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

Content

General information: All of the solvents and reagents used for the synthesis of hydrazinyl thiazole are purchased from commercial sources and has been used without any purification. Wipro 9W green LED is used as light source with wavelength range 400-700 nm. The distance from the light source to the reaction vessel is ~6-8 cm. Reaction has been performed in the oven dried borosilicate glasswares. Silica gel with mesh size 100-200 has been used for column chromatography. NMR has been recorded at 400/300 MHz for ^{1}H and for ^{13}C 100/75 MHz operating frequency in DMSO-*d*6, $CDCl_3$, where Tetramethylsilane(TMS) present as an internal standard. Chemical shift (δ) value reported in the NMR spectra in ppm. Coupling constant (J) value were given in Hertz (Hz). The term m, q, t, d, s referred to multiplet, quartet, triplet, doublet, singlet respectively. Exact mass (HRMS) were recorded on a high resolution mass spectrometer using electrospray ionization (ESI) techniques.

General procedure for the synthesis of hydrazinylthiazole: A mixture of carbonyl compound (1 mmol), thiosemicarbazide (1 mmol), phenacyl bromide (1 mmol) in ethanol : water mixture (1:2, 5 mL) stirred for 60 minutes under 9W green LED irradiation at room temperature. Progress of the reaction was monitored by the thin layer chromatography (TLC). After completion of the reaction, the reaction mixture was worked up with water and extracted with ethyl acetate, thrice. Then the organic portion dried over anhydrous Na_2SO_4 and evaporated and the pure product was separated by column chromatography. Formation of the product confirmed by ^{1}H and, ^{13}C NMR techniques.

Gram Scale Synthesis of hydrazinylthiazole: A mixture of *p*-dimethylaminobenzaldehyde (**1a**, 6.71 mmol), thiosemicarbazide (**2**, 6.71 mmol), *p*-nitrophenacyl bromide (**3a**, 6.71 mmol) in ethanol: water mixture (1:2, 10 mL) stirred for 90 minutes under 9W green LED irradiation at room temperature. Progress of the reaction was monitored by the thin layer chromatography (TLC). After completion of the reaction, the reaction mixture was worked up with water and extracted with ethyl acetate, thrice. Then the organic portion dried over anhydrous Na_2SO_4 and evaporated and the pure product was separated by column chromatography. The isolated yield of the desired product **4a** was found to be 87%.

Mechanistic Study:

(a) UV-Vis experiment: The UV-visible experiments were performed on Shimadzu UV-1900i spectrophotometer with a quartz cuvette of 1.0 cm path length.At first, all the reacting components, i.e., *p*-dimethylaminobenzaldehyde (**1a**), thiosemicarbazide (**2**), *p*-nitrophenacyl bromide (**3a**) were examined individually for their UV-Vis spectrum at concentration of 5 x 10^{-4} M in ethanol. From the absorption plot it was found that except thiosemicarbazide (**2**), rest of the components poorly absorbed in the visible region. After that binary mixtures of the reacting components(i.e., **1a**+**2**, **2**+**3a**, and**1a**+**3a**) were examined at the same concentration as previous. This time it was observed that mixture of **1a**+**2** and **2**+**3a** showed a bathochromic shift with respect to their individual components.Finally, when the mixture of all the components (**1a**+**2**+**3a**) was investigated, further bathochromic shift was observed, with a hump around 600 nm. The bathochromic shifts in binary mixture and further bathochromic shift along with a shoulder in case of

all three components suggests the formation of ternary EDA complex formation between **1a**, **2**, and **3a**. This assumption is further supported by appearance of yellow coloration immediate after mixing all the components.

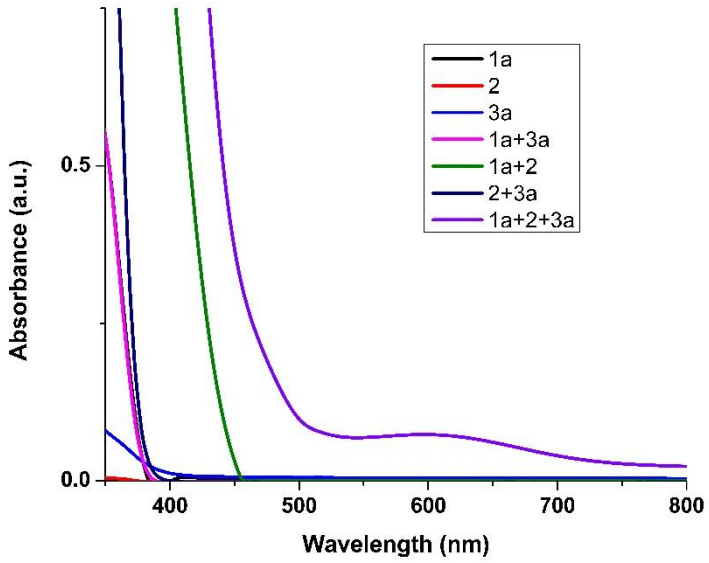


Figure S1:UV-Visible absorption spectra of different reacting components and their mixtures.

(b) Stoichiometry of the EDA complex in solution: To determine the stoichiometry of the ternary EDA complex formed between **1a**, **2**, and **3a** a Job's plot was constructed.[1] For this purpose, we measured the absorption at 450 nm of ethanol solution of **1a**-**3a** (1:1) and **2** having a constant total concentration of 0.02 M, but different donor/acceptor ratios. All the absorption spectra were recorded in 1 cm path quartz cuvettes using Hitachi U2910 UV-Vis spectrophotometer. The difference in absorbance values are plotted against mole fraction of **2**. The maximum absorbance was detected at 50% mole fraction of **2** suggesting 1:1 mixture of (**1a**-**3a**) and **2**, indicating that this is the stoichiometry of the ternary EDA complex.

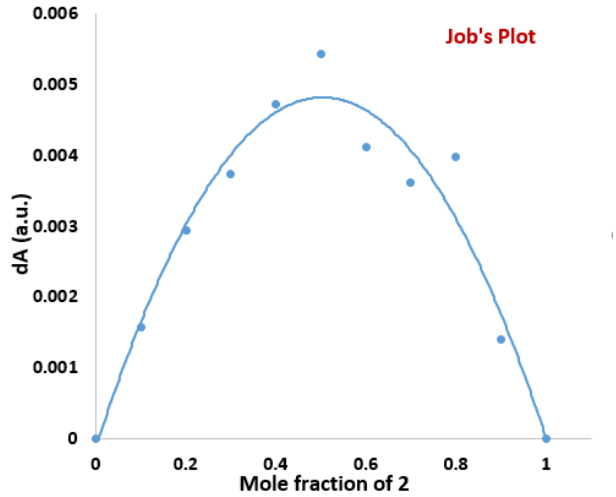


Figure S2: Job's plot for interaction between **1a**-**3a** and **2**.

(c) Determination of the association constant (K_{EDA}): The association constant of the ternary EDA complex formed between **1a**, **2**, and **3a** was determined spectrophotometrically in ethanol, employing the Benesi-Hildebrand methodology.[2] We measured the absorption at 450 nm of solutions with constant concentration of 0.02 M of **1a**-**3a** (1:1) but increased donor/acceptor ratios, adding an excess of **2**. All the absorption spectra were recorded in 1 cm path quartz cuvettes using a Hitachi U2910 UV-Vis spectrophotometer. According to the methodology a straightline is obtained by plotting reciprocal of the absorbance against the reciprocal of concentration of **2**. The association constant (K_{EDA})is obtained by dividing the intercept by slope and found to be K_{EDA}= 1.03 M^{-1}.

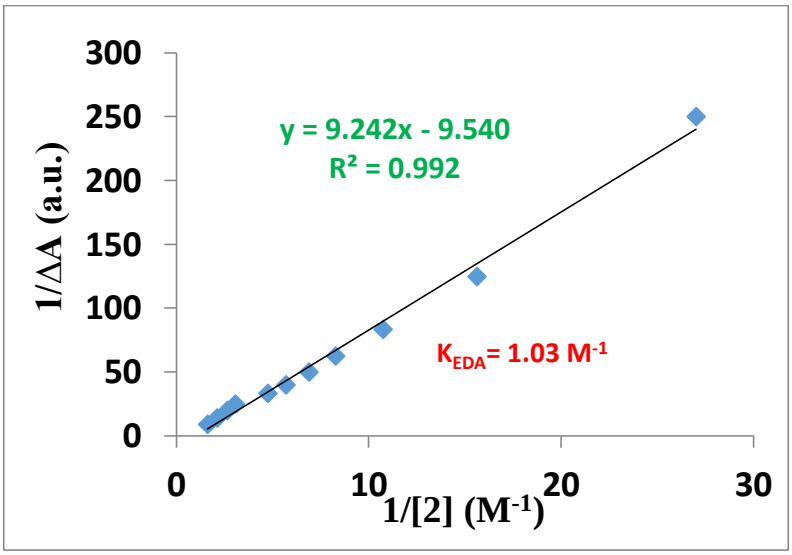
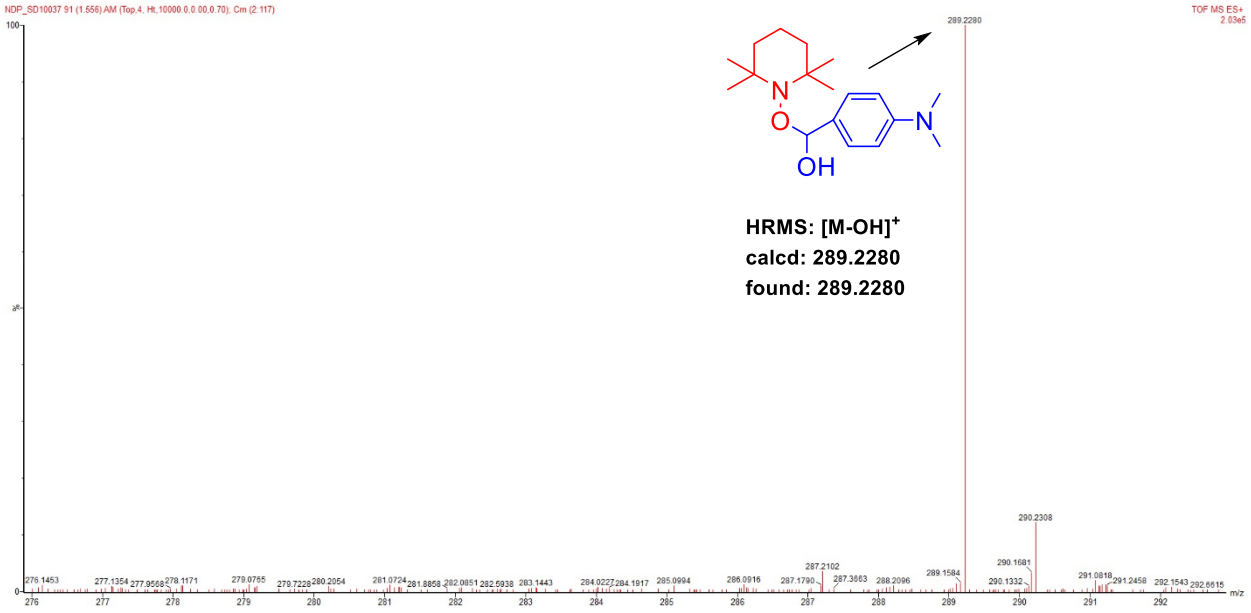
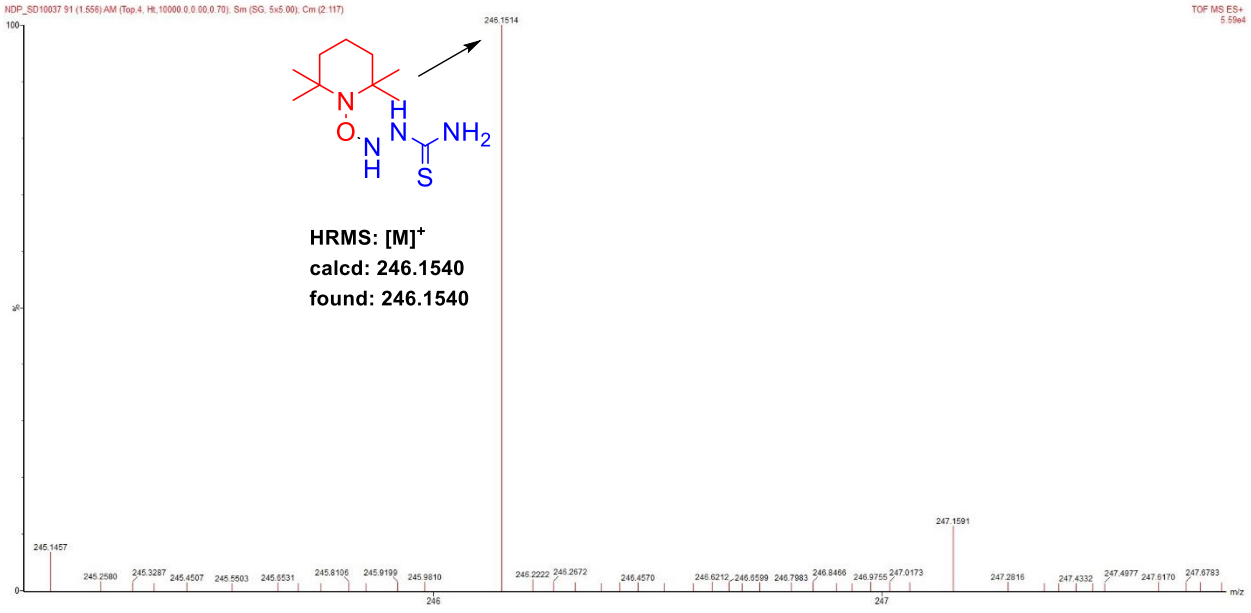


Figure S3: Plot for determination of association constant of the EDA complex (K_{EDA})

(d) Radical trapping experiment with TEMPO: To a mixture of p-dimethylaminobenzaldehyde (**1a**, 1 mmol), thiosemicarbazide (**2**, 1 mmol) and phenacylbromide (**3a**, 1 mmol) in ethanol:water mixture (1:2, 5mL), TEMPO (2eq) was

added and stirred the mixture for 60 minutes under 9W green LED irradiation. The progress of the reaction was monitored by TLC and with completion of the reaction, the mixture was worked up with water and then extracted with ethyl acetate, dried over anhydrous $Na_2SO_4$and evaporated under reduced pressure. The desired product was found in traces along with TEMPO adducts in HRMS. The aldehyde(**1a**)-TEMPO adduct was found as $[M\text{-}OH]^+$ at m/z 289.2280, the thiosemicarbazide(**2**)-TEMPO adduct was found as $[M]^+$ m/z 245.1514, and the phenacyl(**3a**)-TEMPO adduct was found as $[M+H]^+$ at m/z 321.1814. All these adducts not only suggest the radical mechanism for the desired product hydrazinylthiazole but also supports the EDA complex formed between **1a**, **2**, and **3a**.





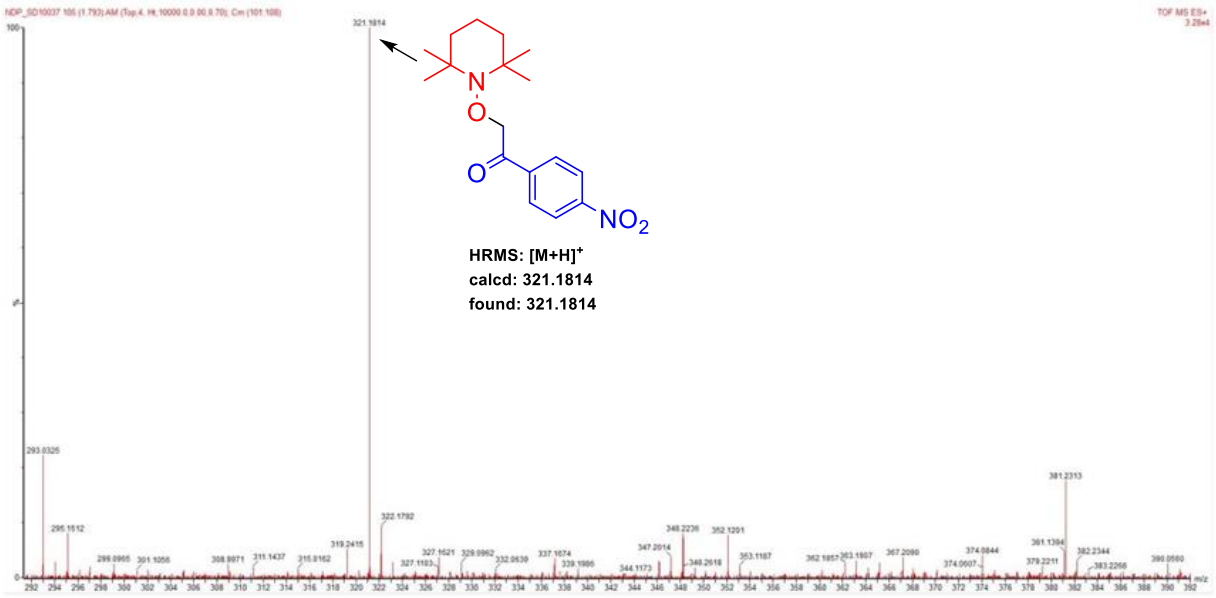
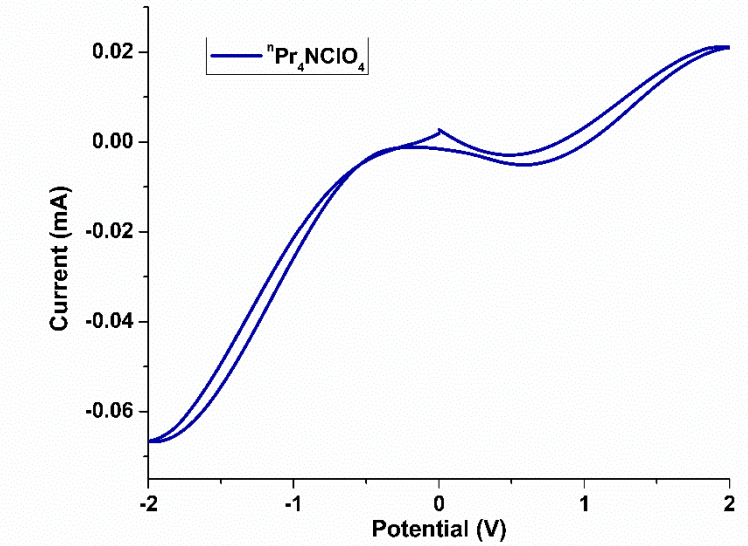
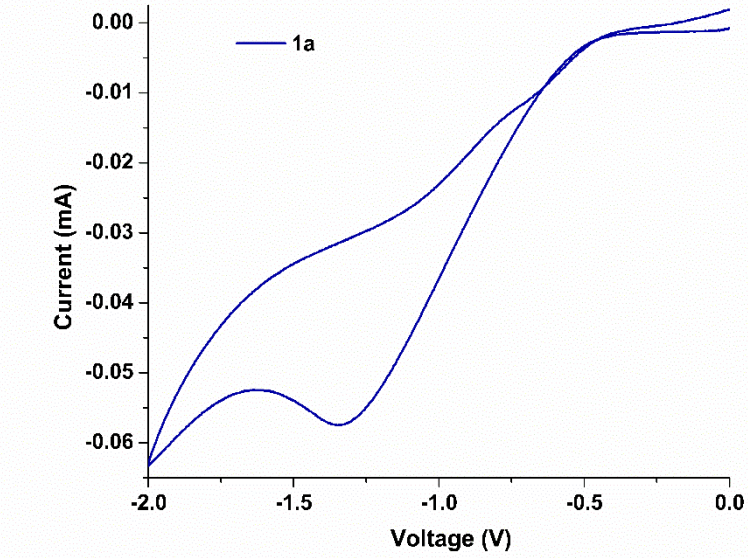


Figure S4: HRMS spectra of TEMPO-adducts of **1a**, **2**, and **3a**.

(e) Quenching experiment with Hydroquinone: To a mixture of *p*-dimethylaminobenzaldehyde (**1a**, 1 mmol), thiosemicarbazide (**2**, 1 mmol) and *p*-nitrophenacyl bromide (**3a**, 1 mmol) in ethanol:water mixture (1:2, 5mL), Hydroquinone (2eq) was added and stirred the mixture for 60 minutes under 9W green LED irradiation. The progress of the reaction was monitored by TLC and with completion of the reaction, the mixture was worked up with water and then extracted with ethyl acetate, dried over anhydrous Na_2SO_4 and evaporated under reduced pressure. The desired product was not detected.

(f) Cyclic voltametrymeasurements: The cyclic voltametry (CV) measurements were carried out on a PGLyte electrochemical workstation by a standard three-electrode system (working electrode: glassy carbon electrode; counter electrode: Pt, reference electrode: Ag/AgCl electrode) using tetrapropylammonium perchlorate (0.02 M) as the electrolyte in ethanol at 50 mV/s scan rate at room temperature. The concentration of **1a**, **2**, and **3a** were kept constant throughout the study at 0.01 M. The voltammograms are shown in figure S5 .From the voltammograms it can be found that **1a** and **3a** showed irreversible reduction while **2** showed two irreversible oxidation. The reduction potential of **1a** is $(E_{red})^{\mathbf{1a}}$= -1.35 V *vs* Ag/AgCl, oxidation potential of **2** is $(E^1{}_{ox})^{\mathbf{2}}$= +1.23 V *vs*Ag/AgCl and +1.48 V *vs* Ag/AgCl, and the reduction potential of **3a** is $(E_{red})^{\mathbf{3a}}$= -1.40 V *vs* Ag/AgCl. All these cyclic voltammograms support for ternary EDA complex formation between **1a**, **2**, and **3a** and the successive electron transfer from **2** to both **1a** and **3a**.


$^{n}Pr_4NClO_4$
0.02
0.00
-0.02
-0.04
-0.06
Current (mA)
-2
-1
0
1
2
Potential (V)


1a
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
Current (mA)
-2.0
-1.5
-1.0
-0.5
0.0
Voltage (V)

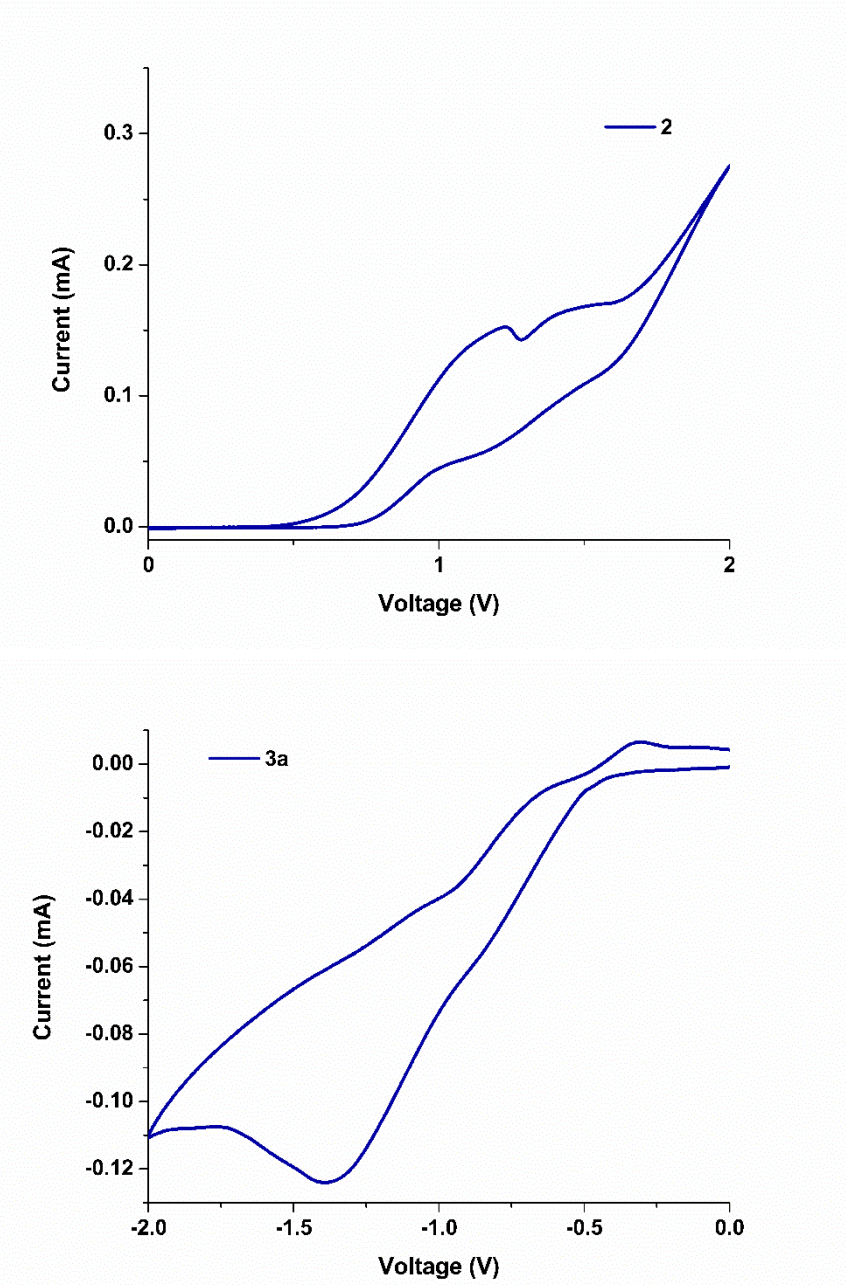


Figure S5: Cyclic voltammograms of $^{n}Pr_4NClO_4$**(**electrolyte**), 1a**, **2**,and **3a**respectively from top.

(g) Light On-Off experiment: A mixture of *p*-dimethylaminobenzaldehyde (**1a**, 1 mmol), thiosemicarbazide (**2**, 1 mmol), p-nitrophenacyl bromide (**3a**, 1 mmol) in ethanol : water mixture (1:2, 5 mL) stirred for 60 minutes under 9W green LED irradiation with a time interval of 10 minutes at room temperature. After every 10 minute interval a aliquot was taken out from the reaction mixture and worked up with water and extracted with ethyl acetate. Then the organic portion dried over anhydrous Na_2SO_4 and the solvent was removed. The yield of the product was obtained using ^{1}H NMR of the crude product in

each interval where 1,3,5-trimethoxybenzene was used as internal standard. The yield of the desired product at different time interval was shown in the figure.

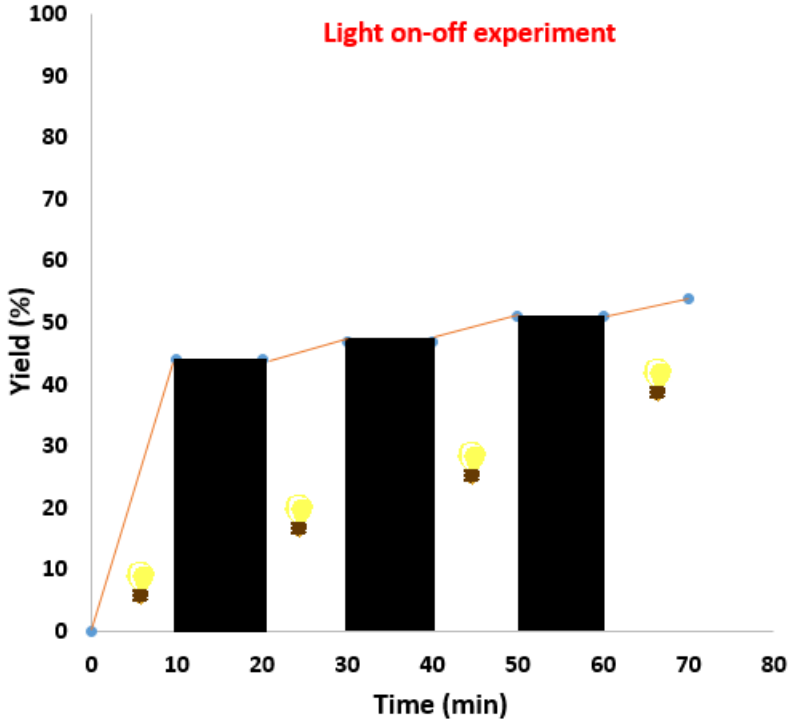


Figure S6: Light on-off experiment

Theoretical Studies:

TD-DFT (Time-Dependent Density Functional Theory) calculations were performed for all three individual molecules, their binary compositions, and all three molecules together to reproduce the UV-Visible spectrum. From the theoretical calculations, it was observed that for single molecules: **1a**, **2**, and **3a**, there was no appreciable absorbance in the visible region, as observed from the experimental results. An absorbance of a higher wavelength was observed for the binary compositions: **1a**+**2** and **2**+**3a**. However, there was no such absorption observed for **1a**+**3a** at a higher wavelength.On the other hand, the mixture of all the components (i.e., **1a**+**2**+**3a**) showed an absorbance of further higher wavelength as to binary mixtures in the range of 600 nm. The results can be elucidated using the given TD-DFT-based UV-Visible spectra (Figure S7).

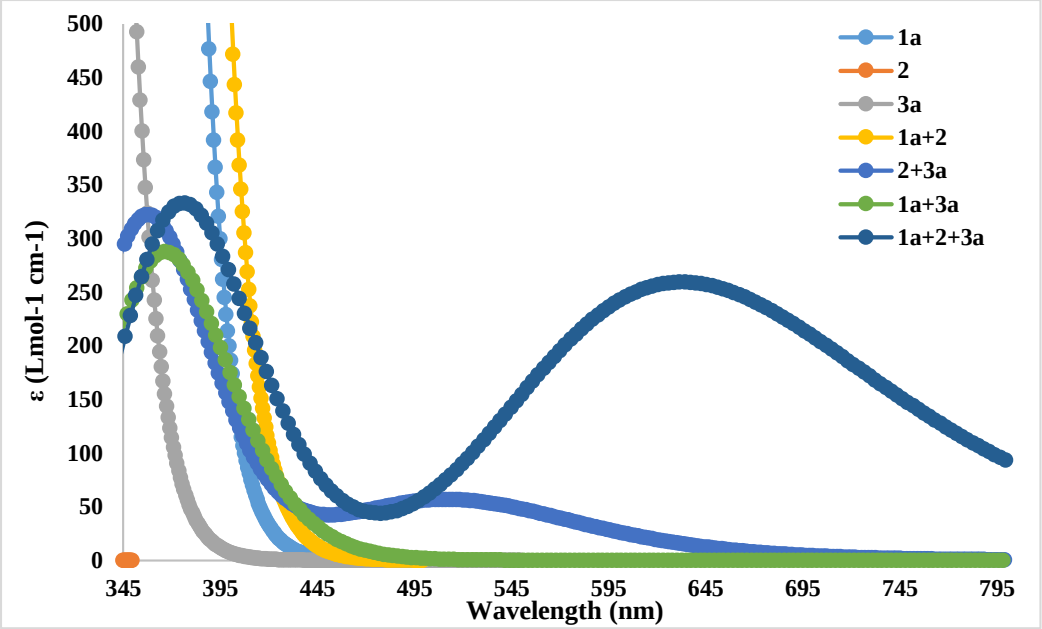


Figure S7: Theoretical UV-Visible Absorption spectrum for the system **1a**, **2**, **3a**, **1a**+**2**, **2**+**3a**, **1a**+**3a** and **1a**+**2**+**3a**

Co-ordinates of the reactant molecules

Compound 1a

22

C	-0.99476200	-0.01554100	-0.00004100
C	-0.17008400	1.14675000	-0.00004300
C	1.20382200	1.04061100	-0.00002400
C	1.84280500	-0.21309600	-0.00002800
C	1.03580500	-1.36256500	-0.00005000
C	-0.34345300	-1.27907600	-0.00006400
H	-0.61780100	2.13129900	-0.00006600
H	1.81465000	1.93739300	-0.00002200
H	1.50411000	-2.34328400	-0.00008400
H	-0.92313100	-2.19208300	-0.00010500
N	-2.35570800	0.08299200	0.00001100
C	-3.18096400	-1.11902200	0.00008300
H	-2.99857800	-1.73412900	0.88727800
H	-4.22957900	-0.83289900	0.00003000

H	-2.99852100	-1.73425300	-0.88701300
C	-3.00284500	1.38986800	0.00000800
H	-2.73637500	1.97368800	-0.88706800
H	-4.08125500	1.25370000	-0.00015200
H	-2.73661000	1.97360800	0.88721000
C	3.29516000	-0.32947200	0.00004500
H	3.67381400	-1.37348100	0.00008000
O	4.08829100	0.60109400	0.00006400

Number of imaginary frequencies=0

Compound 2

10

N	2.19661600	-0.26608700	-0.00002300
H	2.66842200	-0.62690200	-0.82337500
H	2.66838400	-0.62692100	0.82334800
N	0.86278500	-0.70118200	-0.00002600
H	0.63271500	-1.68500200	0.00024400
C	-0.15111600	0.18785300	0.00002400
N	0.18690900	1.47908100	0.00007800
H	1.16516000	1.73279500	-0.00011800
H	-0.52749000	2.18536100	-0.00021800
S	-1.77654100	-0.35557100	-0.00001400

Number of imaginary frequencies=0

Compound 3a

19

C	-0.81613400	-1.00095800	-0.00031900
C	-2.19475300	-1.17755700	-0.00024600
C	-3.01013000	-0.05212800	0.00001300
C	-2.49364500	1.24073500	0.00023700
C	-1.11681000	1.40218000	0.00020700

C	-0.26567300	0.28791700	-0.00008600
H	-0.18664200	-1.88153500	-0.00056000
H	-2.63239300	-2.16585500	-0.00040100
H	-3.16002400	2.09192600	0.00043800
H	-0.68305800	2.39381800	0.00040100
N	-4.47666000	-0.23468900	0.00004700
O	-4.91150900	-1.37930300	0.00059700
O	-5.17770200	0.76913600	-0.00043800
C	1.21717300	0.54747100	-0.00016200
C	2.12138600	-0.67912600	-0.00021900
H	1.94590000	-1.29054900	0.88333000
H	1.94614200	-1.29022400	-0.88403800
O	1.64937500	1.67798400	-0.00011900
Br	4.02791200	-0.23338600	0.00010400

Number of imaginary frequencies=0

1a+2

32

N	-3.79342800	0.58570600	1.88843700
H	-4.15401700	1.53518100	1.87146600
H	-3.00898300	0.56214900	2.53274600
N	-3.33353300	0.24943000	0.59996400
H	-2.62317600	0.82604100	0.15070500
C	-3.88438400	-0.78475100	-0.05915100
N	-4.84352800	-1.46510700	0.57609300
H	-5.11425400	-1.17901800	1.50664500
H	-5.28058500	-2.25215000	0.13055500
S	-3.35627500	-1.19113900	-1.64251700
C	3.08167900	-0.20361100	0.06539800
C	1.73883400	-0.65371000	0.23238600

C	0.67807000	0.21429300	0.10223100
C	0.87720700	1.57625500	-0.20067800
C	2.20020800	2.02536000	-0.36660500
C	3.27699700	1.17187100	-0.23990700
H	1.53835600	-1.69079800	0.46447100
H	-0.33212000	-0.15785500	0.23354100
H	2.38158700	3.07071700	-0.60093000
H	4.27507900	1.56453400	-0.37717000
N	4.13397200	-1.05869400	0.19319100
C	5.50031000	-0.57843900	0.01658000
H	5.74967400	0.20206900	0.74228600
H	6.19075100	-1.40508500	0.16191300
H	5.65992400	-0.17692000	-0.98922500
C	3.91161000	-2.46800000	0.50039500
H	3.31440200	-2.96029500	-0.27349600
H	4.87097300	-2.97535600	0.55747500
H	3.40353800	-2.59625200	1.46128500
C	-0.22144600	2.51119800	-0.34159200
H	0.08209300	3.54888600	-0.58206200
O	-1.41896600	2.26253000	-0.22100900

Number of imaginary frequencies=0

2+3a

29

N	-6.11040700	-1.76085500	-1.34144200
H	-6.63333500	-1.13845100	-1.94951800
H	-6.68217500	-2.57782900	-1.15101800
N	-5.82332200	-1.10226700	-0.13638900
H	-6.56196700	-0.74004500	0.45021500
C	-4.54650800	-0.92288300	0.26366000
N	-3.59295200	-1.40211600	-0.53238100

H	-3.87036700	-1.85392100	-1.39329700
H	-2.61388700	-1.28686100	-0.30395800
S	-4.22343500	-0.11058200	1.74245800
C	2.11782100	-1.51761700	-0.27439300
C	3.49089200	-1.69661600	-0.33558200
C	4.31438600	-0.64827100	0.06568600
C	3.80773300	0.56253700	0.52248000
C	2.42929100	0.72730300	0.58178400
C	1.57334900	-0.30876400	0.18416100
H	1.44995800	-2.31313600	-0.57839900
H	3.92260500	-2.62410200	-0.68472500
H	4.47950000	1.35388700	0.82357600
H	2.03979200	1.67404500	0.93193100
N	5.78057500	-0.82855900	0.00413300
O	6.48740900	0.10801000	0.35322900
O	6.20762400	-1.90502000	-0.39273700
C	0.08194200	-0.19254800	0.23790000
C	-0.56738000	1.07214500	0.76927900
H	-1.60554900	0.87400900	1.02256900
H	-0.04401800	1.52026100	1.60831500
O	-0.62263800	-1.11717200	-0.12988300
Br	-0.59631900	2.43999400	-0.66706200

Number of imaginary frequencies=0

1a+3a

41

C	-4.69949000	-0.30356400	-0.02340300
C	-5.35645900	-1.52414100	0.30939100
C	-6.73090700	-1.61877100	0.28449800
C	-7.53596400	-0.51997000	-0.06906300
C	-6.89504600	0.68564900	-0.39893100

C	-5.51853600	0.80267400	-0.38041500
H	-4.77759300	-2.39413900	0.58844700
H	-7.21265000	-2.55626900	0.54219200
H	-7.49398800	1.54916700	-0.67627800
H	-5.06980200	1.75091800	-0.64311600
N	-3.34003500	-0.20247500	0.00106700
C	-2.68613800	1.05765700	-0.33396400
H	-2.99751200	1.86320400	0.33943300
H	-1.61017600	0.93622300	-0.24109100
H	-2.90852800	1.36720200	-1.36080900
C	-2.51603300	-1.35183400	0.35959300
H	-2.67462200	-2.19087300	-0.32595600
H	-1.46847800	-1.06769700	0.30861300
H	-2.72652800	-1.69799500	1.37704700
C	-8.98903000	-0.61556900	-0.09597500
H	-9.50681200	0.32202700	-0.38985800
O	-9.64709000	-1.61123100	0.17081600
C	4.39311300	0.31653700	0.73874000
C	5.55524900	-0.43047100	0.58888900
C	5.47460800	-1.66814800	-0.03821500
C	4.27356000	-2.18194100	-0.51958200
C	3.12189100	-1.42706800	-0.36112600
C	3.16802200	-0.17387600	0.26725700
H	4.46225000	1.28238300	1.22127800
H	6.50631700	-0.06427000	0.94899000
H	4.25088900	-3.14861000	-1.00280000
H	2.17234100	-1.79997300	-0.72273600
N	6.70788000	-2.46692900	-0.19944500
O	6.61772400	-3.54950200	-0.76396300
O	7.75199300	-2.00309600	0.24051100

C	1.88020900	0.57683900	0.42053700
C	1.87809400	1.96147900	1.04730400
H	0.86272000	2.23592100	1.31158900
H	2.53911800	2.06561200	1.90247400
O	0.82595800	0.09025600	0.05792000
Br	2.47961700	3.29453400	-0.29155000

Number of imaginary frequencies=0

1a+2+3a

51

N	-0.32518700	3.54973000	-1.90803000
H	-0.58700100	4.46629200	-2.25824200
H	-0.91909600	2.86143800	-2.36076300
N	-0.55549700	3.50984600	-0.51864500
H	-1.50310600	3.61581900	-0.15855700
C	0.46013600	3.24084500	0.32196400
N	1.66806500	3.06053100	-0.22124700
H	1.73814600	3.05159900	-1.23012300
H	2.43634100	2.72658200	0.34159900
S	0.18425000	3.15971700	2.01637500
C	-5.02739800	-1.02116400	-0.51979300
C	-3.71730600	-0.46199900	-0.44433200
C	-3.53253300	0.89116400	-0.26796500
C	-4.62590200	1.77390900	-0.15641800
C	-5.92014800	1.22604000	-0.22310800
C	-6.12717000	-0.12669800	-0.40062100
H	-2.84966100	-1.10346300	-0.51559500
H	-2.52450400	1.28699800	-0.20905700
H	-6.78111600	1.88344400	-0.13896300
H	-7.14136400	-0.49800500	-0.45266800
N	-5.21533800	-2.35806200	-0.69972000

C	-6.56443300	-2.90480400	-0.79808100
H	-7.10455100	-2.50455200	-1.66300400
H	-6.50452600	-3.98452700	-0.90693400
H	-7.14840200	-2.68990200	0.10148500
C	-4.07606600	-3.24788800	-0.90931600
H	-3.39359000	-3.24428100	-0.05535100
H	-4.44055500	-4.26320400	-1.04282900
H	-3.50901500	-2.97169600	-1.80491800
C	-4.45908100	3.20390500	0.01549300
H	-5.40570800	3.77117200	0.11106600
O	-3.39735100	3.82123300	0.06104900
C	3.17351500	-2.10122000	0.38928600
C	2.08741100	-2.96725900	0.42645500
C	0.87419200	-2.49150600	0.91136200
C	0.71395000	-1.18534000	1.36373900
C	1.80117600	-0.32753100	1.30761800
C	3.03741200	-0.77301100	0.81767600
H	4.11407400	-2.47118100	0.00247600
H	2.17411000	-3.98898500	0.08451600
H	-0.24160300	-0.85226300	1.74396000
H	1.68990500	0.69404500	1.64879500
N	-0.28964300	-3.40049900	0.94043200
O	-1.33772900	-2.96803000	1.40835800
O	-0.15060000	-4.52992600	0.49217200
C	4.16478500	0.21027500	0.76995400
C	5.58164600	-0.27655500	0.51418500
H	6.28643500	0.46113600	0.88250100
H	5.79834200	-1.25951800	0.92054200
O	3.97671600	1.39977400	0.95195700
Br	5.88852100	-0.39498900	-1.44195300

Number of imaginary frequencies=0

Biological Studies:

Materials and Methods:

Total Phenolic content:

The Folin-Ciocalteu method was used to evaluate total phenolic content of individual samples. In brief, 0.4 mL of sample (50-800 µg/mL) solution was mixed with 0.4 mL of 10% (w/v) Folin-Ciocalteu reagent and 1.0 mL of Na_2CO_3 (7%) to the mixture after 5 min, and incubated at 50 ^{0}C for 10 min. UV-VIS Spectrophotometer (Shimazu, UV-1780) was used to measure the absorbance at 765 nm against a blank without sample. The final data were expressed as mg/g of gallic acid equivalents in milligrams per gram (mg GAE/g) of dry extract.

Total flavonoid content

The total flavonoid content was estimated by following the previously described method. Total 1 mL of sample and standard (quercetin) solution (25-200 µg/mL) were added with 0.2 mL of 10% (w/v) $AlCl_3$ solution in methanol, 0.2 mL (1 M) potassium acetate and 5.6 mL distilled water. After 30 min incubation at room temperature, absorbance of the mixture was taken at 415 nm against the blank. The results were expressed as mg/g of quercetin equivalents in milligrams per gram (mg QE/g) of dry extract.

DPPH radical scavenging assay

Radical scavenging activity (RSA) of different samples was measured by using the DPPH method to evaluate the antioxidant activity The sample solution of 2 mL (10-100 µg/mL) in methanol was mixed into 1 mL of DPPH (0.3 mM) solution. The combined solutions were stored in a dark area for 30 min and the absorbance was recorded at 517 nm against blank. Ascorbic acid was used as a positive control. The percentage of DPPH• scavenging activity (RSA %) was measured using the following equation:

$$\% \text{ Scavenging of DPPH•} = [(A_0 - A_1)/A_0] \text{ X } 100$$

A_0 = absorbance of the control and **A_1**= absorbance of the test samples. After determining the % scavenging of DPPH• of the different concentrations, the IC_{50} values were determined for the ascorbic acid and samples.

Reducing power assay

The Fe^{3+} reducing power of the sample was measured by following the method available in the literature. The different concentrations (100 to 300 µg/ml) of samples were mixed with phosphate buffer (0.2 M, pH 6.6) with potassium hexacyanoferrate (0.1%) followed by incubation at 50°C for 20 min. Further 10% tricarboxylic acid (TCA), distilled water (2.5 ml), and $FeCl_3$ solution (0.01%) were added for reaction mixture and incubated at room temperature for 10 min for color development. The absorbance of the final solution was recorded at 700 nm. Ascorbic acid was used as a positive control.

α-Amylase Inhibitory Assay

Following the literature, the reaction mixture was prepared by adding 25 ml sample solution (100-400 µg/mL), 50 µL of α-amylase (10 µg/mL) solution in phosphate buffer (pH 6.9) and 50 µL of starch solution (0.05%). The reaction was stopped by adding 25 µL of 1M HCl followed by adding up 100 mL of iodine-potassium iodide solution. The solution mixture was incubated for 10 min at 37 °C followed by measuring the absorbance at 630 nm. Acarbose was used as a positive control. The following formula was used to calculate the α-amylase inhibitory activity.

$$\% \text{ Inhibitory activity} = [(A_0 - A_1)/A_0] \text{ X } 100$$

A_0 = absorbance of the control and A_1 = absorbance of the test samples. After determining the α-amylase inhibitory activity of the different concentrations, the IC_{50} values were determined for the acarbose and samples.

Spectroscopic Data of Synthesized Compounds:

(E)-N,N-dimethyl-4-((2-(4-(4-nitrophenyl)thiazol-2-yl)hydrazono)methyl)aniline(**4a**) yield: 98% (360 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.96 (s, 1H, NH), 8.28-8.25 (m, 2H, aromatic H), 8.10(d, 2H,*J* = 8.0 Hz, aromatic H), 7.93 (s, 1H, H-C=N-), 7.65 (s, 1H, Thiazole H), 7.48 (d, 2H, *J* = 8.0 Hz, aromatic H), 6.74 (d, 2H, *J* = 8.0 Hz, aromatic H), 2.96 (s, 6H, -NMe_2); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 169.30, 151.57, 148.95, 146.58, 143.35, 141.29, 128.12, 126.75, 124.55, 122.18, 112.38, 108.38,39.98. HRMS (ESI) m/z calculated for $C_{18}H_{18}N_5O_2S$ $[M+H]^+$368.1181, found368.1181.

(E)-4-(4-bromophenyl)-2-(2-(2-nitrobenzylidene)hydrazinyl)thiazole (**4b**) yield: 92% (370 mg) ^{1} H NMR (400 MHz, DMSO-*d6*): δ 12.54(s, 1H, NH), 8.42(s, 1H, H-C=N-), 8.03-8.01(m, 2H, aromatic H), 7.81-7.75(m, 3H, aromatic H), 7.62-7.58(m, 3H, aromatic H), 7.45(s, 1H, thiazole H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 170.55, 152.11, 150.08, 139.05, 136.33, 136.16, 134.20, 132.44, 131.10, 130.20, 130.16, 127.34, 123.27, 107.94, HRMS (ESI) m/z calculated for $C_{16}H_{12}BrN4O2S$ $[M+H]^+$ 402.9864, found 402.9865.

(E)-4-(4-bromophenyl)-2-(2-(4-methoxybenzylidene)hydrazinyl)thiazole (**4c**)[3a] yield: 95% (368 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.02 (s, 1H, NH), 7.99 (s, 1H, H-C=N-), 7.81-7.79 (m, 2H, aromatic H), 7.61-7.59 (m, 4H, aromatic H), 7.37 (s, 1H, Thiazole H), 7.01-6.98 (m, 2H, aromatic H), 3.79 (s, 3H, -OCH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.95, 160.76, 149.83, 141.93, 134.42, 131.99, 128.30, 128.00, 127.44, 120.93, 114.83, 104.74, 55.74.

(E)-4-(4-bromophenyl)-2-(2-(4-chlorobenzylidene)hydrazinyl)thiazole (**4d**)[3b] yield: 92% (361 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.25(s, 1H, -NH), 8.01(s, 1H, H-C=N-), 7.79(d, *J*=8.0 Hz, 2H, aromatic H), 7.66(d, 2H,*J*=8.0 Hz, aromatic H), 7.60-7.57(m, 2H, aromatic H), 7.48(d, 2H, *J*=8.0 Hz, aromatic H), 7.41(s, 1H, thiazole H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.68, 149.92, 140.52, 134.31, 134.11, 133.78, 132.02, 129.40, 128.34, 128.01, 121.02, 105.25.

(E)-4-(4-bromophenyl)-2-(2-(4-methylbenzylidene)hydrazinyl)thiazole (**4e**)[3c] yield: 92% (342 mg) ^{1}H NMR (400 MHz, DMSO-d6): δ 12.09(s, 1H, NH), 7.99(s, 1H, H-C=N-), 7.79(d, 2H, *J*=8.0 Hz, aromatic H), 7.58(d, 2H, *J* = 8.0 Hz aromatic H), 7.53(d, 2H, *J* = 8.0 Hz, aromatic H),

7.37 (s, 1H, thiazole H), 7.23(d, 2H, *J* = 8.0 Hz, aromatic H), 2.31 (s, 3H, -CH3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.86, 149.82, 142.03, 139.50, 134.38, 132.11, 132.00, 129.91, 128.00, 126.74, 120.96, 104.92, 21.48.

(E)-3-(2-(2-benzylidenehydrazinyl)thiazol-4-yl)-2H-chromen-2-one (**4f**)[3d] yield: 93% (323 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.24 (s, 1H, NH), 8.55 (s, 1H, H-C=N-), 8.07 (s, 1H, aromatic H), 7.86 (d, 1H,*J* = 8.0 Hz, aromatic H), 7.78 (s, 1H, Thiazole H), 7.68-7.61 (m, 3H, aromatic H), 7.47-7.38 (m, 5H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.19, 159.22, 152.79, 144.47, 142.18, 138.65, 134.75, 132.18, 129.87, 129.33, 129.32, 126.79, 125.19, 121.01, 119.66, 116.37, 111.15.

(E)-3-(2-(2-(4-methoxybenzylidene)hydrazinyl)thiazol-4-yl)-2H-chromen-2-one (**4g**)[3d] yield: 94% (354 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.06 (s, 1H, NH), 8.53 (s, 1H, H-C=N-), 8.01 (s, 1H, aromatic H), 7.85 (d, *J* = 8.0Hz, 1H, aromatic H), 7.75 (s, 1H, thiazole H), 7.65-7.60 (m, 3H, aromatic H), 7.45 (d, *J* = 8.0Hz, 1H, aromatic H), 7.41-7.37 (m, 1H, aromatic H), 7.00 (d, *J* = 8.0 Hz, 2H, aromatic H), 3.79 (s, 3H, OCH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ168.26, 160.80, 159.22, 152.77, 144.41, 142.21, 138.57, 132.13, 129.28, 128.34, 127.37, 125.17, 121.03, 119.67, 116.36, 114.83, 110.83, 55.74.

(E)-4-(4-bromophenyl)-2-(2-(furan-2-ylmethylene)hydrazinyl)thiazole (**4h**)[3e] yield: 92% (320 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.13 (s, 1H, NH), 7.91 (s, 1H, H-C=N), 7.79-7.77(m,3H, aromatic H), 7.58 (d, 2H, *J* = 8.0 Hz, aromatic H), 7.38 (s, 1H, aromatic H,) 6.80-6.79 (m, 1H, aromatic H), 6.60-6.58 (m, 1H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.51, 149.75, 145.02, 134.31, 132.17, 132.00, 128.00, 121.00, 112.78, 112.54, 105.02.

(E)-4-(4-nitrophenyl)-2-(2-(pyridin-2-ylmethylene)hydrazinyl)thiazole (**4i**)[3f] yield: 94% (305 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.54 (s,1H, NH), 8.58 (d, 1H, *J* = 4.0 Hz, aromatic H), 8.29-8.26(m, 2H, aromatic H), 8.12-8.07 (m, 3H, H-C=N- and two aromatic H), 7.87-7.85 (m, 2H, aromatic H), 7.77 (s,1H, Thiazole H), 7.38-7.35 (m, 1H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.72, 153.50, 149.95, 149.07, 146.74, 142.50, 140.98, 137.36, 126.83, 124.61, 124.26 119.75, 109.53.

4-(4-nitrophenyl)-2-((E)-2-((E)-3-phenylallylidene)hydrazinyl)thiazole (**4j**) yield: 91% (318 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.20 (s, 1H, NH), 8.26 (d, 2H, *J* = 8.0 Hz, aromatic H), 8.09 (d, 2H, *J* = 12 Hz, olefenic H), 7.88 (d, 1H, J = 4 H, aromatic H), 7.68 (s, 1H, H-C=N-), 7.59 (d, 2H, *J* = 8.0 Hz, aromatic H), 7.38-7.34 (m, 3H, aromatic H and thiazole H), 6.99-6.97 (m, 2H, olefenic H and aromatic H);^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.64, 149.01, 146.67, 145.01, 141.11, 137.62, 136.57, 129.26, 129.01, 127.43, 126.80, 125.53, 124.59, 108.96. HRMS (ESI) m/z calculated for $C_{18}H_{15}N_4O_2S$ $[M+H]^+$351.0915, found 351.0916.

(E)-2-(2-benzylidenehydrazinyl)-4-phenylthiazole (**4k**)[3g] yield: 93% (259 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.19 (s, 1H, NH), 8.04 (s, 1H, H-C=N-), 7.87-7.85 (m, 2H, aromatic H), 7.67-7.65 (m, 2H, aromatic H), 7.46-7.39 (m, 5H, Thiazole H and aromatic H), 7.39-7.30 (m, 2H, aromatic H); ^{13}C NMR (75 MHz, DMSO-*d6*): δ 168.64, 151.07, 141.63, 135.15, 134.85, 129.67, 129.25, 129.02, 127.95, 126.68, 125.95, 104.12.

(E)-2-methoxy-4-((2-(4-(4-nitrophenyl)thiazol-2-yl)hydrazono)methyl)phenol (**4l**) yield: 93% (344 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.08 (s, 1H, NH), 9.46 (s, 1H, OH), 8.29-8.26 (m, 2H, aromatic H), 8.12-8.09 (m, 2H, aromatic H), 7.95 (s, 1H, H-C=N-), 7.69 (s, 1H, Thiazole H), 7.24 (d, 1H, *J* = 2.0 Hz, aromatic H), 7.09-7.07 (m, 1H, aromatic H), 6.83 (d, 1H, *J* = 8.0 Hz, aromatic H), 3.83 (s, 3H, -OCH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 169.26, 148.86, 148.41, 146.64, 142.88, 141.23, 126.77, 126.19, 124.58, 120.98, 116.12, 109.77, 108.67, 55.98, HRMS (ESI) m/z calculated for $C_{17}H_{15}N_4O_4S$ $[M+H]^+$ 371.0814, found 371.0809.

(E)-2-methoxy-5-((2-(4-(4-nitrophenyl)thiazol-2-yl)hydrazono)methyl)phenol (**4m**) yield: 93% (344 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.09 (s, 1H, NH), 9.26 (s, 1H, OH), 8.28 (d, 2H, *J* = 8.0 Hz, aromatic H), 8.11 (d, 2H, *J* = 8.0 Hz, aromatic H), 7.92 (s, 1H, H-C=N-), 7.70 (s, 1H, thiazole H), 7.20 (d, 1H, *J* = 4.0 Hz, aromatic H), 7.02-6.93 (m, 2H, aromatic H), 3.80 (s, 3H, -OCH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 178.00, 150.03, 147.10, 146.88, 143.26, 127.47, 126.79, 124.59, 120.54, 120.19, 113.70, 112.41, 112.19, 108.72, 56.11. HRMS (ESI) m/z calculated for $C_{17}H_{15}N_4O_4S$ $[M+H]^+$371.0814, found 371.0810.

(E)-4-(4-bromophenyl)-2-(2-((5-bromothiophen-2yl)methylene)hydrazinyl)thiazole (**4n**)[3c] yield: 93% (412 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.24 (s, 1H, NH), 8.11(s, 1H, H-C=N-), 7.78(d, 2H, *J* = 8.0 Hz, aromatic H), 7.58(d, 2H, *J* = 8.0 Hz, aromatic H), 7.40(s, 1H, thiazole H), 7.22-7.19 (m, 2H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.25, 157.94, 141.31, 136.29, 134.24, 132.02, 131.72, 130.07, 127.99, 121.04, 113.76, 105.27.

(E)-2-(2-(2-nitrobenzylidene)hydrazinyl)-4-(p-tolyl)thiazole (**4o**)[3h] yield: 94% (318 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.55 (s, 1H, NH), 8.43 (s, 1H, H-C=N-), 8.07-8.04 (m, 2H, aromatic H), 7.83-7.75 (m, 3H, aromatic H), 7.65-7.60 (m, 1H, aromatic H), 7.33 (s, 1H, Thiazole H), 7.23 (d, 2H, *J* = 8.0 Hz), 2.34 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.07, 147.92, 137.39, 136.81, 133.98, 132.18, 130.18, 129.67, 129.04, 127.95, 125.97, 125.17, 103.80, 21.29.

(E)-2-(2-(2-nitrobenzylidene)hydrazinyl)-4-phenylthiazole (**4p**)[3i] yield: 90% (291 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.56 (s, 1H, NH), 8.43 (s, 1H, H-C=N-), 8.06-8.03 (m, 2H, aromatic H), 7.87-7.77 (m, 3H, aromatic H), 7.64-7.59 (m, 1H, aromatic H), 7.44-7.40 (m, 3H, Thiazole H and aromatic H), 7.33-7.29 (m, 1H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.19, 162.76, 147.92, 136.62, 134.99, 134.00, 130.21, 129.12, 129.02, 128.11, 127.97, 126.02, 125.18, 104.88. HRMS (ESI) m/z calculated for $C_{16}H_{13}N_4O_2S$ $[M+H]^+$325.0759, found325.0759.

(E)-2-(2-(4-nitrobenzylidene)hydrazinyl)-4-(4-nitrophenyl)thiazole (**4q**)[3f]yield: 96% (354 mg)^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.62 (s, 1H, NH), 8.30-8.27 (m, 2H, aromatic H), 8.13 (s, 1H, H-C=N-), 7.92-7.87 (m, 4H, aromatic H), 7.48 (m, 3H, Thiazole H and aromatic H); ^{13}C NMR (75 MHz, DMSO-*d6*): δ 167.88, 147.84, 140.79, 138.95, 133.44, 132.09, 128.53, 127.25, 127.25. 126.96, 123.97, 105.15.

(E)-4-(4-chlorophenyl)-2-(2-(2-nitrobenzylidene)hydrazinyl)thiazole (**4r**)[3j] yield: 93% (333 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.55 (s, 1H, NH), 8.43 (s, 1H, H-C=N-), 8.04-8.02 (m, 2H, aromatic H), 7.88-7.86 (m, 2H, aromatic H), 7.81-7.77 (m, 1H, H-C=N-), 7.63-7.59 (m, 1H,

aromatic H), 7.48-7.45 (m, 3H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 168.54, 147.80, 137.10, 133.96, 133.56, 132.64, 130.42, 129.14, 129.14, 128.59, 128.22, 127.69, 125.06, 105.61.

(E)-2-(2-(4-methoxybenzylidene)hydrazinyl)-4-(4-nitrophenyl)thiazole (**4s**)[3a] yield: 97% (343 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 12.14 (s, 1H, NH), 8.29-8.26 (m, 2H, aromatic H), 8.11 (d, 2H, *J* = 8.0 Hz, aromatic H), 8.01 (s, 1H, H-C=N-), 7.70 (s, 1H, Thiazole H), 7.61 (d, 2H, *J* = 8.0 Hz, aromatic H), 7.01 (d, 2H, *J* = 8.0 Hz, aromatic H), 3.80 (s, 3H, -OCH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 169.23, 160.84, 149.00, 146.66, 142.31, 141.21, 128.37, 127.36, 126.79, 124.57, 114.84, 108.76, 55.75.

(E)-2-(2-(1-(4-iodophenyl)ethylidene)hydrazinyl)-4-(4-nitrophenyl)thiazole (**6a**) yield: 95% (441 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.48 (s, 1H, NH), 8.29 (d, 2H, *J* = 8.0 Hz, aromatic H), 8.13 (d, 2H,*J* = 8.0 Hz, aromatic H), 7.80-7.74 (m, 3H, aromatic H and thiazole H), 7.57 (d, 2H,*J* = 8.0 Hz, aromatic H), 2.35 (s, 3H, CH_3); ^{13}C NMR (75 MHz, DMSO-*d6*): δ 170.52, 149.15, 146.62, 141.24, 138.08, 137.75, 137.68, 130.36, 128.15, 126.77, 124.59, 109.61, 14.29. HRMS (ESI) m/z calculated for $C_{17}H_{14}IN_4O_2S$ $[M+H]^+$464.9882, found 464.9877.

(E)-3-(2-(2-(1-phenylethylidene)hydrazinyl)thiazol-4-yl)-2H-chromen-2-one (**6b**)[3d] yield: 93% (336 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.33 (s, 1H, NH), 8.58 (s, 1H, thiazole H), 7.84-7.78 (m, 4H, aromatic H), 7.65-7.62 (m, 1H, aromatic H), 7.48-7.37 (m, 5H, aromatic H), 2.34 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 169.79, 159.24, 152.78, 147.39, 138.53, 138.26, 132.18, 129.28, 128.92, 126.18, 125.24, 121.15, 119.65, 116.39, 111.54, 14.54.

(E)-4-(4-bromophenyl)-2-(2-(1-(4-bromophenyl)ethylidene)hydrazinyl)thiazole (**6c**)[3k] yield: 92% (415 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.36 (s, 1H, NH), 7.84-7.82 (m, 2H, aromatic H), 7.73-7.71 (m, 2H, aromatic H), 7.63-7.59 (m, 4H, aromatic H), 7.42 (s, 1H, Thiazole H), 2.31 (s, 3H, -CH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 170.25, 149.89, 146.08, 137.45, 134.32, 132.02, 131.84, 128.13, 128.02, 122.59, 120.99, 105.54, 14.27.

(E)-2-(2-(1-(4-bromophenyl)ethylidene)hydrazinyl)-4-(p-tolyl)thiazole (**6d**)[3l]yield: 93% (359 mg)^{1}H NMR (300 MHz, DMSO-*d6*): δ 11.32 (s, 1H, NH), 7.79-7.72 (m, 4H, aromatic H), 7.63 (d, 2H, *J* = 8.4 Hz, aromatic H), 7.27-7.22 (m, 3H, aromatic H), 2.33 (s, 3H, -CH_3), 2.32 (s, 3H, -CH_3); ^{13}C NMR (75 MHz, DMSO-*d6*): δ 169.98, 150.95, 145.98, 137.7, 137.17, 132.56, 131.69, 129.48, 128.03, 125.94, 122.35, 103.48, 21.09, 14.10.

(E)-2-(2-(1-phenylethylidene)hydrazinyl)-4-(p-tolyl)thiazole (**6e**)[3m] yield: 92% (282 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.22 (s, 1H, NH), 7.80-7.76 (m, 4H, aromatic H), 7.45-7.35 (m, 3H, aromatic H), 7.24-7.21 (m, 3H, aromatic H and thiazole H), 2.32 (s, 6H, 2×CH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 170.22, 146.78, 138.42, 137.20, 132.62, 129.65, 129.13, 128.89, 126.13, 125.95, 103.63, 21.27, 14.46.

(E)-4-(4-nitrophenyl)-2-(2-(1-(4-nitrophenyl)ethylidene)hydrazinyl)thiazole (**6f**) yield: 96% (368 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.75 (s, 1H, NH), 8.32-8.27 (m, 4H, aromatic H), 8.15-8.14 (m, 2H, aromatic H), 8.04-8.02 (m, 2H, aromatic H), 7.80 (s, 1H, Thaizole H), 2.39 (s, 3H, -CH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 170.21, 149.28, 147.60, 145.28, 144.73, 141.15,

127.15, 126.85, 124.64, 124.19, 110.08, 14.46, HRMS (ESI) m/z calculated for $C_{17}H_{14}N_5O_4S$ $[M+H]^+$ 384.0766, found 384.0769.

(E)-4-phenyl-2-(2-(1-phenylethylidene)hydrazinyl)thiazole (**6g**)[3g] yield: 90% (264 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.27 (s, 1H, NH), 7.90-7.80 (m, 2H, aromatic H), 7.79-7.77 (m, 2H, aromatic H), 7.45-7.35 (m, 6H, Thiazole H and six aromatic H), 7.33-7.32(m, 1H, aromatic H), 2.33 (s, 3H, -CH_3); ^{13}C NMR (75 MHz, DMSO-*d6*): δ 170.29, 151.02, 146.90, 138.39, 135.25, 129.09, 129.02, 128.84, 127.89, 126.10, 125.96, 104.48, 14.44.

4-(4-chlorophenyl)-2-(2-(diphenylmethylene)hydrazinyl)thiazole (**6h**) yield: 92% (358 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 10.66 (s, 1H, NH), 7.82 (d, 2H, *J* = 8.0 Hz, aromatic H), 7.58–7.55 (m, 3H, thiazole H and aromatic H), 7.45–7.32 (m, 10H, aromatic H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 169.56, 149.95, 149.11, 137.89, 134.05, 133.18, 132.38, 129.74, 129.27, 129.05, 128.93, 128.24, 127.67, 127.15, 105.62, HRMS (ESI) m/z calculated for $C_{22}H_{17}ClN_3S$ $[M+H]^+$ 390.0832, found 390.0830.

(E)-4-(4-bromophenyl)-2-(2-(1-(pyridin-2-yl)ethylidene)hydrazinyl)thiazole (**6i**)[3n] yield: 93% (347 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.50 (s, 1H, NH), 8.57 (d, 1H, *J* = 8.0 Hz, aromatic H), 8.03-8.00 (m, 1H, aromatic H), 7.84-7.81 (m, 3H, aromatic H), 7.62-7.59 (m, 2H, aromatic H), 7.46 (s, 1H, Thiazole H), 7.37-7.34 (m, 1H, aromatic H), 2.39 (s, 3H, -CH_3); ^{13}C NMR (75 MHz, DMSO-*d6*): δ 169.97, 155.31, 150.01, 149.06, 147.59, 137.02, 134.43, 132.03, 128.03, 123.93, 121.00, 120.02, 105.89, 12.75.

4-(4-bromophenyl)-2-(2-(propan-2-ylidene)hydrazinyl)thiazole (**6j**)[3o] yield: 90% (279 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 10.67 (s, 1H, NH), 7.80-7.76 (m, 2H, aromatic H), 7.58-7.55 (m, 2H, aromatic H), 7.29 (s, 1H, Thaizole H), 1.94 (s, 3H, -CH_3), 1.92 (s, 3H, -CH_3); ^{13}C NMR (100MHz, DMSO-*d6*): δ 170.53, 150.39, 149.70, 134.62, 131.95, 127.98, 120.78, 104.61, 25.34, 18.17.

(E)-4-(4-bromophenyl)-2-(2-(1-(4-nitrophenyl)ethylidene)hydrazinyl)thiazole (**6k**)[3p] yield: 95% (396 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 11.63 (s, 1H, NH), 8.25-8.24(m, 2H, aromatic H), 8.00-7.99 (m, 2H, aromatic H), 7.82 (d, 2H, *J* = 8.0 Hz, aromatic H), 7.60-7.59 (m, 2H, aromatic H), 7.46(s, 1H, Thiazole H), 2.36 (s, 3H, -CH_3); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 169.91, 147.47, 144.45, 134.30, 132.04, 131.74, 128.04, 127.03, 125.77, 124.16, 121.06, 106.06, 14.36.

2-(2-cyclohexylidenehydrazinyl)-4-(4-nitrophenyl)thiazole (**6l**)[3q] yield: 92% (291 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 10.98 (s, 1H, NH), 8.28-8.25 (m, 2H, aromatic H), 8.11-8.08 (m, 2H, aromatic H), 7.62 (s, 1H, thiazole H), 2.46-2.43 (m, 2H, cyclohexane ring), 2.27-2.24 (m, 2H, cyclohexane ring), 1.65-1.57 (m, 6H, cyclohexane ring); ^{13}C NMR (100 MHz, DMSO-*d6*): δ 170.98, 156.17, 146.53, 141.44, 126.72, 124.57, 108.61, 35.23, 27.68, 27.31, 26.01, 25.55.

(E)-4-(4-nitrophenyl)-2-(2-(1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)hydrazinyl)thiazole(**6m**) yield: 92% (340 mg) ^{1}H NMR (400 MHz, DMSO-*d6*): δ 10.72 (s, 1H, NH), 8.28-8.24 (m, 2H, aromatic H), 8.11-8.07 (m, 2H, aromatic H), 7.61 (s, 1H, thiazole H), 2.04-1.82 (m, 2H, camphor H), 1.81-1.68 (m, 2H, camphor H), 1.36-1.29 (m, 3H, camphor H), 1.28-1.18 (m, 6H, camphor H), 0.75 (s, 3H, camphor H); ^{13}C NMR (100 MHz, DMSO-*d6*): δ

170.88, 165.38, 148.87, 146.50, 141.46, 126.69, 124.54, 108.55, 52.60, 48.10, 43.91, 35.25, 32.92, 27.34, 19.69, 18.97, 11.65. HRMS (ESI) m/z calculated for $C_{19}H_{23}N_4O_2S$ $[M+H]^+$371.1542, found 371.1539.

(E)-2-(4-(dimethylamino)benzylidene)hydrazinecarbothioamide (**G**) ^{1}H NMR (400 MHz, $CDCl_3$): δ9.38 (s, 1H, NH), 7.76 (s, 1H, H-C=N-), 7.53, (d, 2H, *J* = 8.0 Hz, aromatic H), 7.20 (s, 1H, NH_2), 6.69 (d, 2H, *J* = 9.2 Hz, aromatic H), 6.28 (s, 1H, NH_2) 3.05(s, 6H, NMe_2); ^{13}C NMR (75 MHz, $CDCl_3$): δ 177.90, 151.76, 144.14, 128.46, 120.15, 111.40, 39.47, HRMS (ESI) m/z calculated for $C_{10}H_{15}N_4S$ $[M+H]^+$ 223.1017, found 223.1016.

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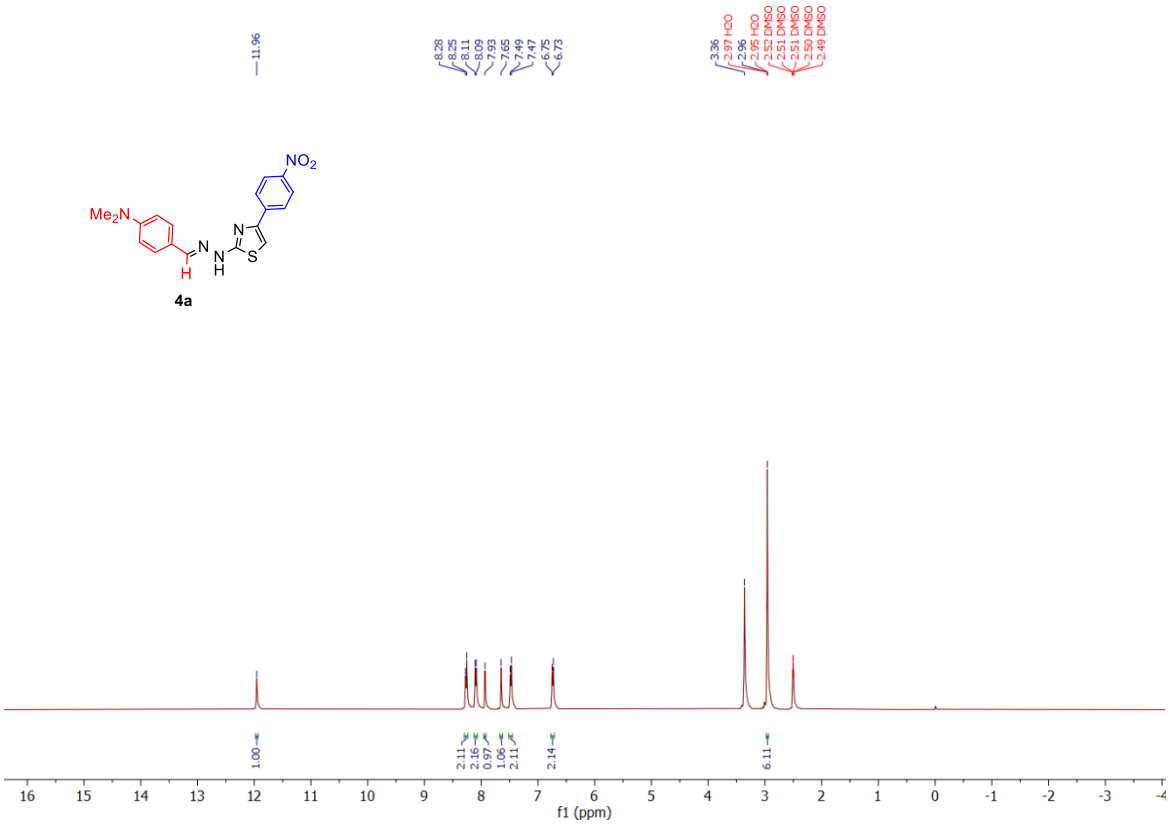
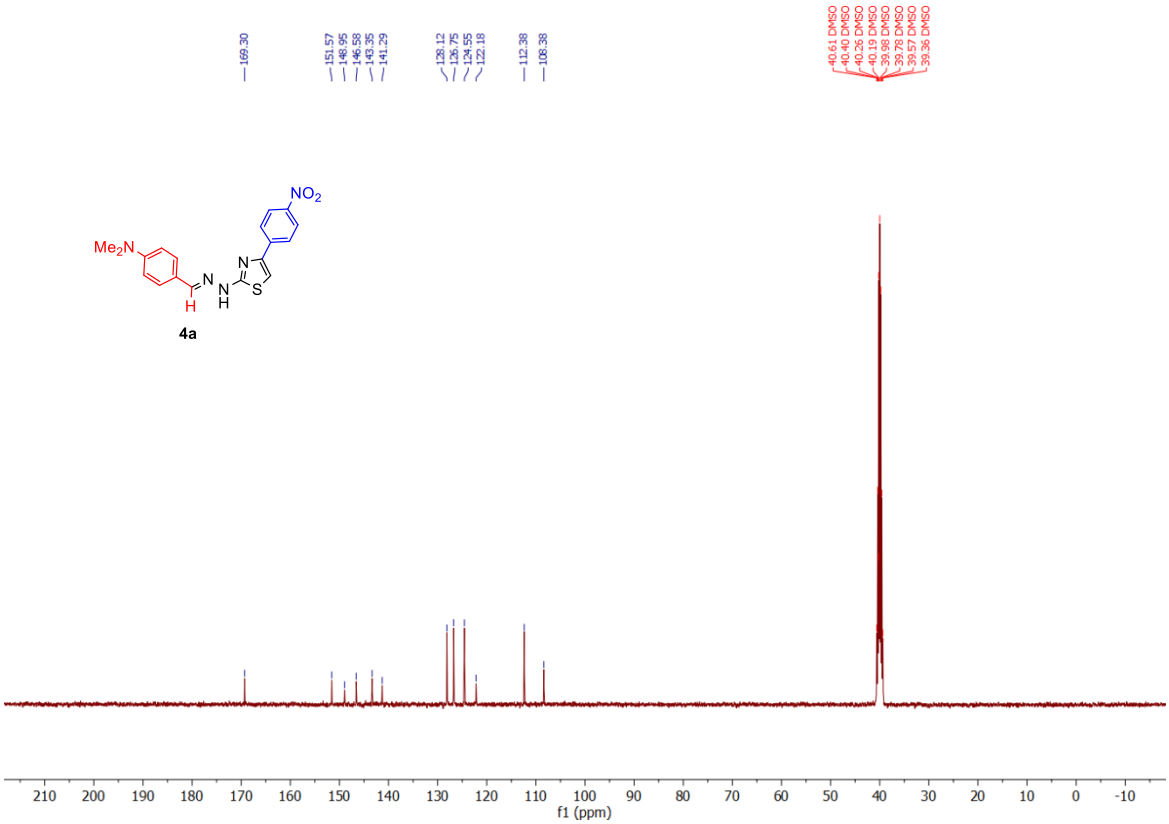
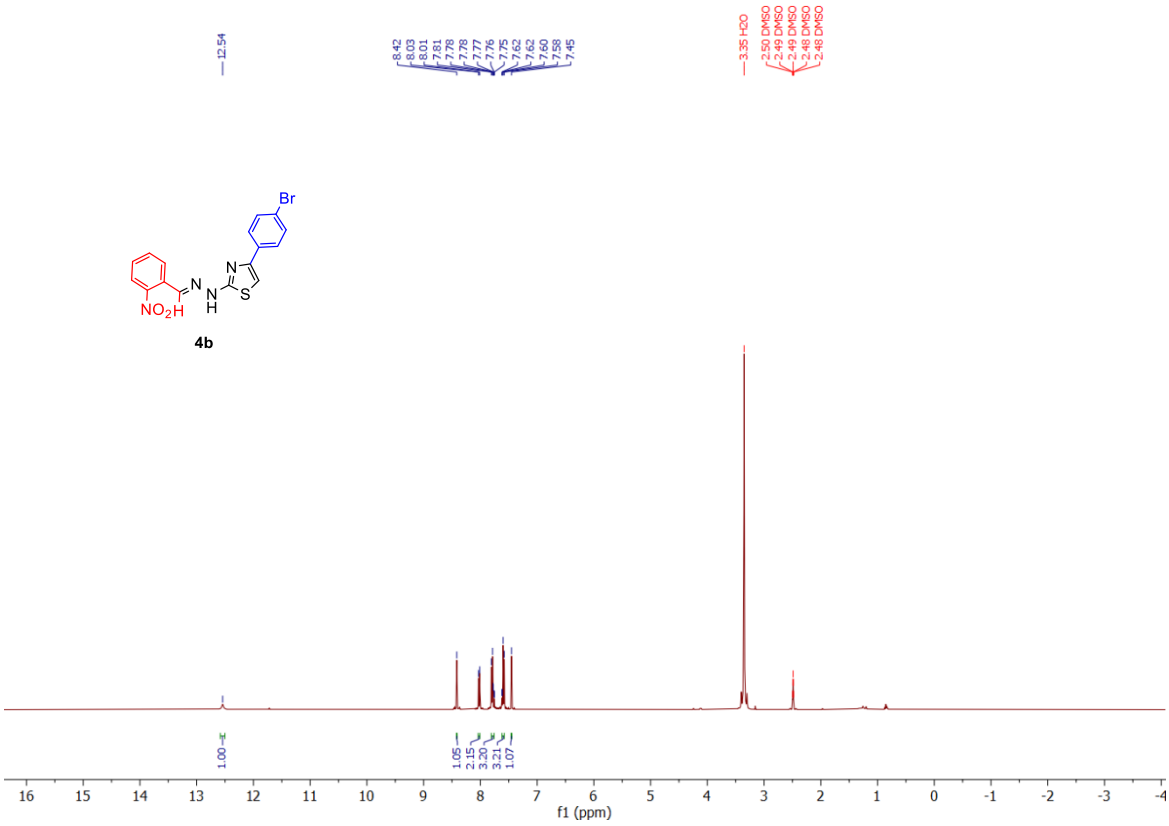
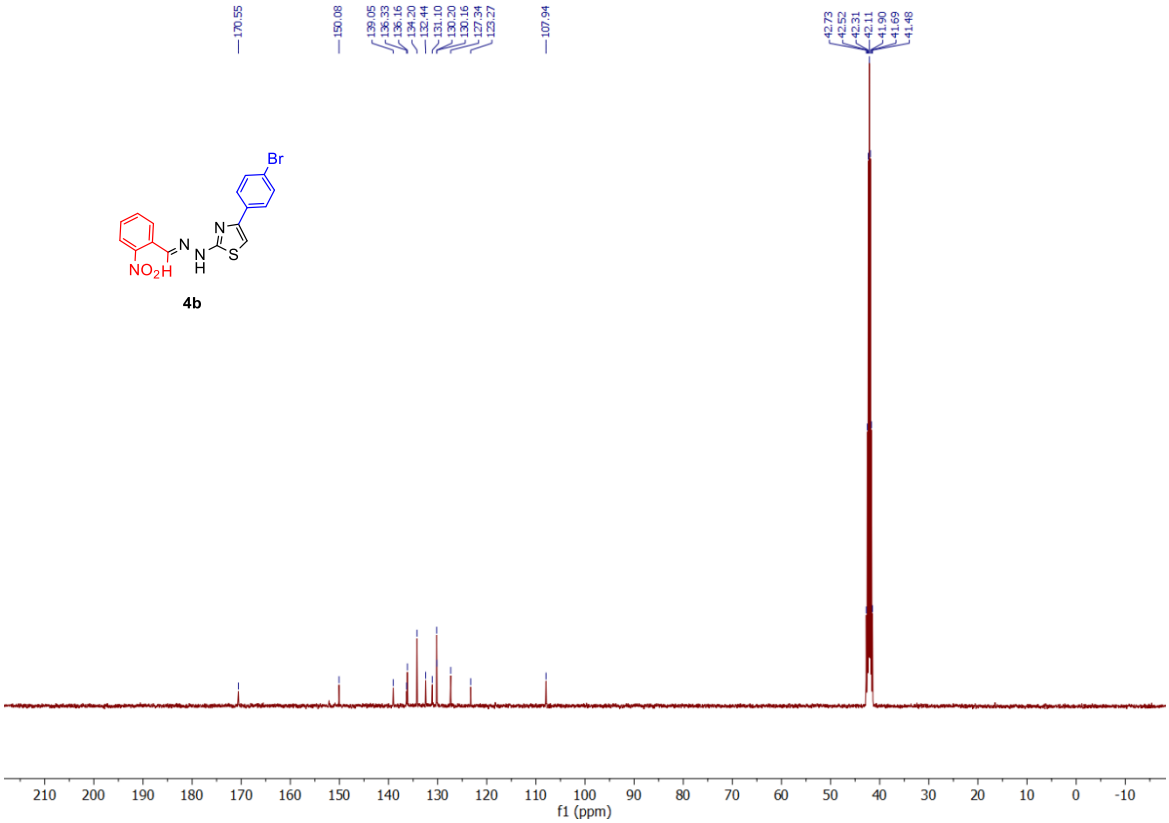
^{1}H and ^{13}C NMR spectra of 4a



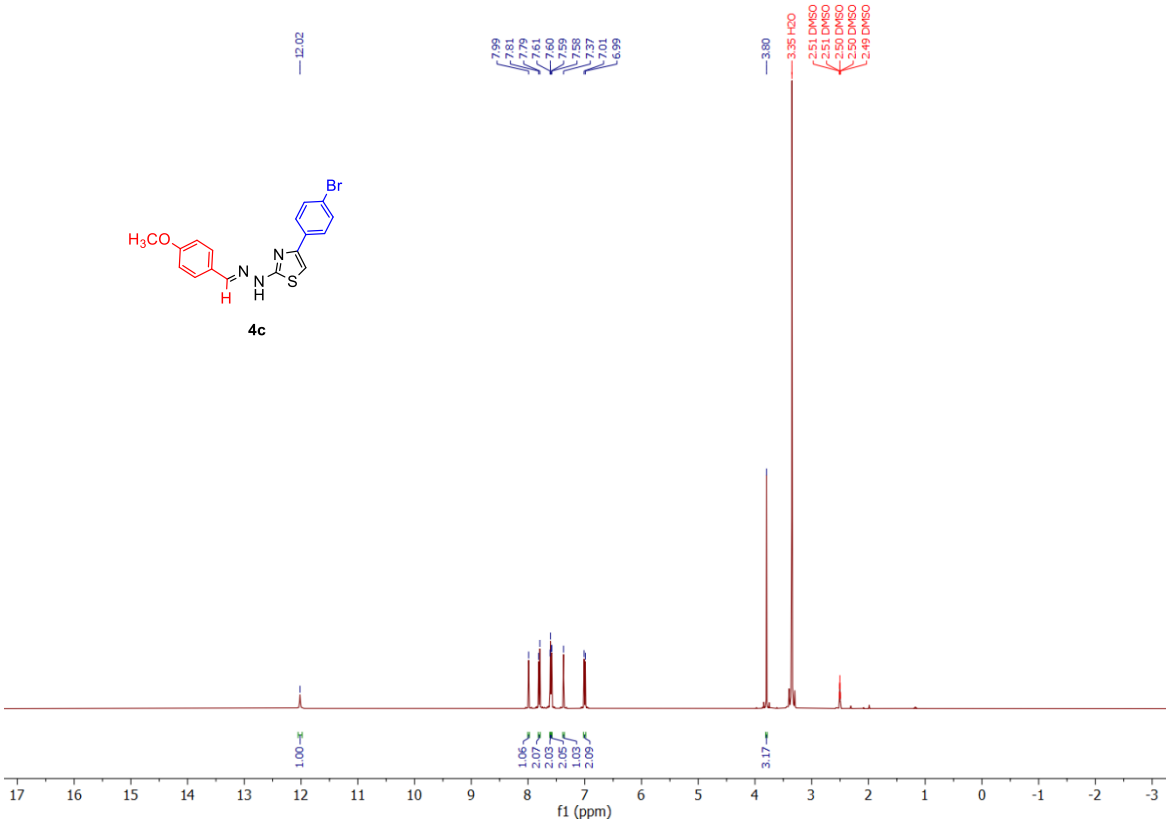


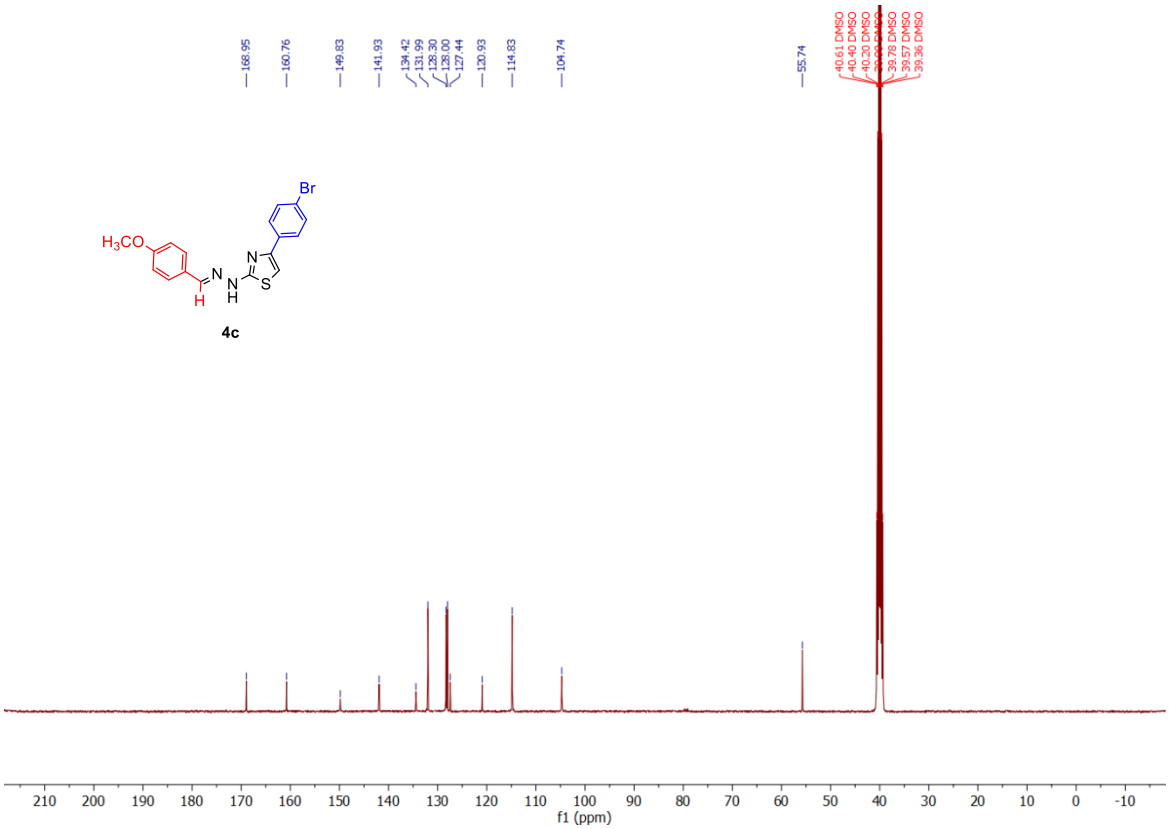
^{1}H and ^{13}C NMR spectra of 4b



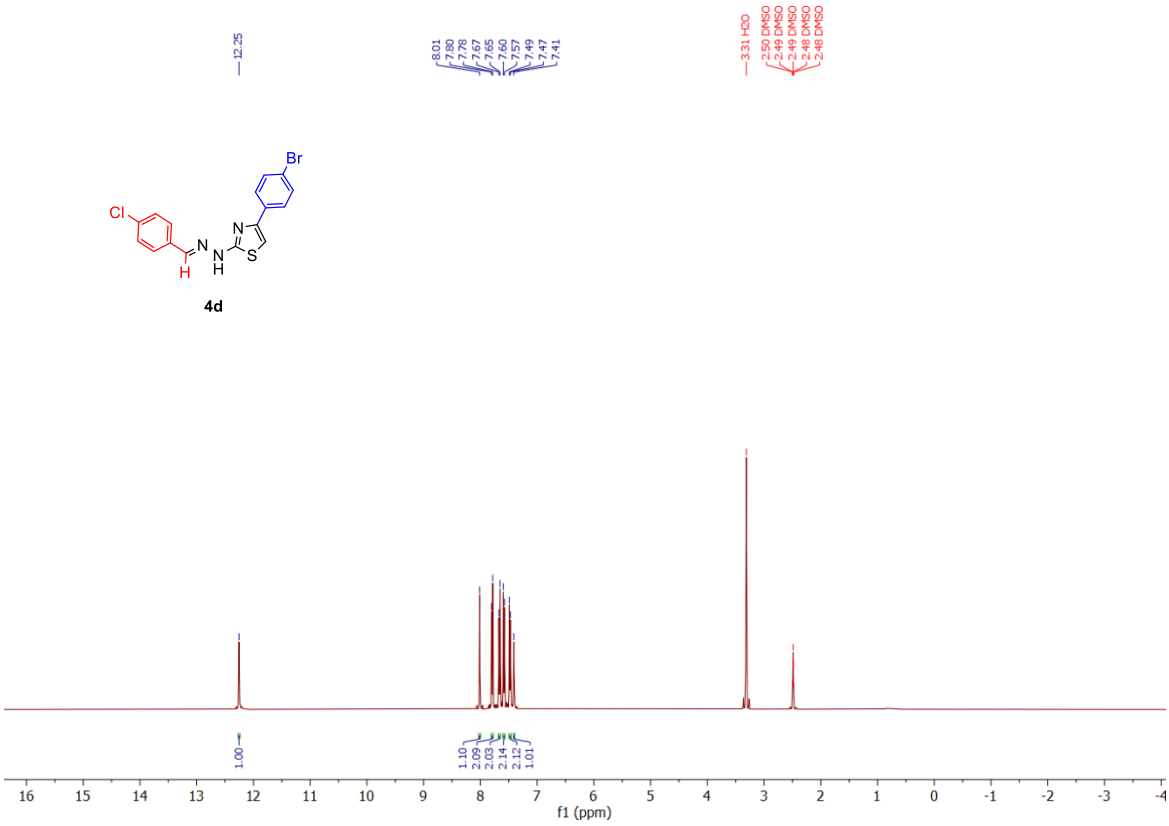


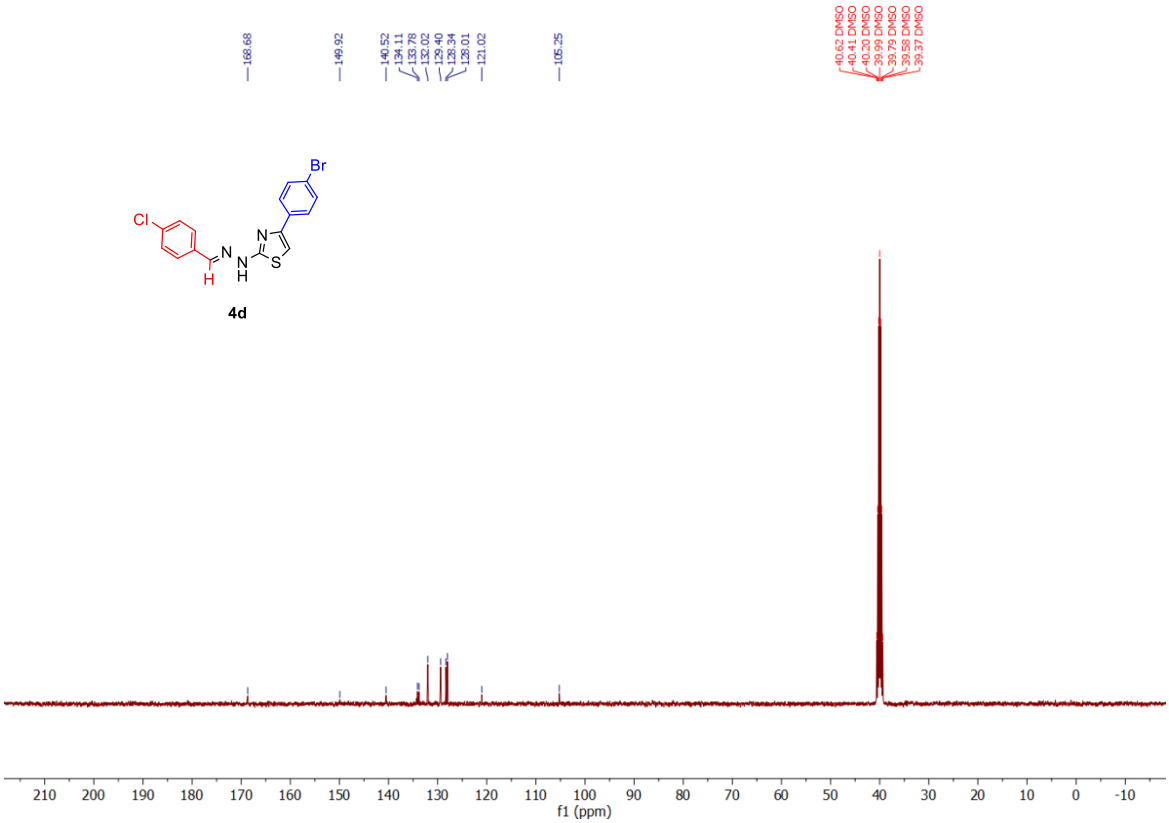
^{1}H and ^{13}C NMR spectra of 4c



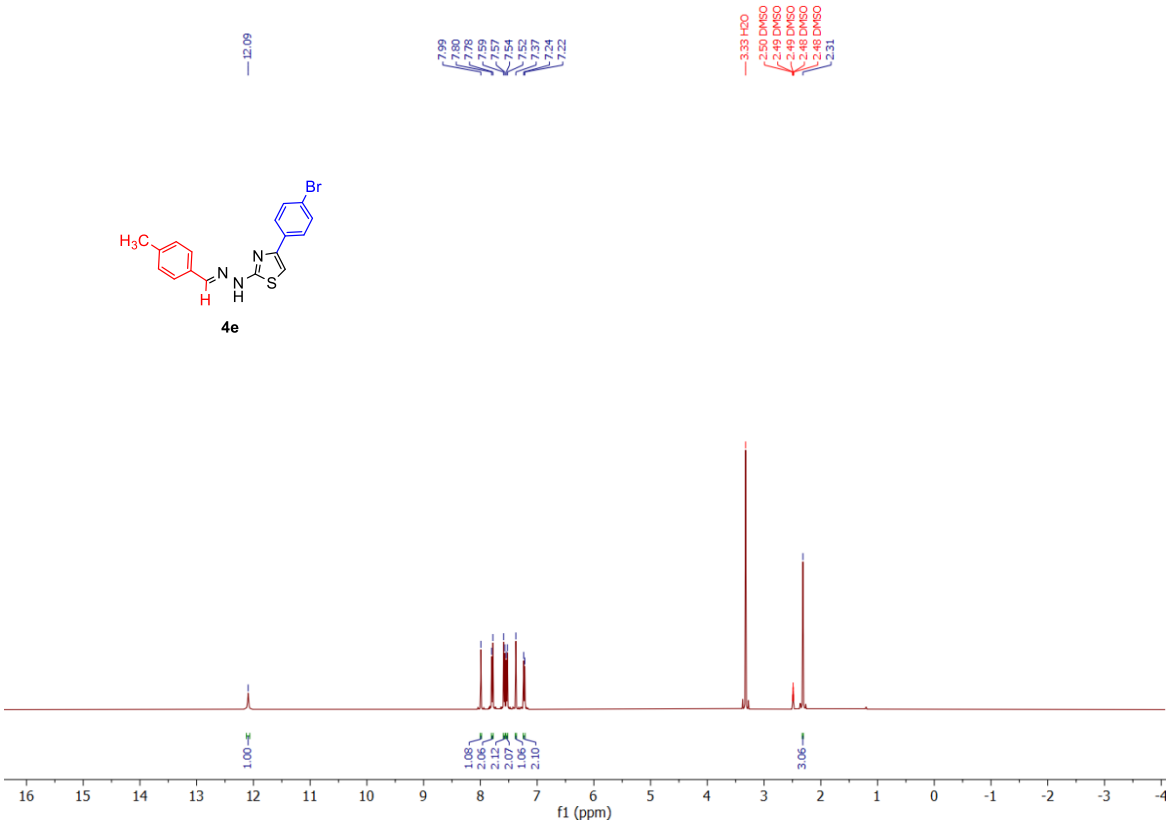


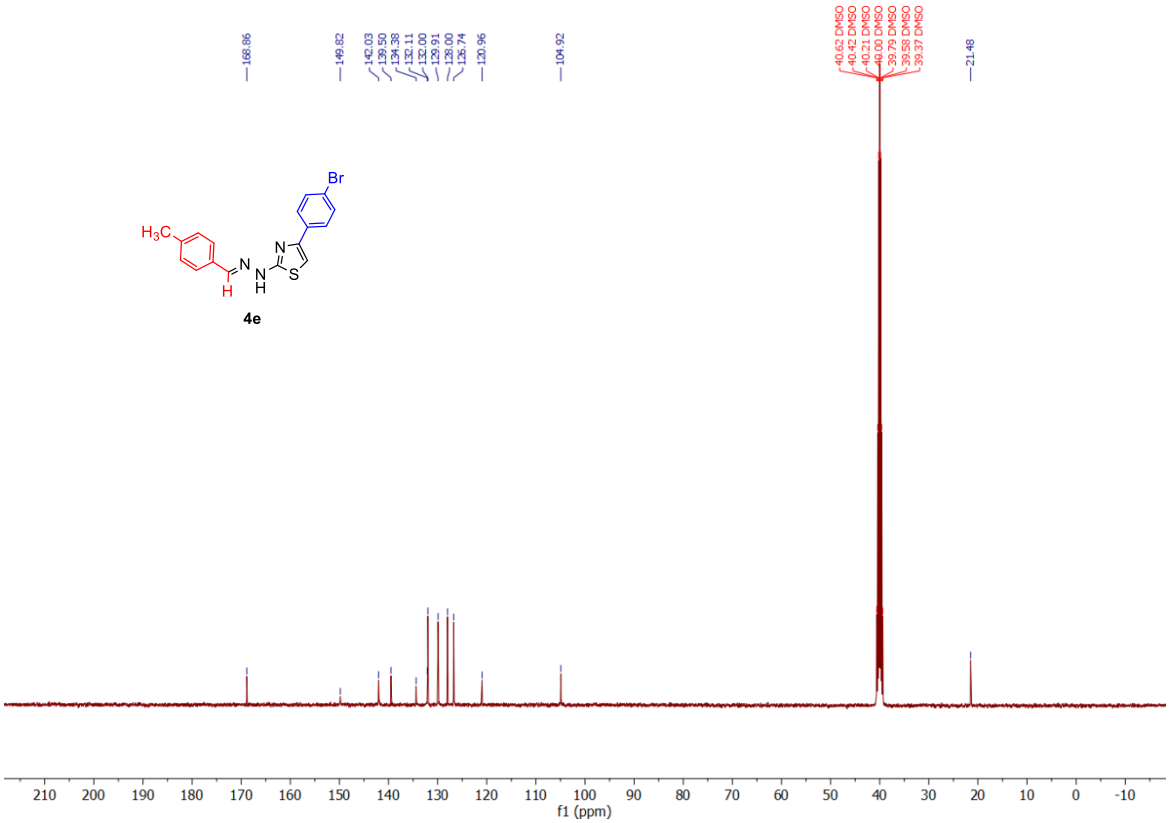
^{1}H and ^{13}C NMR spectra of 4d



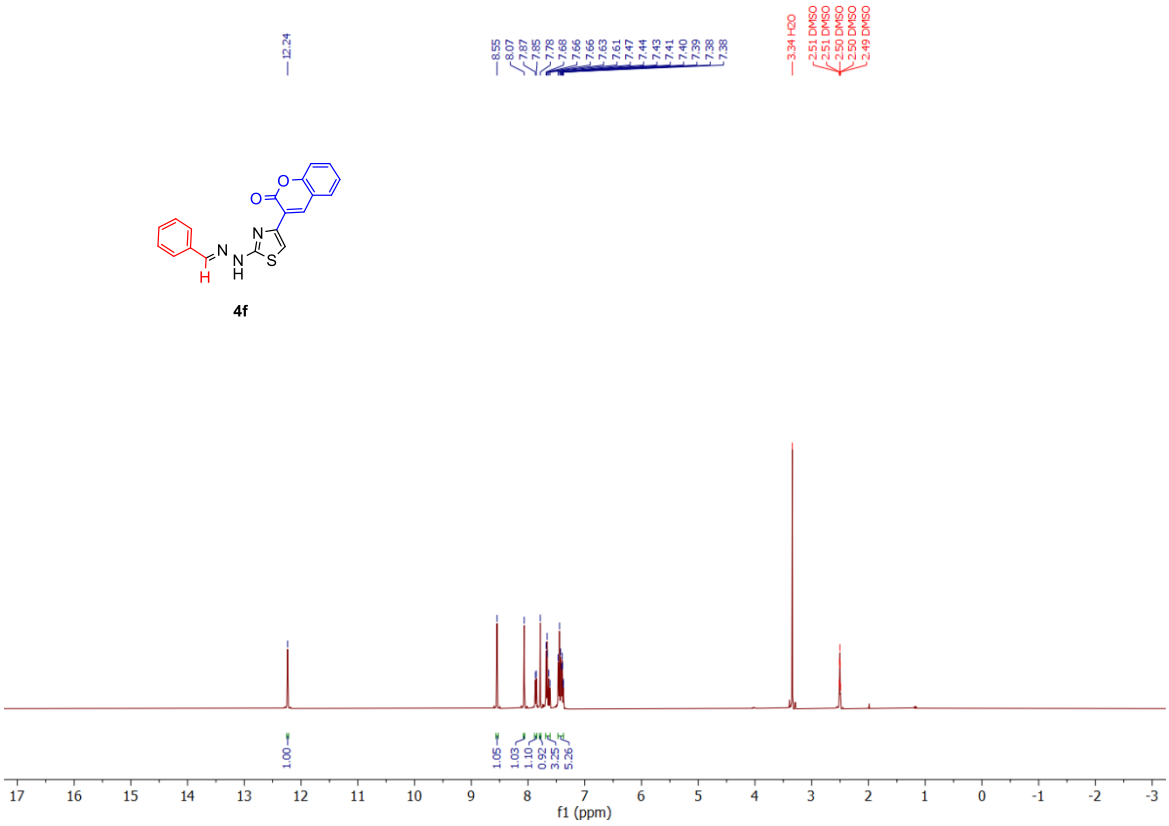


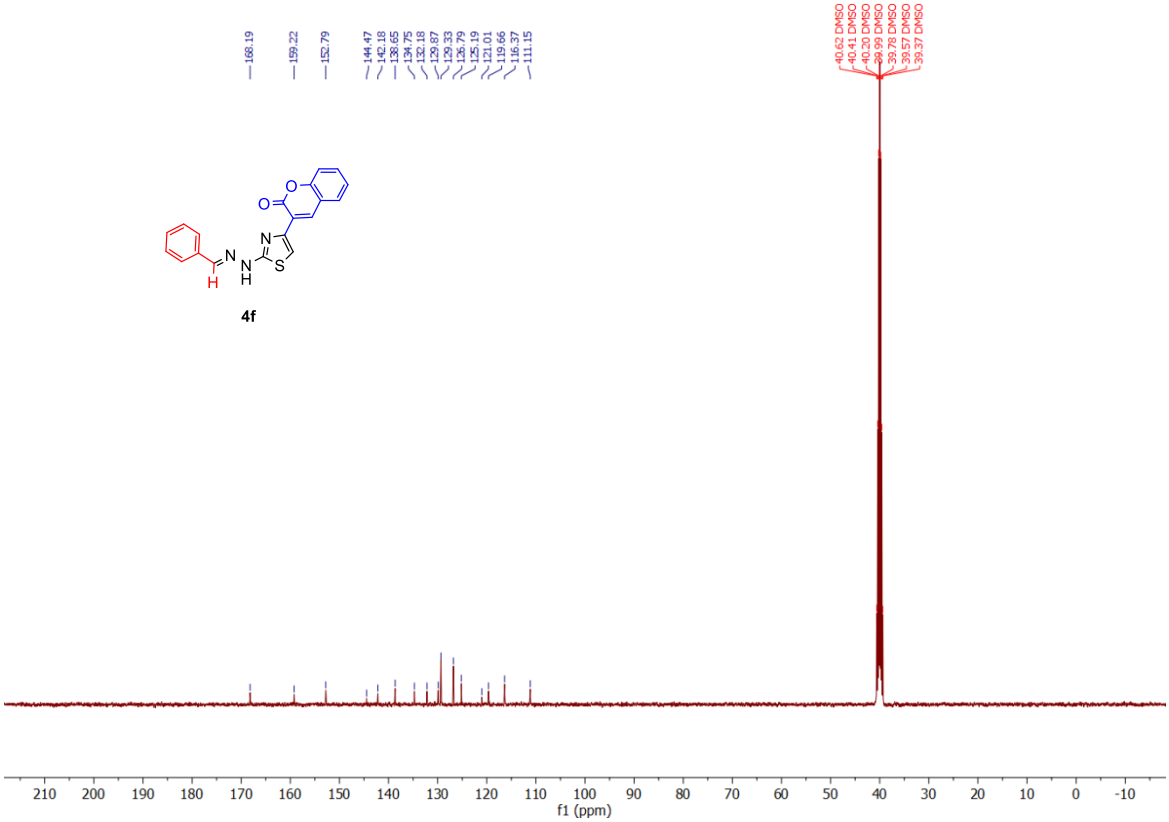
^{1}H and ^{13}C NMR spectra of 4e



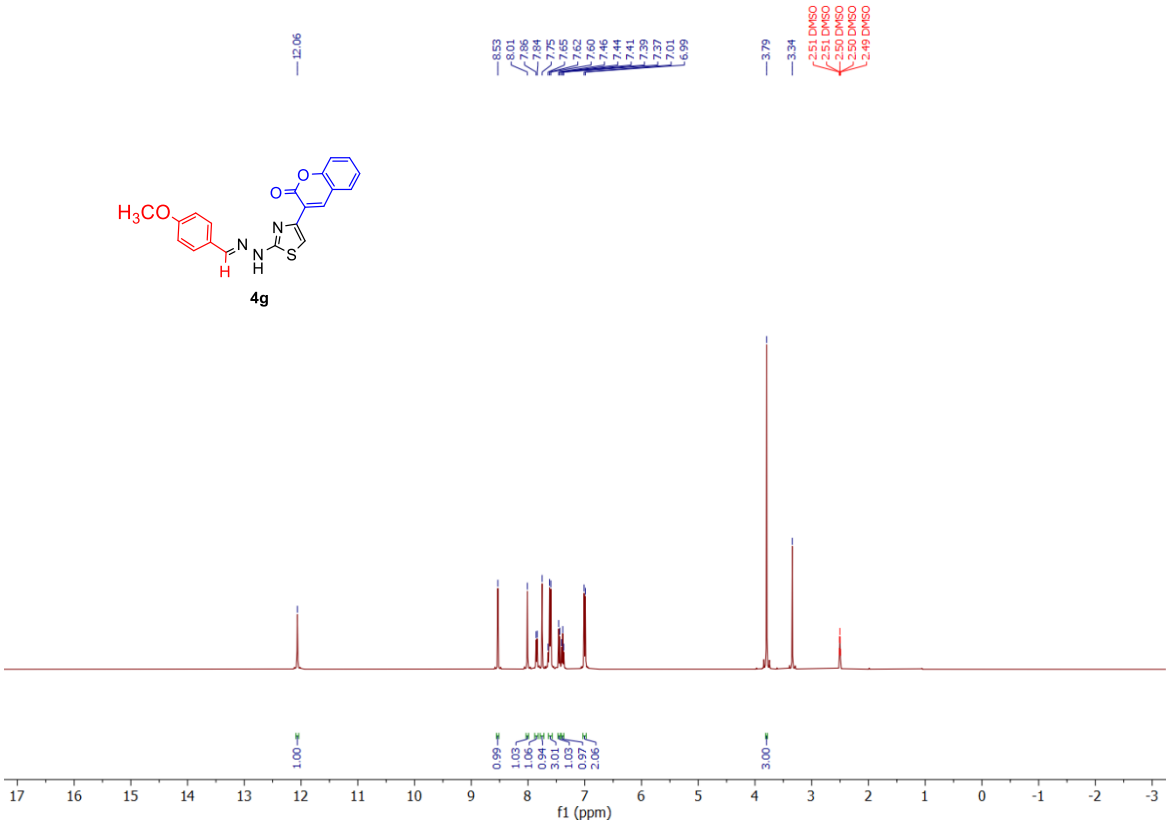


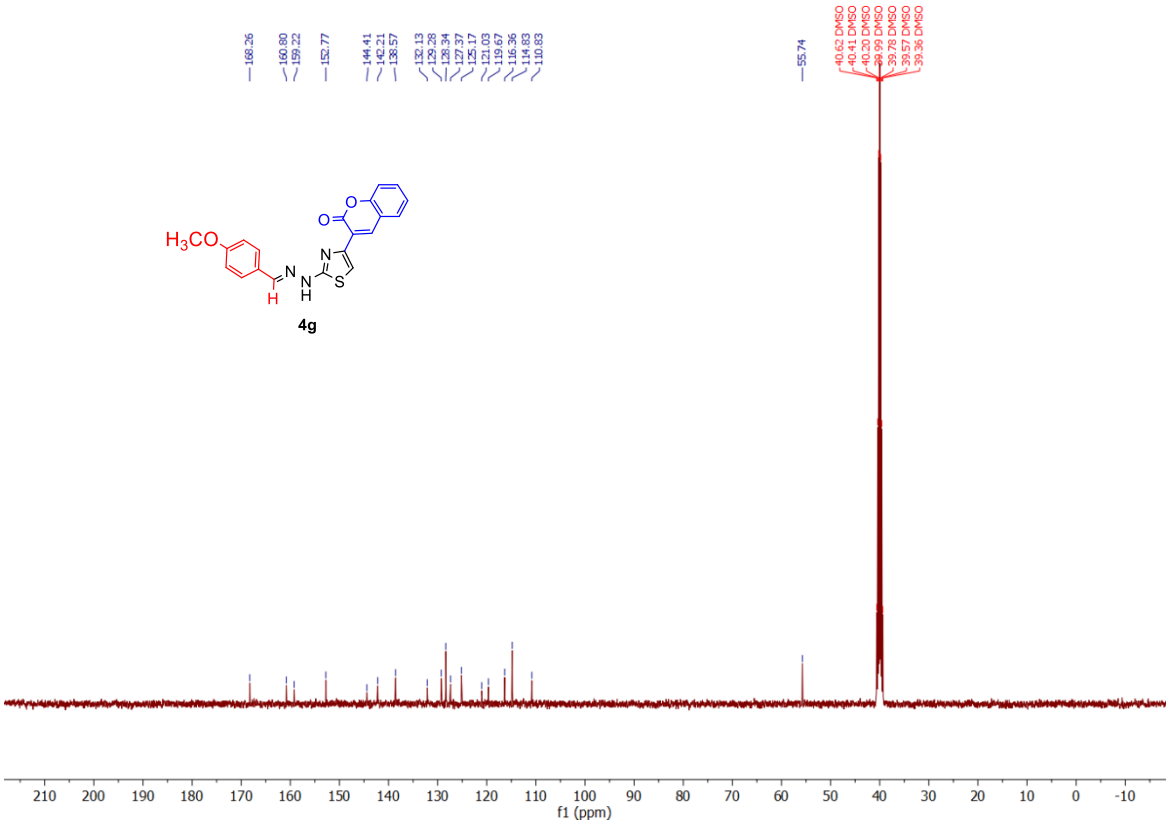
^{1}H and ^{13}C NMR spectra of 4f



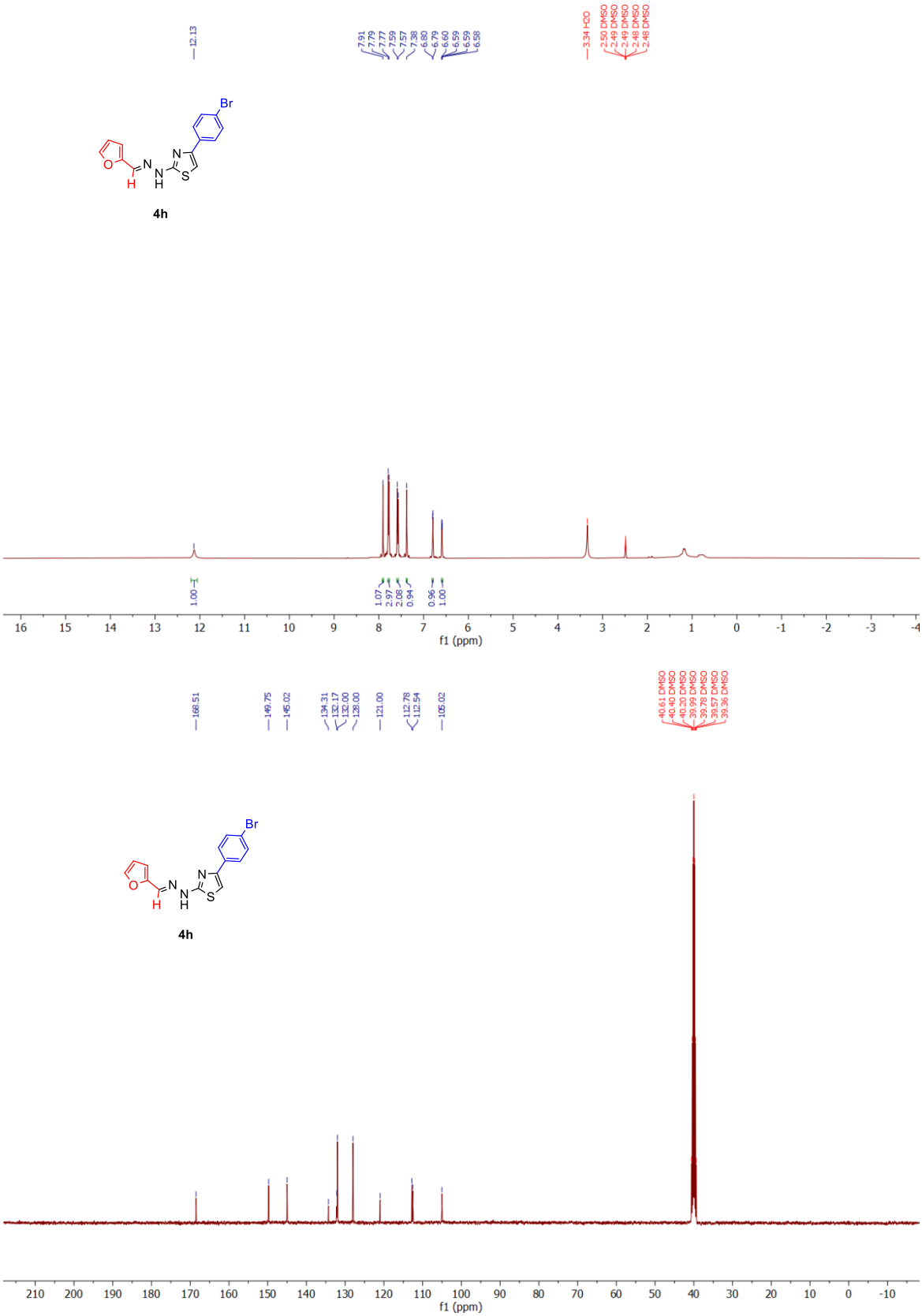


^{1}H and ^{13}C NMR spectra of 4g

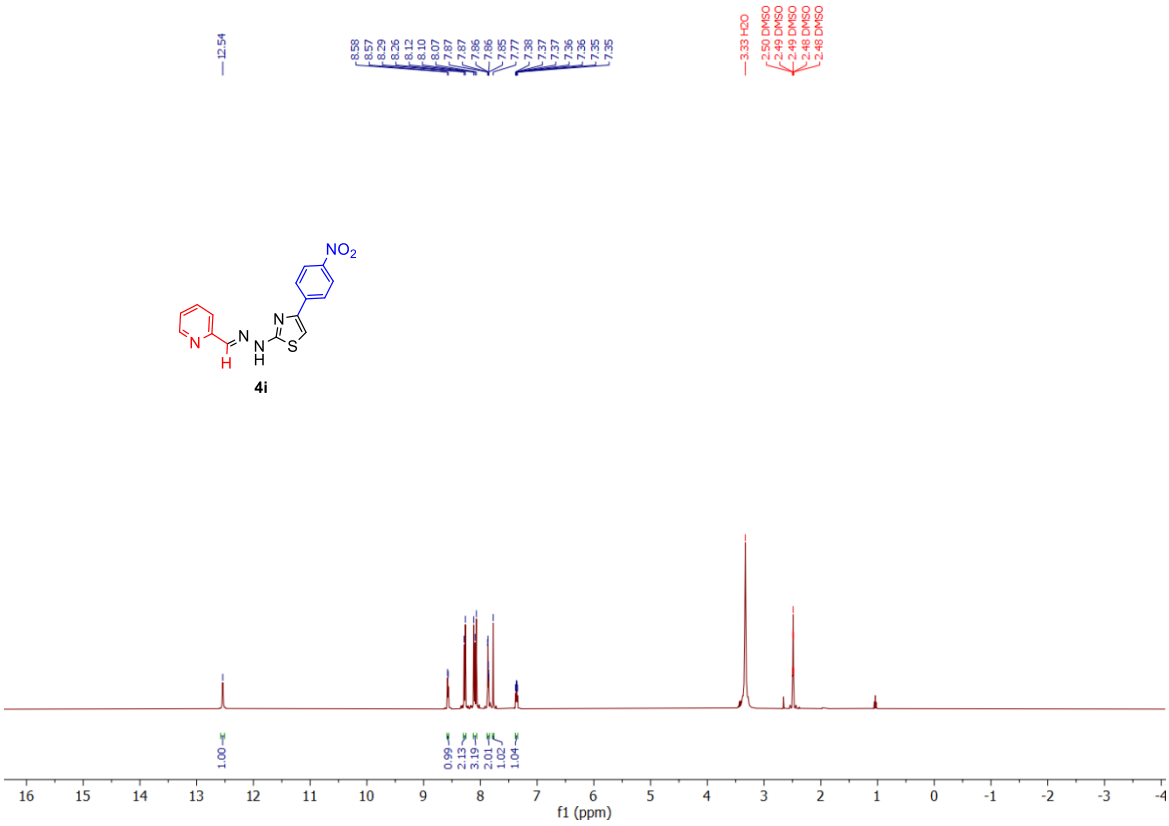


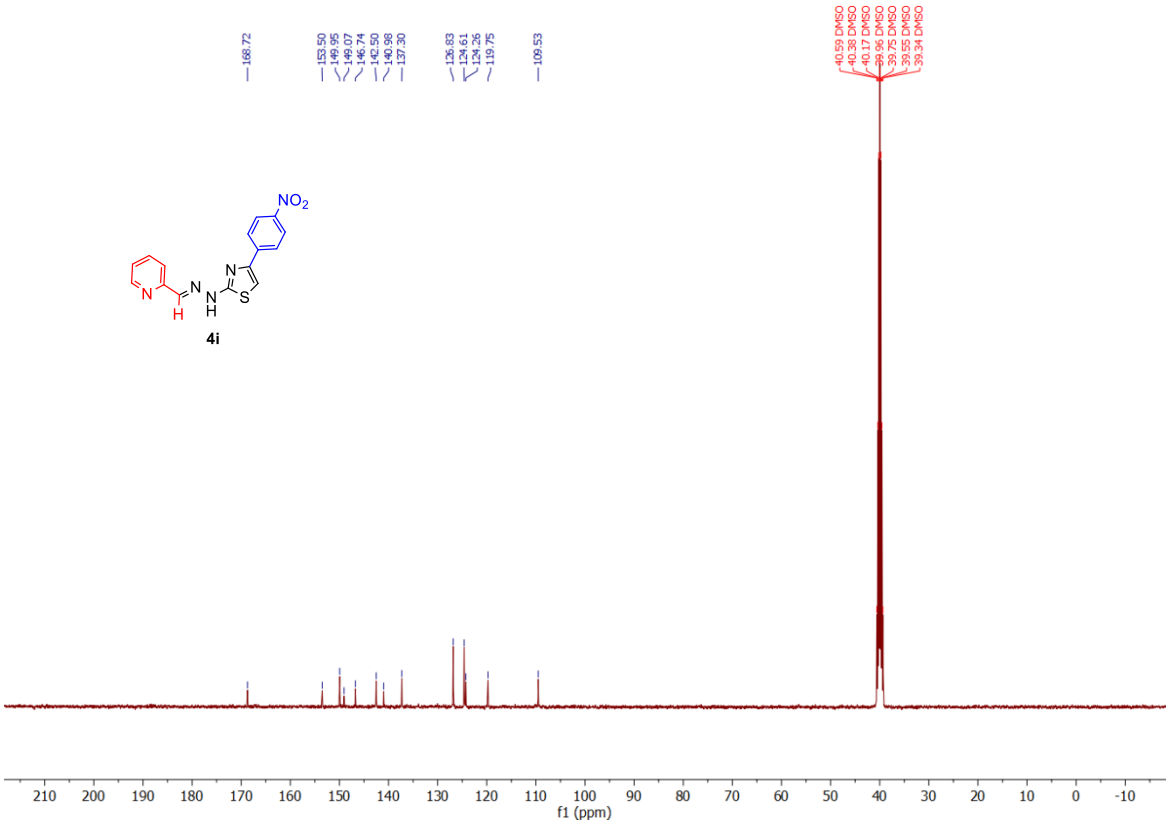


^{1}H and ^{13}C NMR spectra of 4h

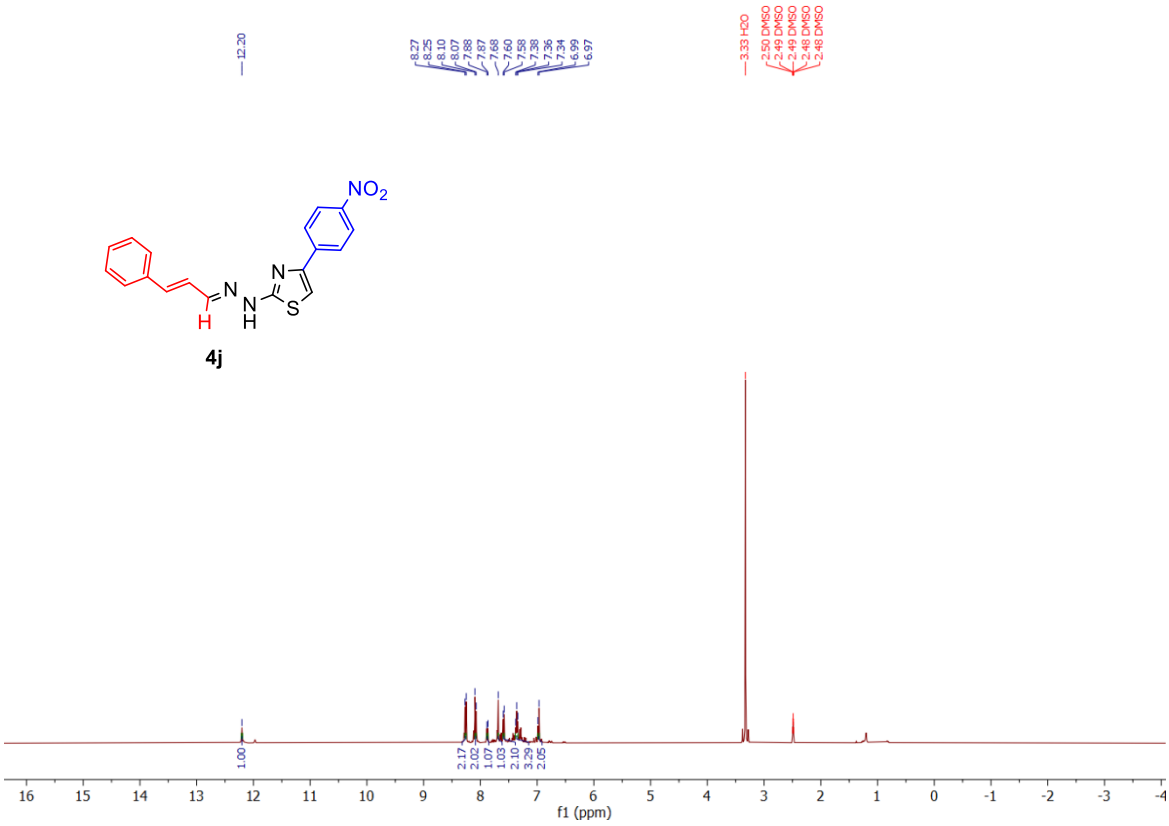


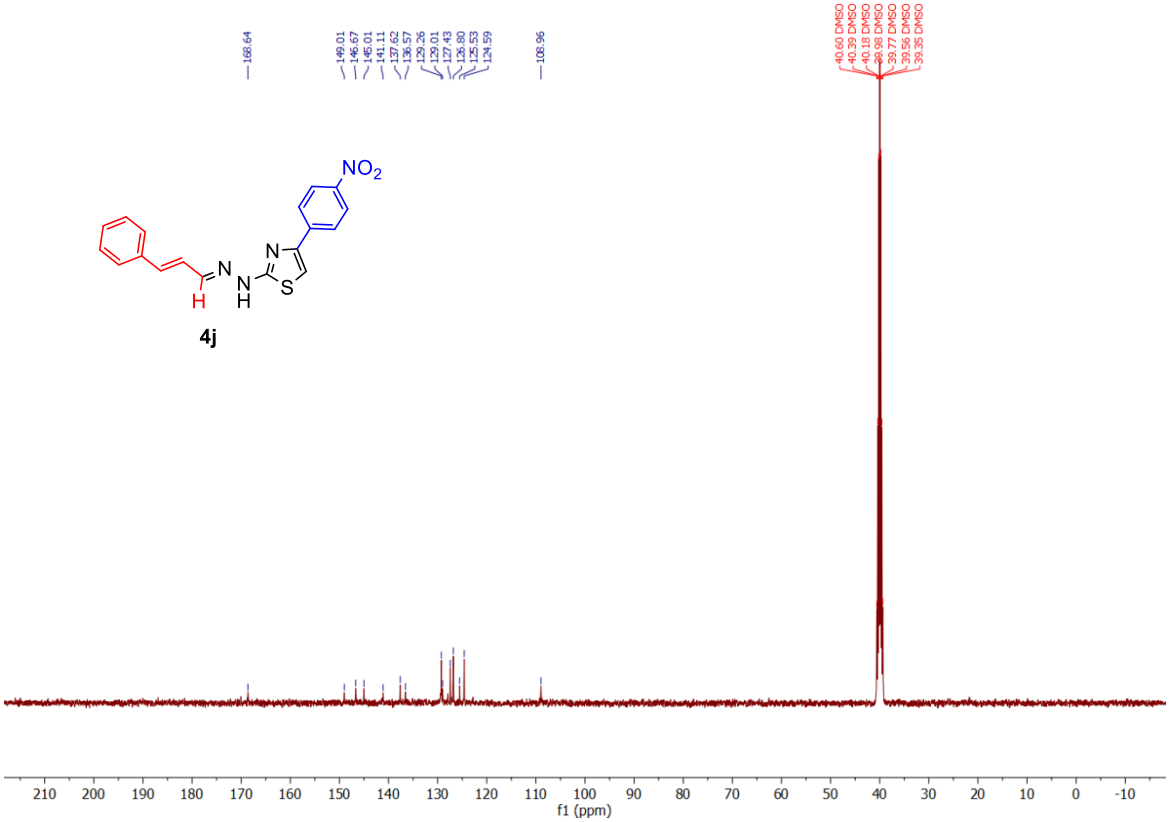
^{1}H and ^{13}C NMR spectra of 4i



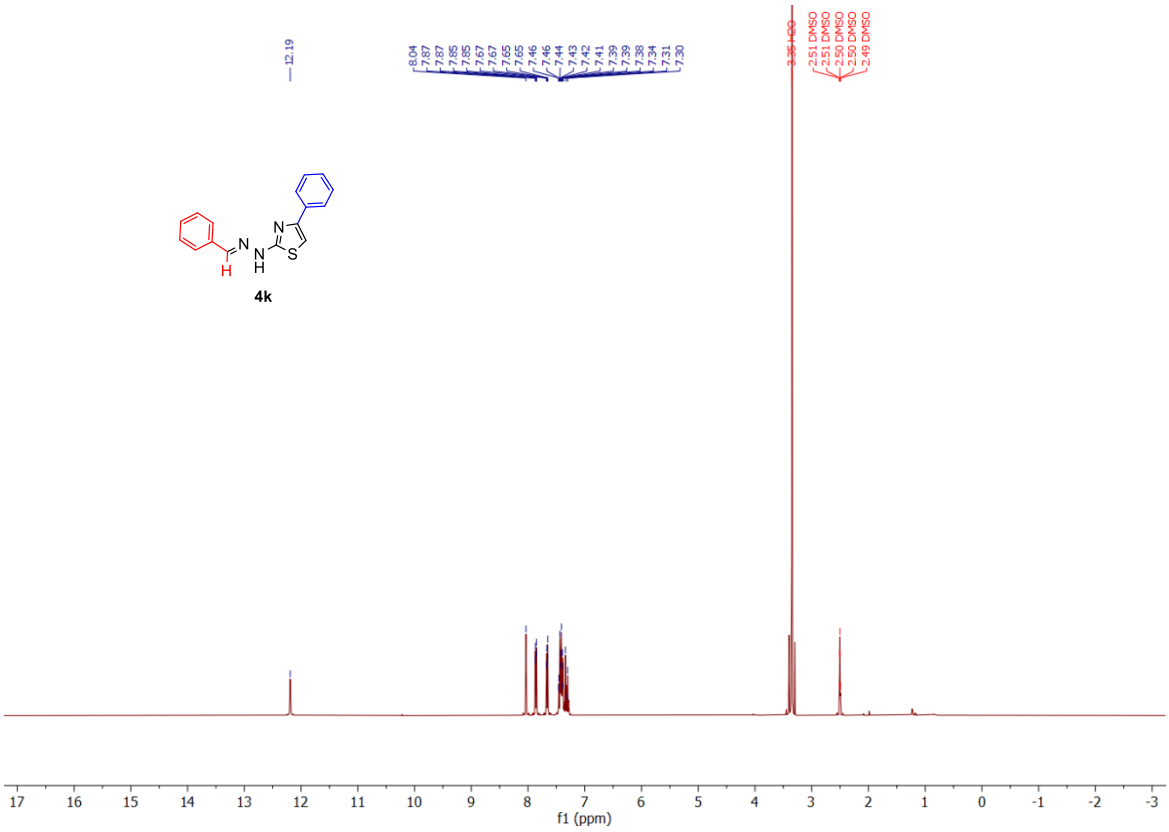


^{1}H and ^{13}C NMR spectra of 4j

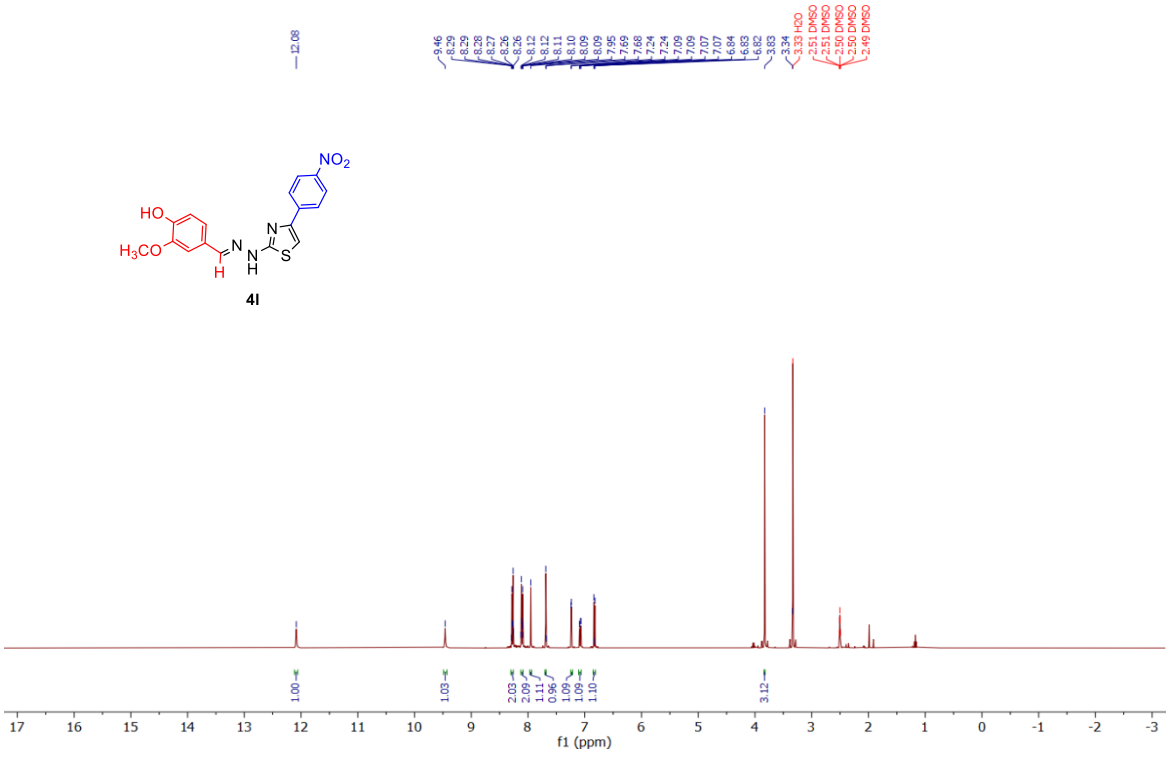


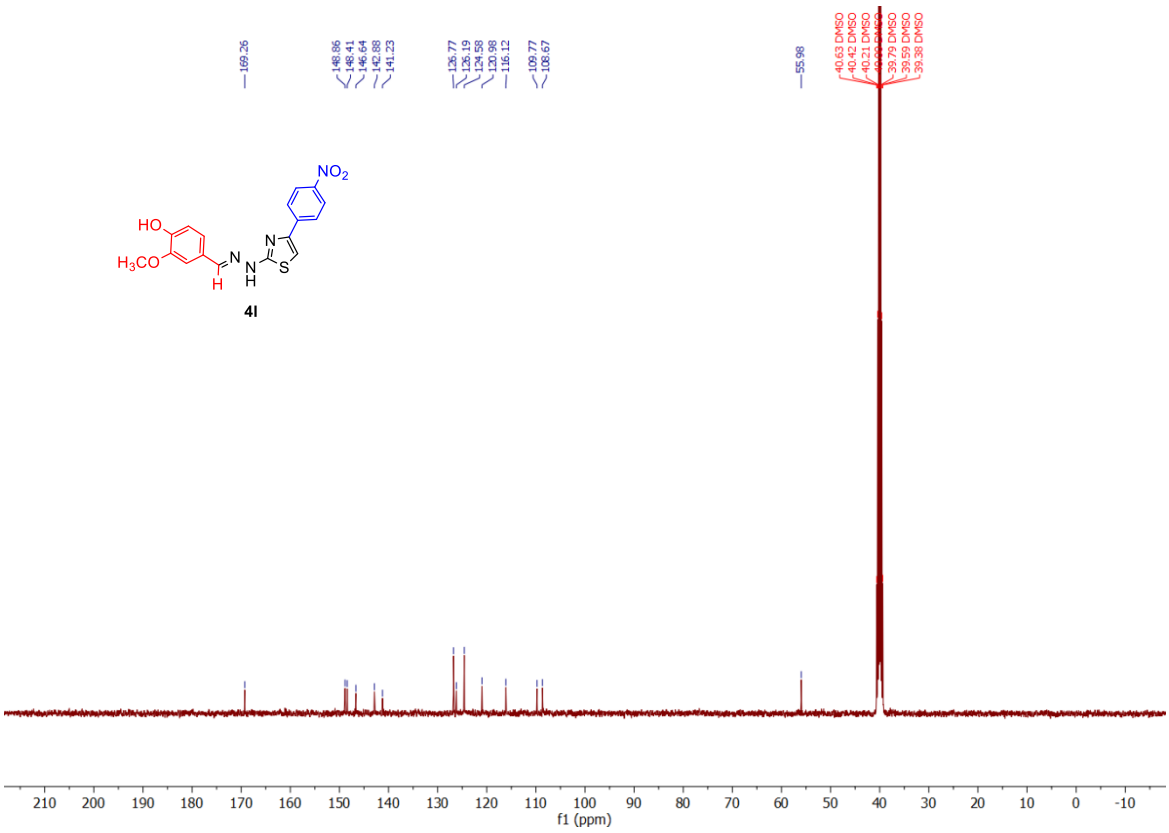


^{1}H NMR spectra of 4k

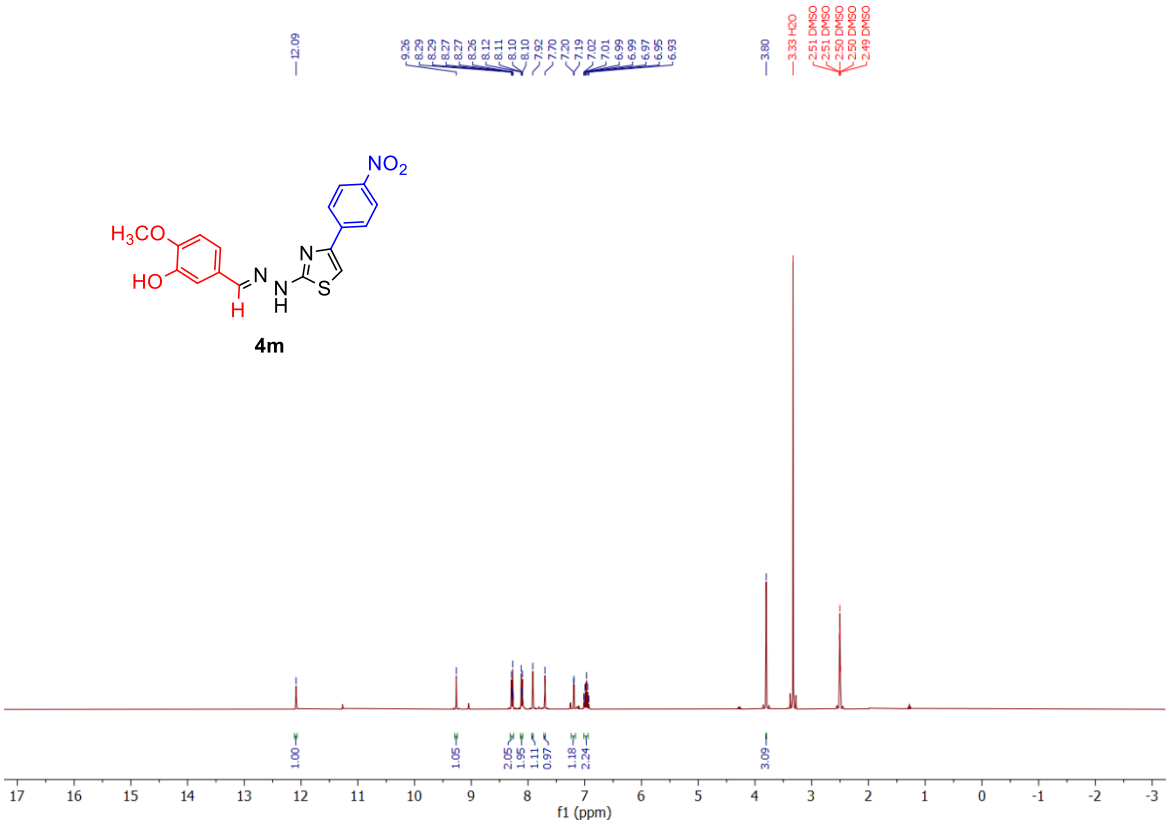


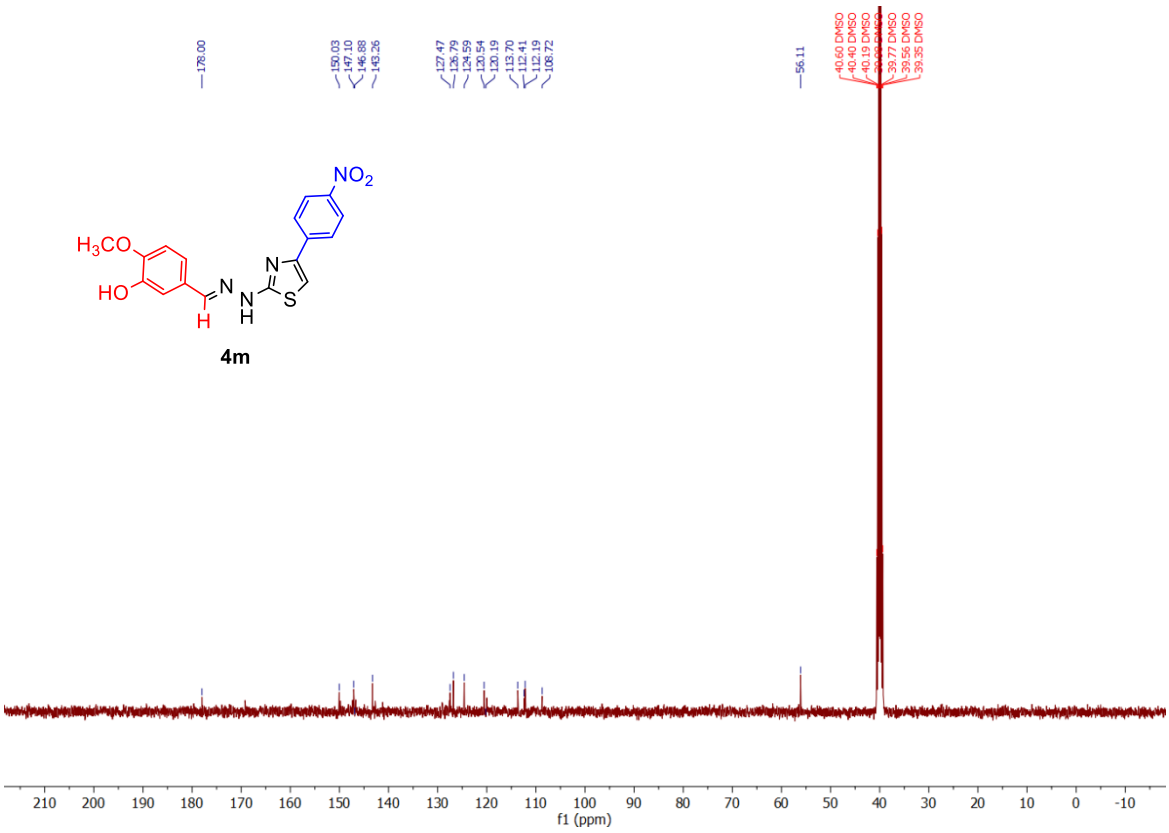
^{1}H and ^{13}C NMR spectra of 4l



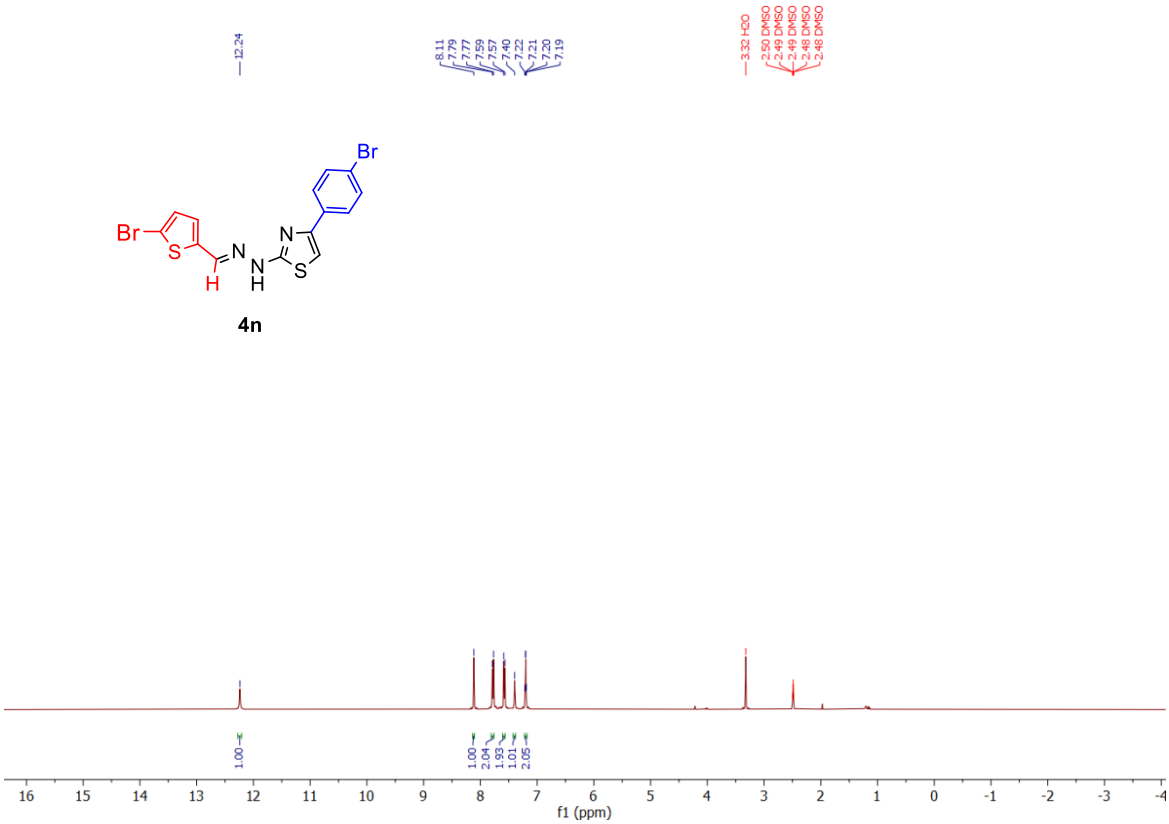


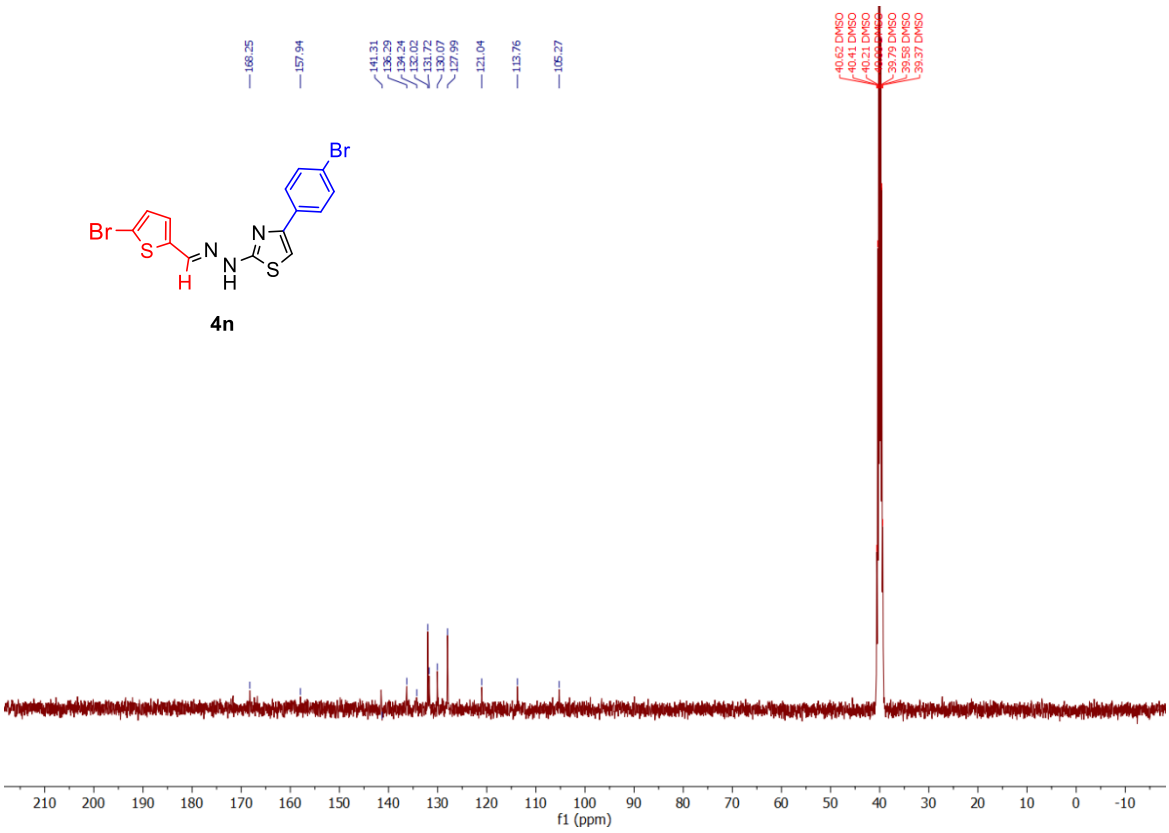
^{1}H and ^{13}C NMR spectra of 4m



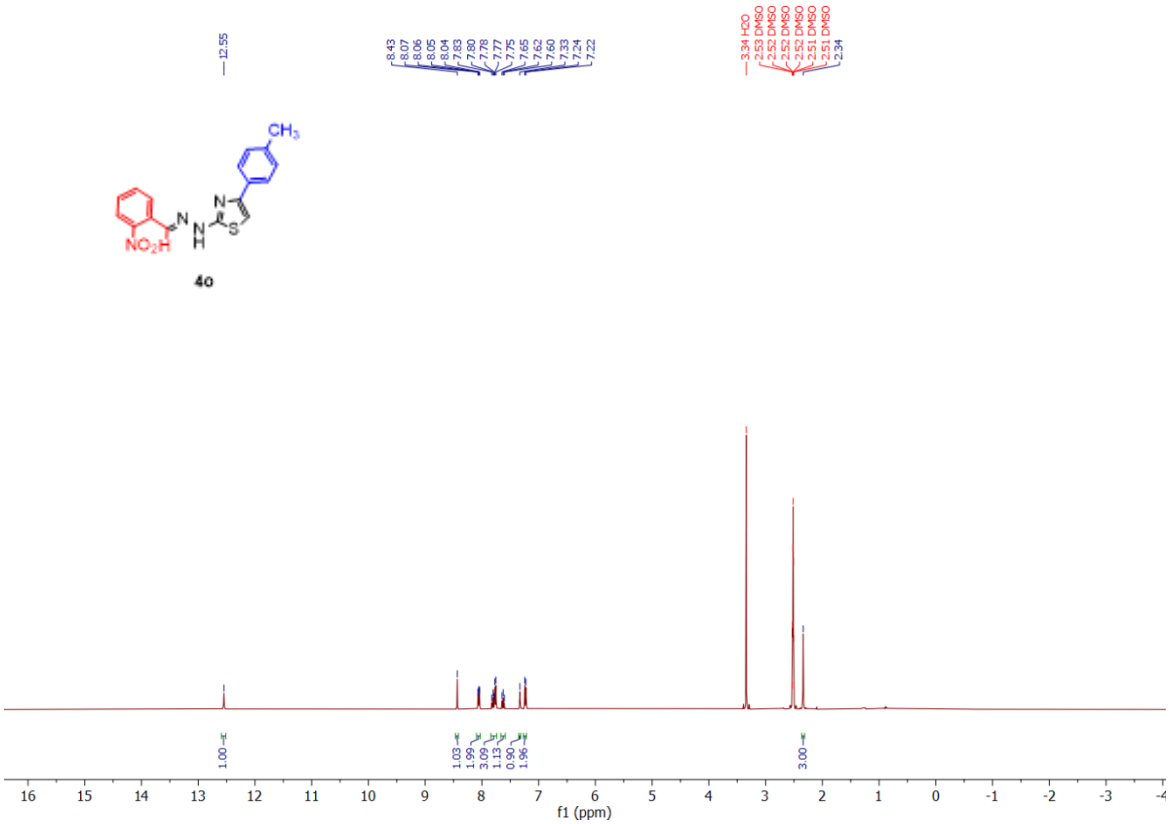


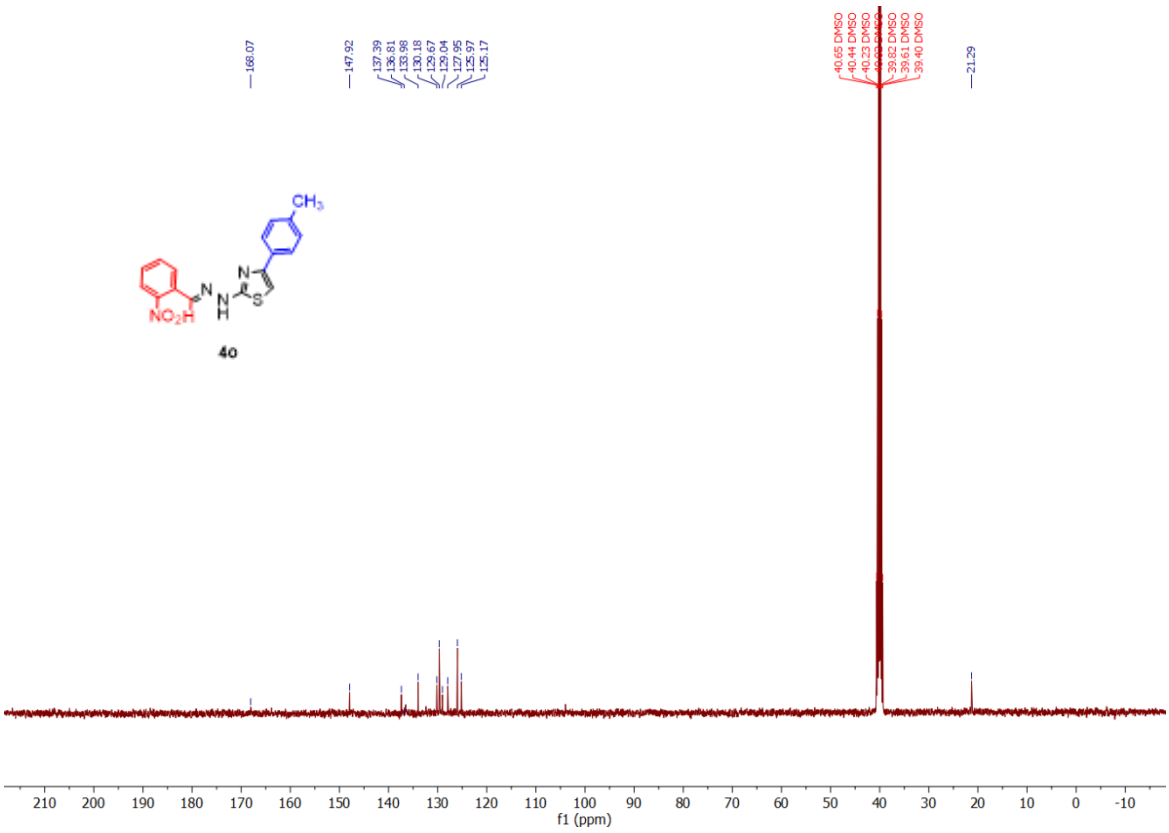
^{1}H and ^{13}C NMR spectra of 4n



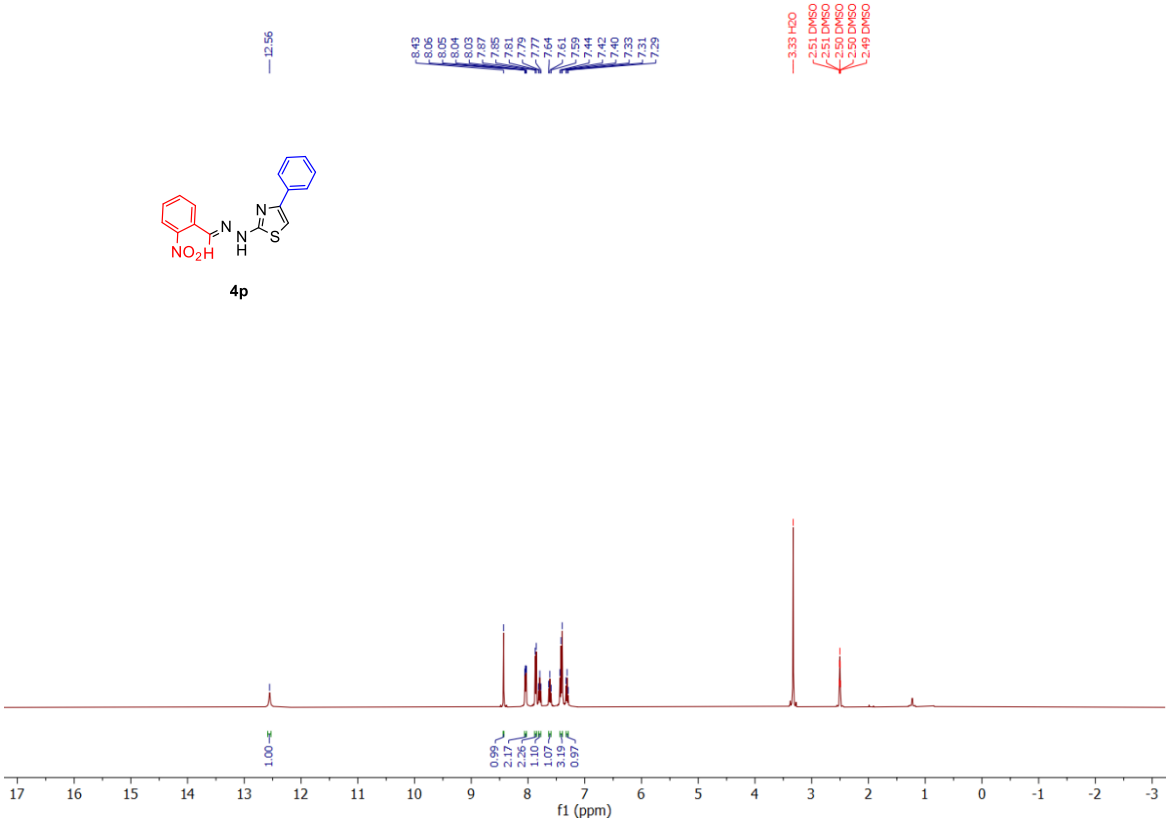


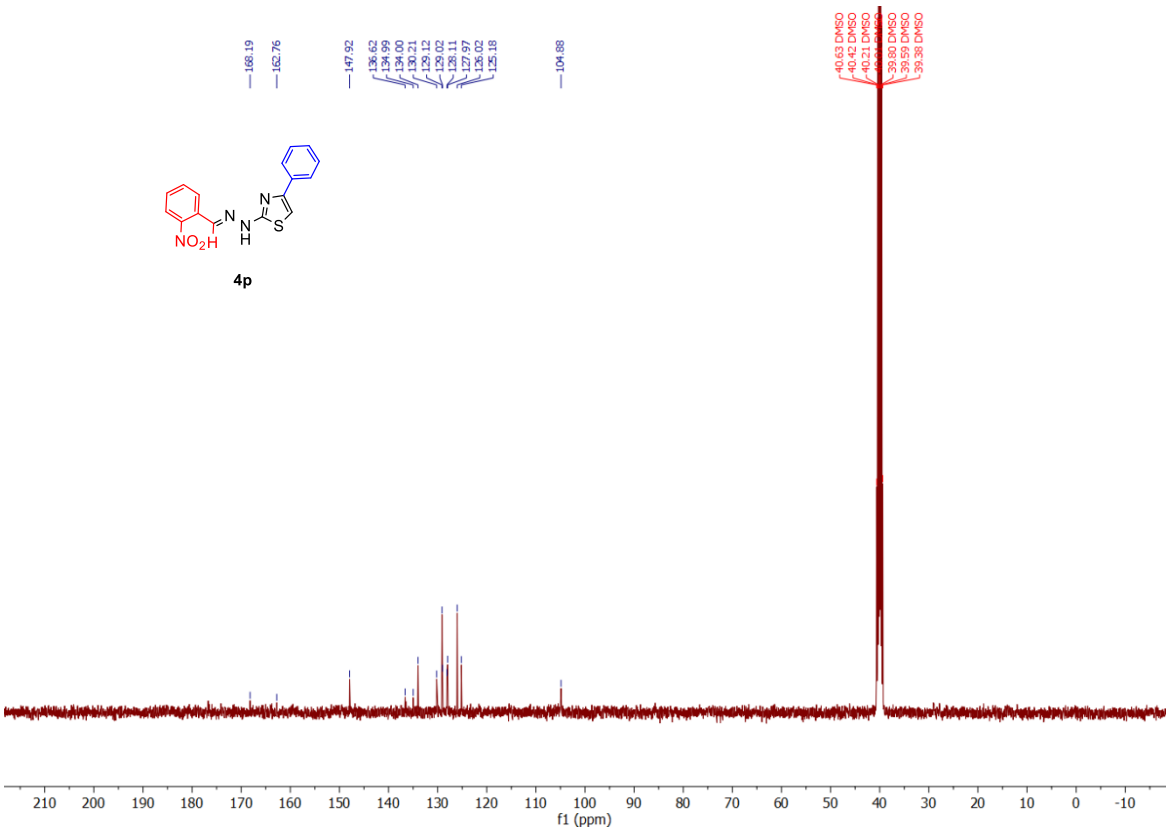
^{1}H and ^{13}C NMR spectra of 4o



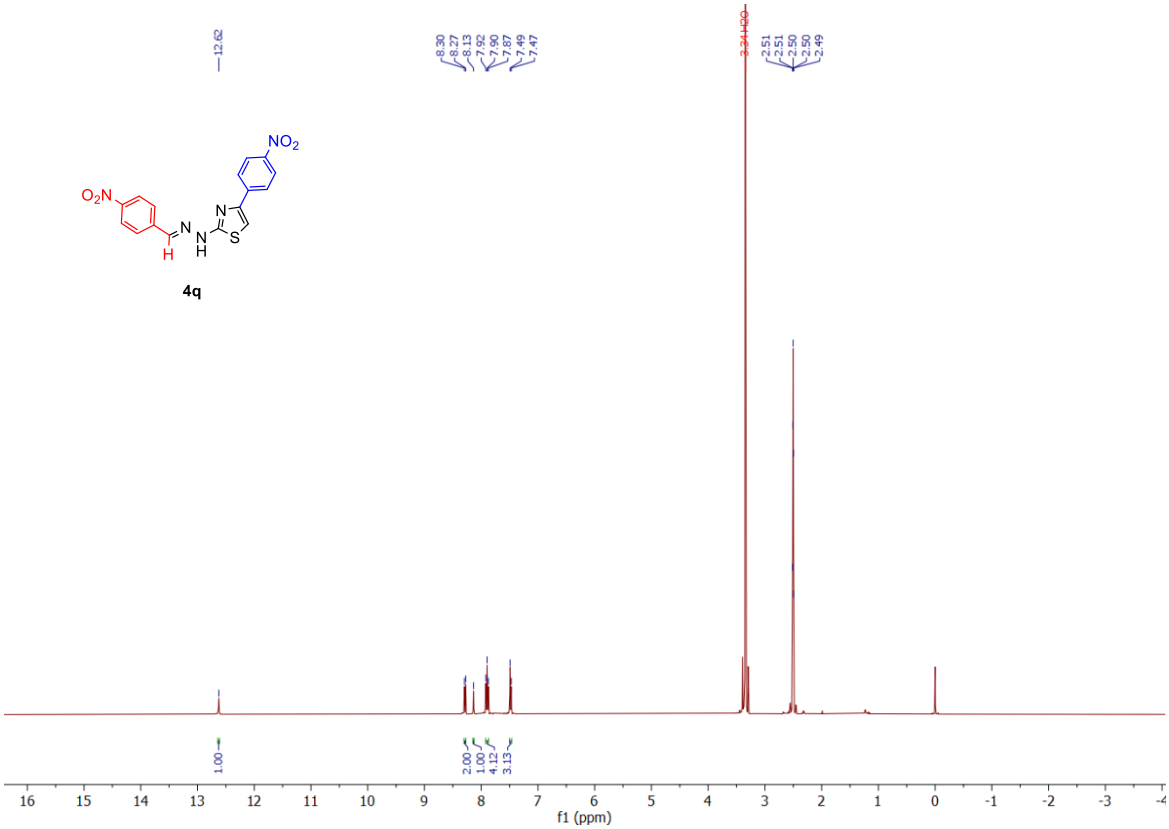


^{1}H and ^{13}C NMR spectra of 4p

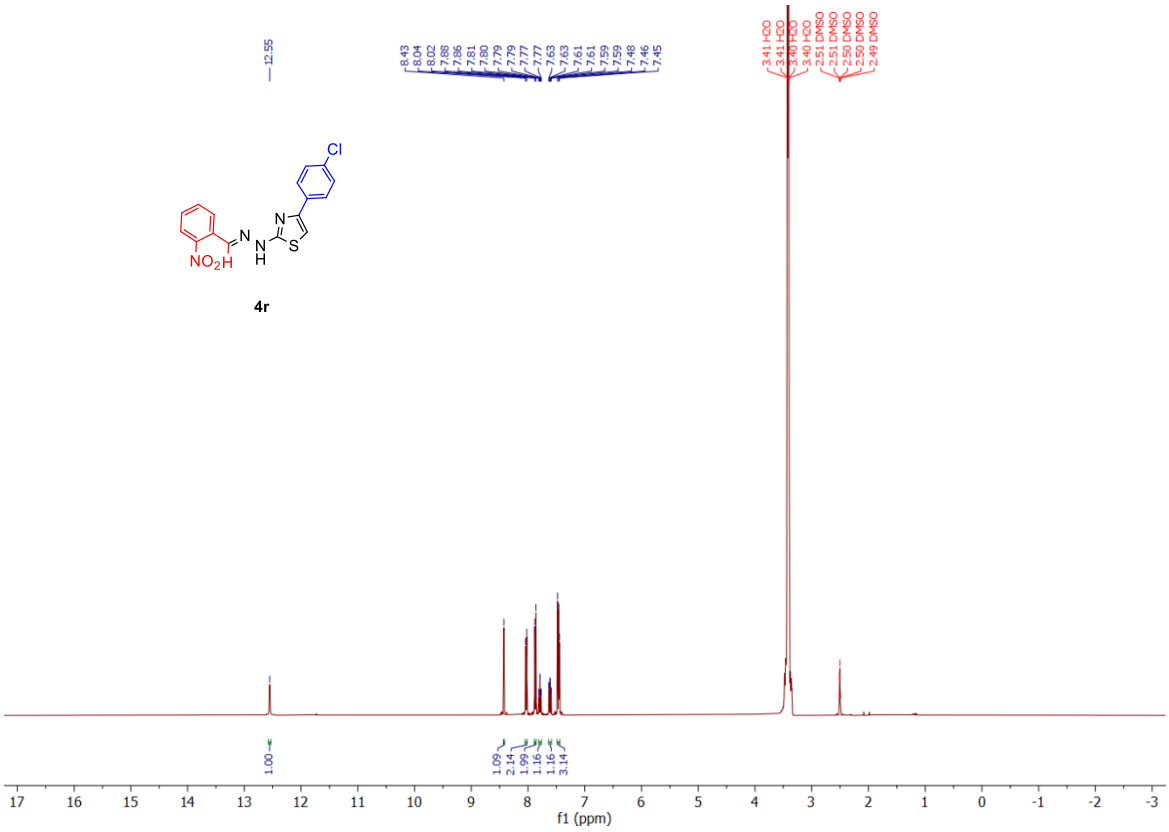


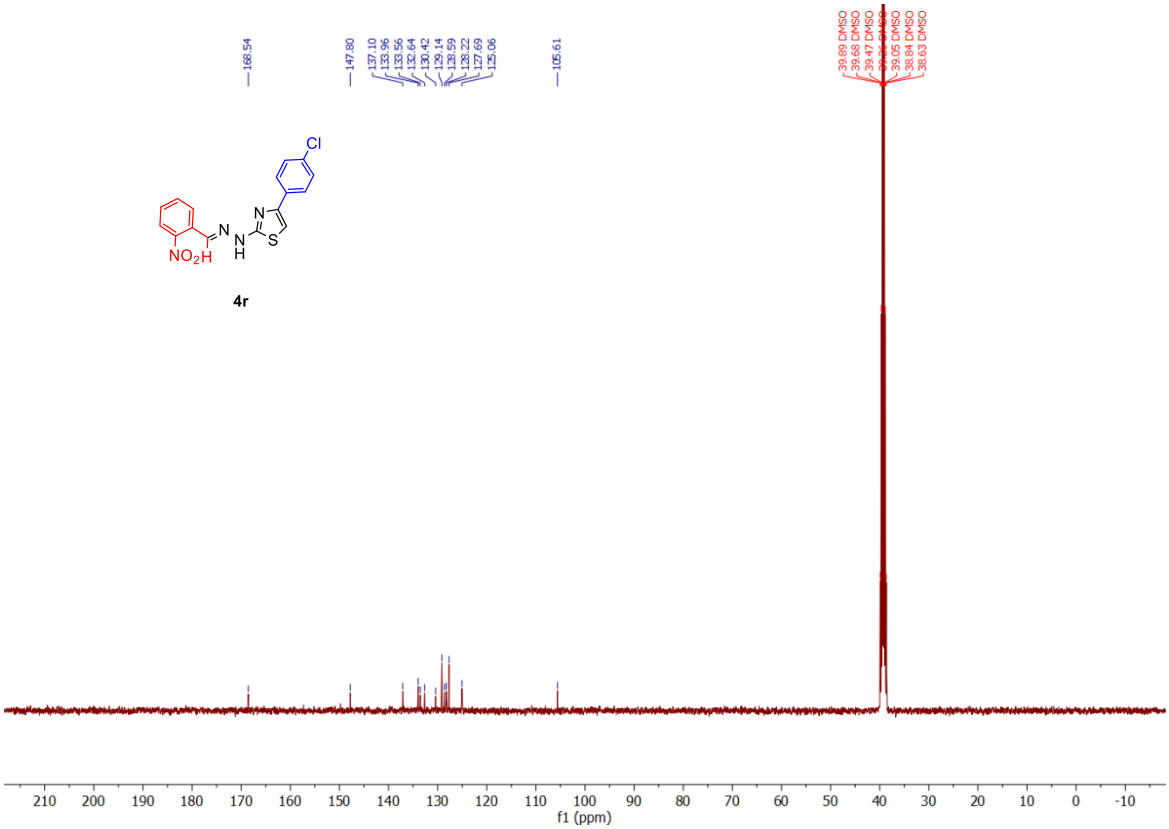


^{1}H NMR spectra of 4q

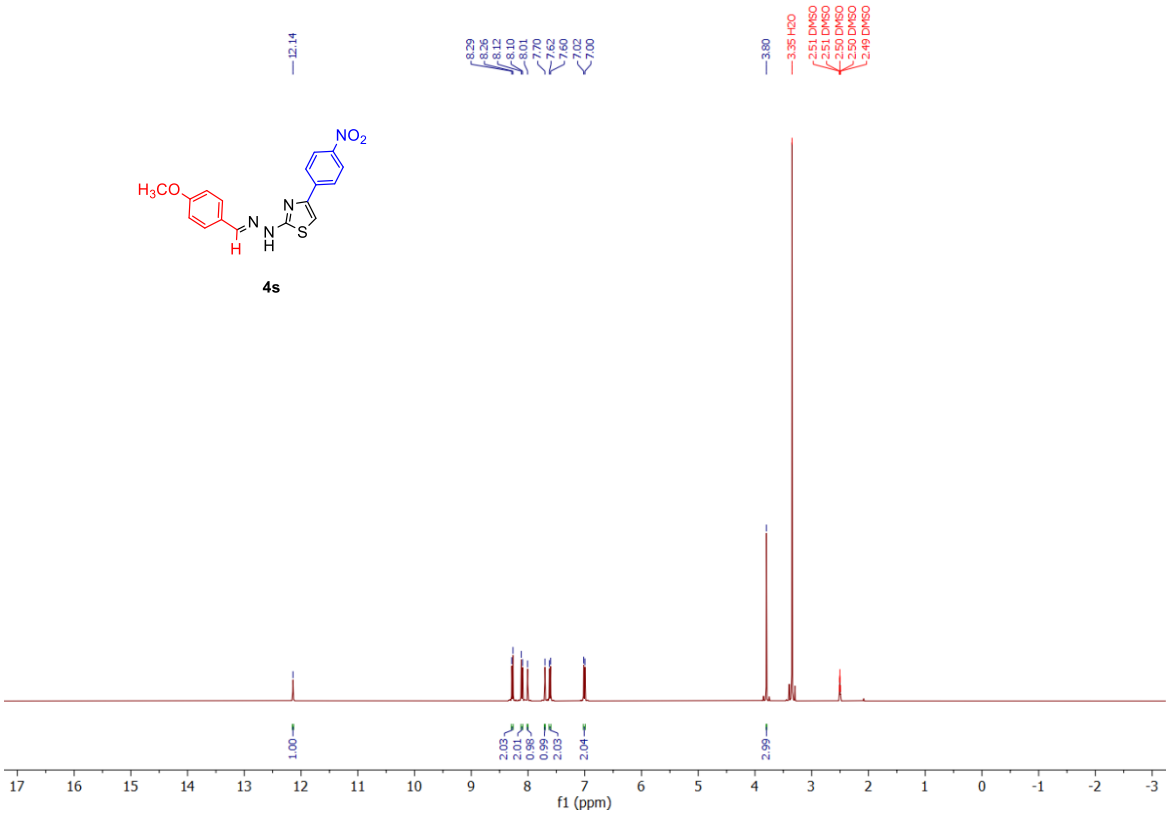


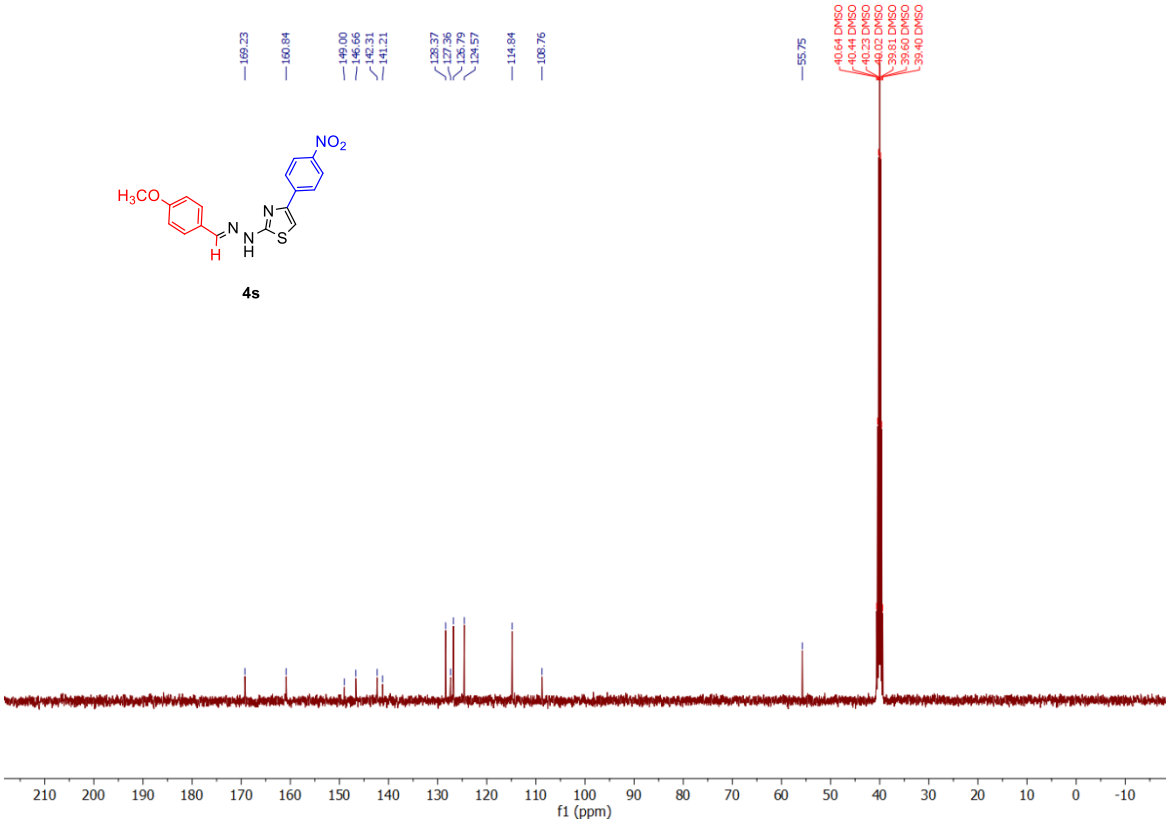
^{1}H and ^{13}C NMR spectra of 4r



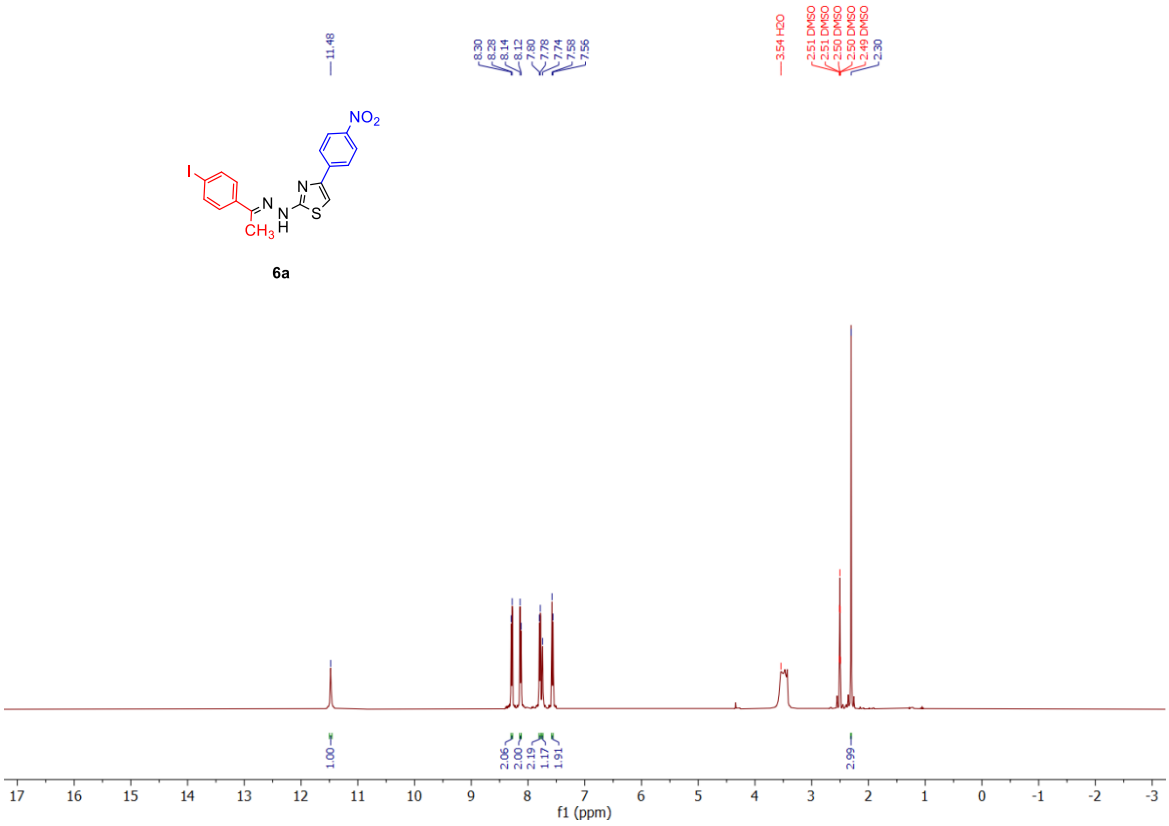


^{1}H and ^{13}C NMR spectra of 4s

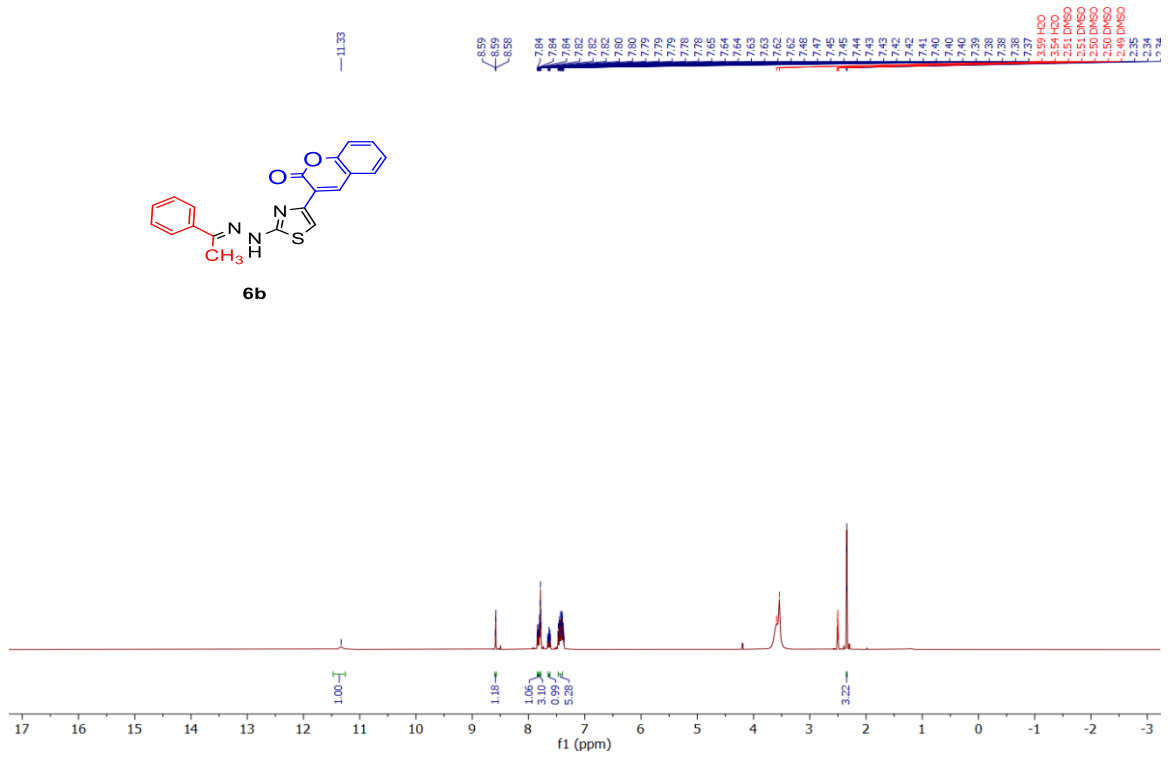


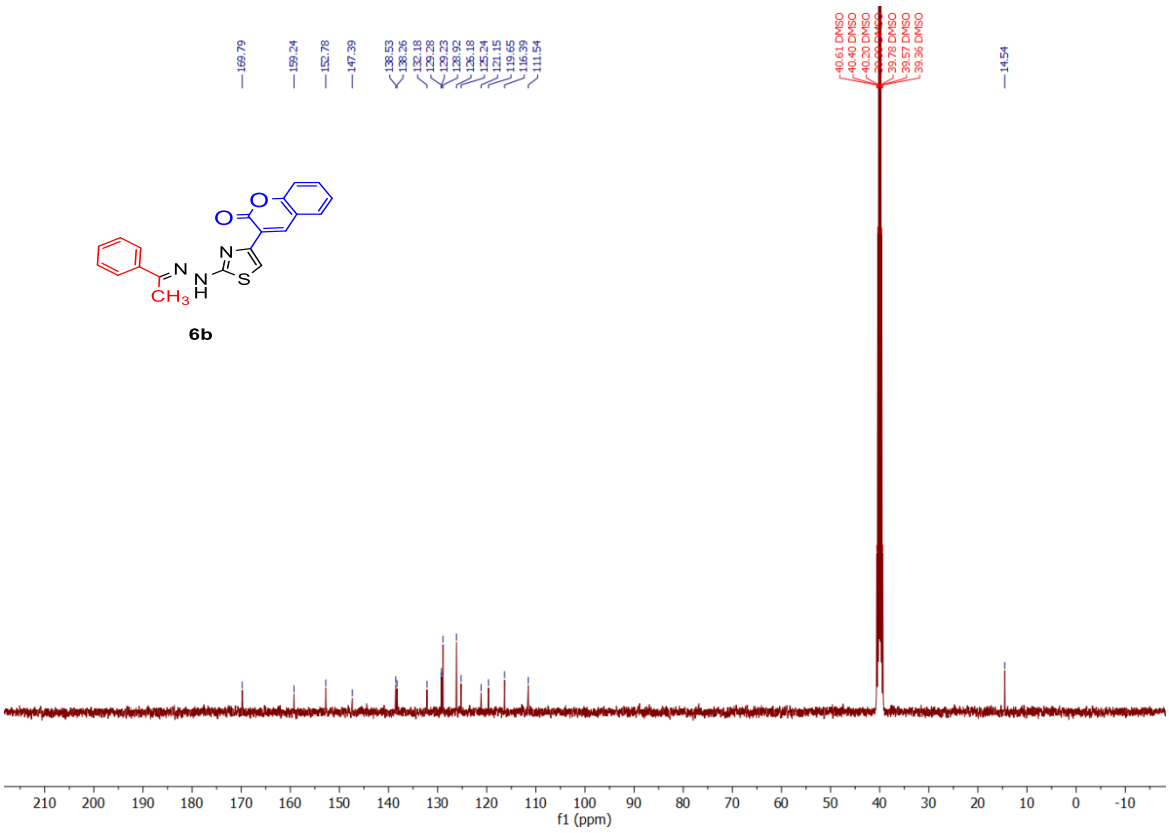


^{1}H NMR spectra of 6a

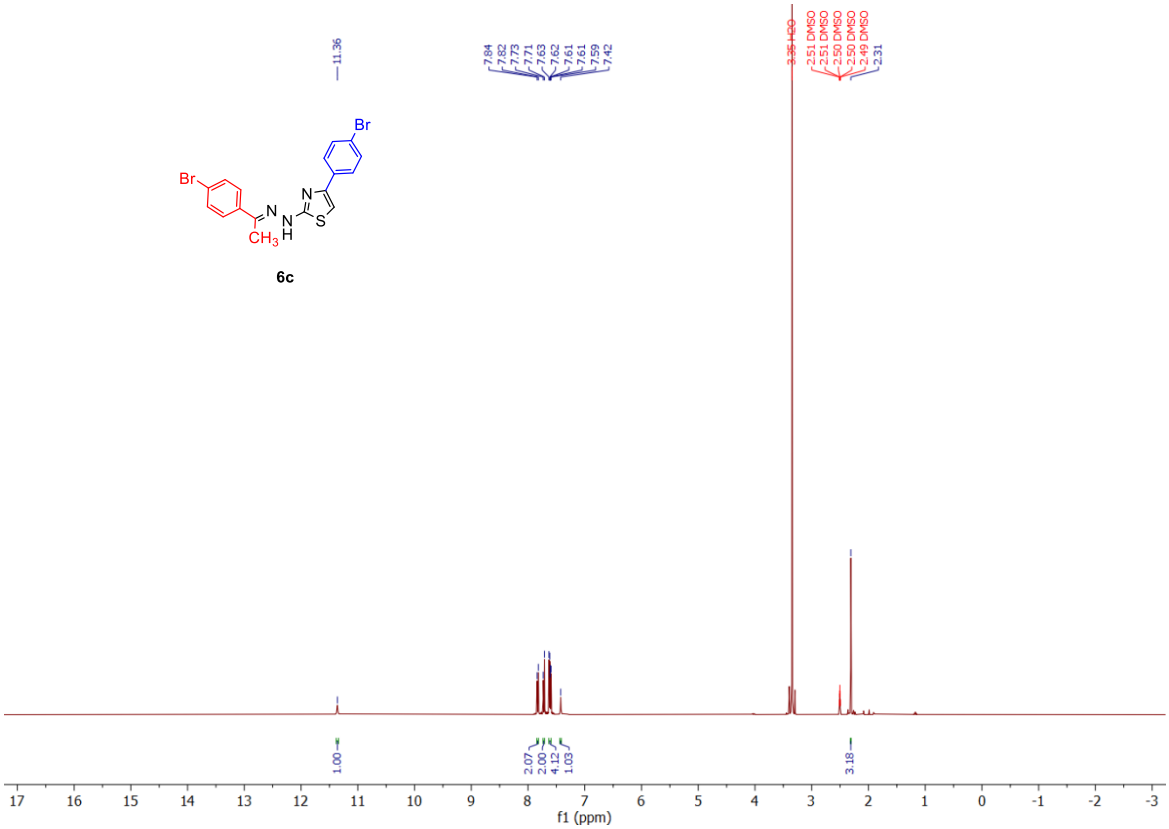


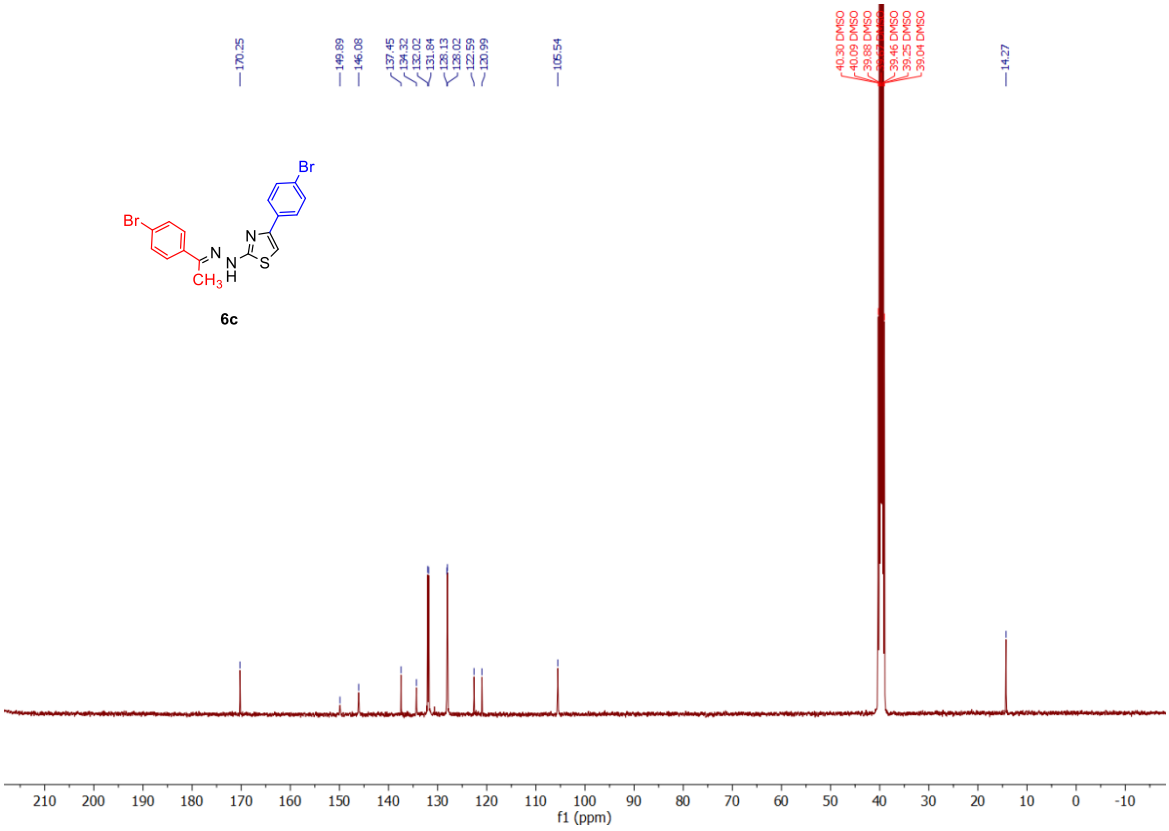
^{1}H and ^{13}C NMR spectra of 6b



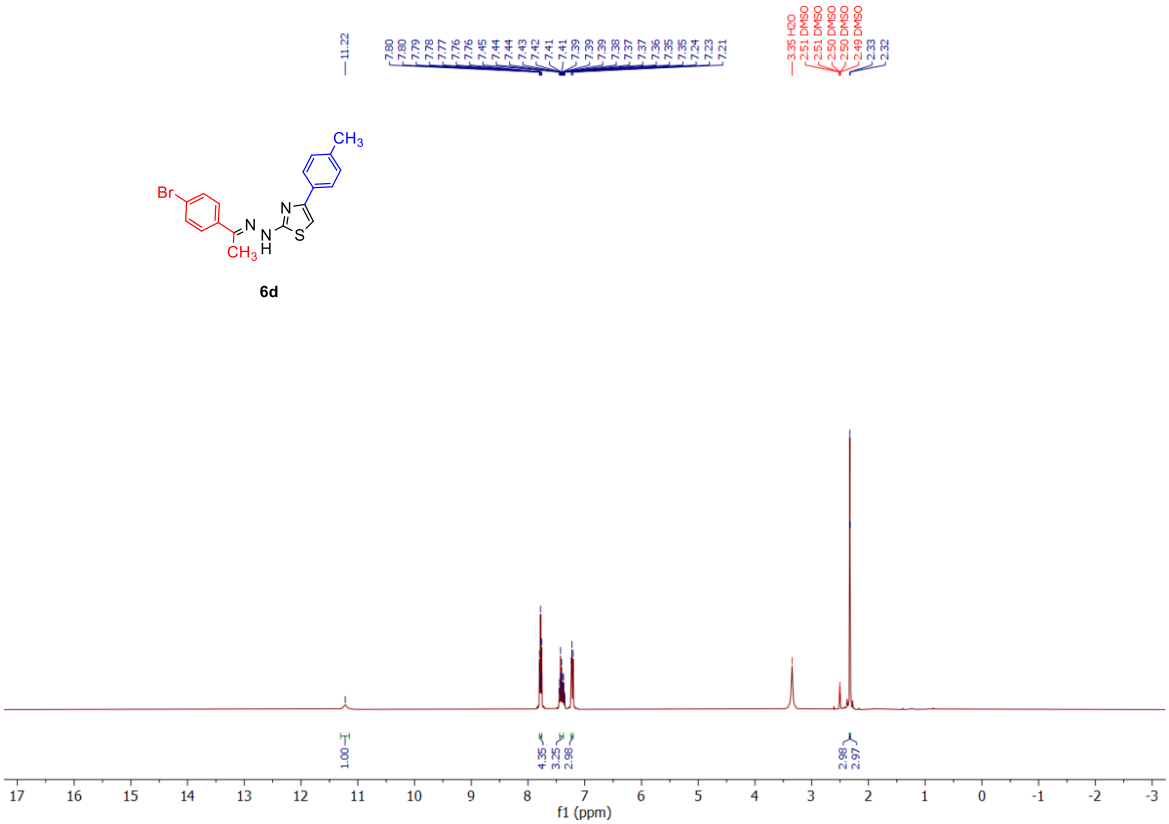


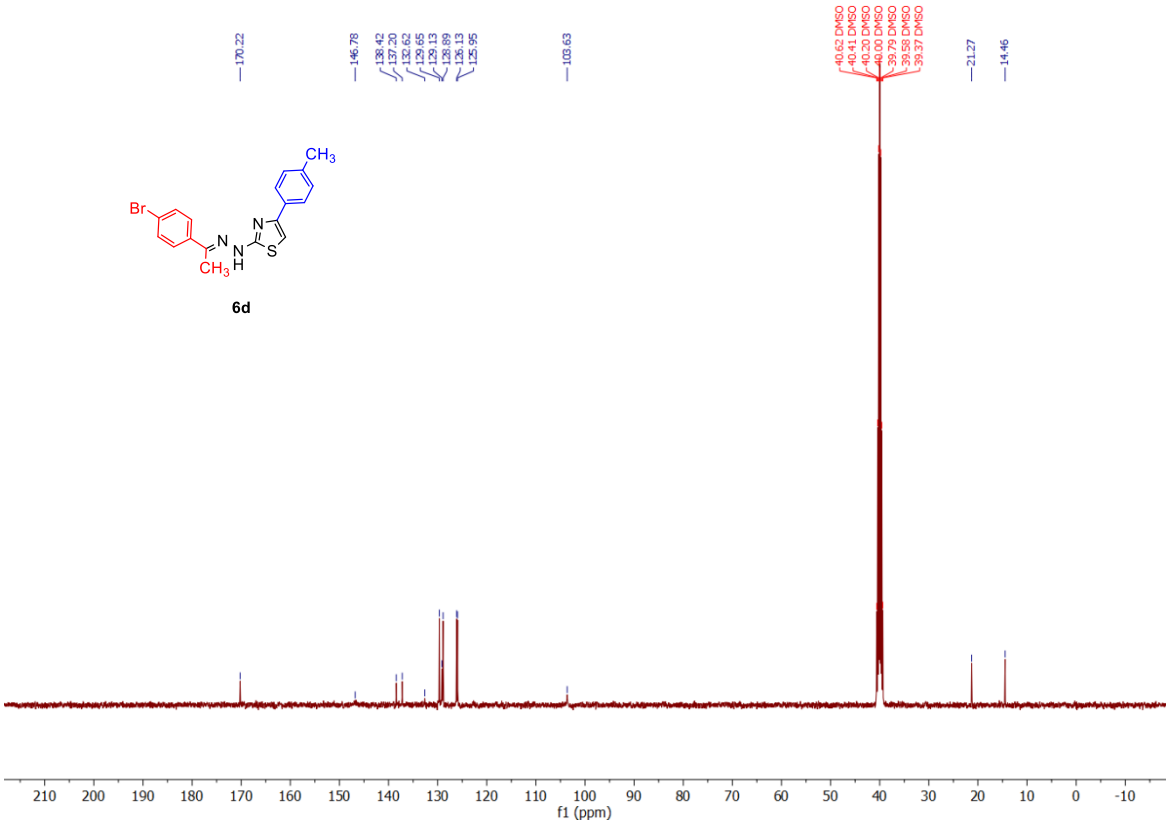
^{1}H and ^{13}C NMR spectra of 6c



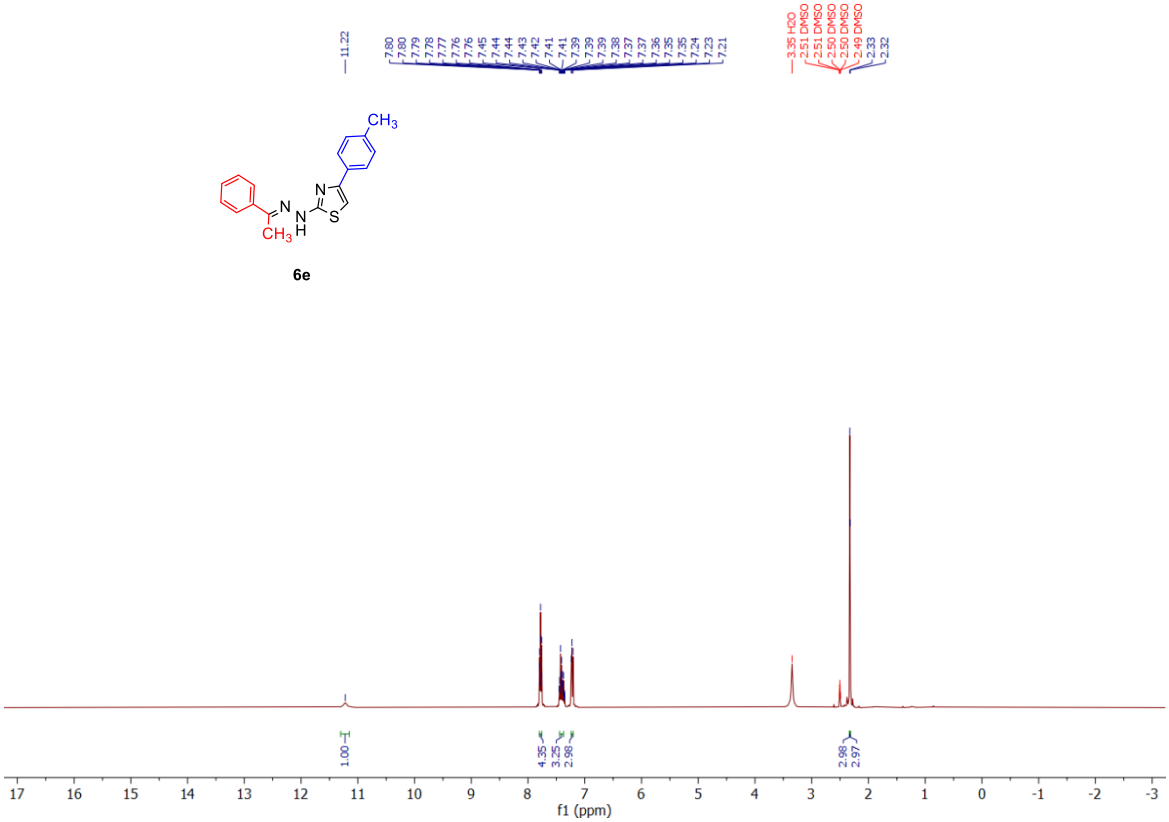


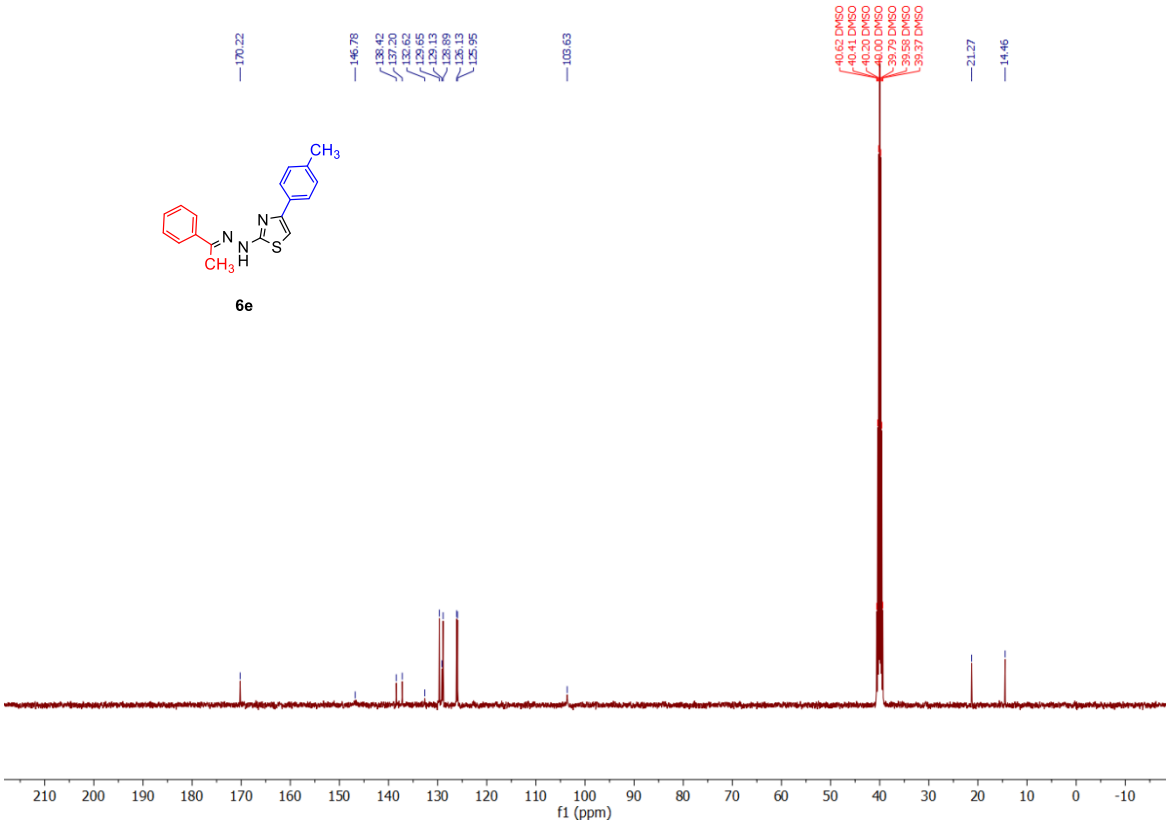
^{1}H and ^{13}C NMR spectra of 6d



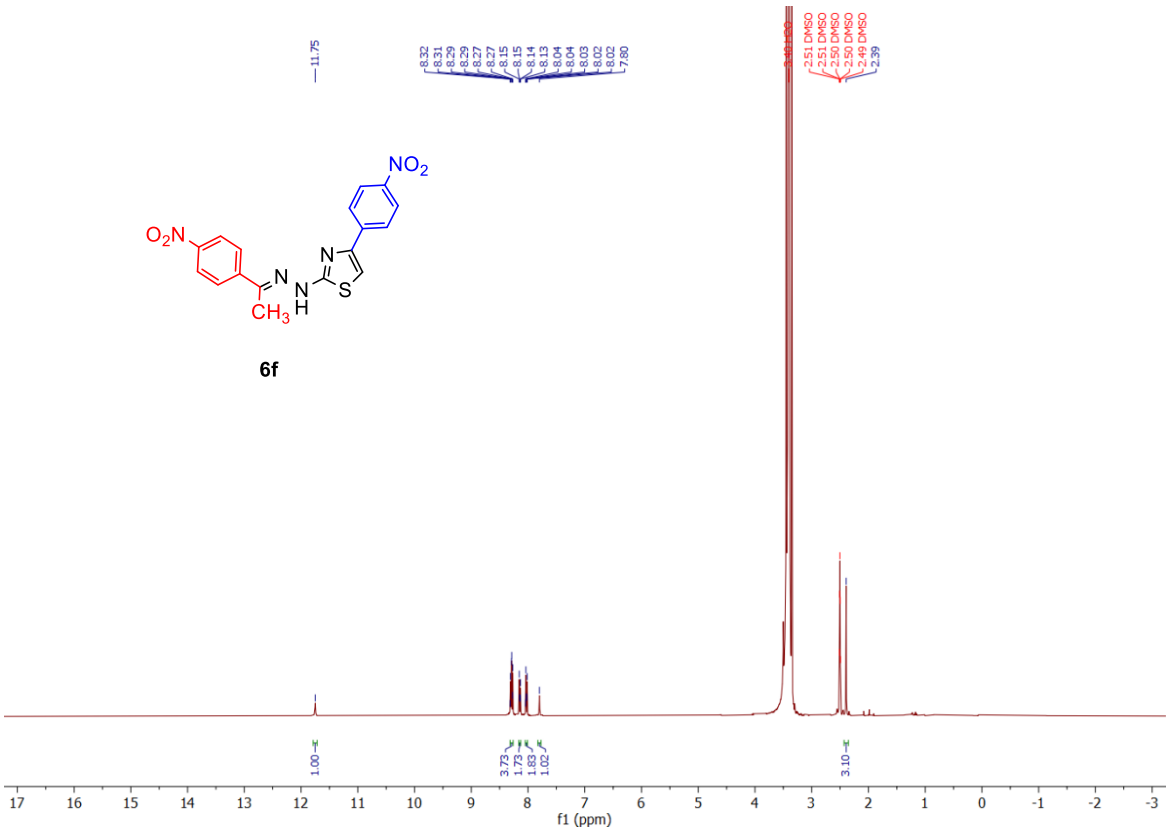


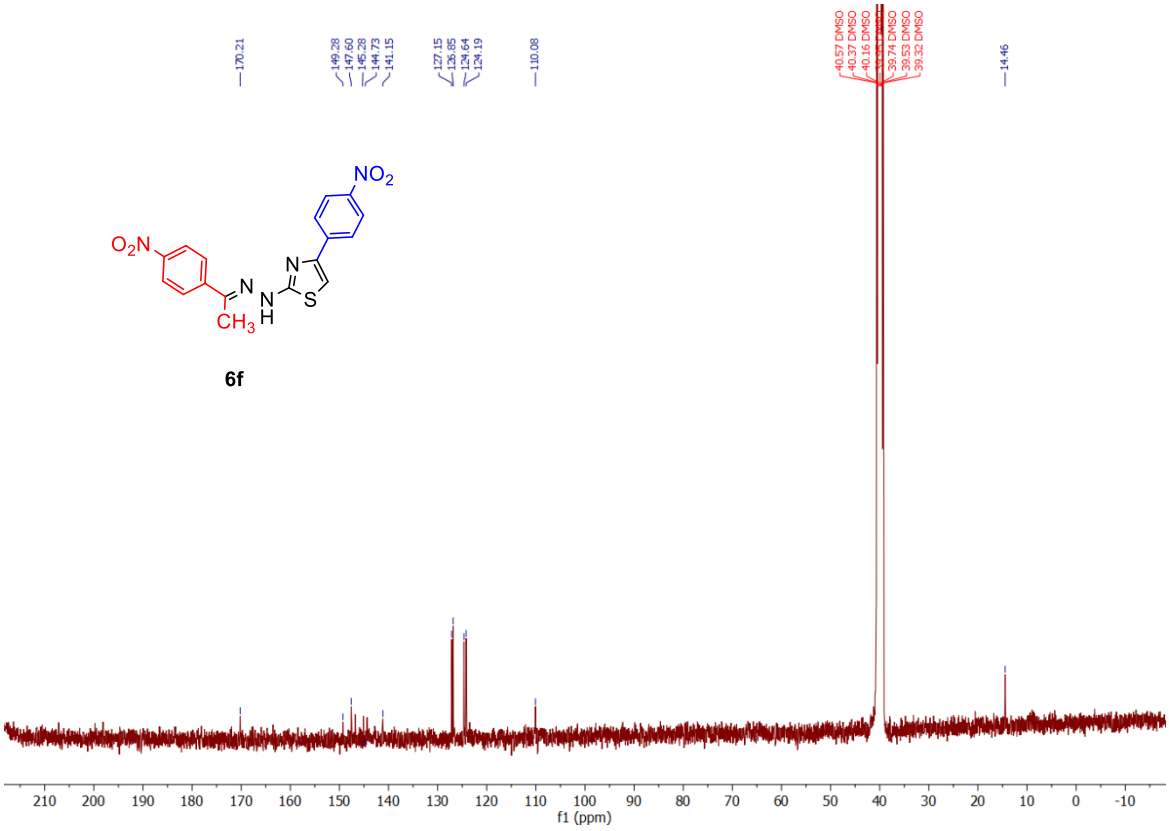
^{1}H and ^{13}C NMR spectra of 6e





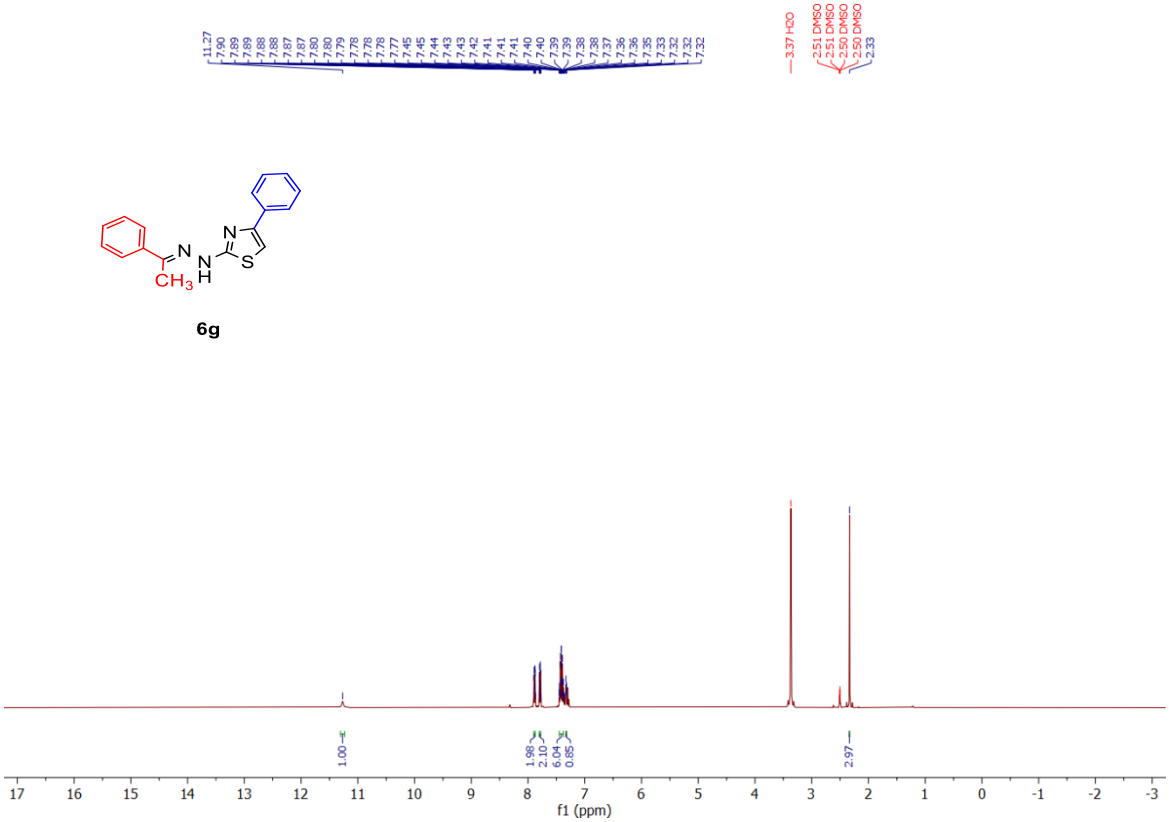
^{1}H and ^{13}C NMR spectra of 6f





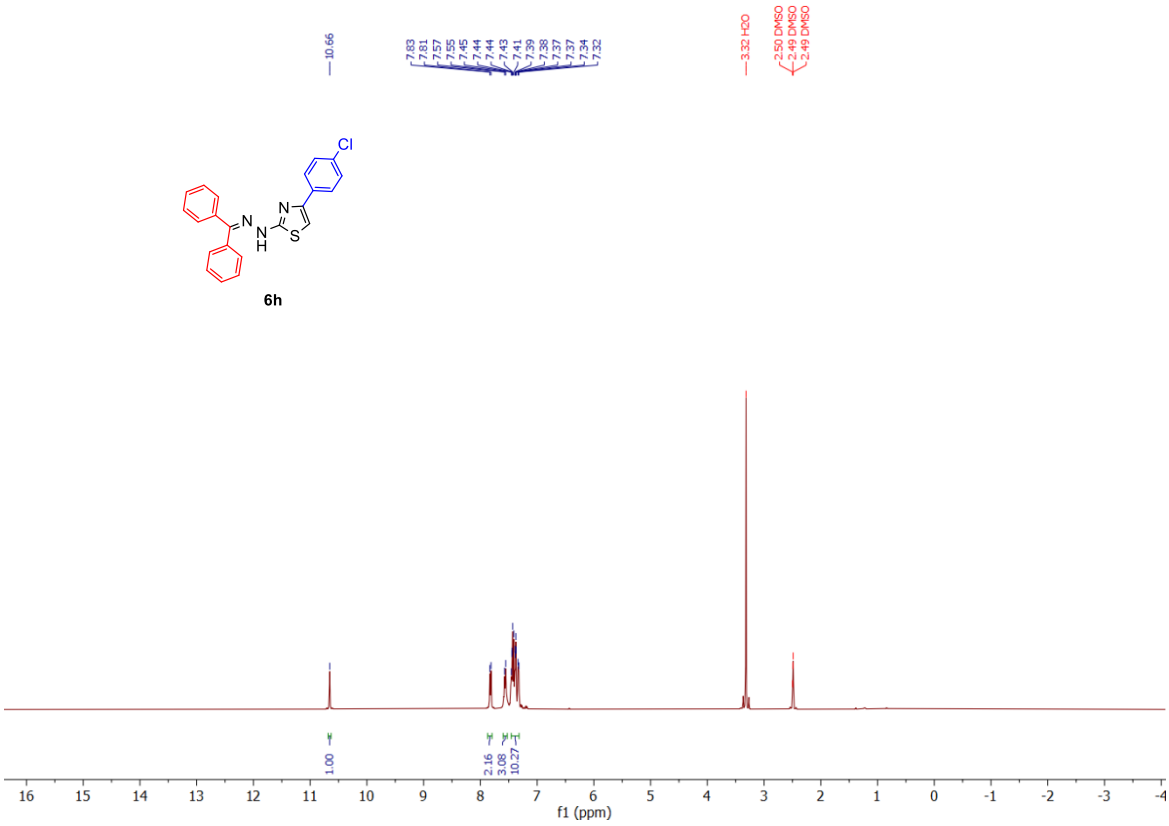
6f

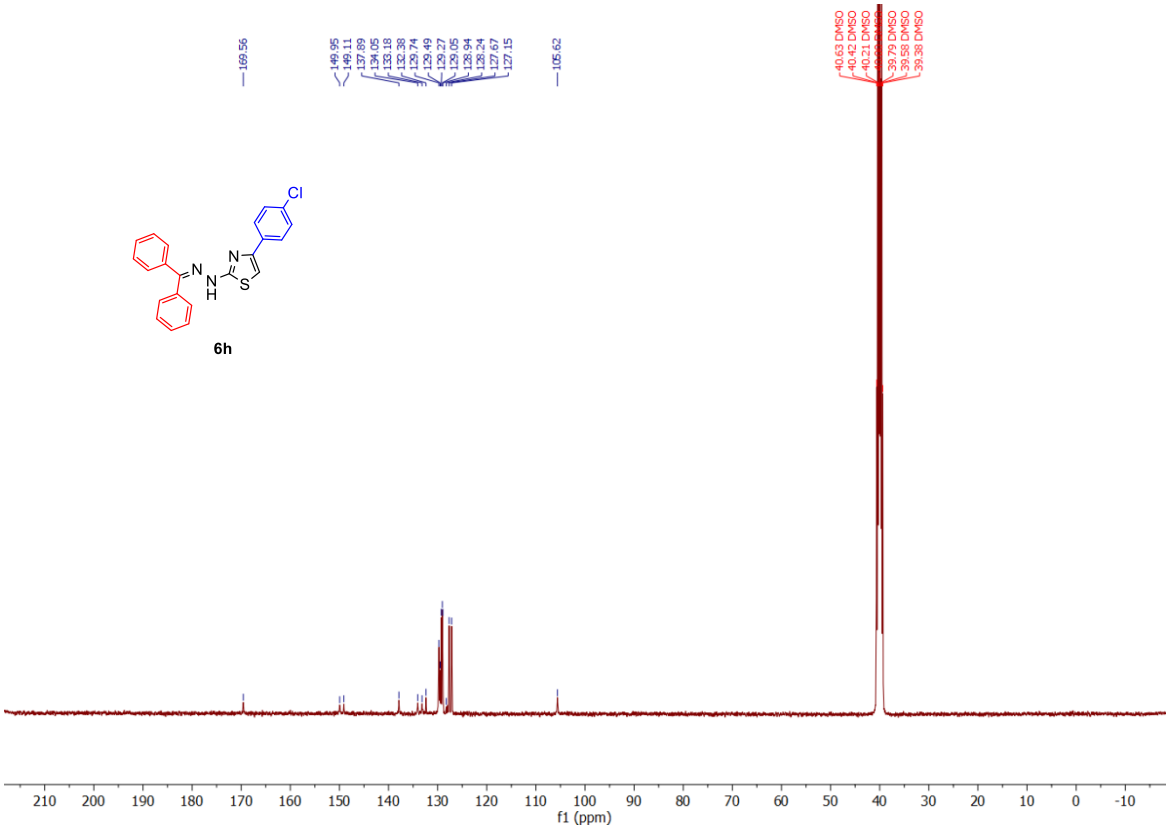
^{1}H NMR spectra of 6g



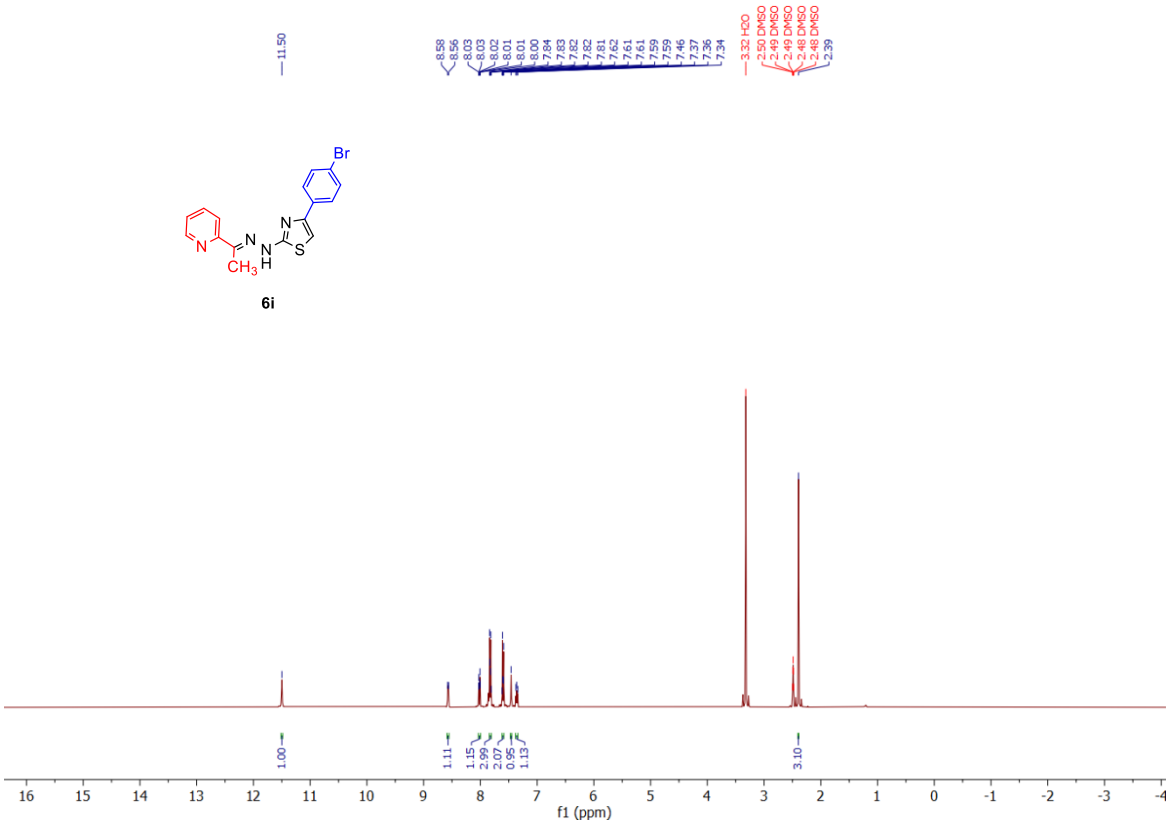
6g

^{1}H and ^{13}C NMR spectra of 6h

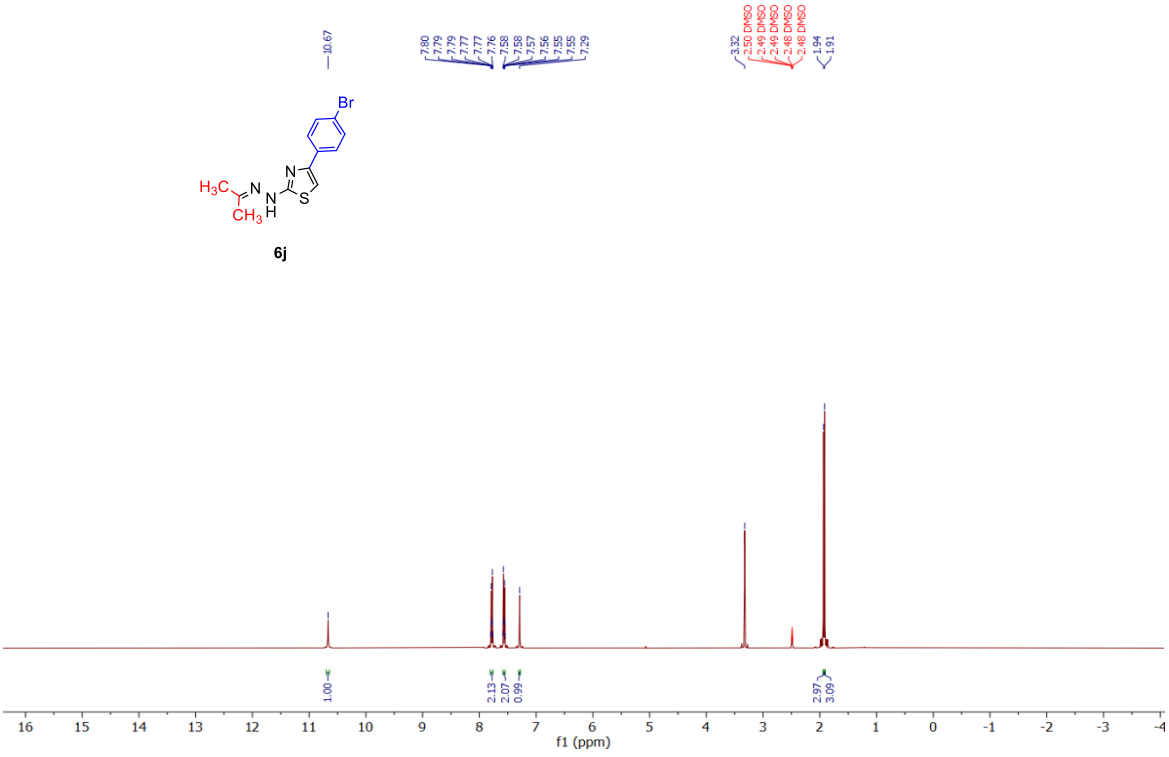


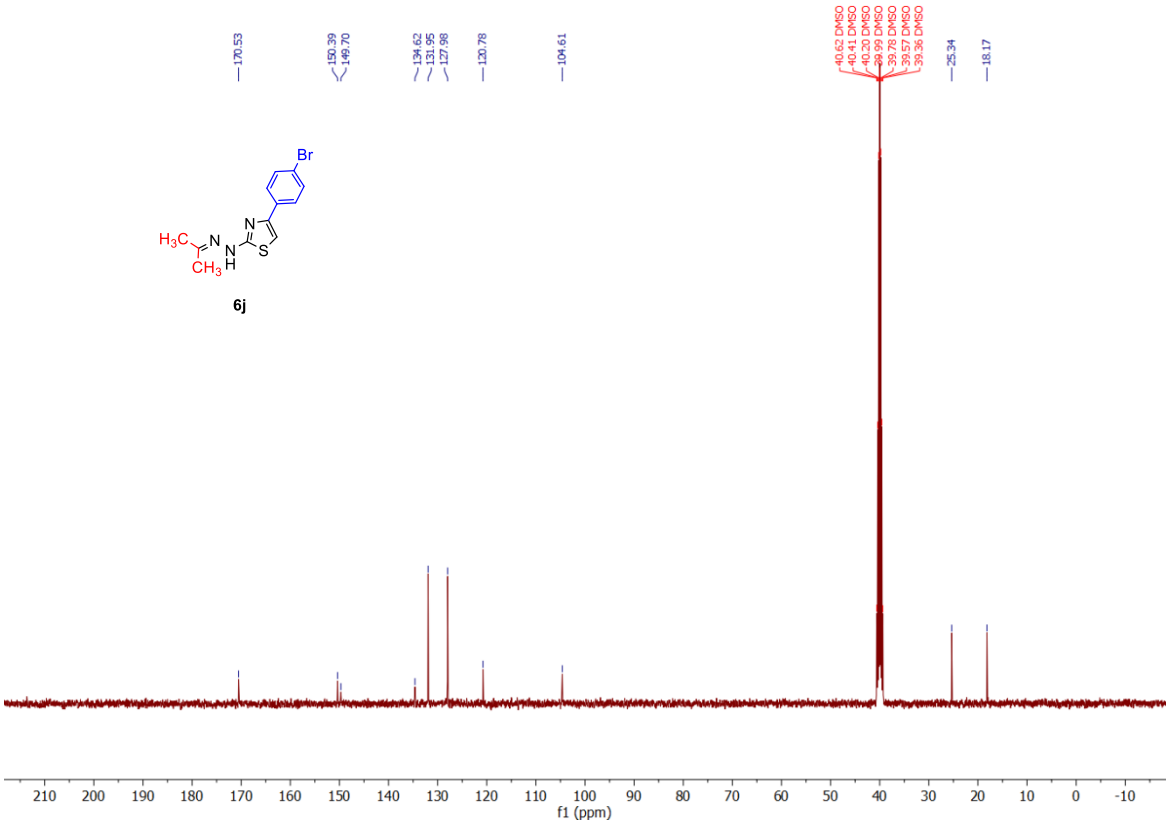


^{1}H NMR spectra of 6i

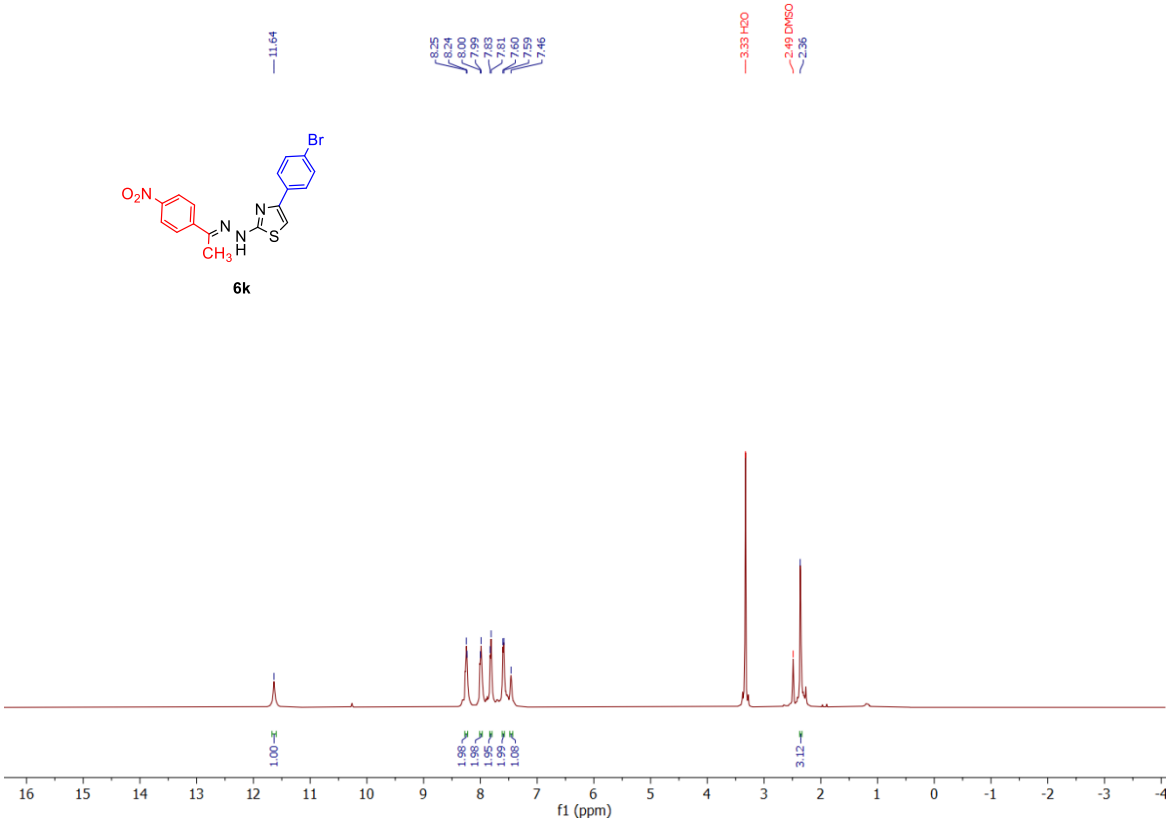


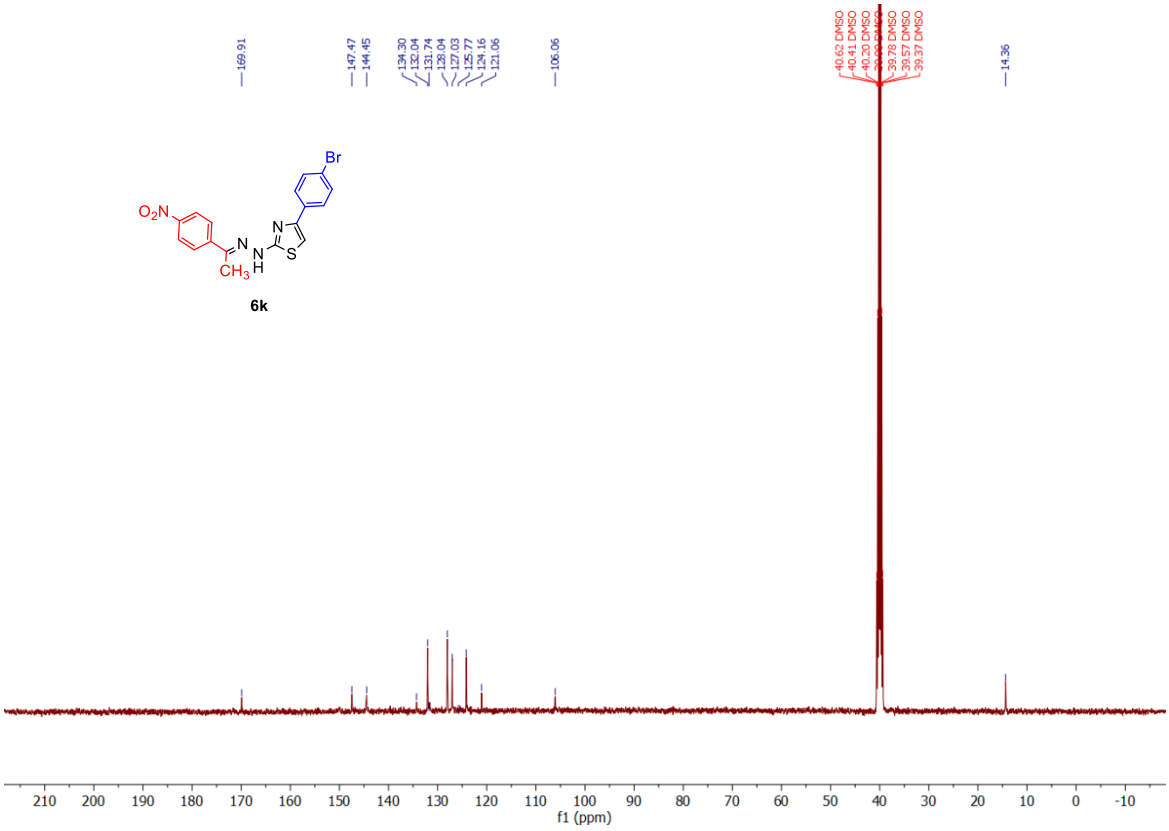
^{1}H and ^{13}C NMR spectra of 6j



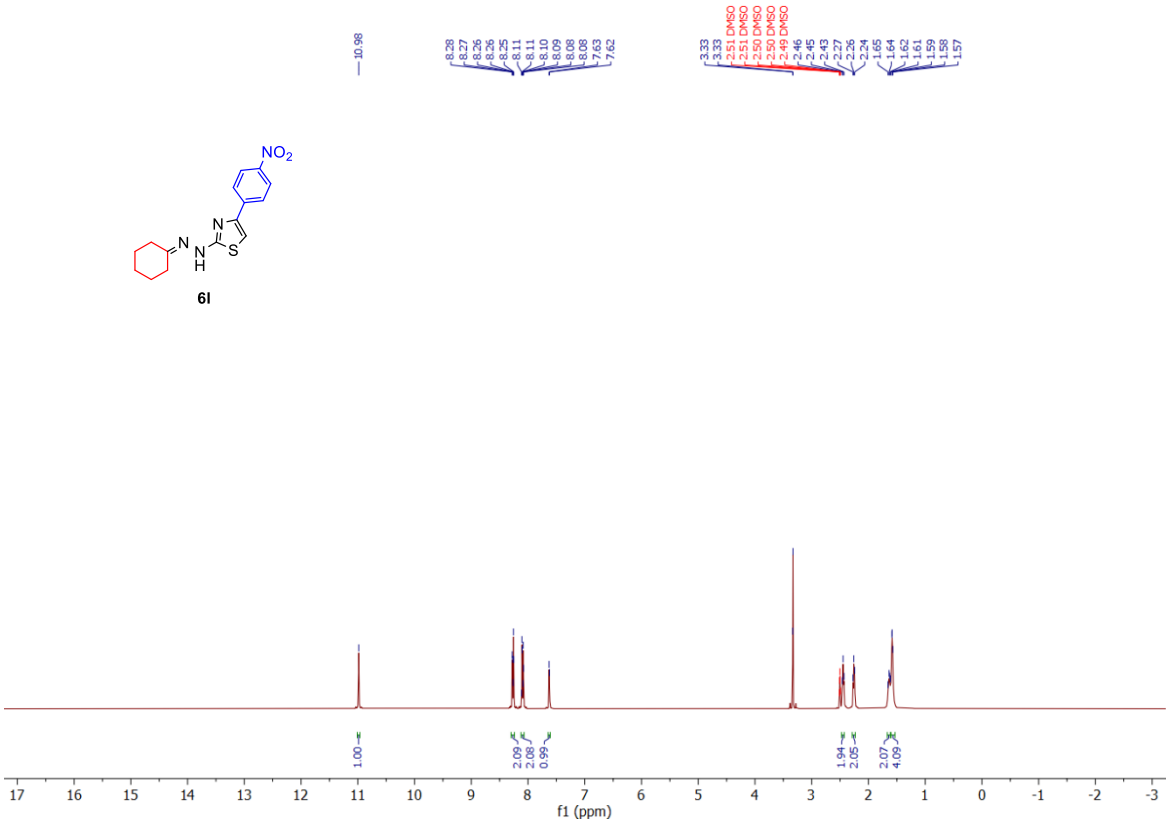


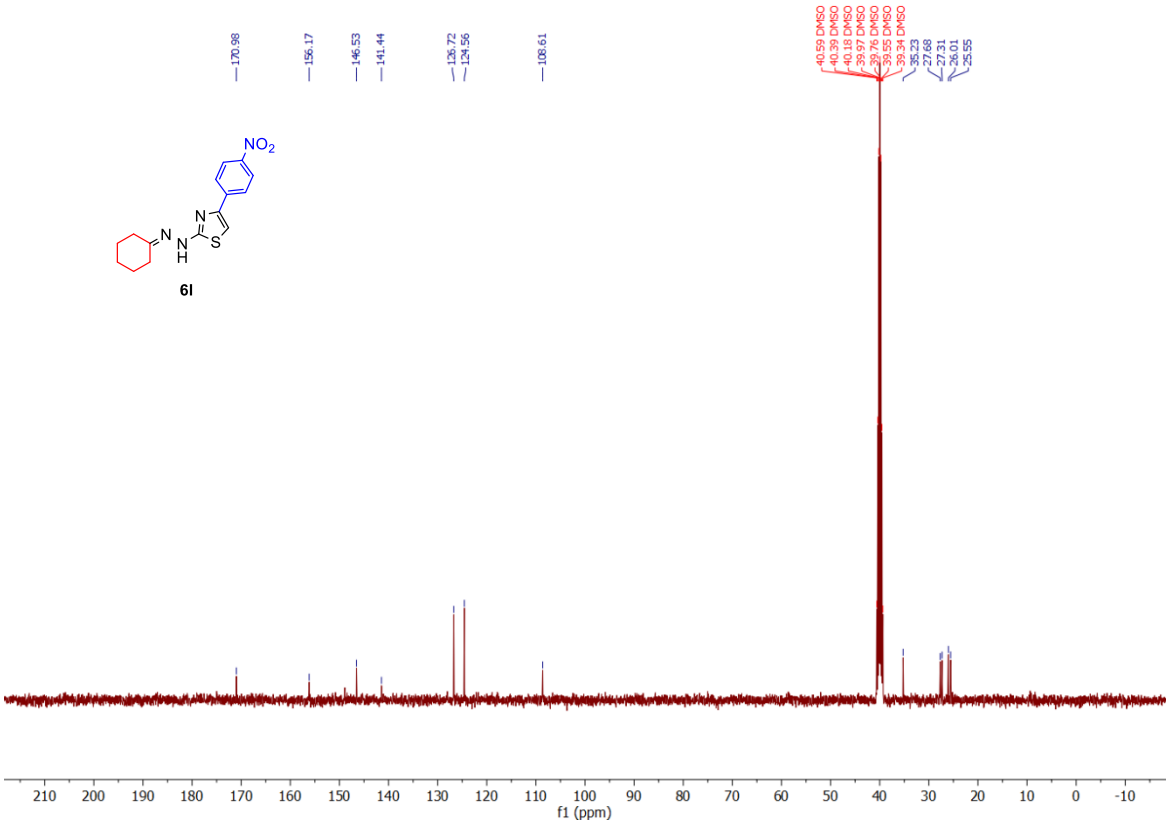
^{1}H and ^{13}C NMR spectra of 6k



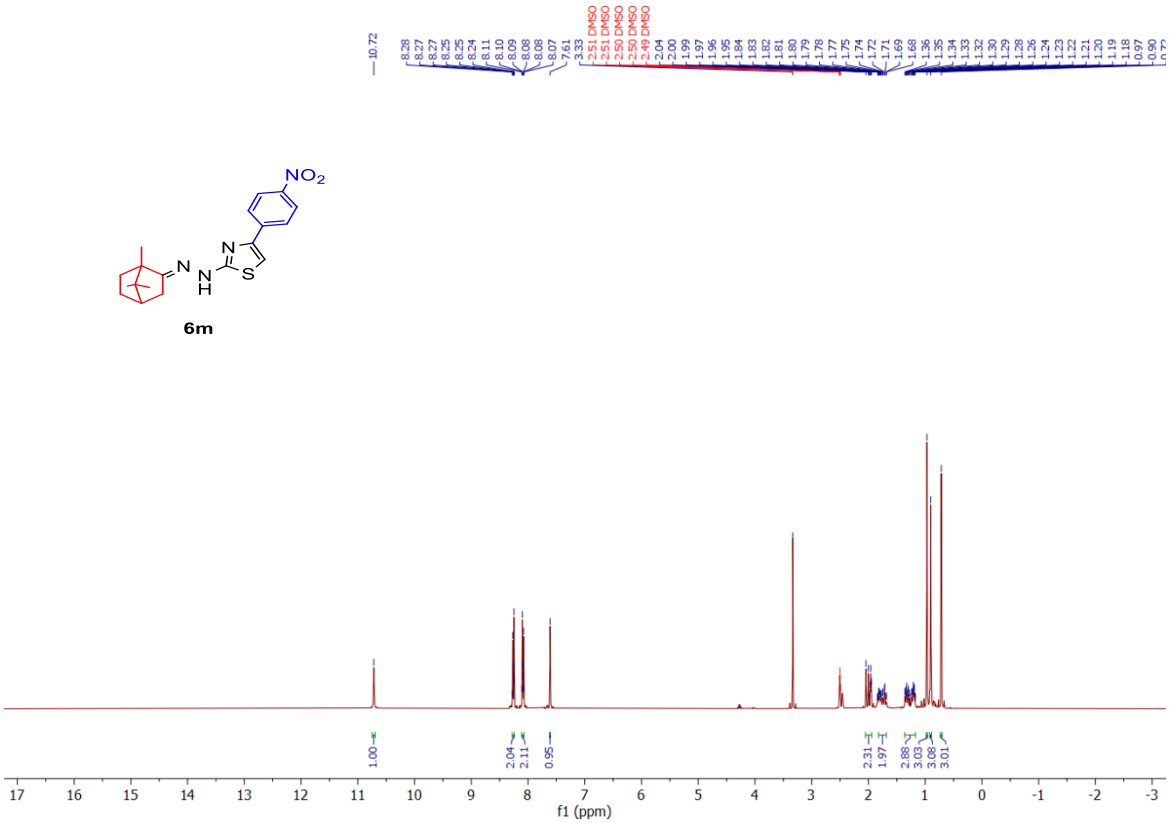


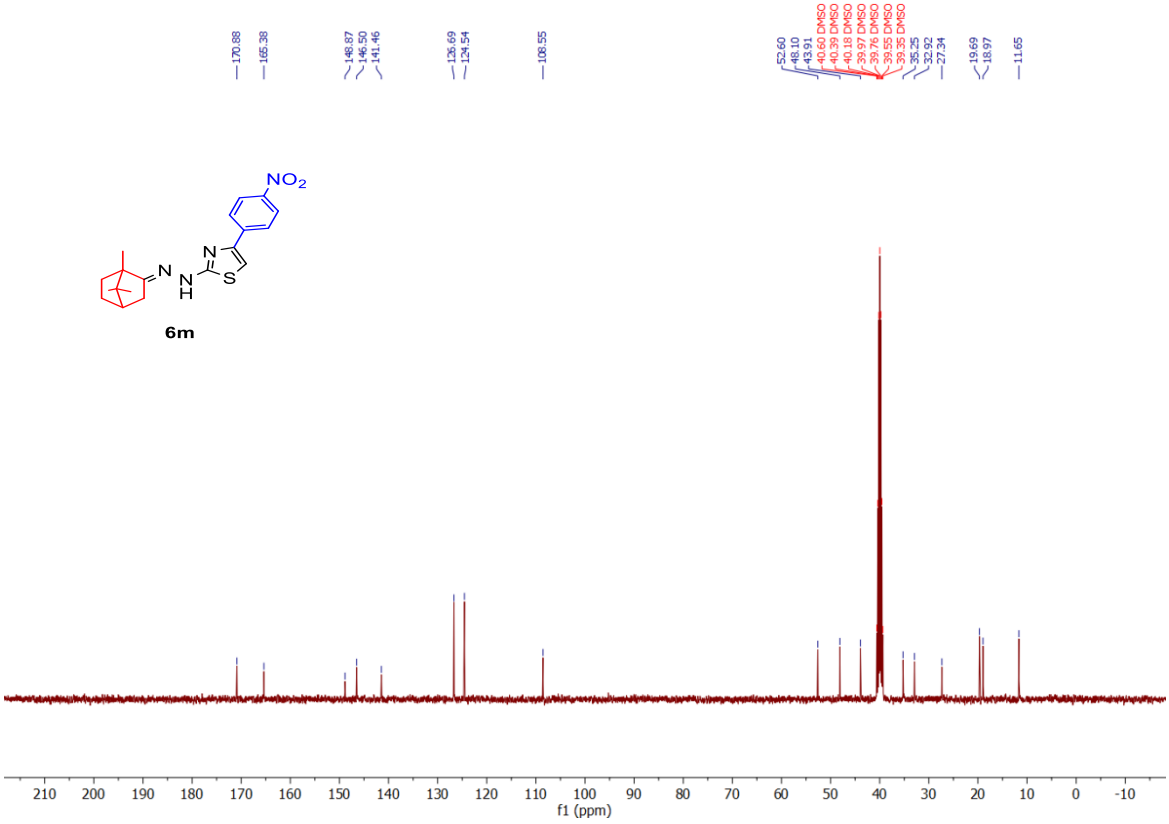
^{1}H and ^{13}C NMR spectra of 6l



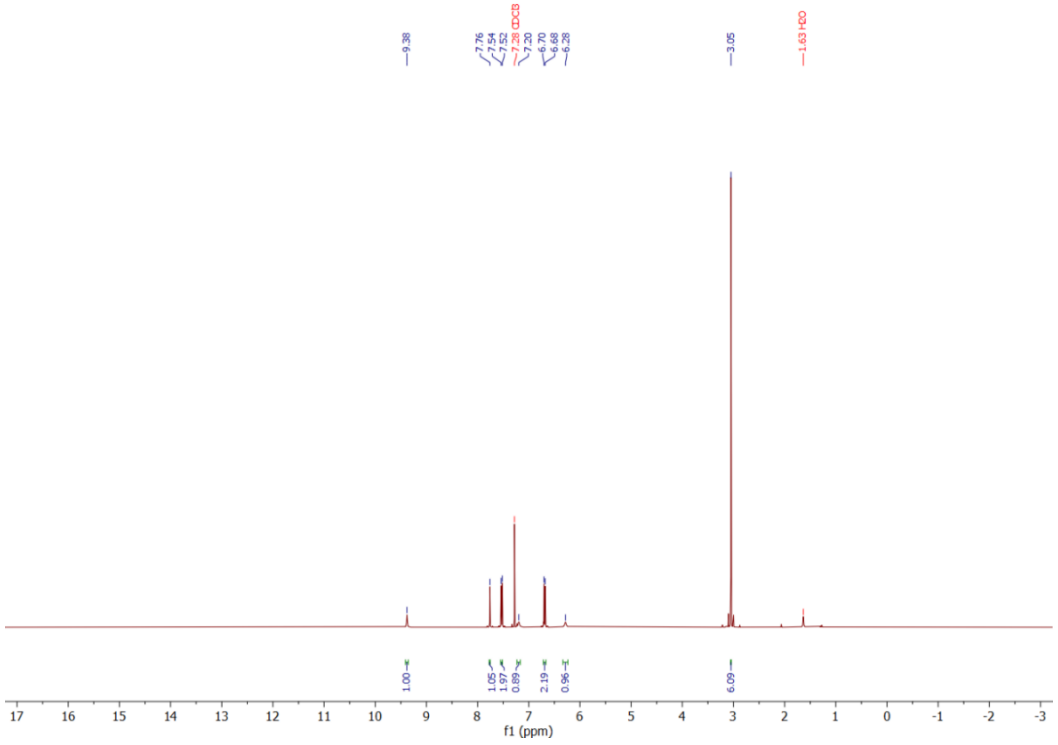


^{1}H and ^{13}C NMR spectra of 6m





^{1}H NMR spectra of G



Crystallographic experimental data

Table 1. Crystal data and structure refinement for 4a

Identification code	KSK-SD 16
Empirical formula	$C_{54}H_{51}N_{15}O_6S_3$
Formula weight	1102.28
Temperature/K	298
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	17.3937(2)
b/Å	15.73990(10)
c/Å	21.0535(2)
α/°	90
β/°	112.6080(10)
γ/°	90
Volume/Å^3	5321.00(9)
Z	4
ρ_{calc}g/cm^3	1.376
μ/mm^{-1}	1.820
F(000)	2304.0
Crystal size/mm^3	0.002 × 0.002 × 0.001
Radiation	Cu Kα (λ = 1.54184)
2Θ range for data collection/°	5.504 to 136.378
Index ranges	-19 ≤ h ≤ 20, -17 ≤ k ≤ 18, -25 ≤ l ≤ 23
Reflections collected	36668
Independent reflections	9658 [R_{int} = 0.0285, R_{sigma} = 0.0220]
Data/restraints/parameters	9658/0/709
Goodness-of-fit on F^2	1.050
Final R indexes [I>=2σ (I)]	R_1 = 0.0373, wR_2 = 0.1025
Final R indexes [all data]	R_1 = 0.0431, wR_2 = 0.1070
Largest diff. peak/hole / e Å^{-3}	0.16/-0.23

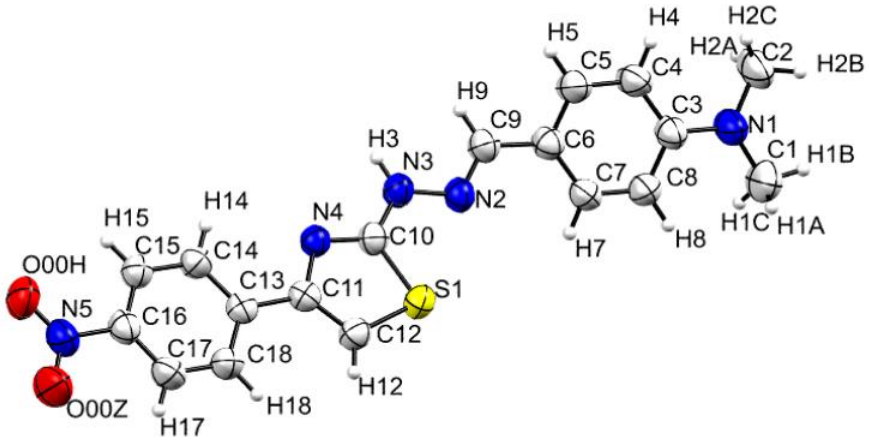


Table 2. Bond Lengths for 4a

Atom	Atom	Length/Å	Atom	Atom	Length/Å

Table 2. Bond Lengths for 4a

Atom	Atom	Length/Å	Atom	Atom	Length/Å
S1	C10	1.7400(14)	C3	C4	1.391(2)
S1	C12	1.7166(15)	C3	C8	1.403(2)
N1	C3	1.3803(19)	C5	C4	1.375(2)
N1	C2	1.43100(2)	C6	C9	1.453(2)
N1	C1	1.44300(2)	C6	C7	1.391(2)
N2	N3	1.3777(16)	C6	C5	1.386(2)
N2	C9	1.2724(19)	C7	C8	1.373(2)
N3	C10	1.3555(19)	C11	C13	1.47118)
N4	C10	1.2973(17)	C11	C12	1.355(2)
N4	C11	1.3871(17)	C13	C18	1.395(2)
N5	C16	1.4565(19)	C13	C14	1.392(2)
N5	O00H	1.2167(19)	C14	C15	1.380(2)
N5	O00Z	1.21700(2)	C16	C15	1.379(2)
			C16	C17	1.383(2)

Table 3. Crystal data and structure refinement for 4r

Identification code	KSK-SD 33
Empirical formula	$C_{32}H_{22}Cl_2N_8O_4S_2$
Formula weight	718.60
Temperature/K	293(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	18.3410(2)
b/Å	7.29160(10)
c/Å	25.2962(2)
α/°	90
β/°	106.6970(10)
γ/°	90
Volume/Å^3	3240.36(6)
Z	4
ρ_{calc}g/cm^3	1.473
μ/mm^{-1}	3.446
F(000)	1476.0
Crystal size/mm^3	0.002 × 0.002 × 0.001
Radiation	Cu Kα (λ = 1.54184)
2Θ range for data collection/°	5.03 to 136.366
Index ranges	$-22 \le h \le 22$, $-8 \le k \le 6$, $-29 \le l \le 30$
Reflections collected	22215
Independent reflections	5884 [R_{int} = 0.0278, R_{sigma} = 0.0225]
Data/restraints/parameters	5884/0/434

Goodness-of-fit on F^2	1.067
Final R indexes [I>=2σ (I)]	R_1 = 0.0337, wR_2 = 0.0958
Final R indexes [all data]	R_1 = 0.0383, wR_2 = 0.0992
Largest diff. peak/hole / e $Å^{-3}$	0.26/-0.53

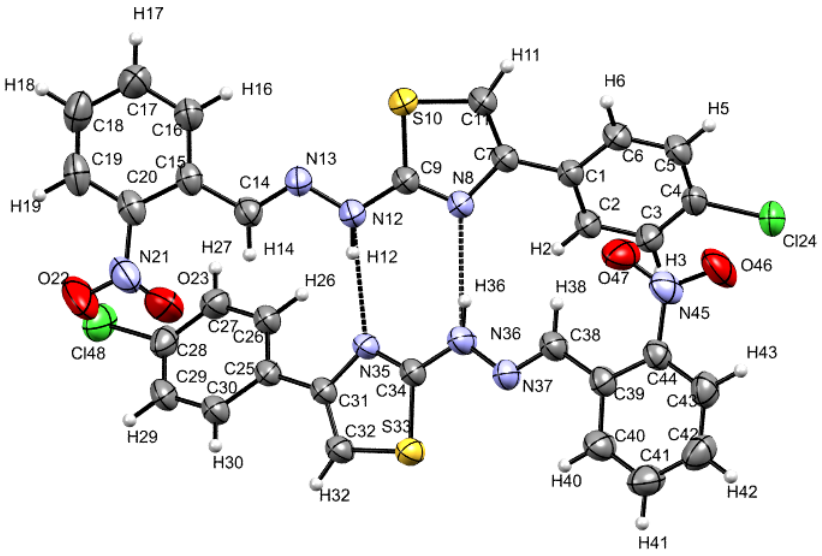


Table 3. Bond Length for 4r

Atom	Atom	Length/Å	Atom	Atom	Length/Å
Cl24	C4	1.7419(17)	C1	C2	1.390(3)
S33	C34	1.7225(17)	C1	C6	1.396(2)
S33	C32	1.7167(17)	C7	C11	1.354(2)
S10	C9	1.7291(17)	C31	C32	1.351(2)
S10	C11	1.7208(18)	C14	C15	1.465(2)
Cl48	C28	1.7431(18)	C44	C39	1.398(2)
N8	C7	1.396(2)	C44	C43	1.387(3)
N8	C9	1.302(2)	C15	C20	1.400(2)
N35	C31	1.393(2)	C15	C16	1.393(3)
N35	C34	1.298(2)	C39	C38	1.463(2)
N13	N12	1.360(2)	C39	C40	1.396(3)
N13	C14	1.278(2)	C26	C27	1.384(3)
O47	N45	1.223(2)	C2	C3	1.382(2)
N12	C9	1.363(2)	C4	C5	1.372(3)
N37	N36	1.360(2)	C4	C3	1.383(2)
N37	C38	1.272(2)	C5	C6	1.375(3)
O46	N45	1.223(2)	C30	C29	1.379(3)
N36	C34	1.365(2)	C20	C19	1.385(3)
N45	C44	1.465(2)	C29	C28	1.373(3)
O23	N21	1.222(3)	C16	C17	1.375(3)

Atom	Atom	Length/Å	Atom	Atom	Length/Å
C25	C31	1.471(2)	C28	C27	1.375(3)
C25	C26	1.389(3)	C43	C42	1.367(3)
C25	C30	1.393(2)	C19	C18	1.360(3)
N21	C20	1.465(3)	C40	C41	1.373(3)
N21	O22	1.215(2)	C42	C41	1.381(3)
C1	C7	1.472(2)	C18	C17	1.382(3)

Table 4. Crystal data and structure refinement for 6c

Identification code	KSKSD10066
Empirical formula	$C_{17}H_{13}Br_2N_3S$
Formula weight	451.18
Temperature/K	298
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	9.61780(10)
b/Å	12.12040(10)
c/Å	14.86240(10)
α/°	90
β/°	99.5390(10)
γ/°	90
Volume/Å^3	1708.58(3)
Z	4
ρ_{calc}g/cm^3	1.754
μ/mm^{-1}	7.170
F(000)	888.0
Crystal size/mm^3	0.002 × 0.002 × 0.001
Radiation	Cu Kα (λ = 1.54184)
2Θ range for data collection/°	9.324 to 136.402
Index ranges	$-10 \le h \le 11$, $-14 \le k \le 14$, $-17 \le l \le 17$
Reflections collected	16387
Independent reflections	3078 [R_{int} = 0.0276, R_{sigma} = 0.0199]
Data/restraints/parameters	3078/0/209
Goodness-of-fit on F^2	1.050
Final R indexes [I>=2σ (I)]	R_1 = 0.0330, wR_2 = 0.0849
Final R indexes [all data]	R_1 = 0.0355, wR_2 = 0.0864
Largest diff. peak/hole / e Å^{-3}	0.78/-0.77

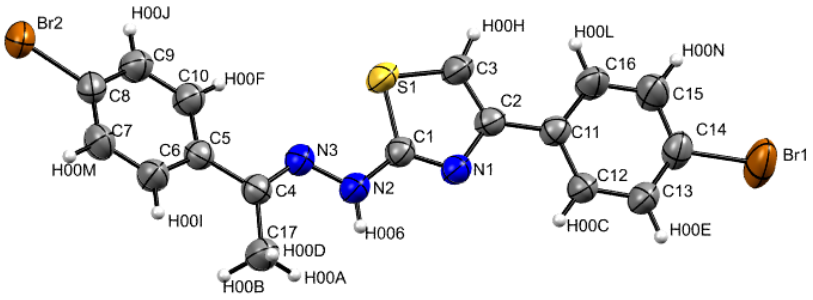


Table 5. Bond Lengths for 6c

Atom	Atom	Length/Å	Atom	Atom	Length/Å
Br2	C8	1.899(3)	C5	C6	1.389(4)
Br1	C14	1.901(3)	C11	C12	1.386(4)
S1	C1	1.725(3)	C11	C16	1.392(4)
S1	C3	1.720(3)	C4	C17	1.500(4)
N1	C2	1.392(3)	C12	C13	1.387(4)
N1	C1	1.295(3)	C8	C9	1.379(4)
N3	N2	1.363(3)	C8	C7	1.366(4)
N3	C4	1.287(3)	C13	C14	1.367(4)
N2	C1	1.367(3)	C10	C9	1.371(4)
C2	C11	1.466(4)	C14	C15	1.379(5)
C2	C3	1.354(4)	C6	C7	1.388(4)
C5	C4	1.477(4)	C16	C15	1.371(5)
C5	C10	1.393(4)			