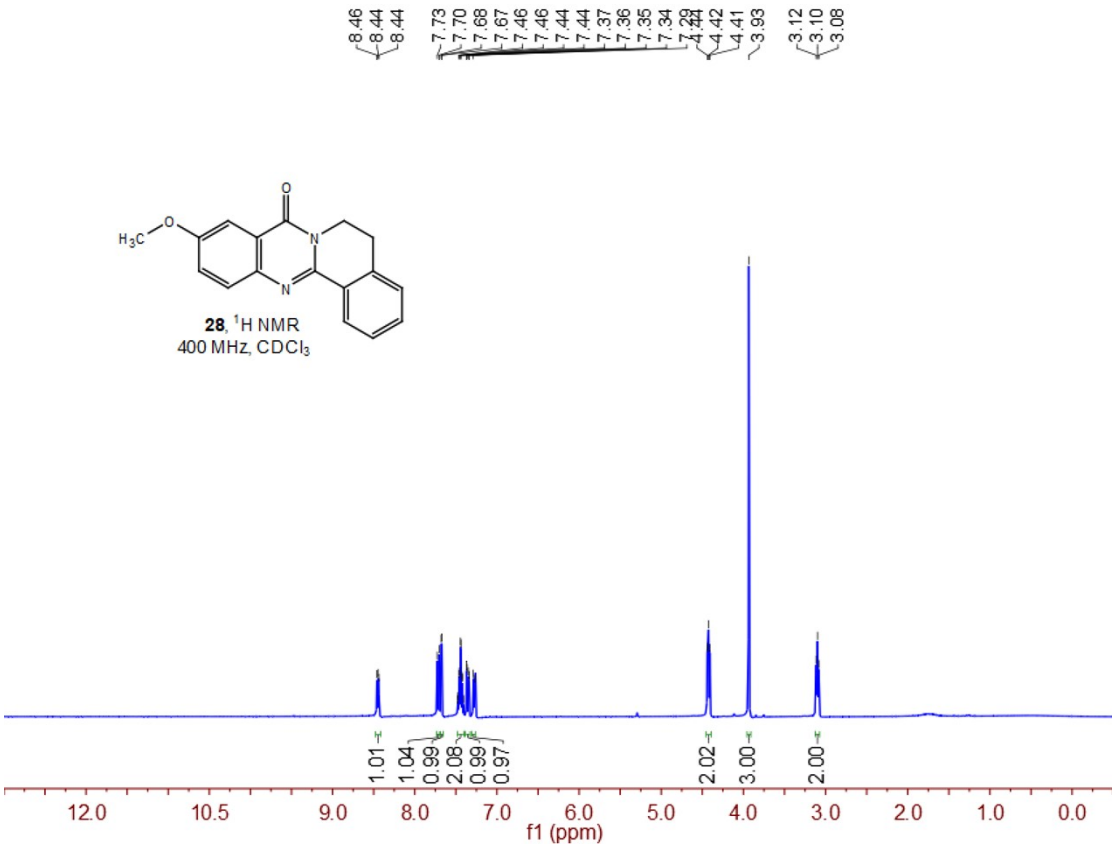


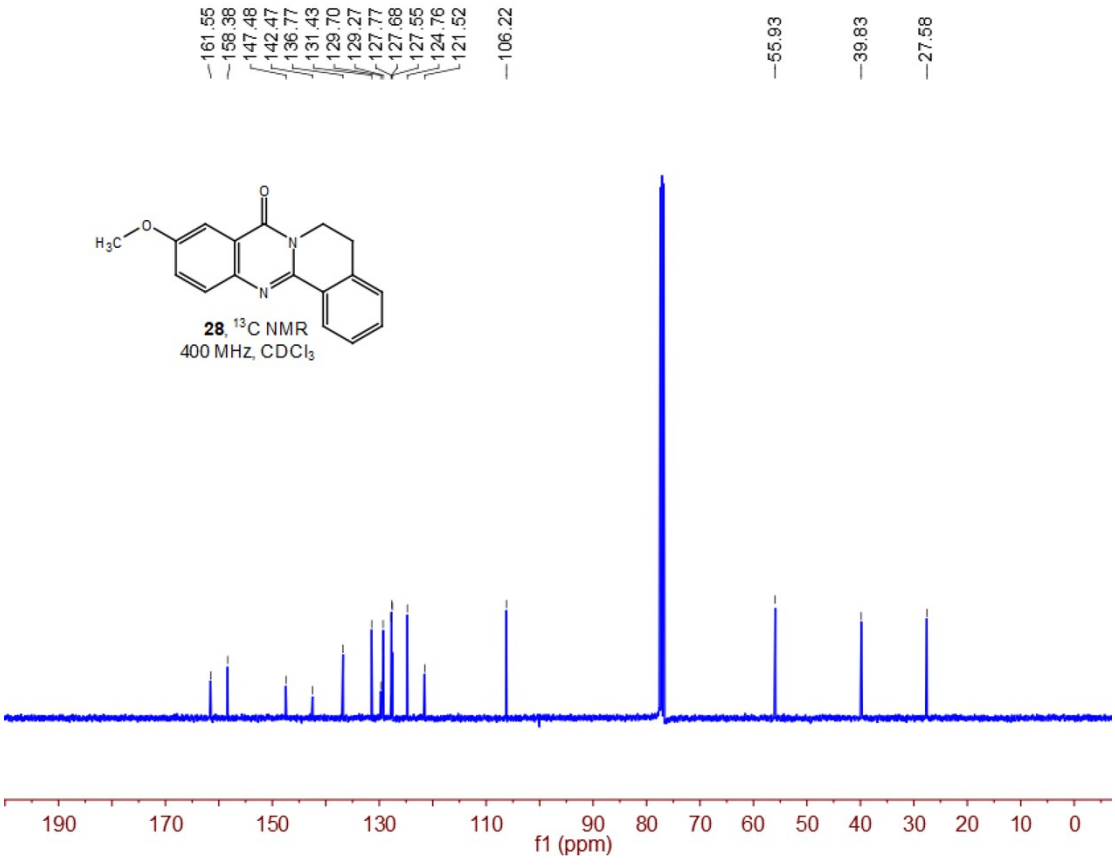
27, ^{1}H NMR
400 MHz, $CDCl_3$

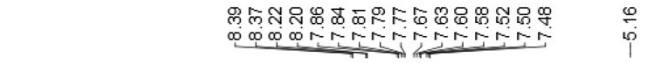


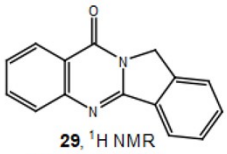


27, ^{13}C NMR
400 MHz, $CDCl_3$

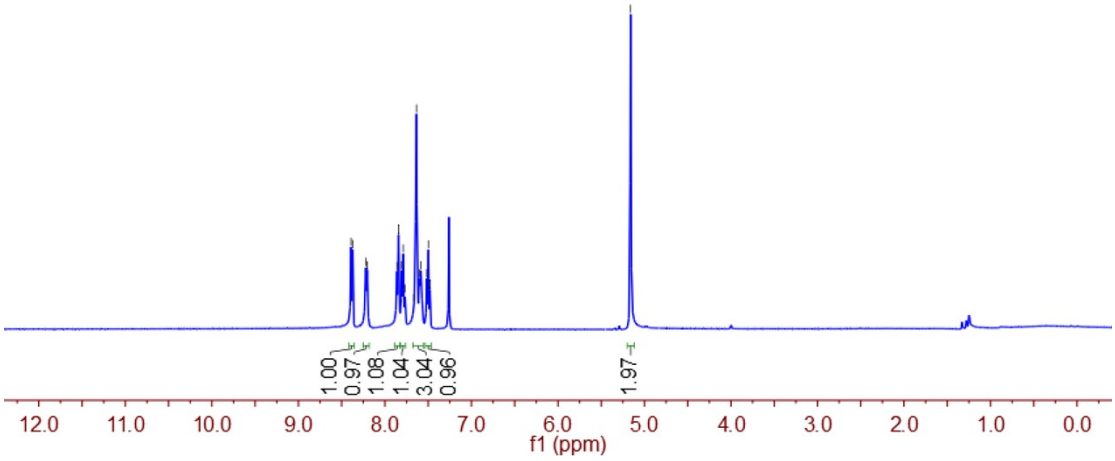

8.46
8.44
8.44
7.73
7.70
7.68
7.67
7.46
7.46
7.44
7.44
7.37
7.36
7.35
7.34
4.42
4.41
3.93
3.12
3.10
3.08
O
H3C
O
N
N
28, 1H NMR
400 MHz, CDCl3
1.01
1.04
0.99
2.08
0.99
0.97
2.02
3.00
2.00
12.0
10.5
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

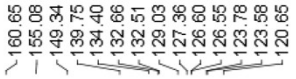

161.55
158.38
147.48
142.47
136.77
131.43
129.70
129.27
127.77
127.68
127.55
124.76
121.52
106.22
55.93
39.83
27.58
O
H3C
O
N
N
28, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

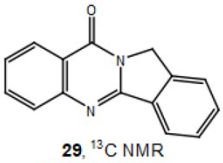




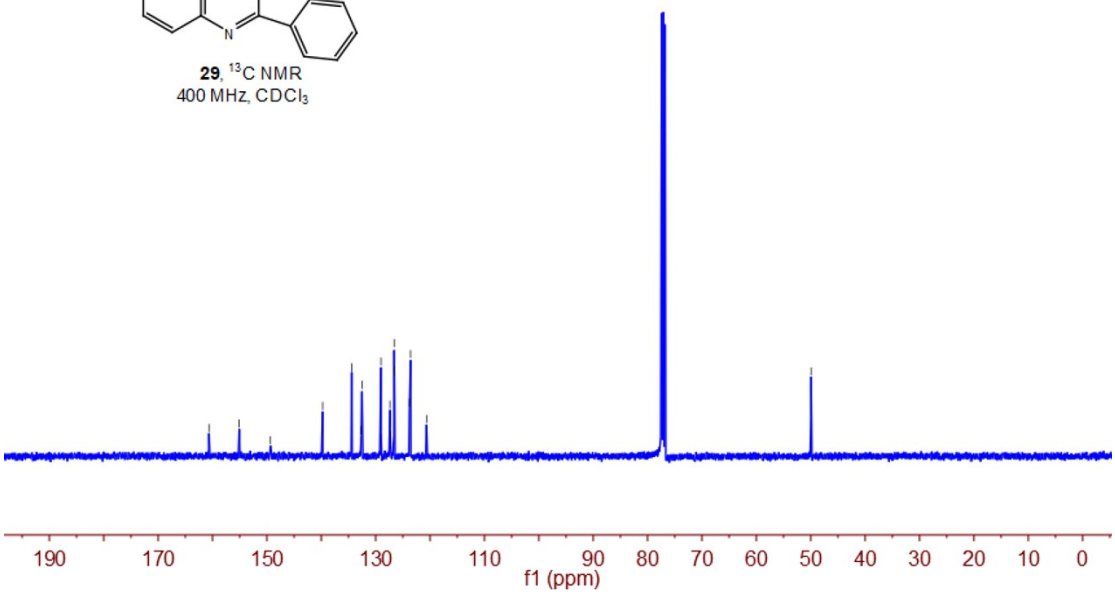
29, ^{1}H NMR
400 MHz, $CDCl_3$

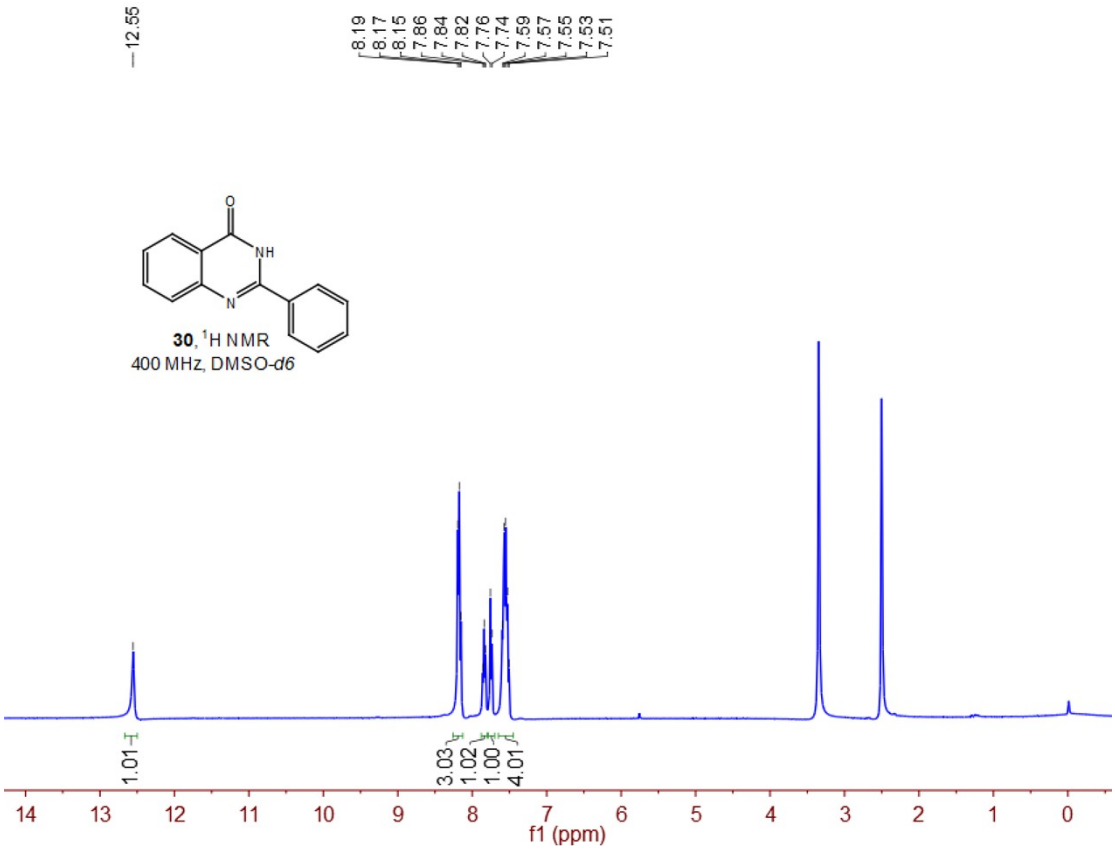


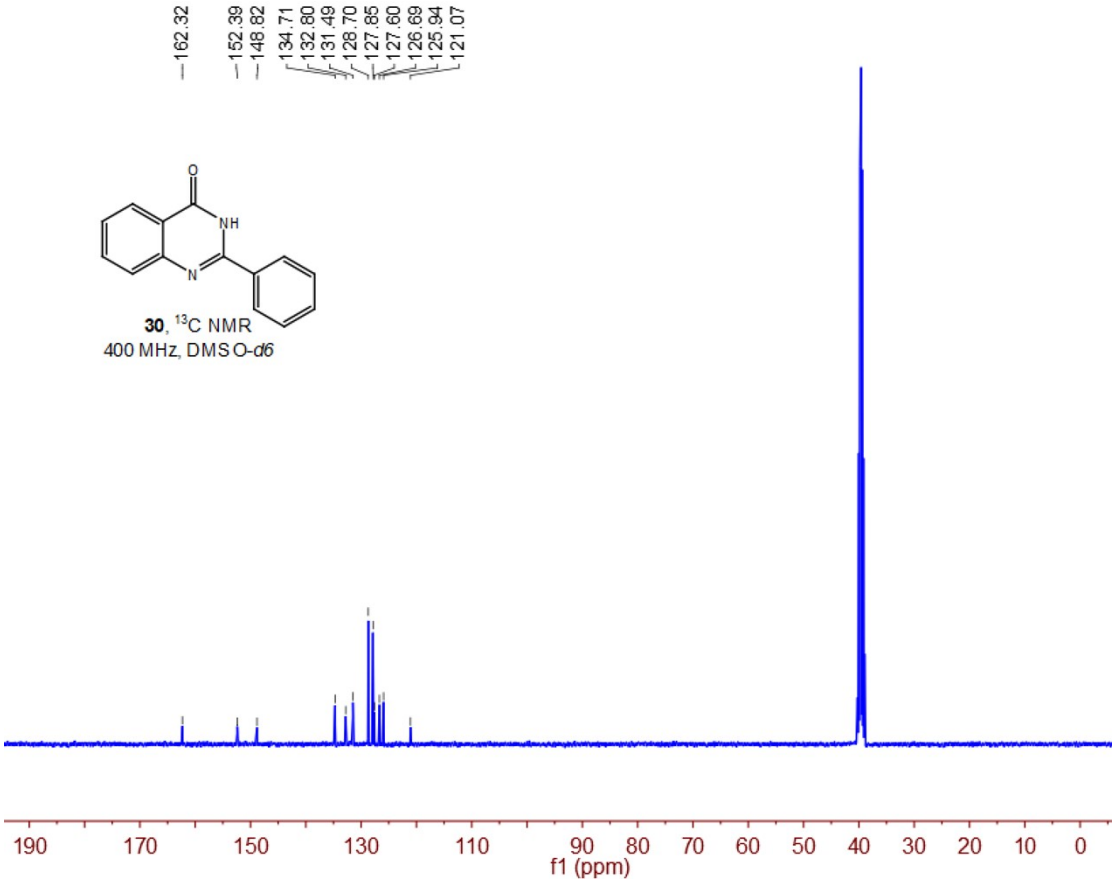


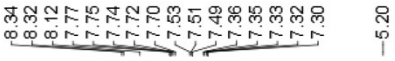


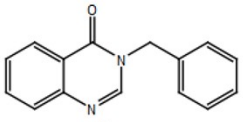
29, ^{13}C NMR
400 MHz, $CDCl_3$



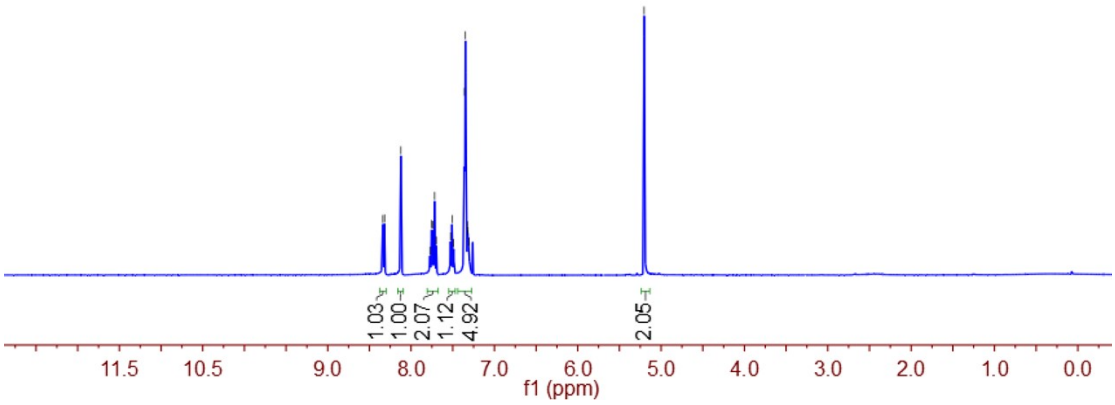

12.55
8.19
8.17
8.15
7.86
7.84
7.82
7.76
7.74
7.59
7.57
7.55
7.53
7.51
O
NH
N
30, 1H NMR
400 MHz, DMSO-d6
1.01
3.03
1.02
1.00
4.01
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
f1 (ppm)

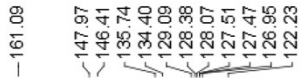

162.32
152.39
148.82
134.71
132.80
131.49
128.70
127.85
127.60
126.69
125.94
121.07
O
NH
N
30, 13C NMR
400 MHz, DMSO-d6
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

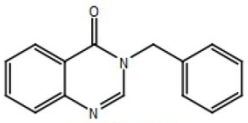




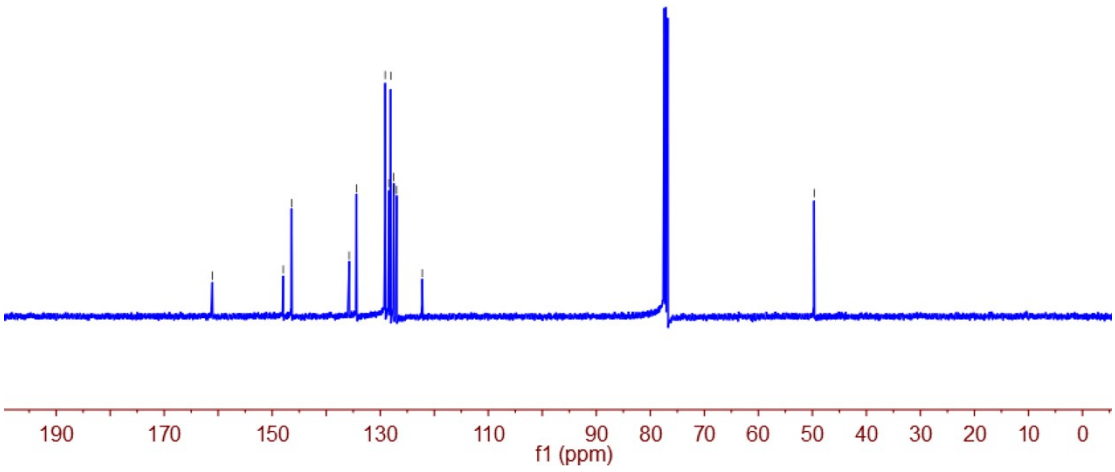
31, ^{1}H NMR
400 MHz, $CDCl_3$

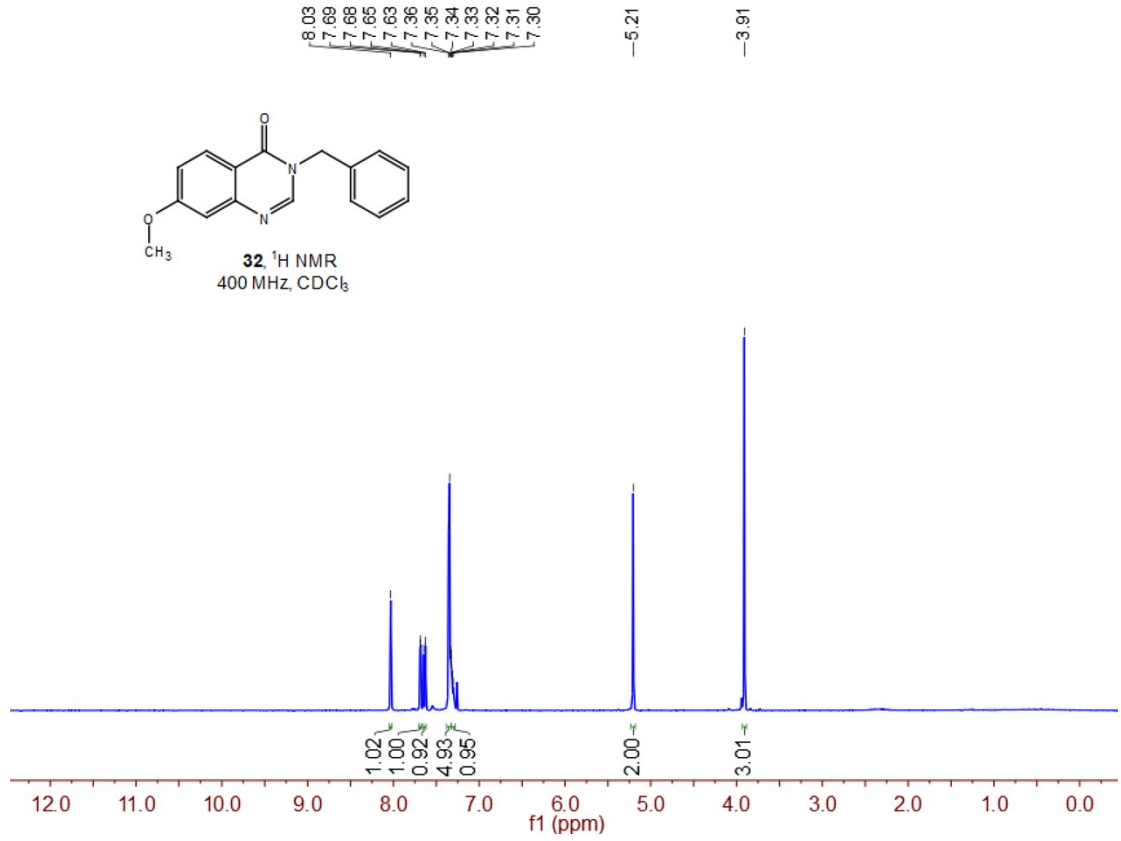


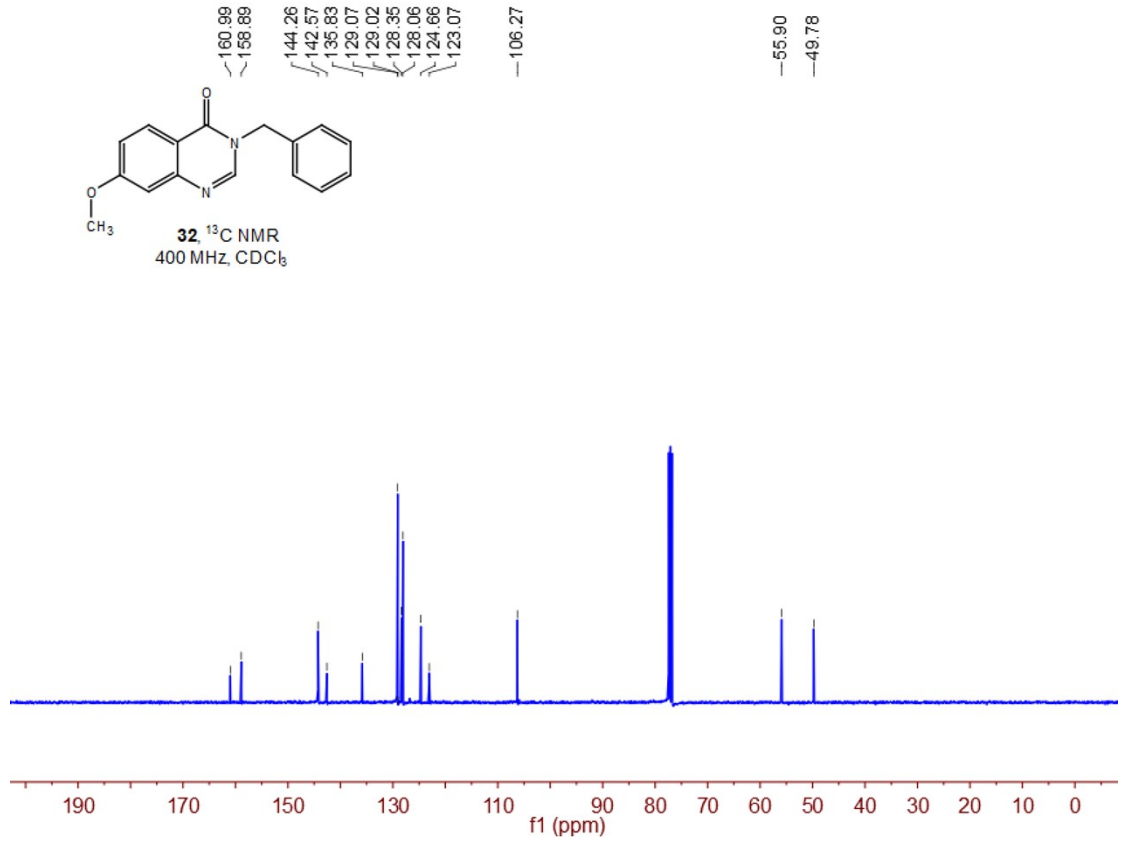


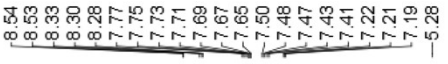


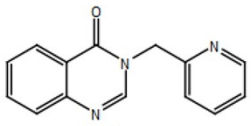
31, ^{13}C NMR
400 MHz, $CDCl_3$



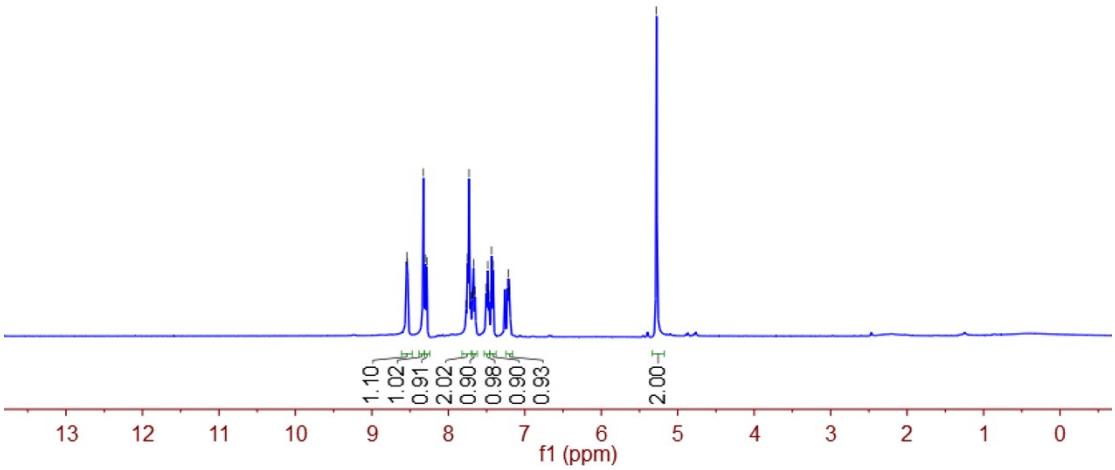

8.03
7.69
7.68
7.65
7.63
7.36
7.35
7.34
7.33
7.32
7.31
7.30
5.21
3.91
O
N
N
O
CH3
32, 1H NMR
400 MHz, CDCl3
1.02
1.00
0.92
4.93
0.95
2.00
3.01
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

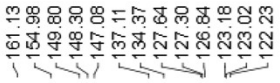

160.99
158.89
144.26
142.57
135.83
129.07
129.02
128.35
128.06
124.66
123.07
106.27
55.90
49.78
O
N
N
O
CH3
32, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

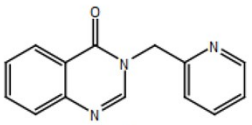




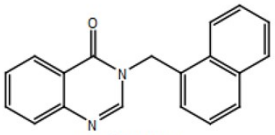
33, ^{1}H NMR
400 MHz, $CDCl_3$



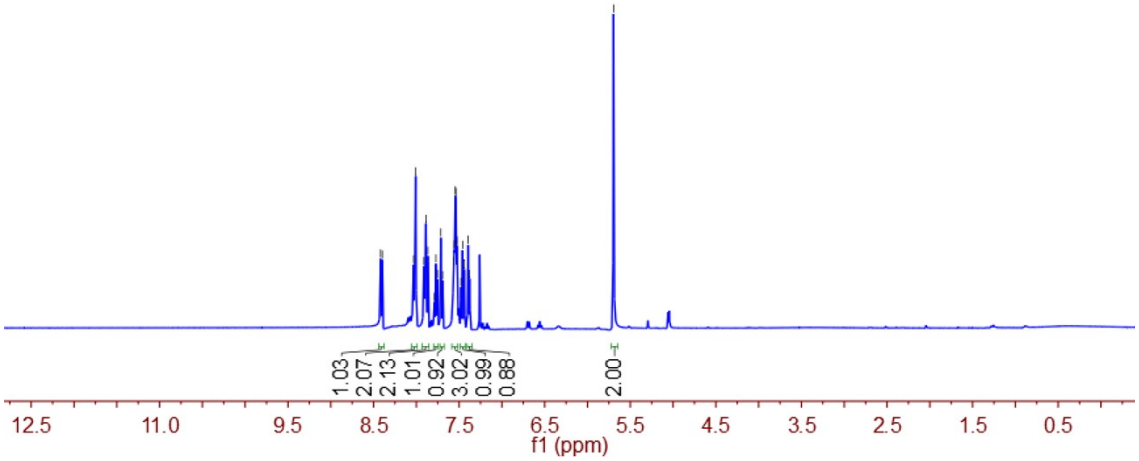


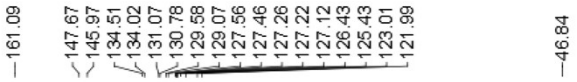


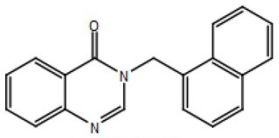
33, ^{13}C NMR
400 MHz, $CDCl_3$



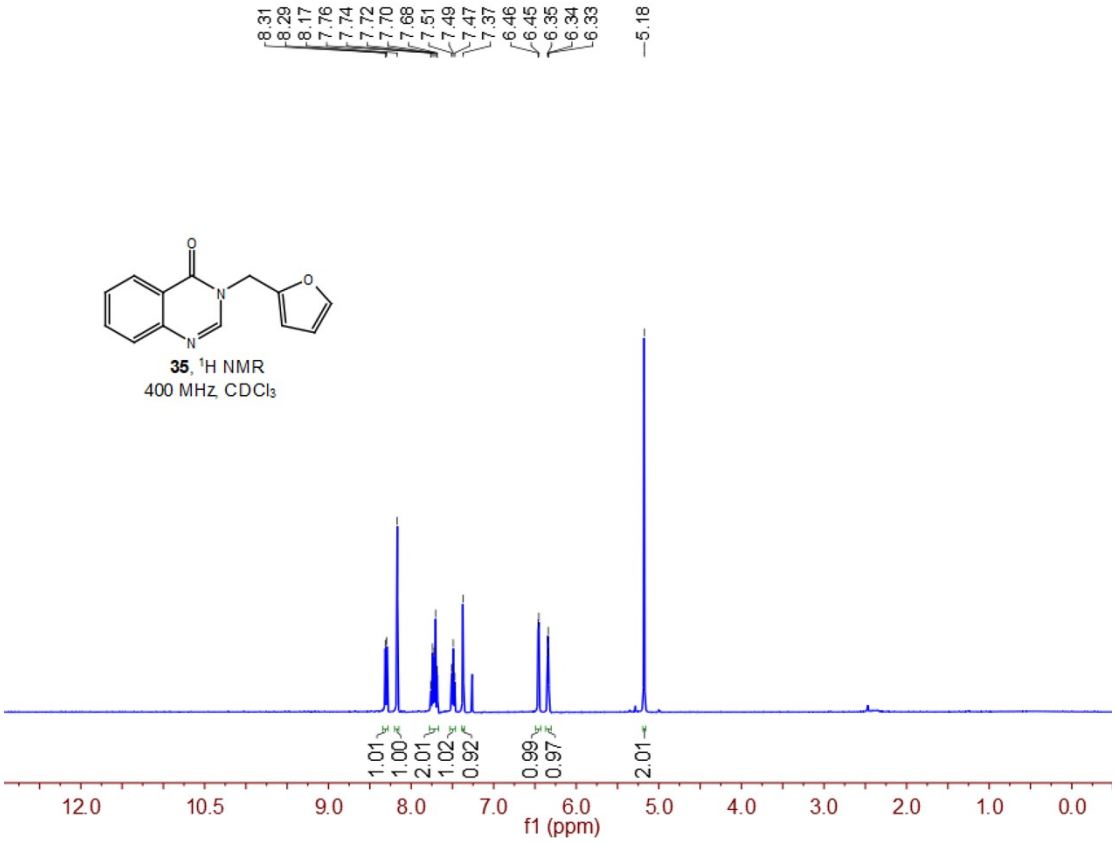
34, ^{1}H NMR
400 MHz, $CDCl_3$

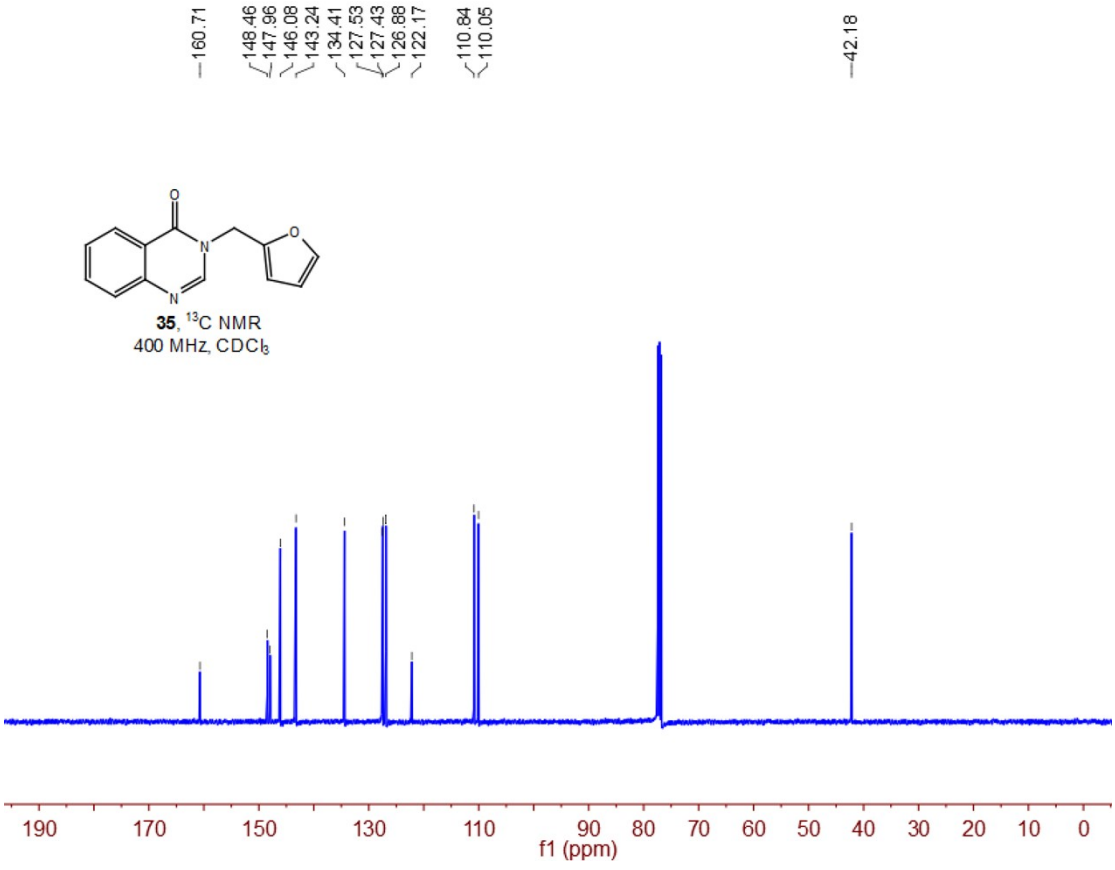


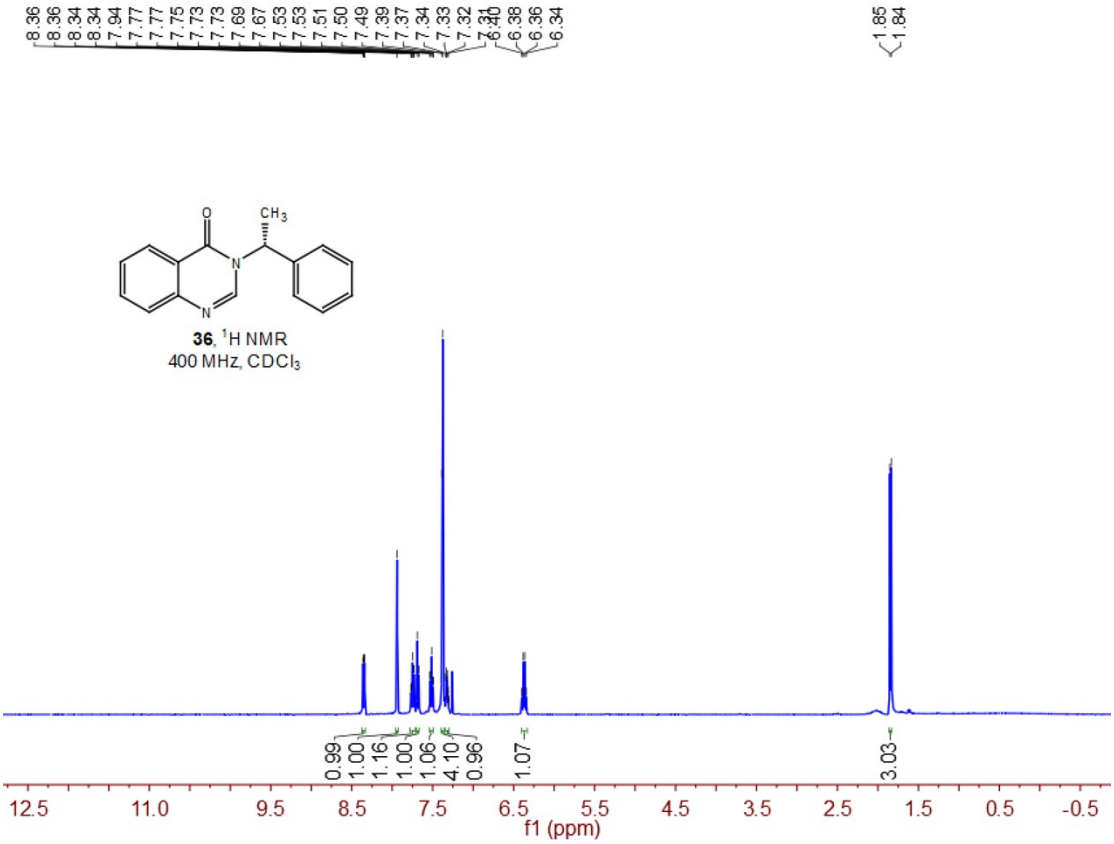


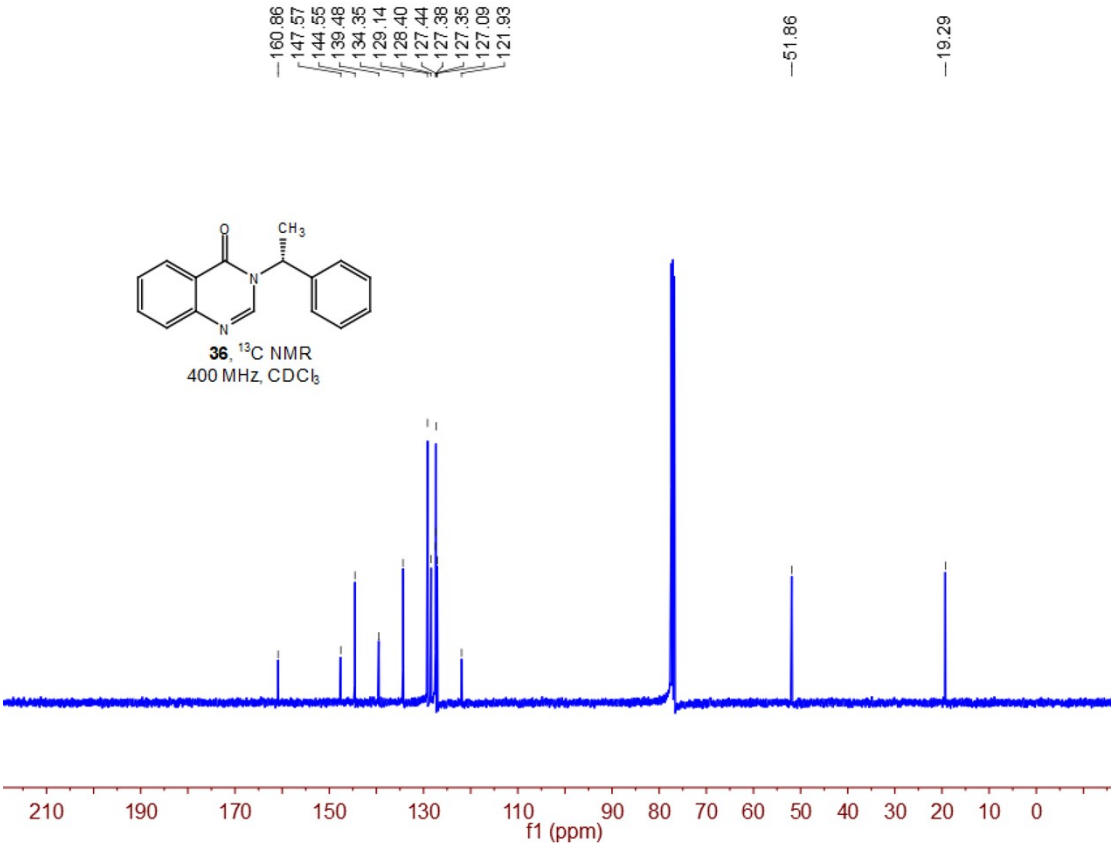


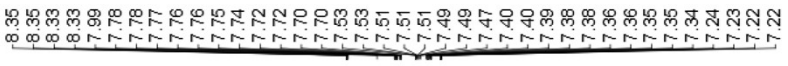
34, ^{13}C NMR
400 MHz, $CDCl_3$

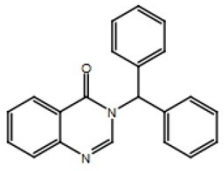

8.31
8.29
8.17
7.76
7.74
7.72
7.70
7.68
7.51
7.49
7.47
7.37
6.46
6.45
6.35
6.34
6.33
5.18
35, 1H NMR
400 MHz, CDCl3
1.01
1.00
2.01
1.02
0.92
0.99
0.97
2.01
12.0
10.5
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


160.71
148.46
147.96
146.08
143.24
134.41
127.53
127.43
126.88
122.17
110.84
110.05
42.18
35, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

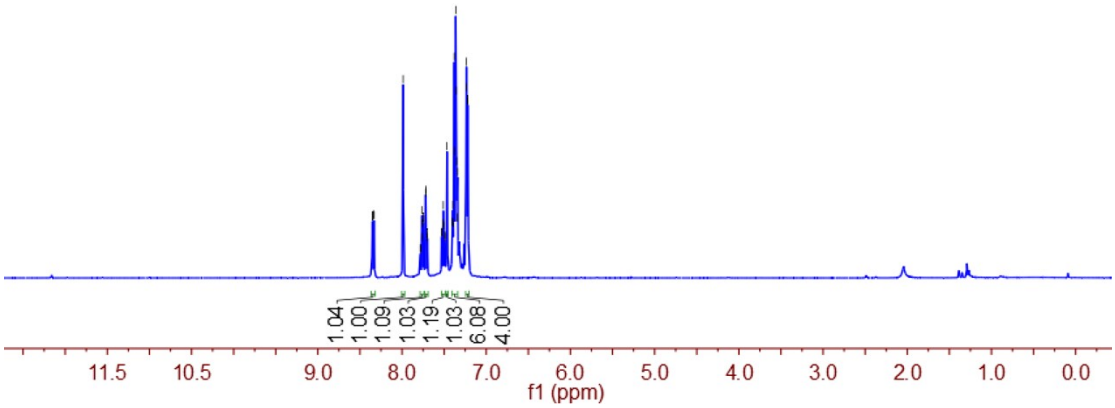

8.36
8.36
8.34
8.34
7.94
7.77
7.77
7.75
7.73
7.73
7.69
7.67
7.53
7.53
7.51
7.50
7.49
7.39
7.37
7.34
7.33
7.32
7.31
6.40
6.38
6.36
6.34
1.85
1.84
O
CH3
N
N
36, 1H NMR
400 MHz, CDCl3
0.99
1.00
1.16
1.00
1.06
4.10
0.96
1.07
3.03
12.5
11.0
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

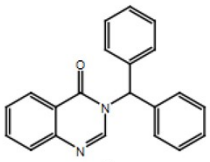

160.86
147.57
144.55
139.48
134.35
129.14
128.40
127.44
127.38
127.35
127.09
121.93
51.86
19.29
O
CH3
N
N
36, 13C NMR
400 MHz, CDCl3
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



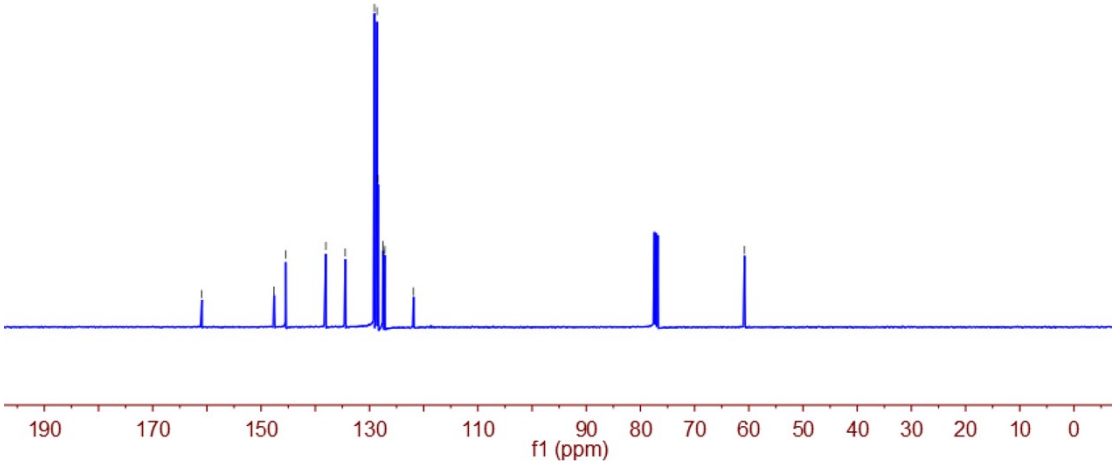


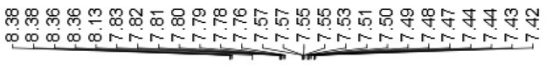
37, ^{1}H NMR
400 MHz, $CDCl_3$

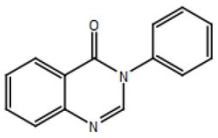




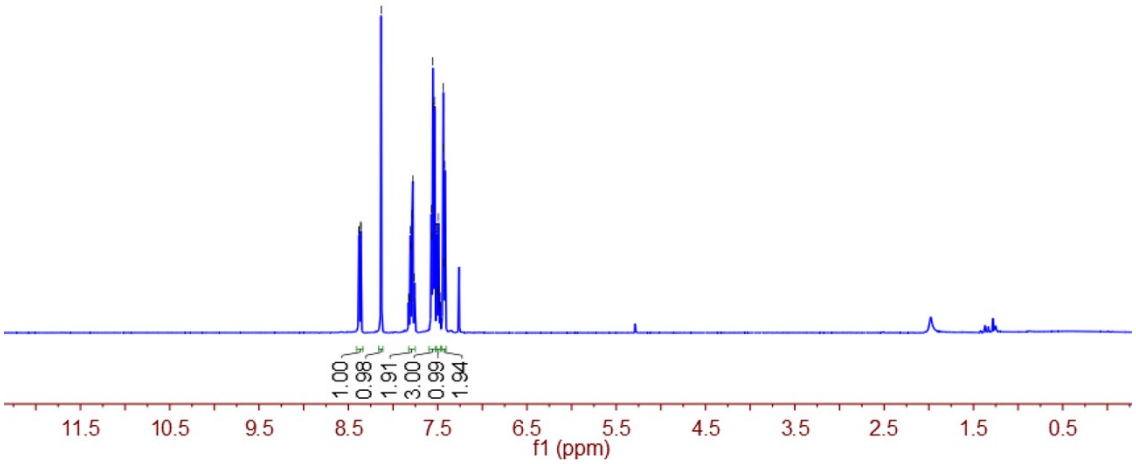
37, ^{13}C NMR
400 MHz, $CDCl_3$

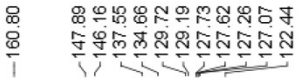


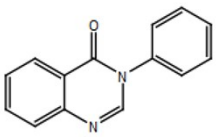




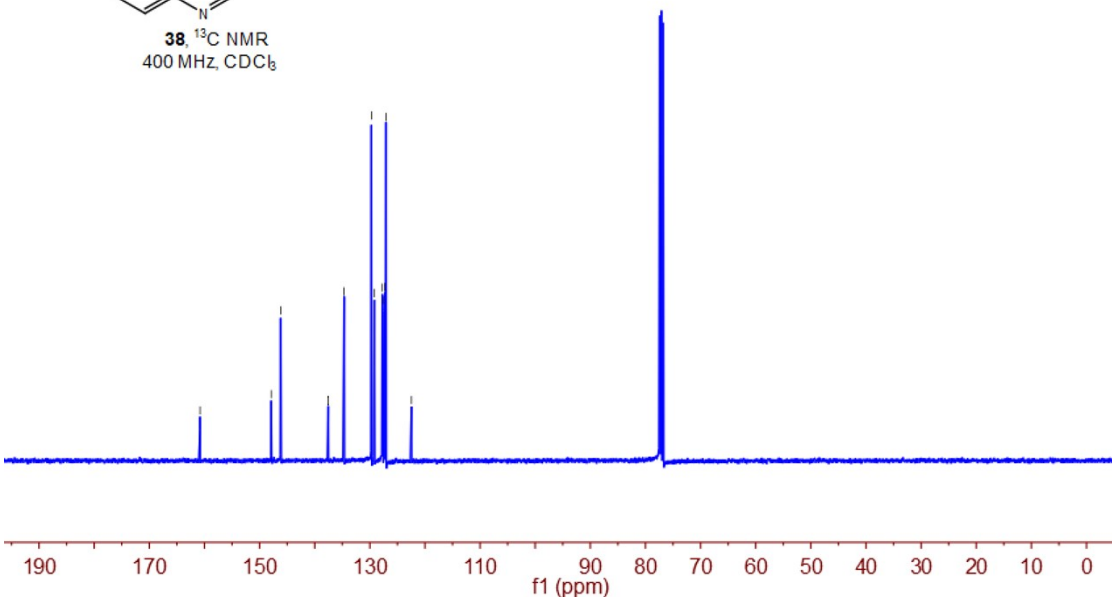
38, ^{1}H NMR
400 MHz, $CDCl_3$

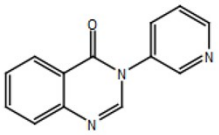




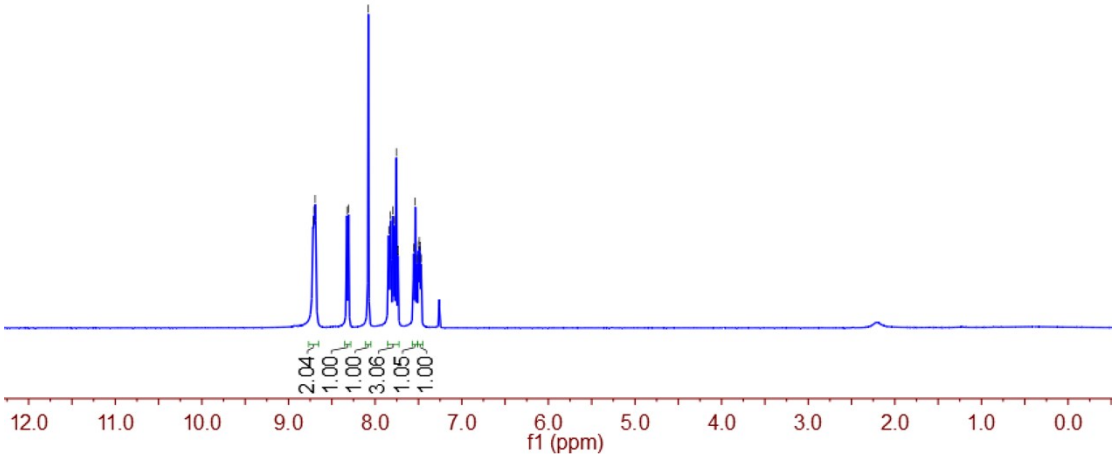


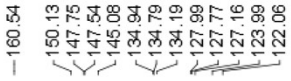
38, ^{13}C NMR
400 MHz, $CDCl_3$

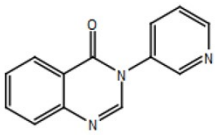




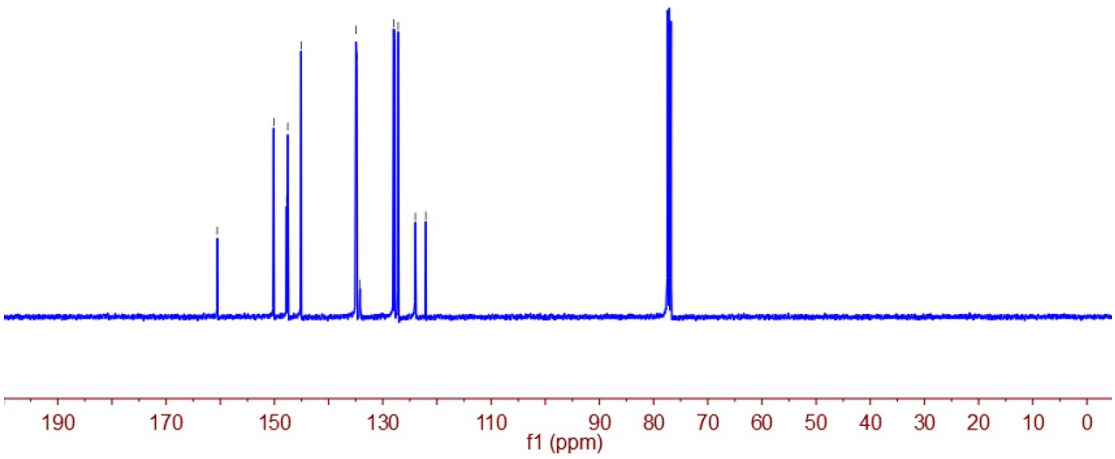
39, ^{1}H NMR
400 MHz, $CDCl_3$

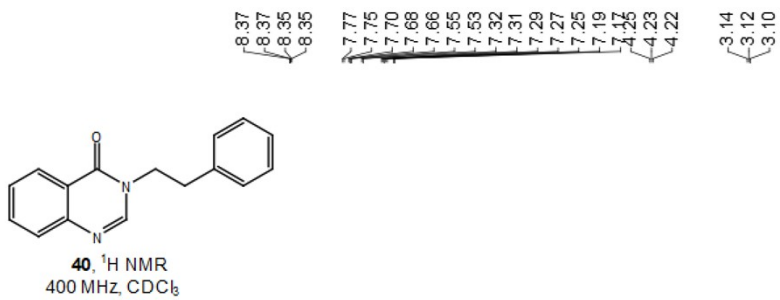




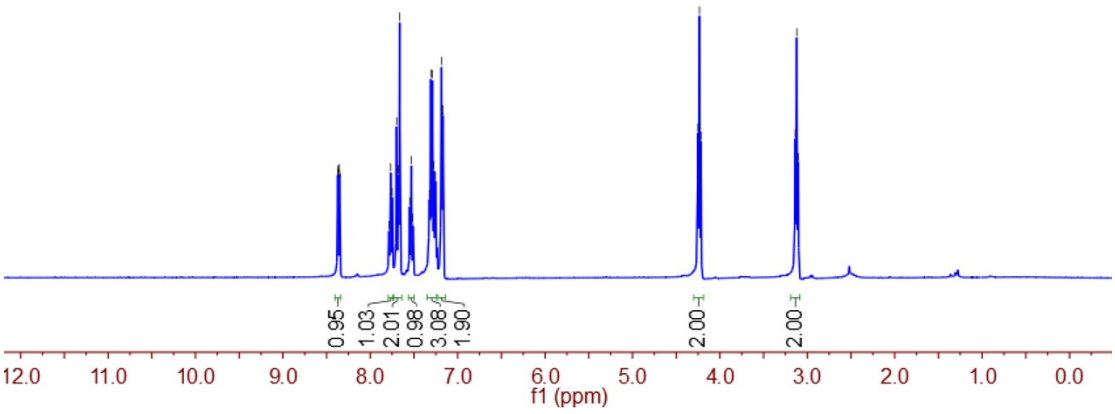


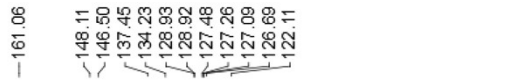
39, ^{13}C NMR
400 MHz, $CDCl_3$

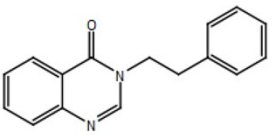




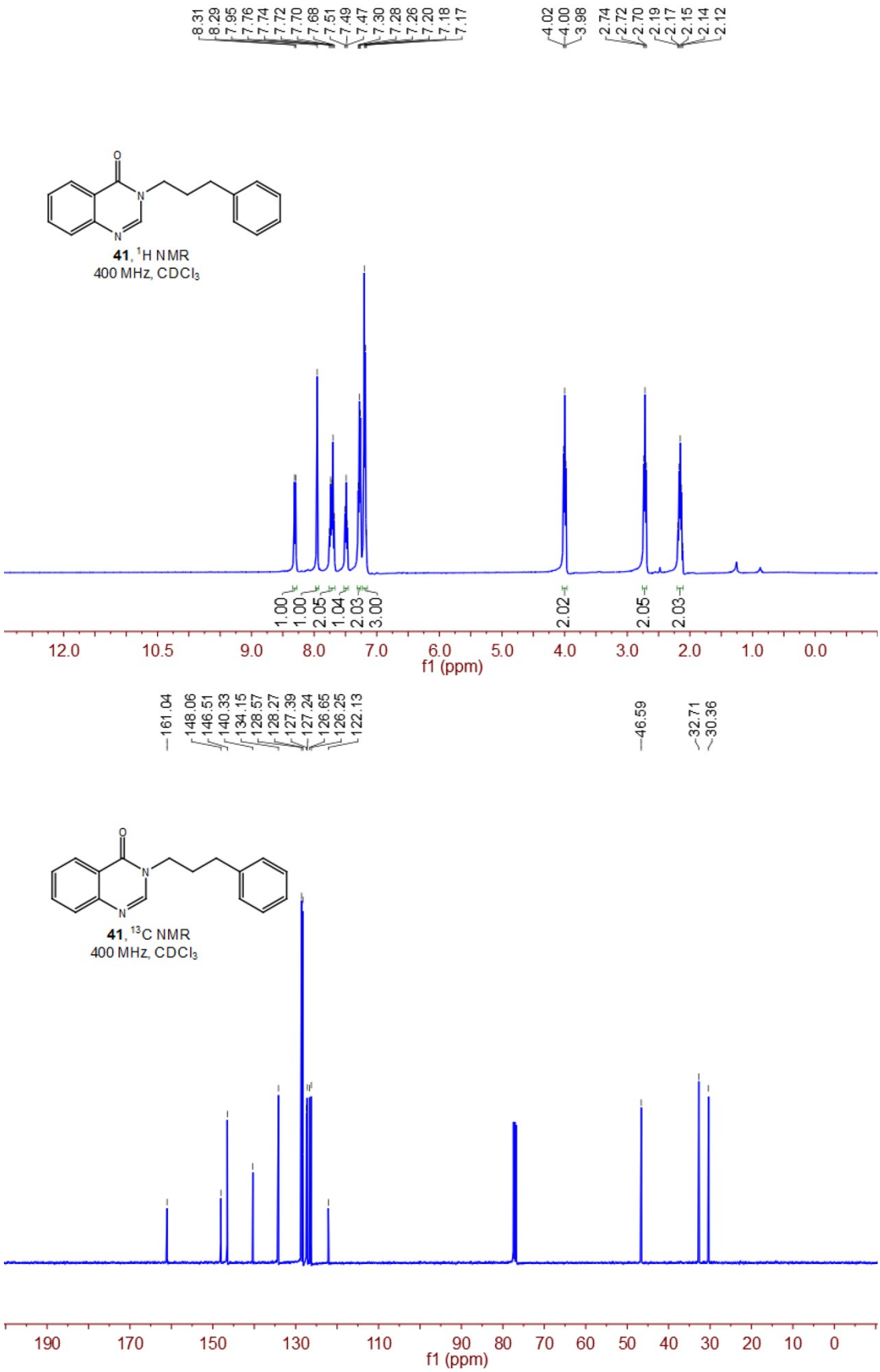
40, ^{1}H NMR
400 MHz, $CDCl_3$

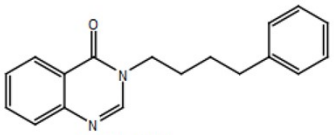




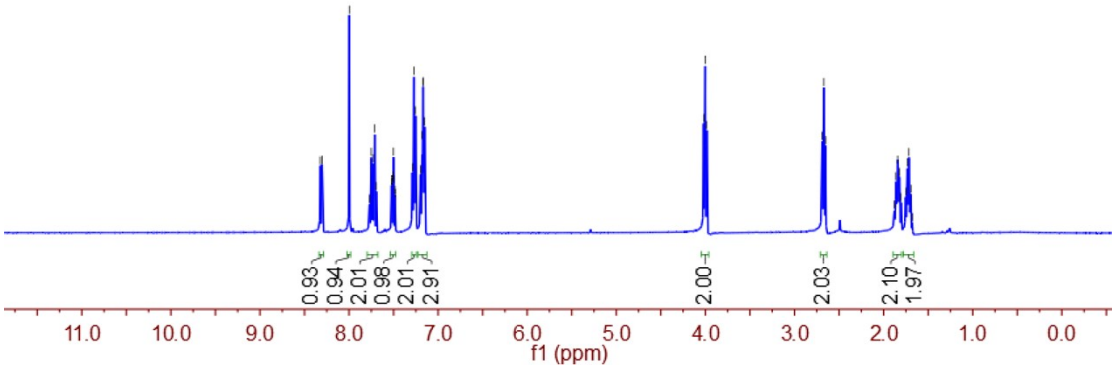


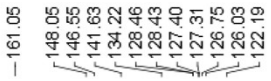
40, ^{13}C NMR
400 MHz, $CDCl_3$

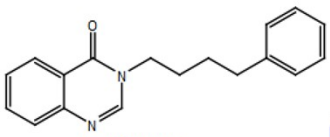

8.31
8.29
7.95
7.76
7.74
7.72
7.70
7.68
7.51
7.49
7.47
7.30
7.28
7.26
7.20
7.18
7.17
4.02
4.00
3.98
2.74
2.72
2.70
2.19
2.17
2.15
2.14
2.12
41, 1H NMR
400 MHz, CDCl3
1.00
1.00
2.05
1.04
2.03
3.00
2.02
2.05
2.03
12.0
10.5
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)
161.04
148.06
146.51
140.33
134.15
128.57
128.27
127.39
127.24
126.65
126.25
122.13
46.59
32.71
30.36
41, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



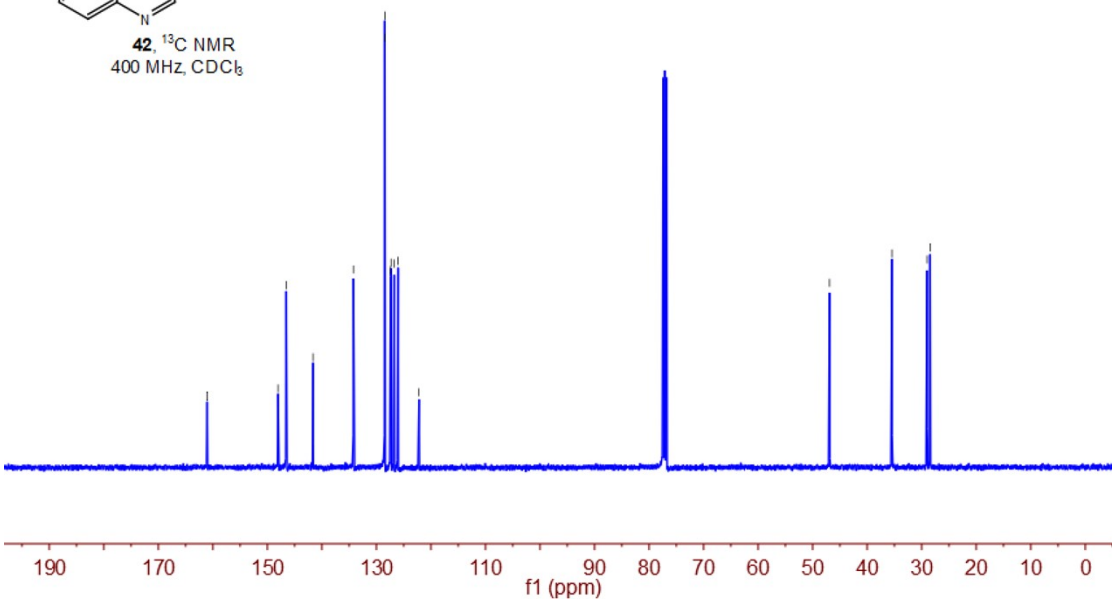
42, ^{1}H NMR
400 MHz, $CDCl_3$

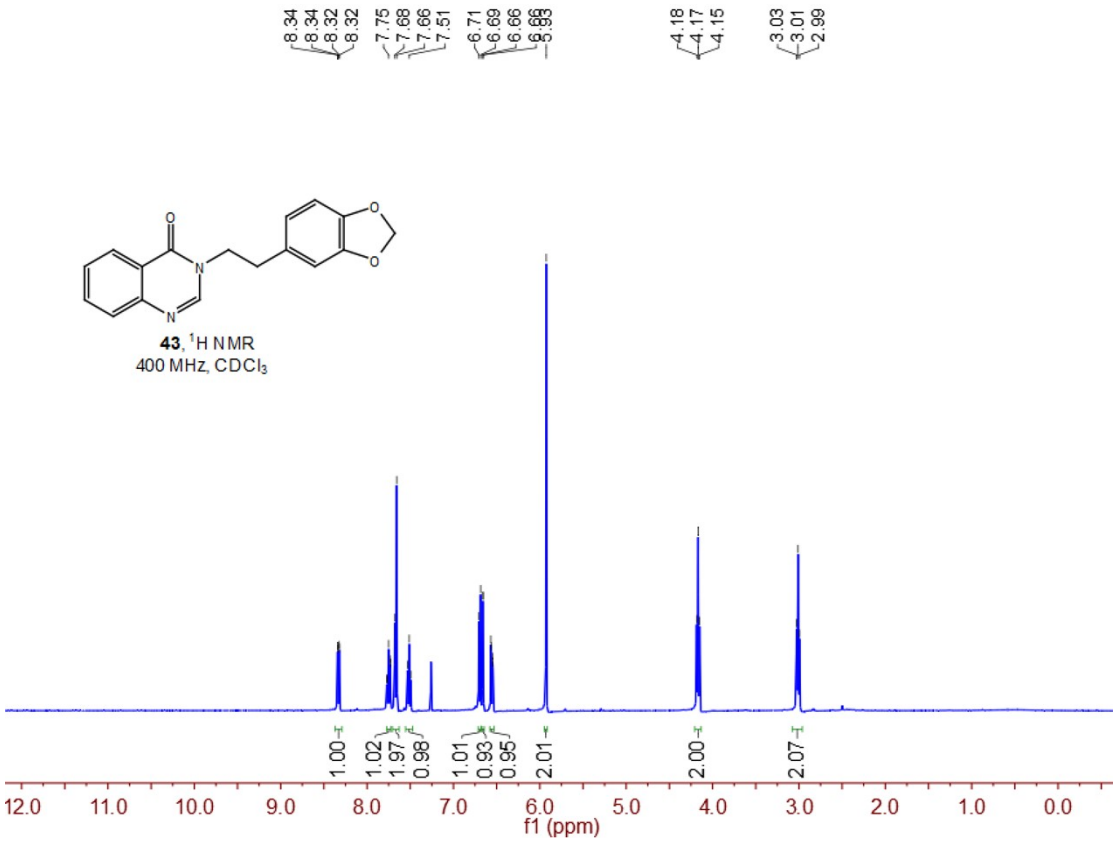


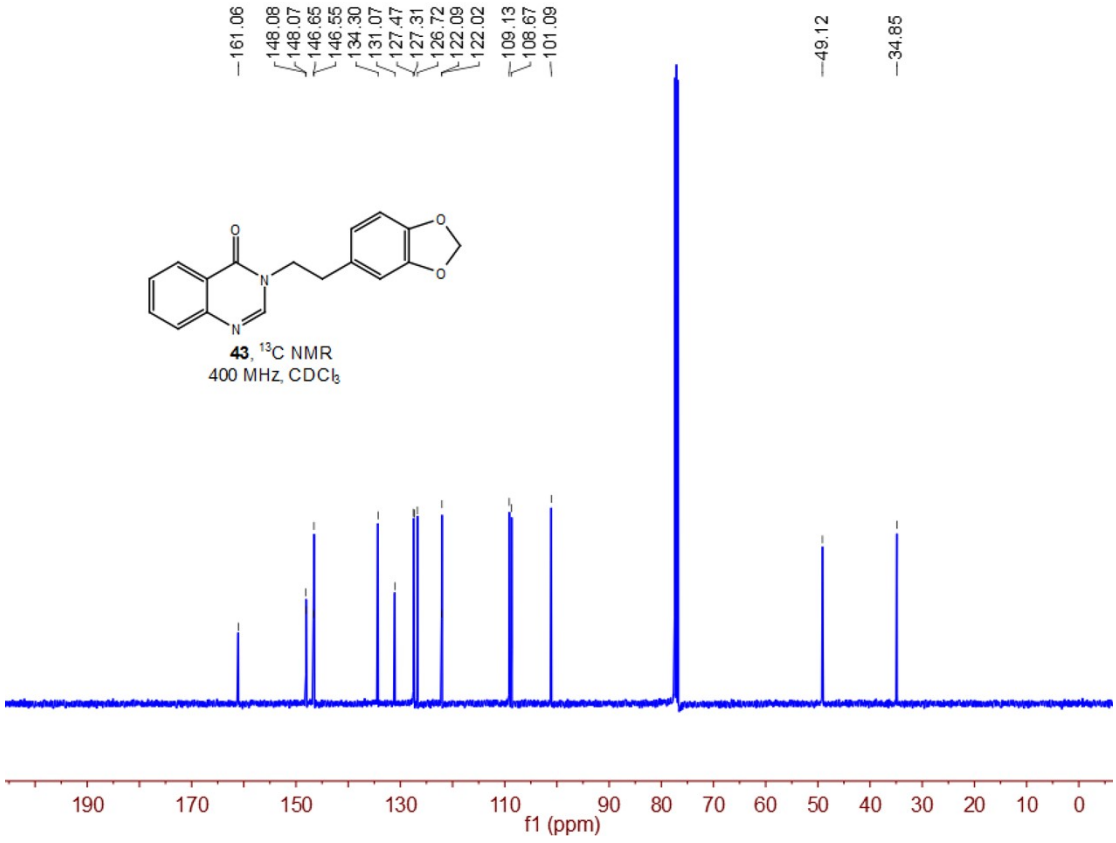


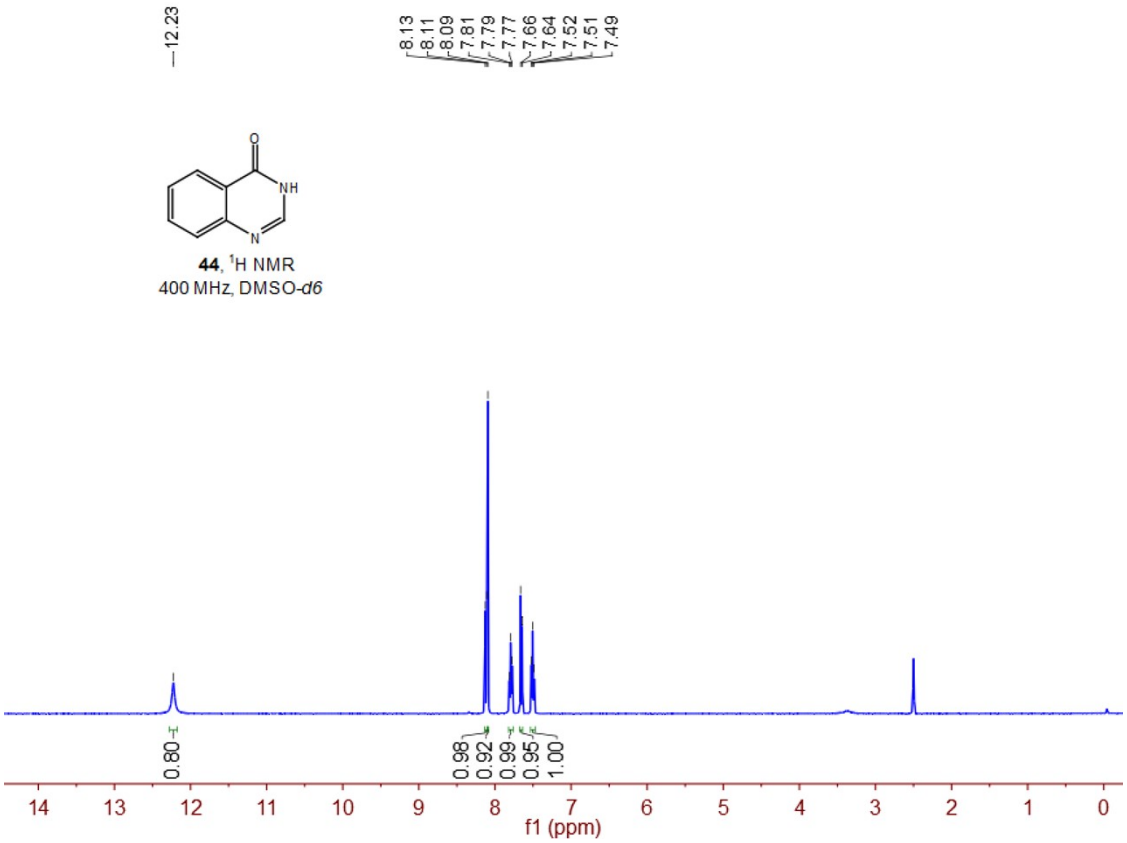


42, ^{13}C NMR
400 MHz, $CDCl_3$

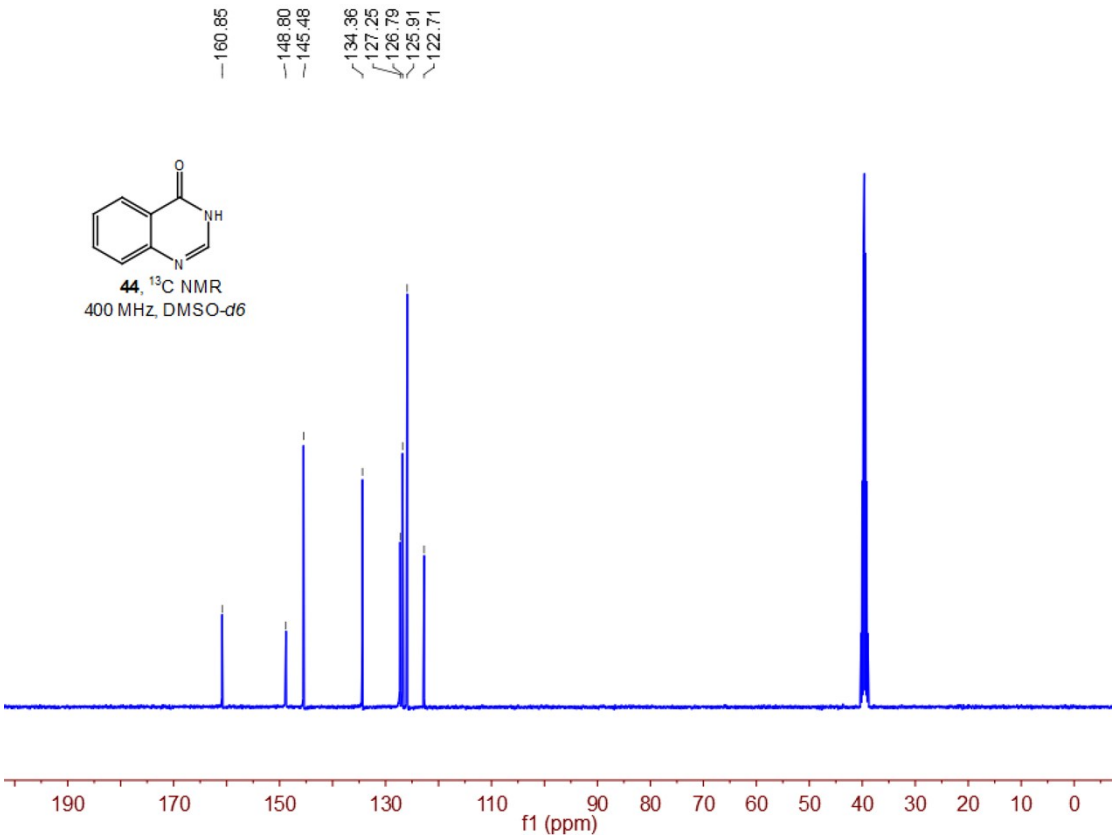



8.34
8.34
8.32
8.32
7.75
7.68
7.66
7.51
6.71
6.69
6.66
4.18
4.17
4.15
3.03
3.01
2.99
O
N
N
O
O
43, 1H NMR
400 MHz, CDCl3
1.00
1.02
1.97
0.98
1.01
0.93
0.95
2.01
2.00
2.07
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

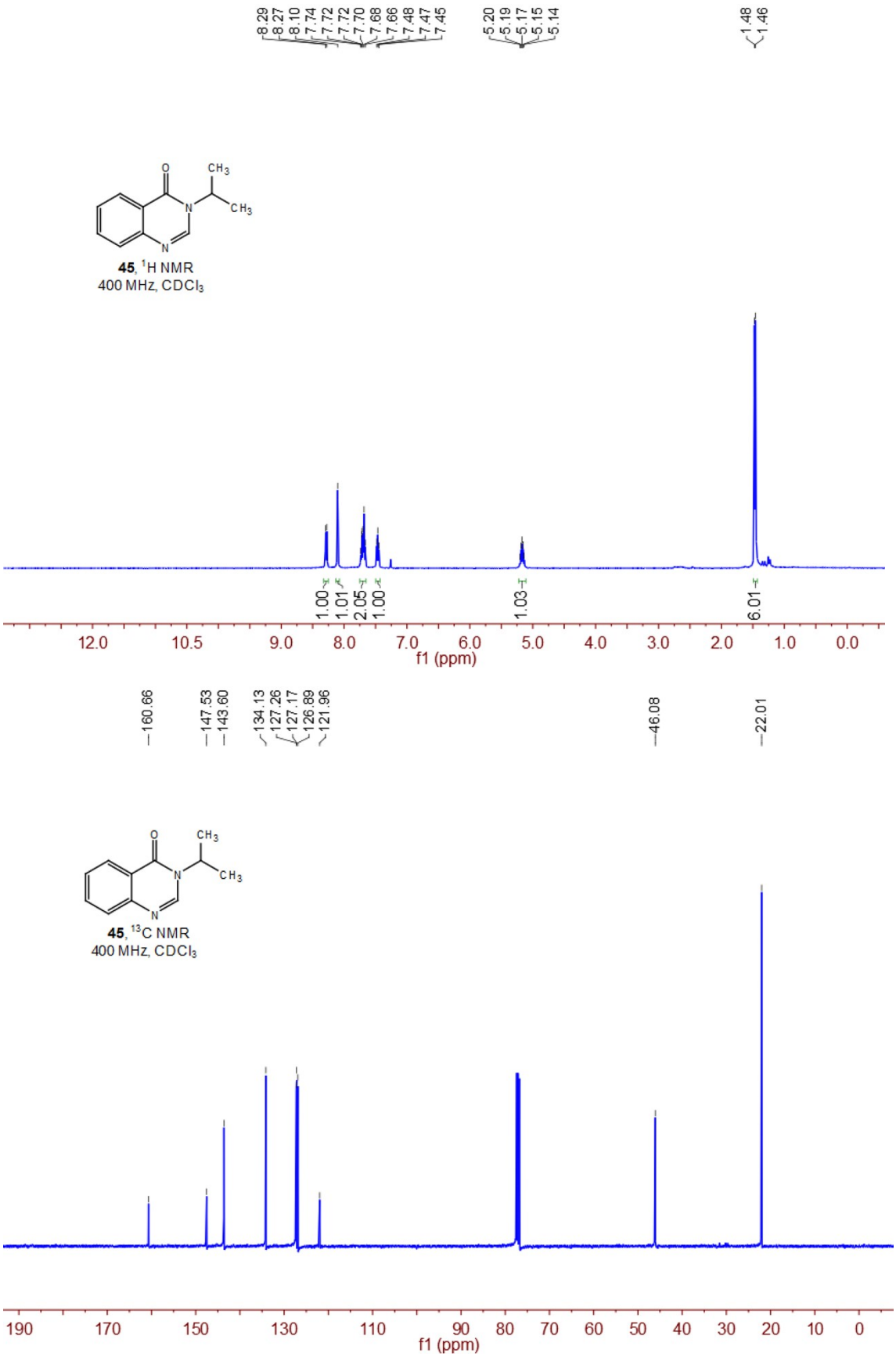

161.06
148.08
148.07
146.65
146.55
134.30
131.07
127.47
127.31
126.72
122.09
122.02
109.13
108.67
101.09
49.12
34.85
O
N
N
O
O
43, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

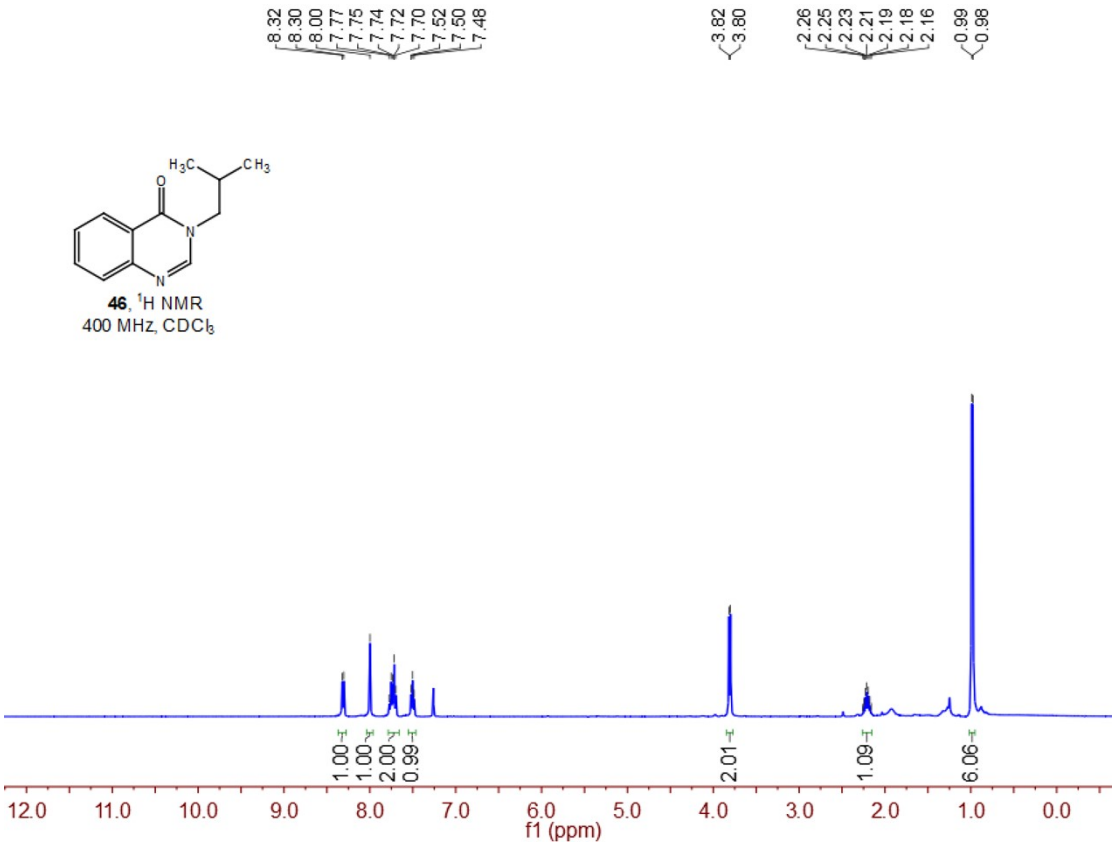


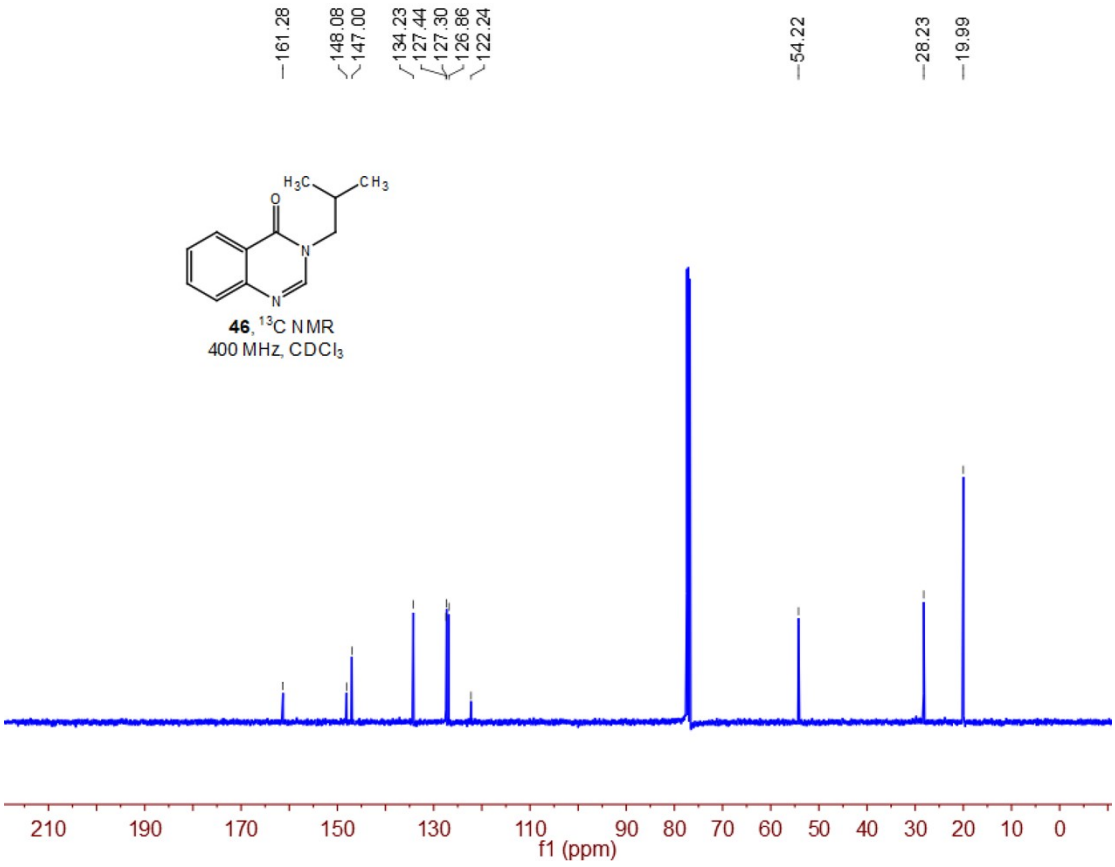
44, ^{1}H NMR
400 MHz, DMSO-*d6*

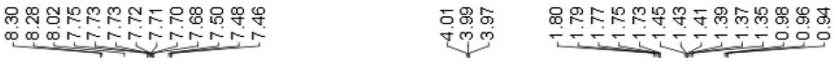


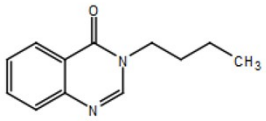
44, ^{13}C NMR
400 MHz, DMSO-*d6*


8.29
8.27
8.10
7.74
7.72
7.72
7.70
7.68
7.66
7.48
7.47
7.45
5.20
5.19
5.17
5.15
5.14
1.48
1.46
O
CH3
N
CH3
N
45, 1H NMR
400 MHz, CDCl3
1.00
1.01
2.05
1.00
1.03
6.01
12.0
10.5
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)
160.66
147.53
143.60
134.13
127.26
127.17
126.89
121.96
46.08
22.01
O
CH3
N
CH3
N
45, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

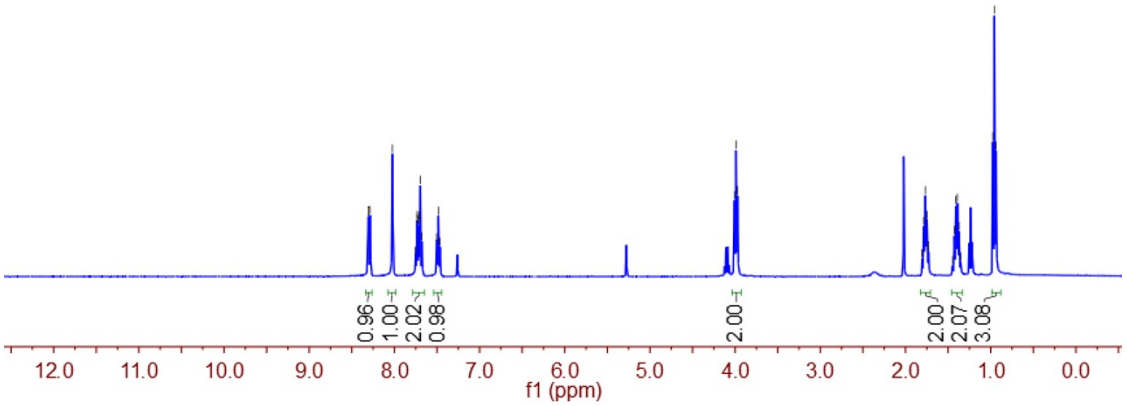

8.32
8.30
8.00
7.77
7.75
7.74
7.72
7.70
7.52
7.50
7.48
3.82
3.80
2.26
2.25
2.23
2.21
2.19
2.18
2.16
0.99
0.98
H3C
CH3
O
N
N
46, 1H NMR
400 MHz, CDCl3
1.00
1.00
2.00
0.99
2.01
1.09
6.06
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

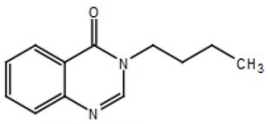

161.28
148.08
147.00
134.23
127.44
127.30
126.86
122.24
54.22
28.23
19.99
H3C
CH3
O
N
N
46, 13C NMR
400 MHz, CDCl3
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



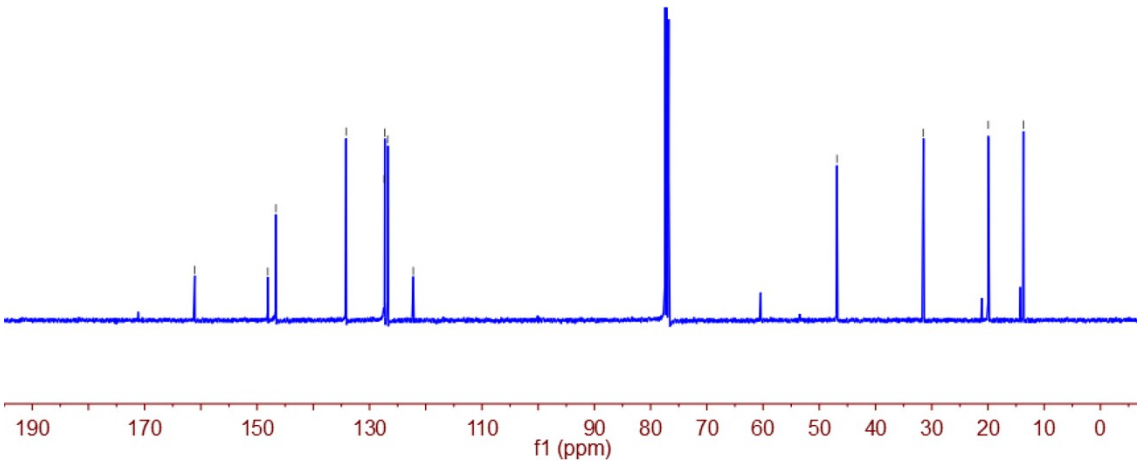


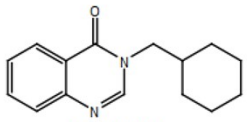
47, ^{1}H NMR
400 MHz, $CDCl_3$



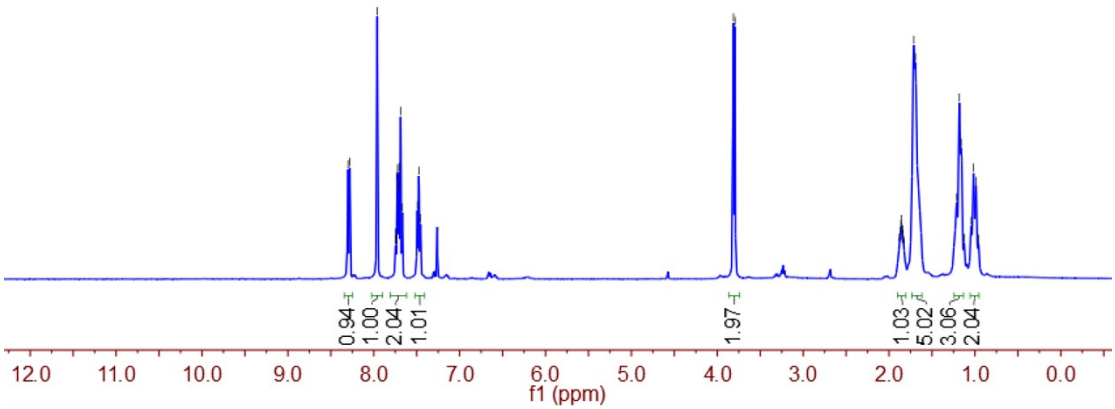


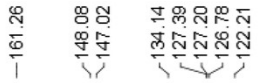
47, ^{13}C NMR
400 MHz, $CDCl_3$

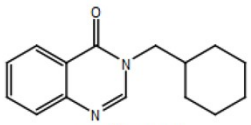




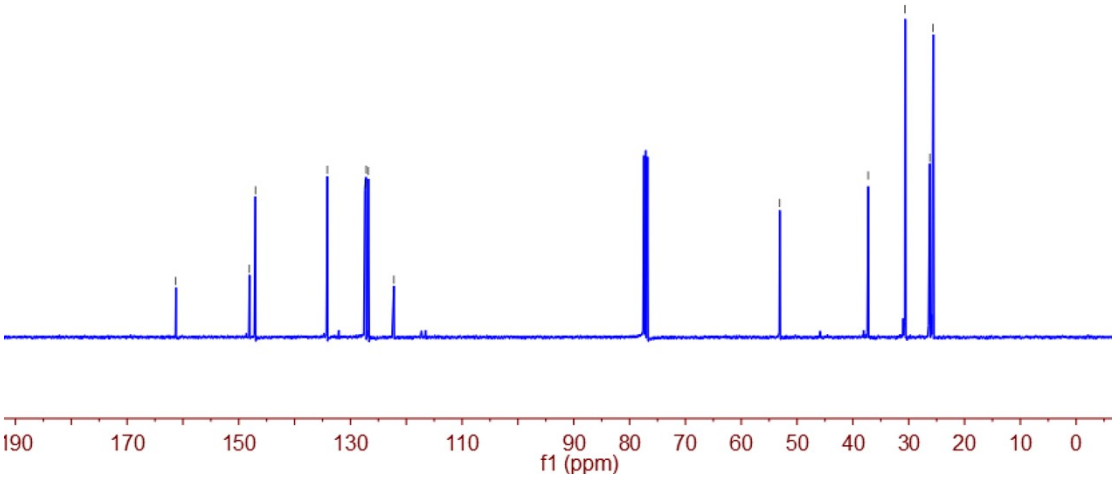
48, ^{1}H NMR
400 MHz, $CDCl_3$

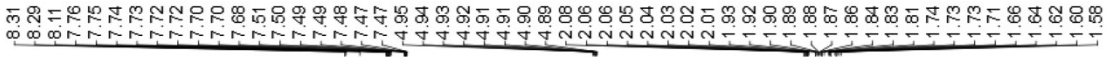


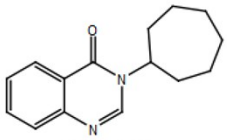




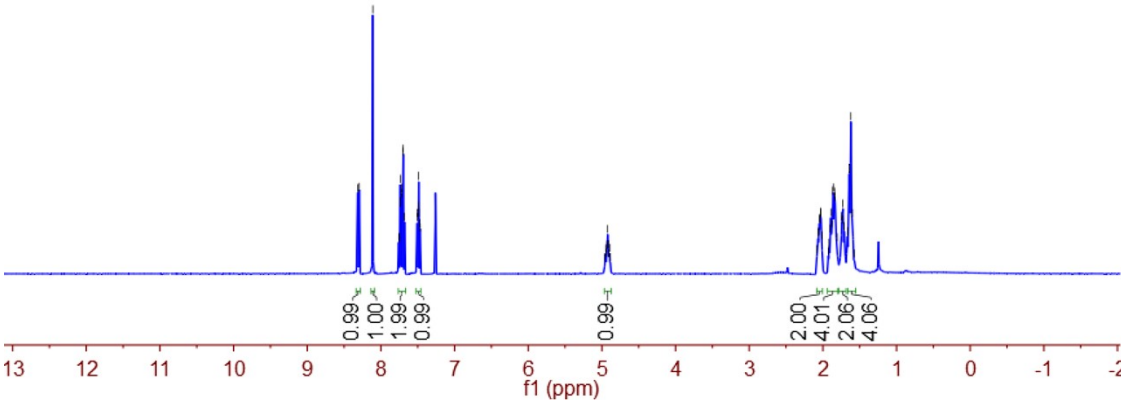
48, ^{13}C NMR
400 MHz, $CDCl_3$

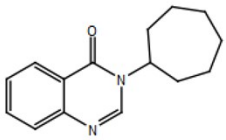




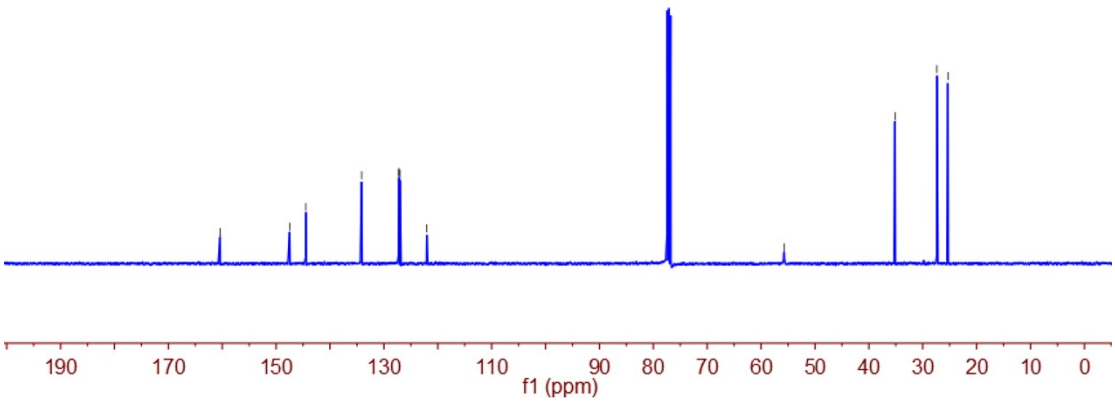


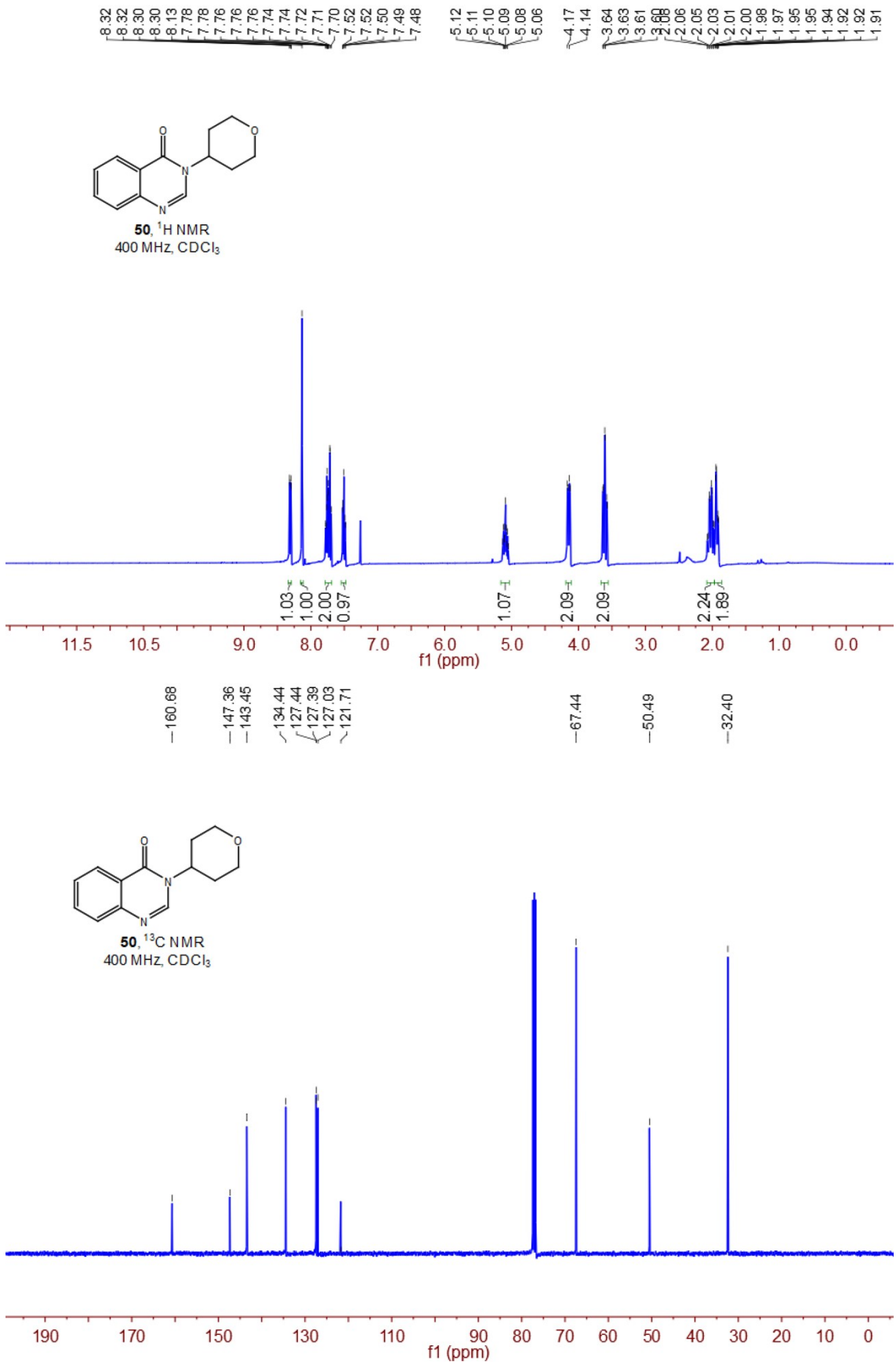
49, ^{1}H NMR
400 MHz, $CDCl_3$

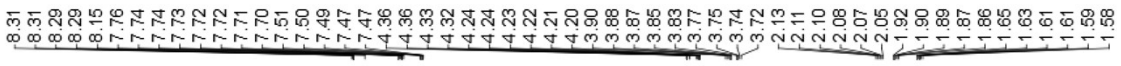


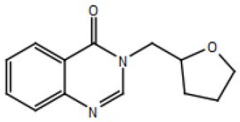


49, ^{13}C NMR
400 MHz, $CDCl_3$

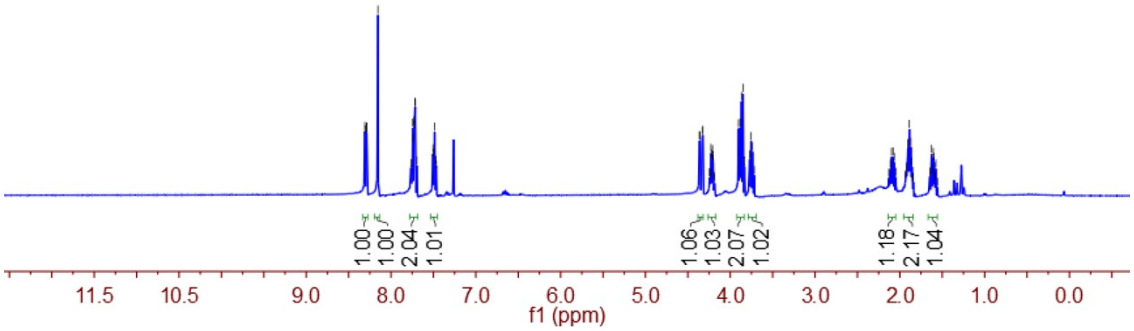


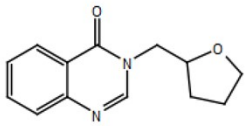

8.32
8.32
8.30
8.30
8.13
7.78
7.78
7.76
7.76
7.76
7.74
7.74
7.72
7.71
7.70
7.52
7.52
7.50
7.49
7.48
5.12
5.11
5.10
5.09
5.08
5.06
4.17
4.14
3.64
3.63
3.61
2.06
2.05
2.03
2.01
2.00
1.98
1.97
1.95
1.95
1.94
1.92
1.92
1.91
O
O
N
N
50, 1H NMR
400 MHz, CDCl3
1.03
1.00
2.00
0.97
1.07
2.09
2.09
2.24
1.89
11.5
10.5
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)
160.68
147.36
143.45
134.44
127.44
127.39
127.03
121.71
67.44
50.49
32.40
O
O
N
N
50, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



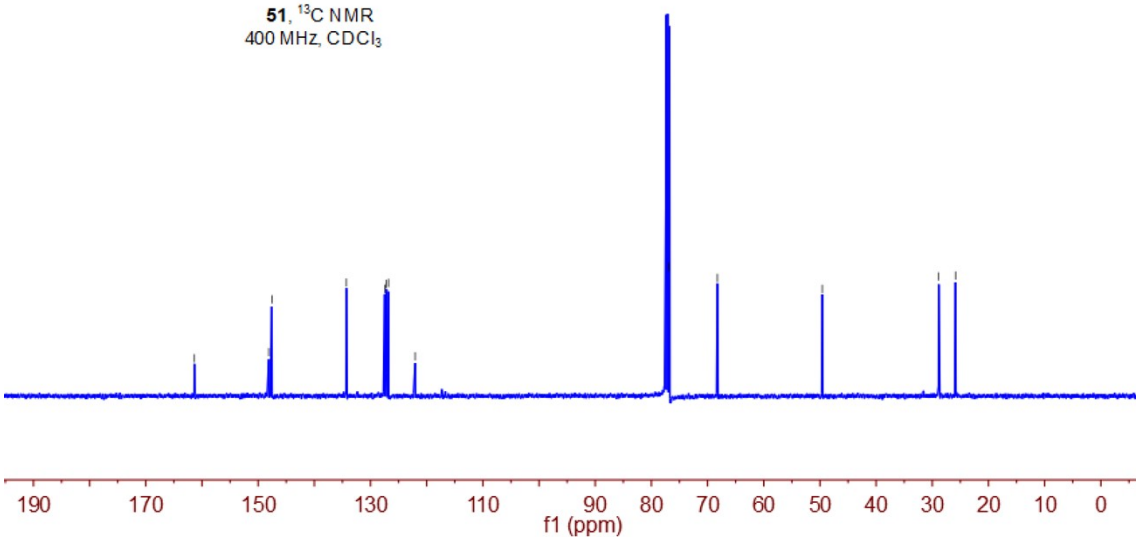


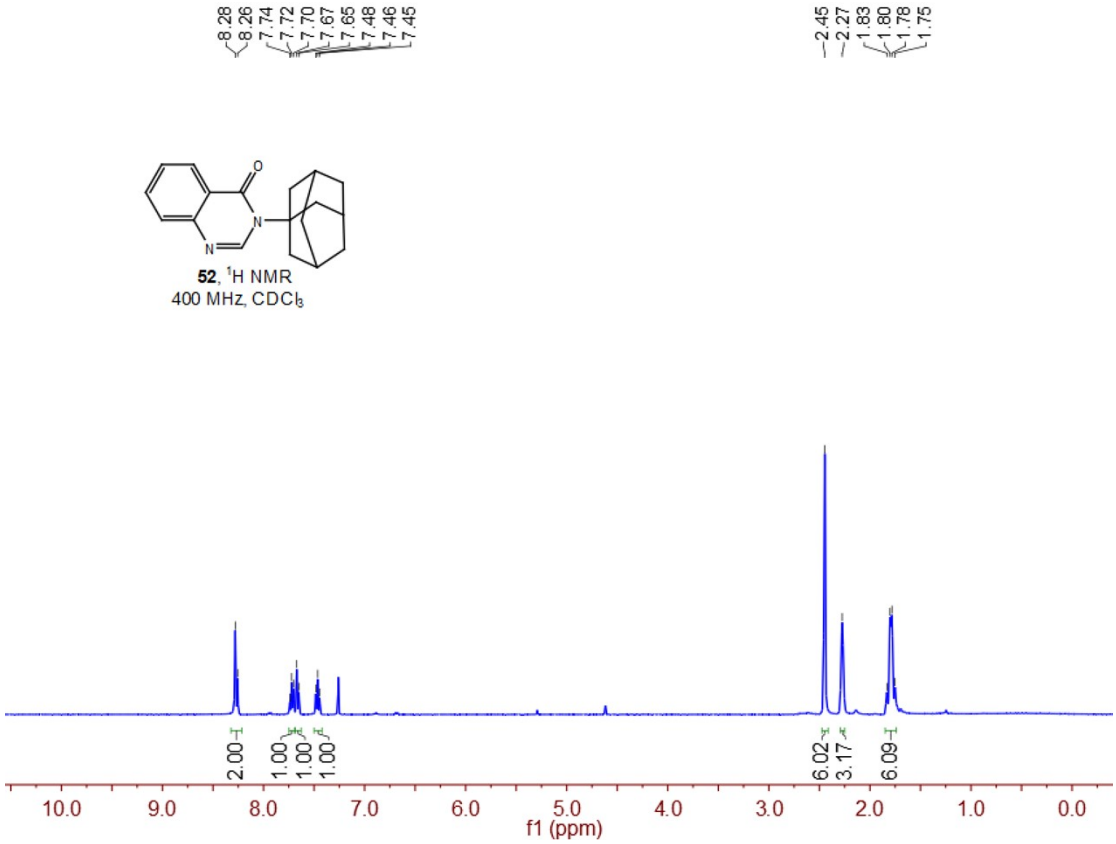
51, ^{1}H NMR
400 MHz, $CDCl_3$

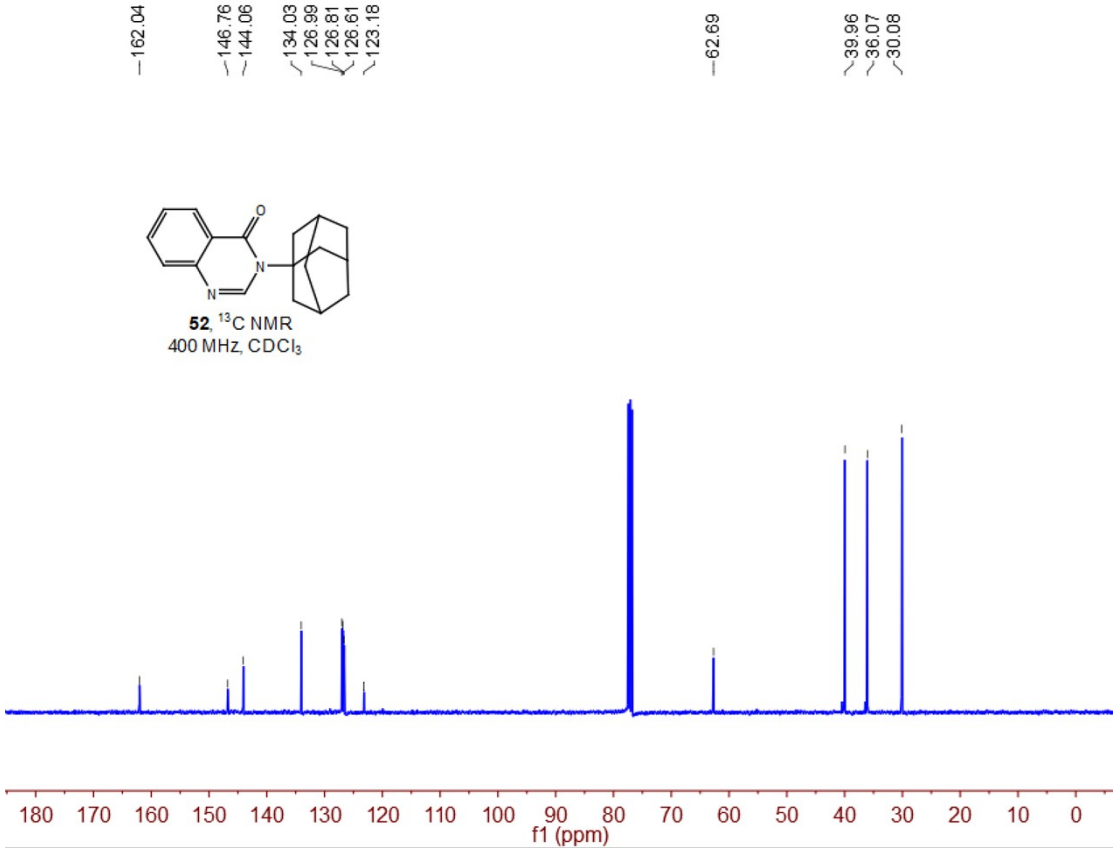


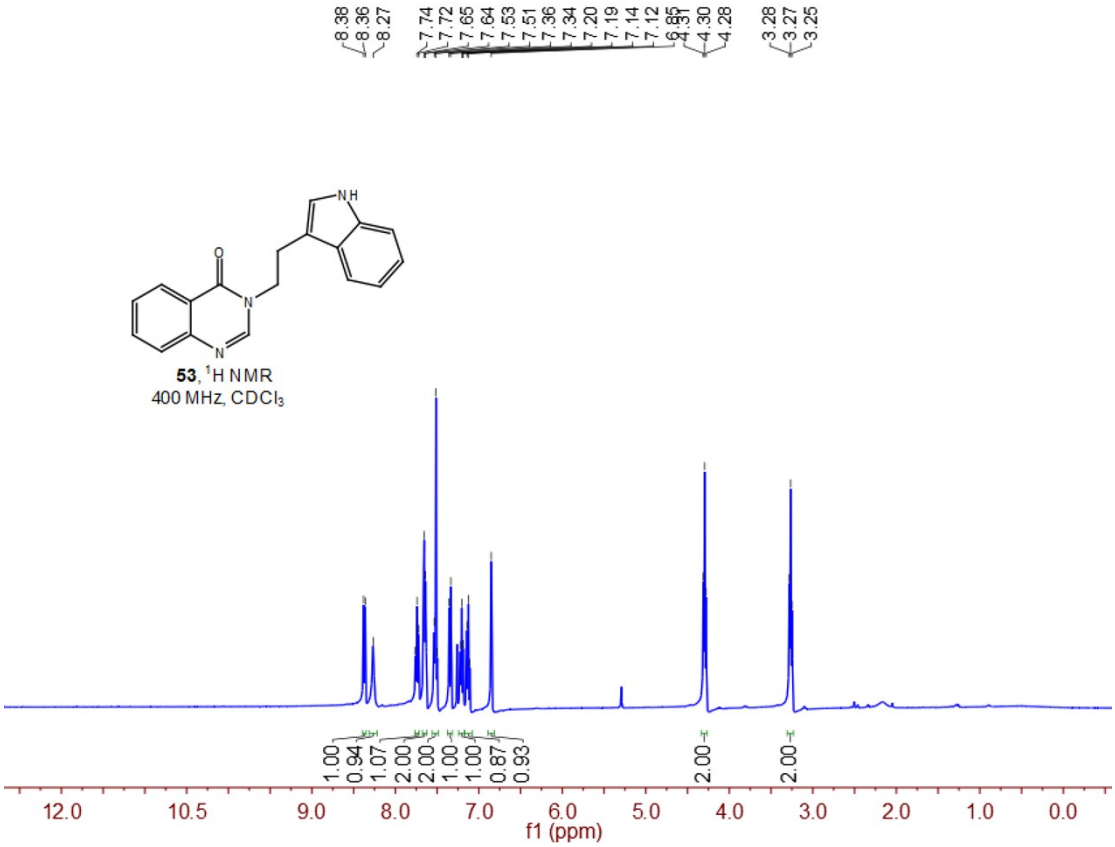


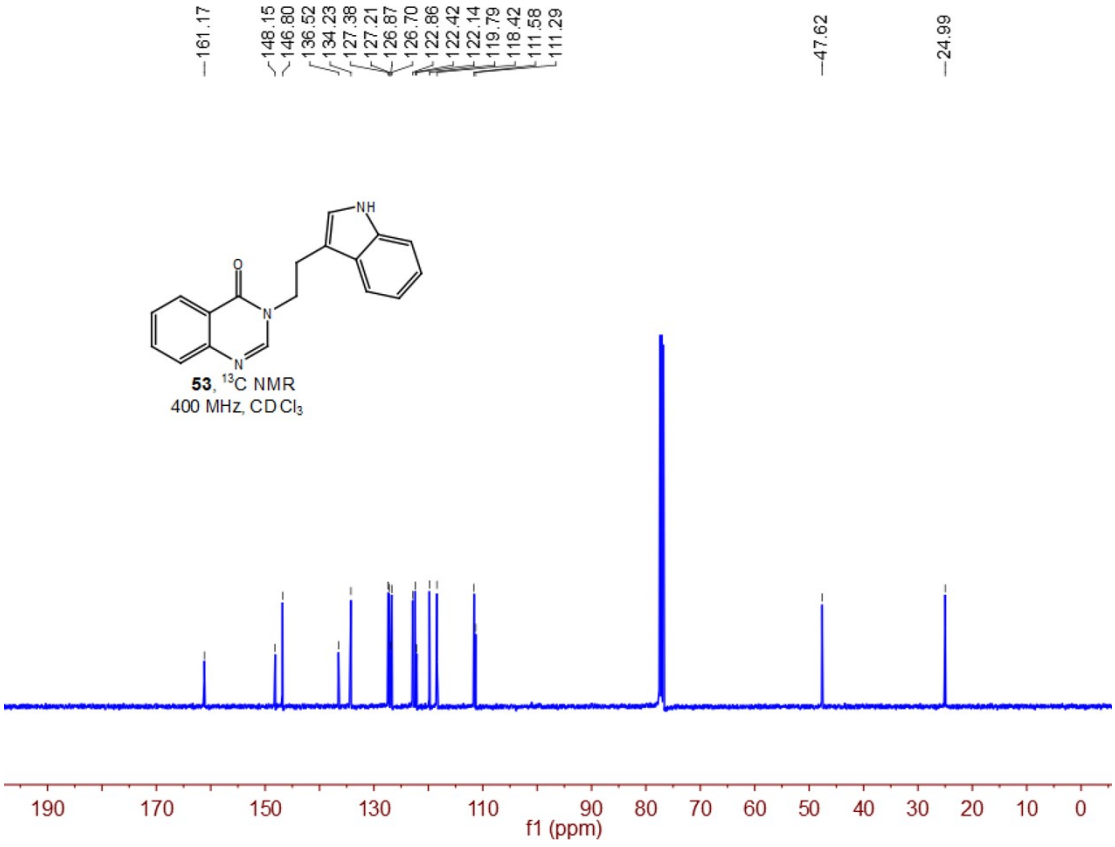
51, ^{13}C NMR
400 MHz, $CDCl_3$

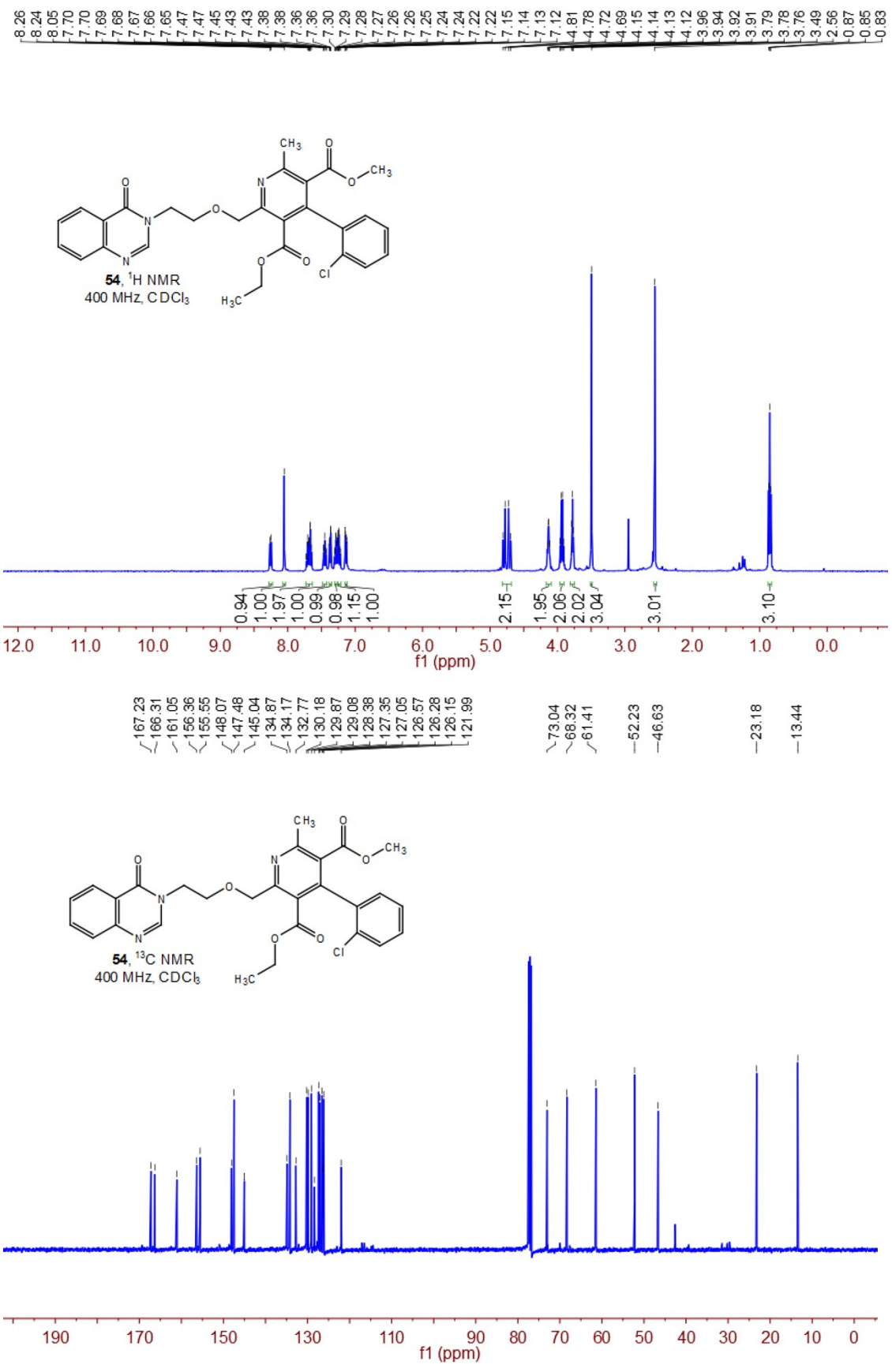


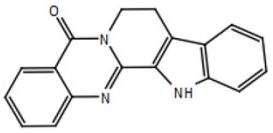

8.28
8.26
7.74
7.72
7.70
7.67
7.65
7.48
7.46
7.45
2.45
2.27
1.83
1.80
1.78
1.75
O
N
N
52, 1H NMR
400 MHz, CDCl3
2.00
1.00
1.00
1.00
6.02
3.17
6.09
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


162.04
146.76
144.06
134.03
126.99
126.81
126.61
123.18
62.69
39.96
36.07
30.08
O
N
N
52, 13C NMR
400 MHz, CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

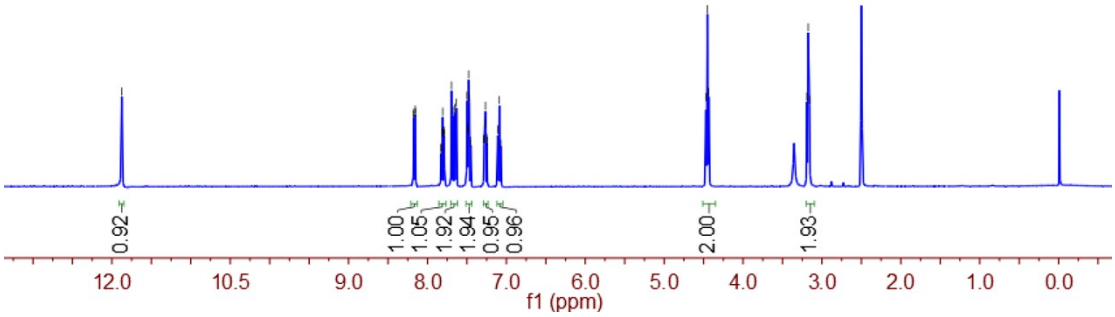

8.38
8.36
8.27
7.74
7.72
7.65
7.64
7.53
7.51
7.36
7.34
7.20
7.19
7.14
7.12
6.85
4.31
4.30
4.28
3.28
3.27
3.25
NH
O
N
N
53, 1H NMR
400 MHz, CDCl3
1.00
0.94
1.07
2.00
2.00
1.00
1.00
0.87
0.93
2.00
2.00
12.0
10.5
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

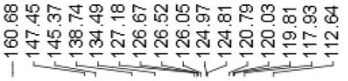

161.17
148.15
146.80
136.52
134.23
127.38
127.21
126.87
126.70
122.86
122.42
122.14
119.79
118.42
111.58
111.29
47.62
24.99
NH
O
N
N
53, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

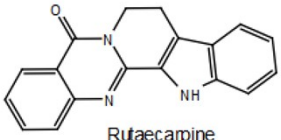

8.26
8.24
8.05
7.70
7.70
7.69
7.68
7.67
7.66
7.65
7.47
7.47
7.45
7.43
7.43
7.38
7.38
7.36
7.36
7.30
7.29
7.28
7.27
7.26
7.26
7.25
7.24
7.24
7.22
7.22
7.15
7.14
7.13
7.12
4.81
4.78
4.72
4.69
4.15
4.14
4.13
4.12
3.96
3.94
3.92
3.91
3.79
3.78
3.76
3.49
2.56
0.87
0.85
0.83
54, 1H NMR
400 MHz, CDCl3
0.94
1.00
1.97
1.00
0.99
0.98
1.15
1.00
2.15
1.95
2.06
2.02
3.04
3.01
3.10
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)
167.23
166.31
161.05
156.36
155.55
148.07
147.48
145.04
134.87
134.17
132.77
130.18
129.87
129.08
128.38
127.35
127.05
126.57
126.28
126.15
121.99
73.04
68.32
61.41
52.23
46.63
23.18
13.44
54, 13C NMR
400 MHz, CDCl3
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



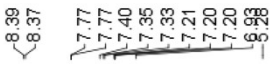
Rutaecarpine
55, ^{1}H NMR
400 MHz, DMSO-*d6*

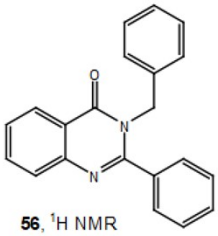




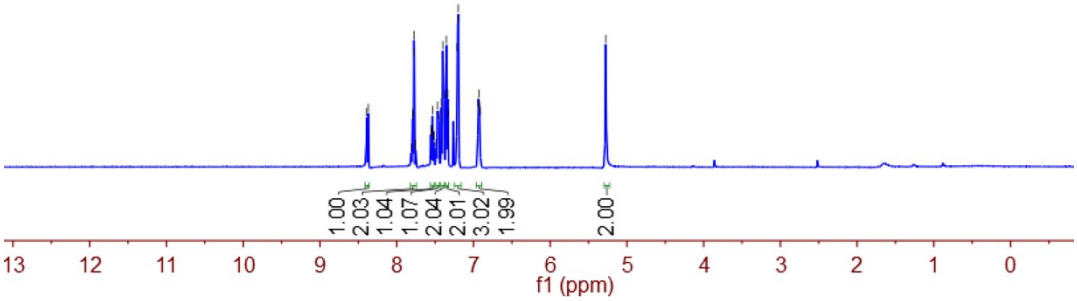


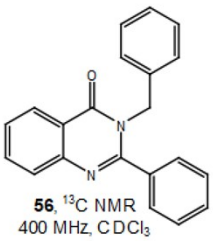
Rutaecarpine
55, ^{13}C NMR
400 MHz, DMSO-*d6*





56, ^{1}H NMR
400 MHz, $CDCl_3$





56, ^{13}C NMR
400 MHz, $CDCl_3$