Chemistry & Biology Interface, 2015, 5, 3, 175-187

RESEARCH PAPER ISSN: 2249 –4820

CHEMISTRY & BIOLOGY INTERFACE

An official Journal of ISCB, Journal homepage; www.cbijournal.com

Synthesis and Characterization of Some Novel Thiazole Derivatives

Chirag Chamakiya[a], Parth Manvar[a], Ranjan Khunt[a] and Anamik Shah[a]*

[a]*National Facility for Drug Discovery Centre, Department of Chemistry, Saurashtra University, Rajkot-360005, Gujarat (India)*
*E-mail: anamik_shah@hotmail.com**
Received 6 May 2015; Accepted 16 June 2015

Abstract: A series of substituted thiazole derivatives were synthesized by reaction of thiosemicarbazide with substituted vanillin under acidic condition and methanol as a solvent followed by cyclization using substituted phenacylbromides at room temperature. The characterizations of synthesized compounds were-done by ^{1}H and ^{13}C NMR and Mass spectroscopy.

Keywords: Thiazoles, Vanillin, Phenacylbromide

Introduction

A major confront of modern synthetic chemistry is to design highly efficient chemical reaction sequences that provide maximum structural complexity and diversity with a minimum number of synthetic steps to assemble compounds having interesting properties. Great efforts have been focused on preparinglibraries of small heterocyclic molecules having high degree of structural diversity and extensive utility as therapeutic agents [1]. Thiazoles are very important class of heterocyclic chemistry as they possess potential pharmacological activities. Basically thiazole is a heterocyclic compound containing a nitrogen atom and a sulfur atom as a part of five member aromatic ring.In addition, thiazole ring is highly reactive due to the presence of an acidic proton at C-2 and has emerged as an important synthon to generate variety of New Chemical Entities (NCE). Thiazole can bind to adenosine receptor namely A_1, A_2, A_3, Dopamine receptor and HIV-integrase inhibitors [2]. This class of compounds is present in many natural and synthetic products with wide range of pharmacological activities, such as anti-viral [3], anti-convulsant [4], anti-fungal and anti-microbial [5-6], anti-inflammatory [7-8], anticancer [9-10], antidiabetic [11], antiHIVagents [12-15], antiproliferative [16-17].

Vanillin is most widely used flavoring agent in the world. It is chemically known as (4-hydroxy-3-methoxybenzaldehyde) and it is broadly used for biopreservative because of its antimicrobial and antioxidant properties [18]. It is an important raw material in pharmaceutical industries for production of drugs such as aldomet, dopamine, papaverine etc. [19-20]. In view of above mentioned findings and due to excellent activities and reactivity we tried to synthesize thiazole compounds using two substituted vanillin by easier methods that may be value in designing new, potent and selective pharmaceutically active compounds. The synthesis of different thiazole derivatives has been carried out via hydrazinecarbothioamide intermediate followed by cyclization using various substituted phenacylbromides.

Materials and Methods

All the reagents were purchased from Sigma Aldrich Corporation and Spectrochem Chemicals Ltd. HPLC grade methanol was purchased from Merck India Limited, Mumbai, India. Melting points were determined in electro thermal apparatus using open capillaries and are uncorrected. The reactions were monitored by thin layer chromatography (TLC). ^{1}H and ^{13}C NMR spectra were recorded in DMSO-*d*6 solvent by Bruker 400 MHz spectrometer. Chemical shifts are expressed in δ ppm downfield from TMS as an internal standard. Mass spectra were recorded on Shimadzu GCMS-QP-2010 Ultra Model using Direct Injection Probe technique.

Experimental Procedure

General procedure for preparation of compound 2a-b

In an oven dried round bottom flask, substituted vanillin (**1a** and **1b**respectively) (0.01 mol) and thiosemicarbazide (0.01 mol) were mixed in around 4-5 ml of MeOH in the presence of catalytic amount of AcOH. The reaction mixture was then heated with stirring at 80 °C for 2 hour. After completion of reaction as monitored by TLC using 30% ethyl acetate:hexane solvent system, the reaction mixture was cooled and the obtained solid product was filtered and washed with hexane.

General Procedure for preparation of compound 4a-n

In a clean and dryround bottom flask, the obtained product from first step (**2a–b)** (0.01 mol) and substituted Phenacylbromides (**3a-g)** were reacted at room temperature with stirring. The progress ofongoing reaction was gradually monitoring by TLC using10% chloroform:methanol solvent system. After completion of reaction, solid product was separated out by filtration and the isolated product was washed with water and dried well.

Result and Discussion

Initially, we synthesize our target molecules with the help of vanillin as model substrate, MeOH as a solvent in presence of AcOH as catalyst at room temperature by reacting with thiosemicarbazide. Obtained product was then further treated with substituted phenecylbromides**3a-g** and cyclized to afford desired thiazole derivatives **4a-n**. Under this observedcondition,the yield of the substituted thiazole derivative was varied from 46–94%. All the reactions were performed at room temperature and completed within 1–2 h. It is interesting to note that, the reaction was completed within 30 min in case of compound **4j**, **4l** and **4n**. The structures of all title compounds**4a-n** have been elucidated on the basis of ^{1}H,^{13}C NMR and Mass spectroscopy analysis.

Conclusion

The heterocyclic class of compounds known as thiazole is an important subunit with a wide range of applications in many fields. In this

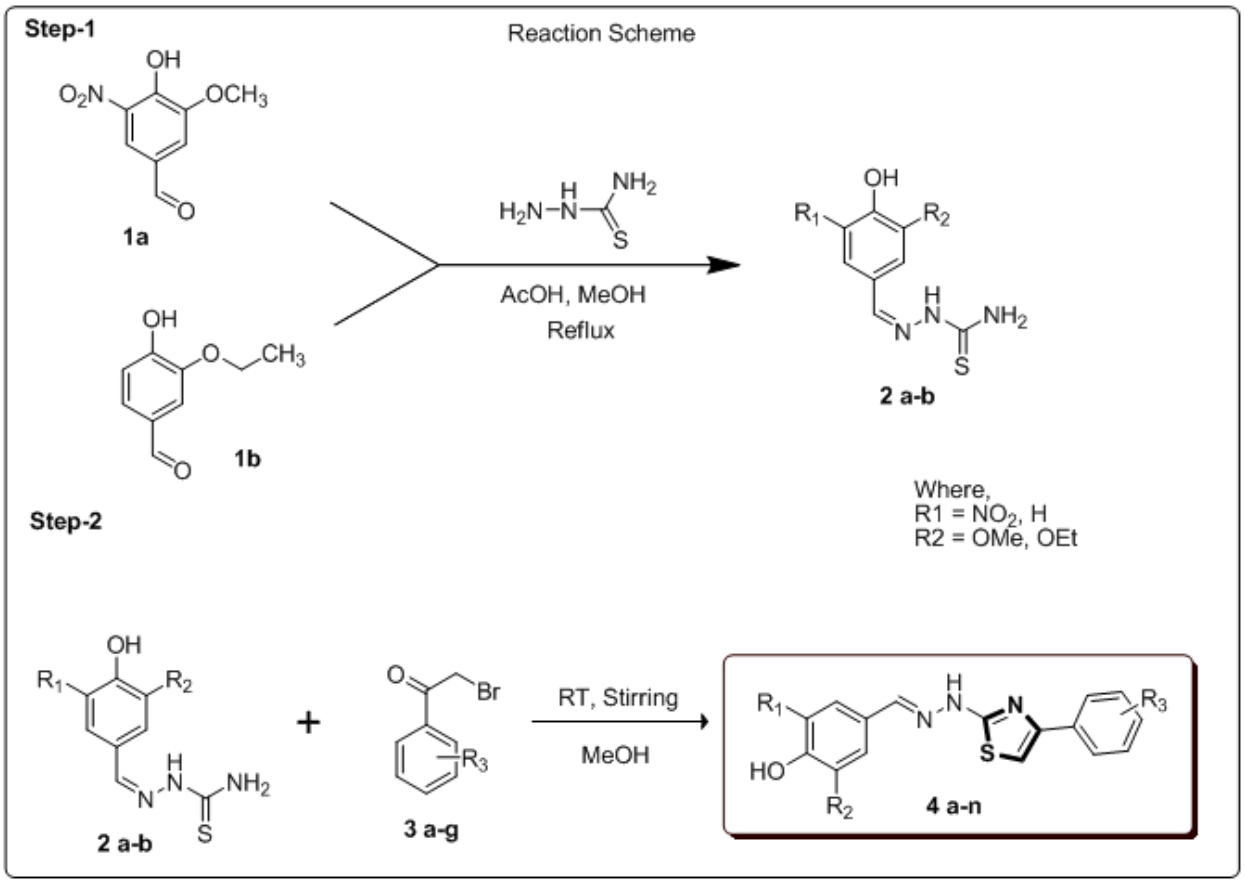
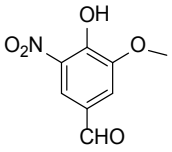
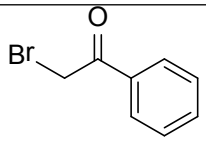
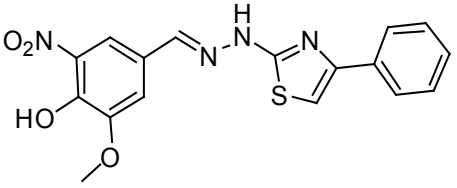
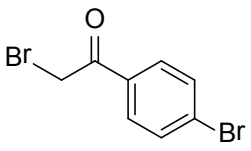
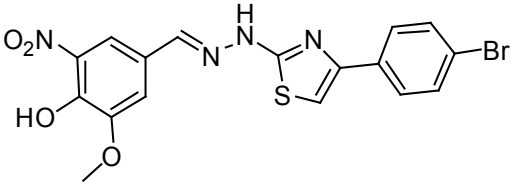
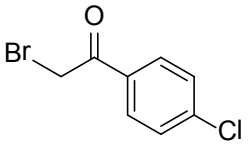
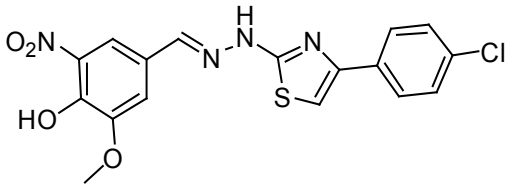
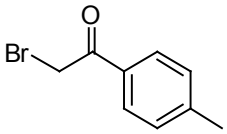
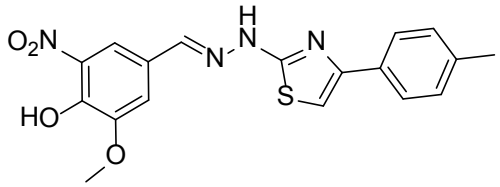
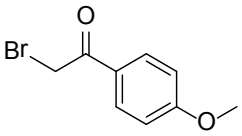
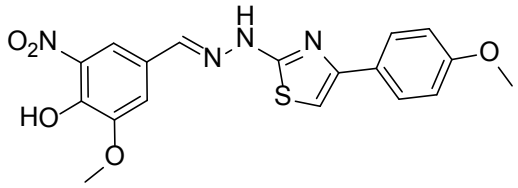
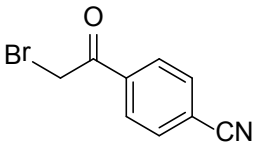
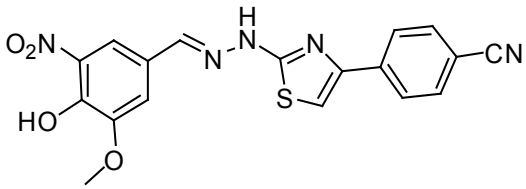
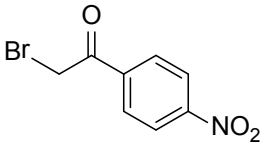
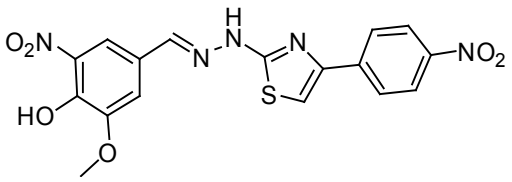
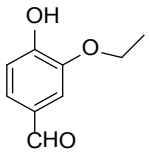
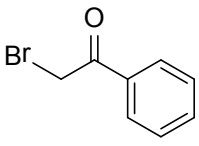
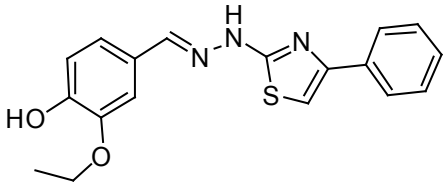
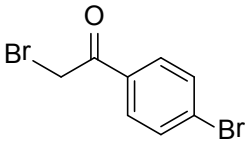
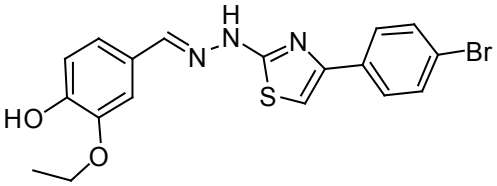
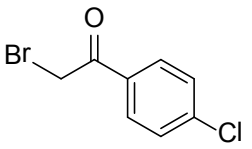
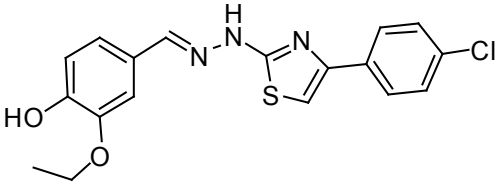
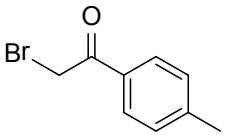
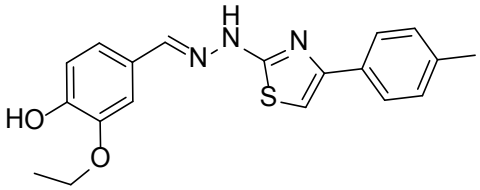
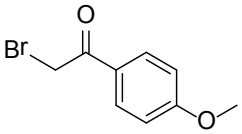
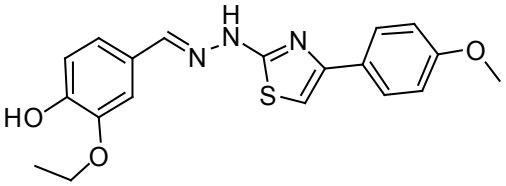
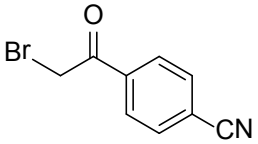
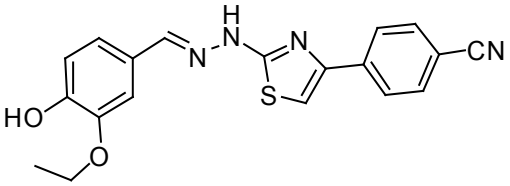
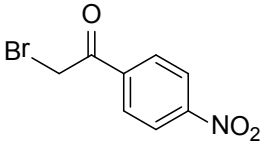
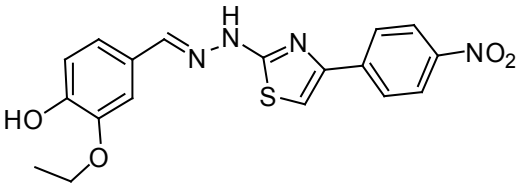


Table 1.Physical Data of final compounds. (4 a-n)

Sr. No.	Aldehyde	Phenacylbromide	Final Structure	%Yield
1	 1a	 3a	 4a	78
2	1a	 3b	 4b	92

3	1a	 3c	 4c	58
4	1a	 3d	 4d	89
5	1a	 3e	 4e	72
6	1a	 3f	 4f	88
7	1a	 3g	 4g	94
8	 1b	 3a	 4h	46

9	1b	 3b	 4i	79
10	1b	 3c	 4j	77
11	1b	 3d	 4k	82
12	1b	 3e	 4l	93
13	1b	 3f	 4m	94
14	1b	 3g	 4n	81

context, vanillin containing this thiazole nucleus represents an outstanding source of compounds with a wide range of biological activities, which can play an important role in the development of new drugs in the treatment of human diseases. From the NMR data, it was concluded that the remarkable result shown that proton of thiazole ring system were varied in between 7.40-7.80 due to the various substitution in phenyl ring present at adjacent position.

Spectral & Physical Data:-

2-Methoxy-6-nitro-4-((2-(4-phenylthiazol-2 yl)hydrazono)methyl)phenol (4a)

Orange solid, Melting point: 192-194 °C,^{1}H NMR (DMSO-d_6) δ 3.93 (s, 3H), 7.27 (s, 1H), 7.40 (d, *J* = 7.3 Hz, 2H), 7.42 – 7.44 (m, 2H), 7.47 (s, 1H), 7.80 – 7.86 (m, 2H), 8.04 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 56.50, 105.05, 112.17, 124.00, 126.26, 127.70, 128.51, 129.48, 135.50, 135.93, 148.47, 148.71, 150.68, 154.45, 169.62. MS: m/z 370

4-((2-(4-(4-Bromophenyl)thiazol-2-yl)hydrazono)methyl)-2-methoxy-6-nitrophenol (4b)

Orange solid, Melting point: 200-202 °C, ^{1}H NMR (DMSO-d_6) δ 3.95 (s, 3H), 7.28 (s, 1H), 7.29 – 7.31 (m, 1H), 7.43 – 7.47 (m, 1H), 7.55 (d, *J* = 7.5 Hz, 2H), 7.76 (d, *J* = 7.5 Hz, 2H), 8.04 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 56.48, 105.95, 112.17, 123.03, 124.00, 127.46, 128.51, 132.26, 132.52, 135.93, 148.47, 148.54, 148.71, 150.68, 169.62. MS: m/z 449

4-((2-(4-(4-Chlorophenyl)thiazol-2-yl)hydrazono)methyl)-2-methoxy-6-nitrophenol (4c)

Orange solid, Melting point: 212-214 °C, ^{1}H NMR (DMSO-d_6) δ 3.94 (s, 3H), 7.28 (s, 1H), 7.39 – 7.45 (m, 1H), 7.54 (d, *J* = 7.5 Hz, 2H), 7.81 – 7.86 (m, 1H), 8.00 – 8.10 (m, 3H). ^{13}C NMR (DMSO-d_6) δ 56.50, 105.95, 112.17, 124.00, 127.10, 128.30, 128.51, 131.99, 135.12, 135.93, 148.47, 148.54, 148.71, 150.68, 169.62. MS: m/z 404

2-Methoxy-6-nitro-4-((2-(4-(p-tolyl)thiazol-2-yl)hydrazono)methyl)phenol (4d)

Orange solid, Melting point: 218-220 °C,^{1}H NMR (DMSO-d_6) δ 2.33 (s, 3H), 3.97 (s, 3H), 7.25 (s, 1H), 7.27 (s, 2H), 7.29 – 7.32 (m, 1H), 7.44 – 7.47 (m, 1H), 7.84 (d, *J* = 7.5 Hz, 2H), 8.04 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 21.42, 56.50, 105.95, 112.17, 124.00, 127.32, 128.51, 129.38, 132.72, 135.93, 137.26, 148.47, 148.54, 148.71, 150.68, 169.62. MS: m/z 384

2-Methoxy-4-((2-(4-(4-methoxyphenyl) thiazol-2-yl)hydrazono)methyl)-6-nitrophenol (4e)

Orange solid, Melting point: 196-198 °C,^{1}H NMR (DMSO-d_6) δ 3.79 (s, 3H), 3.94 (s, 3H), 7.05 (d, *J* = 7.5 Hz, 2H), 7.27 (s, 1H), 7.41 – 7.44 (m, 1H), 7.68 (d, *J* = 7.5 Hz, 2H), 7.81 – 7.85 (m, 1H), 8.04 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 55.35, 56.50, 105.95, 112.17, 113.80, 124.00, 128.51, 128.67, 129.83, 135.93, 148.47, 148.54, 148.71, 150.68, 158.97, 169.62. MS: m/z 400

4-(2-(2-(4-Hydroxy-3-methoxy-5-nitrobenzylidene)hydrazinyl)thiazol-4 yl) benzonitrile (4f)

Orange solid, Melting point: 230-232 °C,^{1}H NMR (DMSO-d_6) δ 3.96 (s, 3H), 7.54 (d, J = 1.5 Hz, 1H), 7.67 (s, 1H), 7.73 (d, *J* = 1.5 Hz, 1H), 7.88 (d, *J* = 8.4 Hz, 2H), 8.00 – 8.09 (m, 3H). ^{13}C NMR (DMSO-d_6) δ 56.50, 107.61, 109.53, 112.16, 114.39, 118.95, 125.06, 126.05, 132.65, 137.16, 138.58, 139.93, 143.41, 148.64, 149.68, 168.36. MS: m/z 395

2-Methoxy-6-nitro-4-((2-(4-(4-nitrophenyl) thiazol-2-yl)hydrazono)methyl)phenol (4g)

Orange solid, Melting point: 240-242 °C, ^{1}H NMR (DMSO-d_6) δ 3.95 (s, 3H), 7.27 (s, 1H), 7.38 – 7.44 (d,*J* = 2.4 Hz, 1H), 7.80 – 7.87 (d, *J*= 2.4 Hz, 1H), 8.04 (s, 1H), 8.16 (d, *J* = 7.5 Hz, 2H), 8.28 (d, *J* = 7.5 Hz, 2H). ^{13}C NMR (DMSO-d_6) δ 56.50, 105.95, 112.17, 124.00,

124.86, 127.15, 128.51, 134.96, 135.93, 145.99, 148.47, 148.54, 148.71, 150.68, 169.62. MS: m/z 415.

2-Ethoxy-4-((2-(4-phenylthiazol-2-yl) hydrazono)methyl)phenol (4h)

White solid, Melting point: 216-218 °C,^{1}H NMR (DMSO-d_6) δ 1.37 (t, *J* = 6.95 Hz, 3H), 4.07 (q, *J* = 6.95 Hz, 2H), 6.87 (d, *J* = 8.14 Hz, 1H), 7.10 (dd, *J* = 8.21, 1.68 Hz, 1H), 7.25 (d, *J* = 1.67 Hz, 1H), 7.35 (t, *J* = 9.30 Hz, 2H), 7.44 (t, *J* = 7.58 Hz, 2H), 7.84 (d, *J* = 7.21 Hz, 2H), 8.02 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 14.71, 63.76, 103.54, 110.60, 115.67, 120.69, 125.65, 127.87, 128.63, 133.53, 143.46, 147.04, 148.76, 168.36.MS: m/z 339.

4-((2-(4-(4-Bromophenyl)thiazol-2-yl) hydrazono)methyl)-2-ethoxyphenol (4i)

White solid, Melting point: 202-204 °C,^{1}H NMR (DMSO-d_6) δ 1.37 (t, *J* = 6.9 Hz, 3H), 4.08 (q, *J* = 6.9 Hz, 2H), 6.88 (d, *J* = 8.1 Hz, 1H), 7.10 (dd, 1H), 7.25 (d, *J* = 1.5 Hz, 1H), 7.40 (s, 1H), 7.63 (d, *J* = 8.5 Hz, 2H), 7.81 (d, *J* = 8.5 Hz, 2H), 8.02 (s, 1H).^{13}C NMR (DMSO-d_6) δ 14.70, 63.75, 104.37, 110.55, 115.66, 120.78, 125.46, 127.62, 131.52, 132.93, 143.23, 143.32, 147.03, 147.66, 148.73, 168.45.MS: m/z 418

4-((2-(4-(4-Chlorophenyl)thiazol-2-yl) hydrazono)methyl)-2-ethoxyphenol (4j)

White solid, Melting point: 208-210 °C,^{1}H NMR (DMSO-d_6) δ 1.39 (t, *J* = 8.0 Hz, 3H), 4.13 (q, *J* = 8.0 Hz, 2H), 6.88 (d, *J* = 7.3 Hz, 1H), 7.00 (d, *J* = 8.1 Hz, 2H), 7.27 (s, 1H), 7.54 (d, *J* = 7.5 Hz, 2H), 8.01 – 8.08 (m, 3H). ^{13}C NMR (DMSO-d_6) δ 14.65, 64.77, 105.95, 112.21, 115.80, 121.45, 127.10, 128.09, 128.30, 131.99, 135.12, 145.11, 147.39, 148.54, 152.07, 169.62. MS: m/z 373

2-Ethoxy-4-((2-(4-(p-tolyl)thiazol-2-yl) hydrazono)methyl)phenol(4k)

White solid, Melting point: 240-242 °C,^{1}H NMR (DMSO-d_6) δ 1.37 (t, *J* = 6.9 Hz, 3H), 2.32 (s, 3H), 4.07 (q, *J* = 6.9 Hz, 2H), 6.85 (d, *J* = 8.1 Hz, 1H), 7.07 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.21 (d, *J* = 8.3 Hz, 4H), 7.74 (d, *J* = 8.1 Hz, 2H), 7.92 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 14.71, 20.78, 63.75, 102.25, 110.43, 115.66, 120.28, 125.39, 125.84, 129.12, 132.05, 136.67, 141.76, 147.02, 148.41, 150.43, 168.24.MS: m/z 353

2-Ethoxy-4-((2-(4-(4-methoxyphenyl)thiazol-2-yl)hydrazono)methyl)phenol(4l)

White solid, Melting point: 204-206 °C,^{1}H NMR (DMSO-d_6) δ 1.38 (t, *J* = 6.9 Hz, 3H), 3.18 (s, 3H), 3.80 (s, 3H), 4.08 (q, *J* = 6.9 Hz, 2H), 6.89 (d, *J* = 8.1 Hz, 1H), 7.02 (d, *J* = 8.9 Hz, 2H), 7.14 (dd, 1H), 7.20 (s, 1H), 7.28 (s, 1H), 7.77 (d, *J* = 8.8 Hz, 2H), 8.12 (s, 1H).^{13}C NMR (DMSO-d_6) δ 14.70, 48.54, 55.19, 63.79, 101.77, 110.77, 114.05, 115.68, 121.11, 125.12, 127.27, 145.15, 147.06, 149.10, 159.27, 168.27. MS: m/z 369

4-(2-(2-(3-Ethoxy-4-hydroxybenzylidene) hydrazinyl)thiazol-4-yl)benzonitrile (4m)

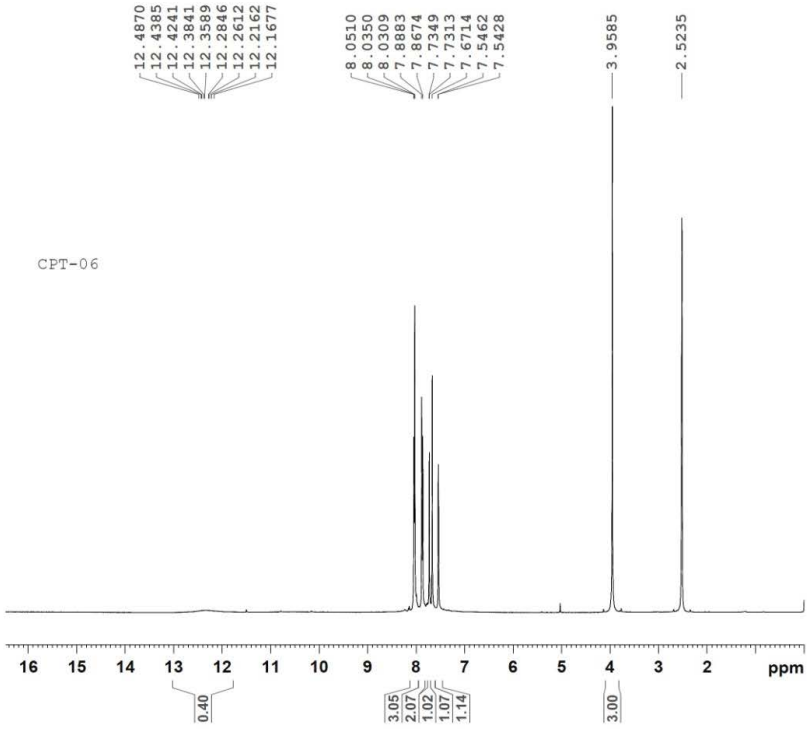
White solid, Melting point: 244-246 °C,^{1}H NMR (DMSO-d_6) δ 1.38 (t, *J* = 8.0 Hz, 3H), 4.13 (q, *J* = 8.0 Hz, 2H), 6.88 (d, *J* = 7.4 Hz, 1H), 6.98 – 7.05 (m, 2H), 7.27 (s, 1H), 7.74 (d, *J* = 7.5 Hz, 2H), 8.02 – 8.10 (m, 2H), 8.76 (s, 1H). ^{13}C NMR (DMSO-d_6) δ 14.65, 64.77, 105.95, 111.51, 112.21, 115.80, 117.54, 121.45, 127.25, 128.09, 132.13, 134.01, 145.11, 147.39, 148.54, 152.07, 169.62. MS: m/z 364

2-Ethoxy-4-((2-(4-(4-nitrophenyl)thiazol-2-yl)hydrazono)methyl)phenol(4n)

White solid, Melting point: 236-238 °C,^{1}H NMR (DMSO-d_6) δ 1.37 (t, *J* = 6.9 Hz, 3H), 4.08 (q, *J* = 6.9 Hz, 2H), 6.86 (d, *J* = 8.1 Hz, 1H), 7.08 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.23 (d, *J* = 1.7 Hz, 1H), 7.71 (s, 1H), 7.97 (s, 1H), 8.11 (d, *J* = 8.9 Hz, 2H), 8.28 (d, *J* = 8.9 Hz, 2H).^{13}C NMR (DMSO-d_6) δ 14.70, 63.73, 108.20, 110.44, 115.65, 120.47, 124.07, 125.60, 126.28, 140.56, 142.53, 146.10, 147.03, 148.20, 148.59, 168.72. MS: m/z 384

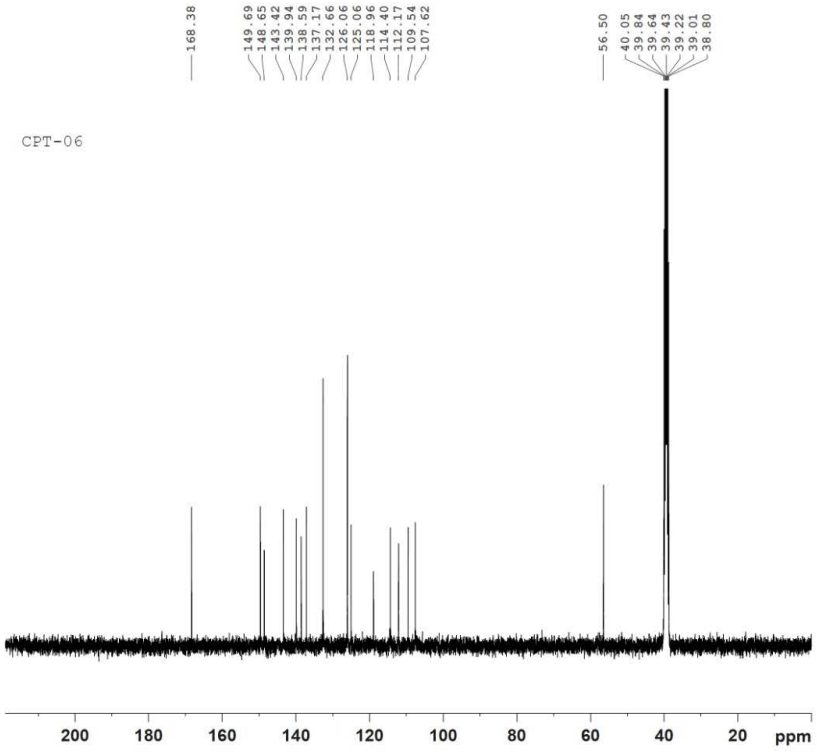
References

^{1}H NMR spectrum of compound-4f



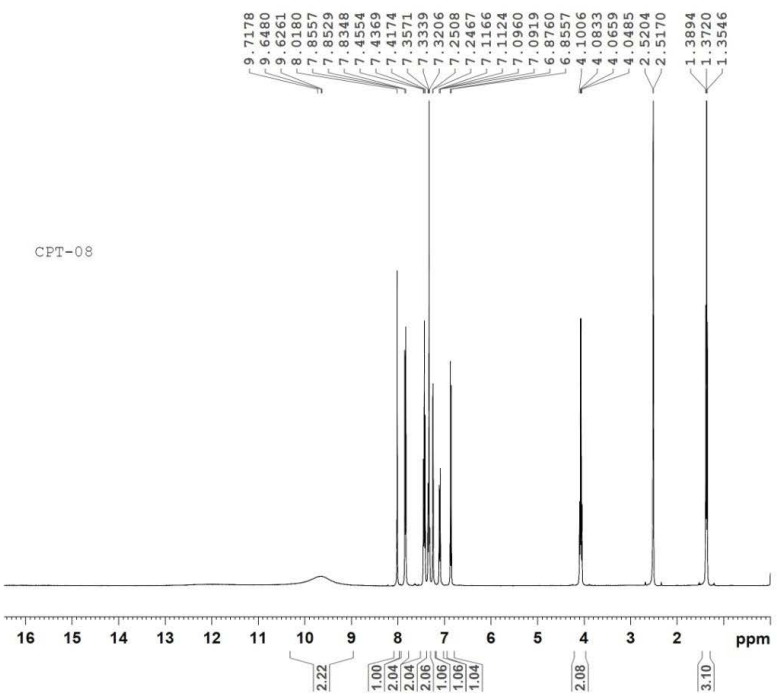

```
NAME              CPT-06
EXPNO                  1
PROCNO                 1
Date_           20150112
Time_              13.31
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG             zg30
TD                 65536
SOLVENT              DMSO
NS                     16
DS                      2
SWH             8223.685 Hz
FIDRES          0.125483 Hz
AQ              3.9846387 sec
RG                   181
DW                60.800 usec
DE                 6.50 usec
TE                300.0 K
D1             1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 14.10 usec
PL1                 0.00 dB
PL1W          8.31434441 W
SFO1        400.1324710 MHz
SI                 32768
SF          400.1299946 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```

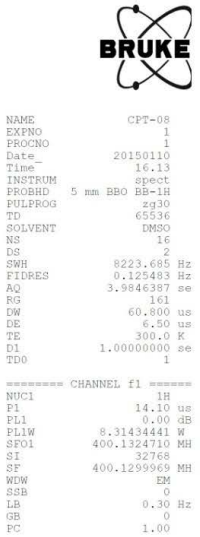
^{13}C NMR spectrum of compound-4f



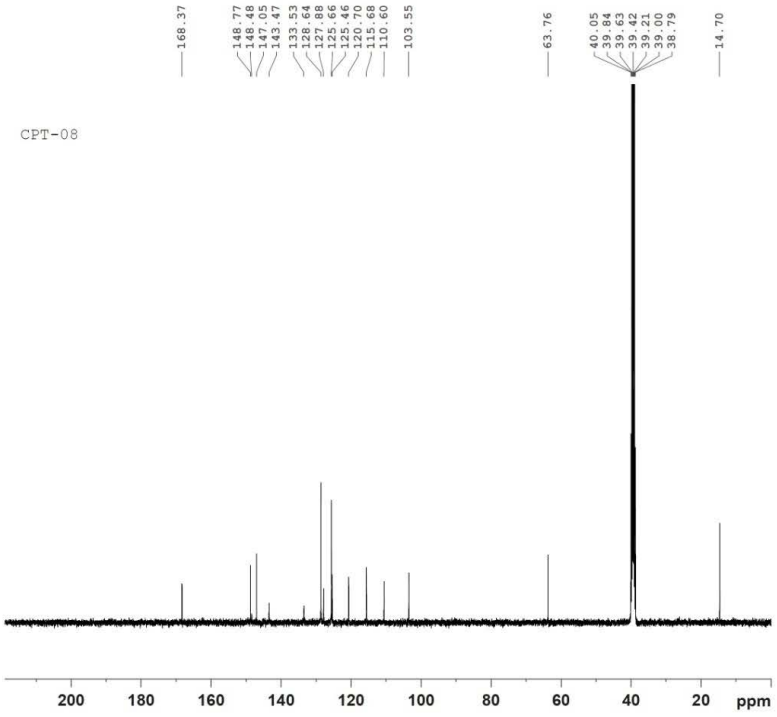

```
NAME              CPT-06
EXPNO                  2
PROCNO                 1
Date_           20150112
Time_              14.30
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG           zgpg30
TD                 65536
SOLVENT              DMSO
NS                   1024
DS                      4
SWH            24038.461 Hz
FIDRES          0.366798 Hz
AQ              1.3631988 sec
RG                  2050
DW                20.800 usec
DE                 6.50 usec
TE                300.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                 10.00 usec
PL1                 0.00 dB
PL1W         35.41759872 W
SFO1        100.6228298 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                 0.00 dB
PL12               15.08 dB
PL13               18.08 dB
PL2W          8.31434441 W
PL12W         0.25812379 W
PL13W         0.12936834 W
SFO2        400.1316005 MHz
SI                 32768
SF          100.6128193 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```

^{1}H NMR spectrum of compound-4h





^{13}C NMR spectrum of compound-4h

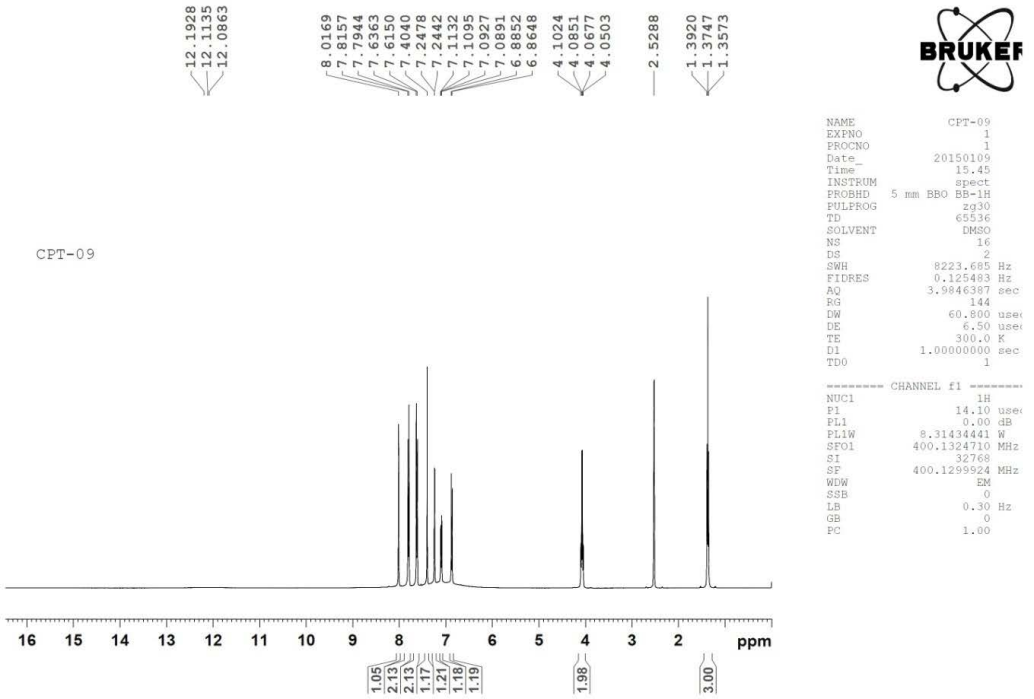


NAME CPT-08
EXPNO 2
PROCNO 1
Date_ 20150110
Time 17.12
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 1024
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 2050
DW 20.800 usec
DE 6.50 usec
TE 300.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

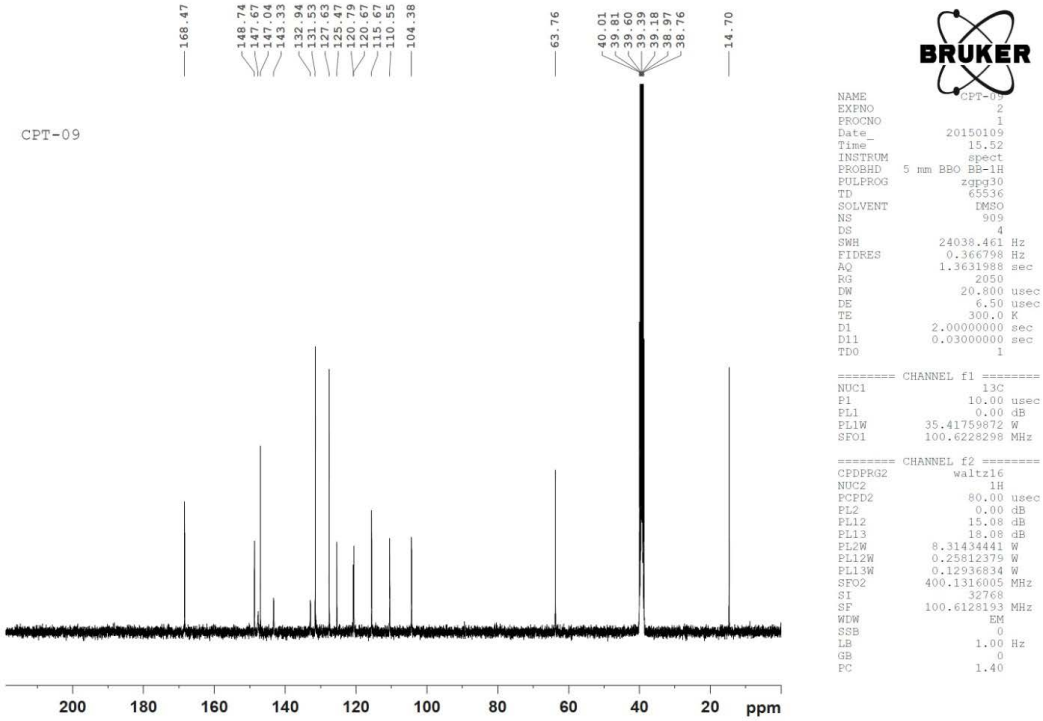
======== CHANNEL f1 ========
NUC1 13C
P1 10.00 usec
PL1 0.00 dB
PL1W 35.41759872 W
SFO1 100.6228298 MHz

======== CHANNEL f2 ========
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 0.00 dB
PL12 15.08 dB
PL13 18.08 dB
PL2W 8.31434441 W
PL12W 0.25812379 W
PL13W 0.12936834 W
SFO2 400.1316005 MHz
SI 32768
SF 100.6128193 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

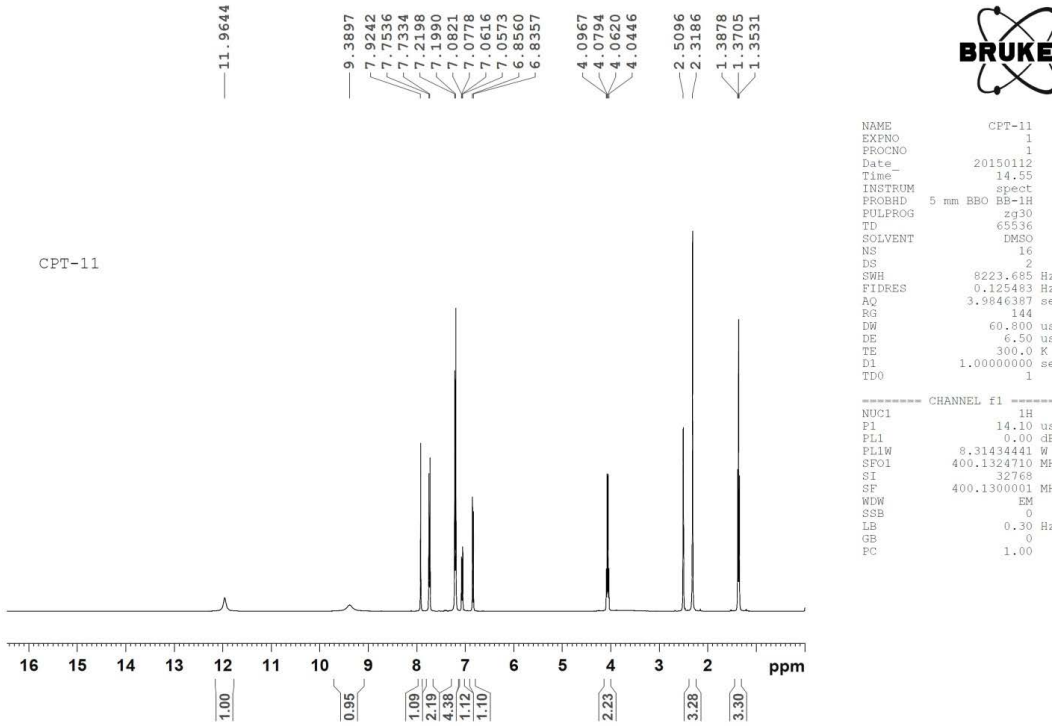
^{1}H NMR Spectrum of compound 4i



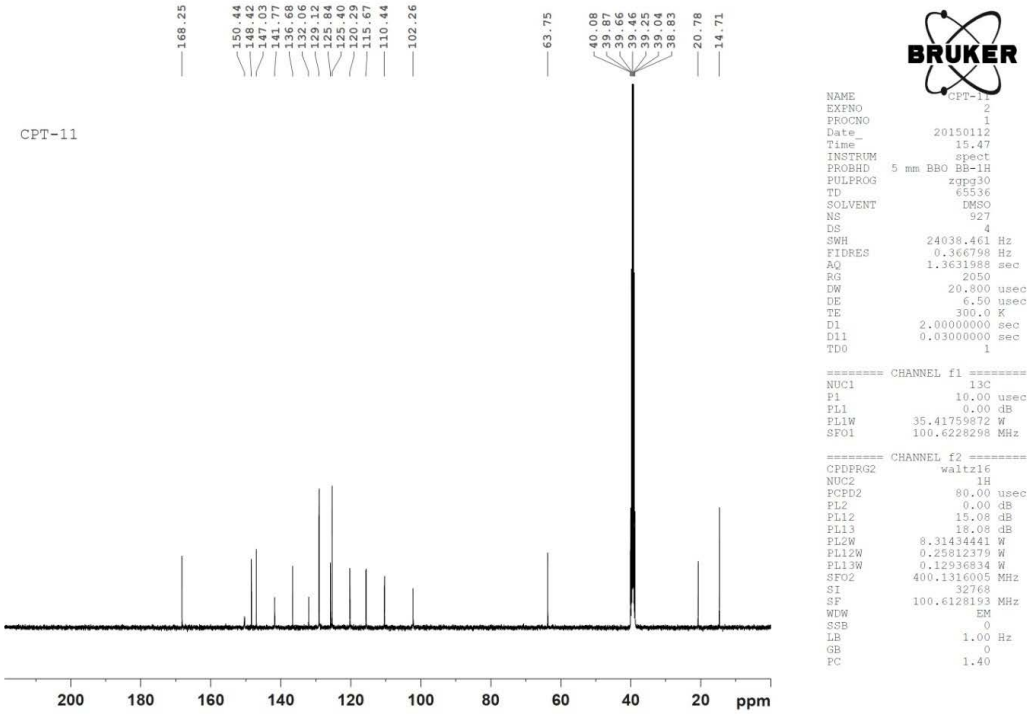
^{13}C NMR spectrum of compound-4i



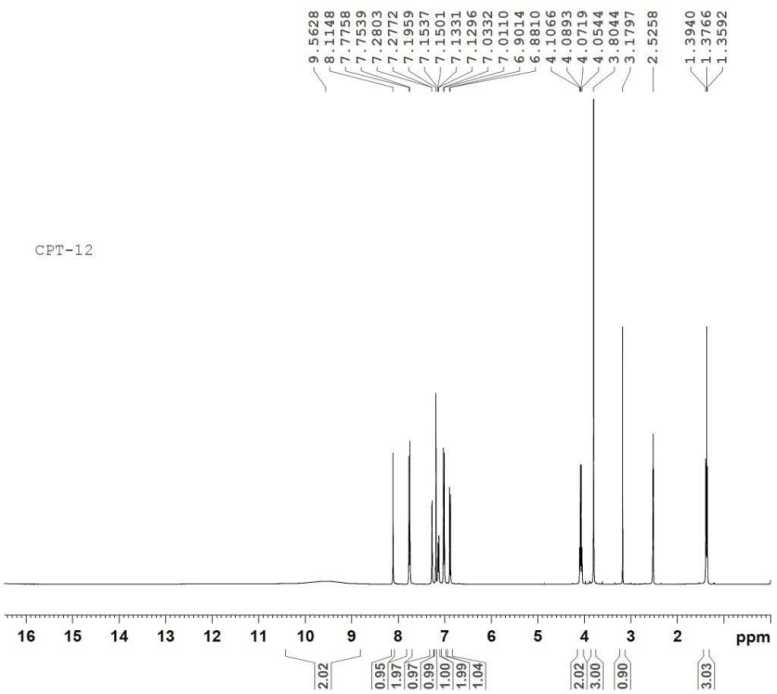
^{1}H NMR spectrum of compound 4k



^{13}C NMR spectrum of compound 4k

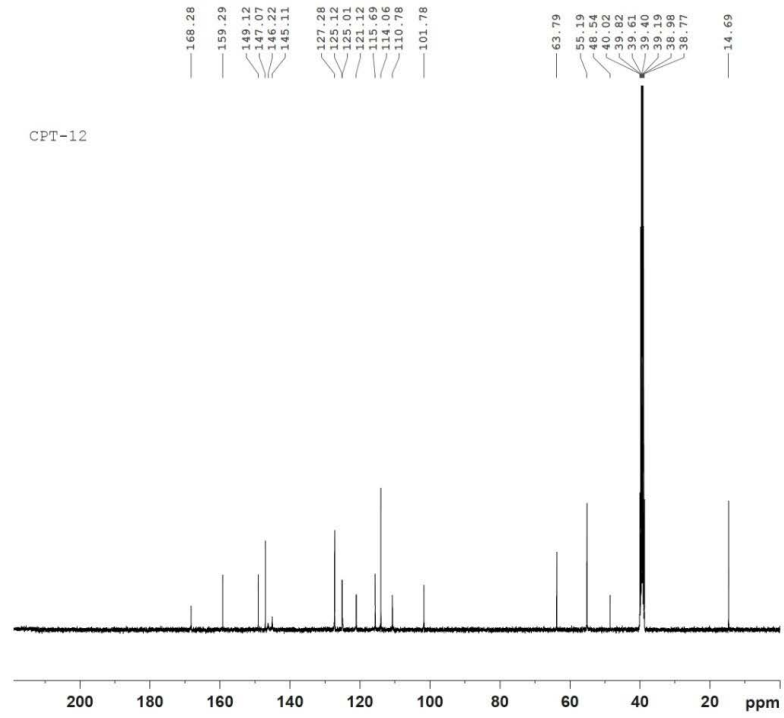


^{1}H NMR spectrum of compound-4l



NAME	CPT-12
EXPNO	1
PROCNO	1
Date_	20150110
Time_	12.58
INSTRUM	spect
PROBHD	5 mm BBO BB-1H
PULPROG	zg30
TD	65536
SOLVENT	DMSO
NS	16
DS	2
SWH	8223.685 Hz
FIDRES	0.125483 Hz
AQ	3.9846387 se
RG	114
DW	60.800 us
DE	6.50 us
TE	300.0 K
D1	1.00000000 se
TD0	1
======== CHANNEL f1 ======	
NUC1	1H
P1	14.10 us
PL1	0.00 dB
PL1W	8.31434441 W
SFO1	400.1324710 MH
SI	32768
SF	400.1299936 MH
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

^{13}C NMR spectrum of compound-4l



NAME	CPT-12
EXPNO	2
PROCNO	1
Date_	20150110
Time_	13.57
INSTRUM	spect
PROBHD	5 mm BBO BB-1H
PULPROG	zgpg30
TD	65536
SOLVENT	DMSO
NS	1024
DS	4
SWH	24038.461 Hz
FIDRES	0.366798 Hz
AQ	1.3631988 sec
RG	2050
DW	20.800 usec
DE	6.50 usec
TE	300.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	10.00 usec
PL1	0.00 dB
PL1W	35.41759872 W
SFO1	100.6228298 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	0.00 dB
PL12	15.08 dB
PL13	18.08 dB
PL2W	8.31434441 W
PL12W	0.25812379 W
PL13W	0.12936834 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6128193 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

1. R. Pundeer, V. Kiran, Shushma, S. Bhatia, Der PharmaChemica**, 2011**, 3(3), 109-114.
2. C. B. Mishra, S. Kumari, M. Tiwari, Eur. J. Med. Chem, **2014**, 92, 1-34.
3. G. Turan-Zitouni, A. Ozdemir, ZA Kaplancikli, PhosphoursSulphurSillicon, **2011**, 186, 233-239.
4. A. Satoh, Y. Nagatomi, Y. Hirata, G. Suzuki, T. Kimura, H. Kawamoto, Bioorg. Med. Chem., **2009**, 19, 5465-5468.
5. BP Mallikarjuna, BS Kumar, GVS Kumar, RY Prasad, SM Chandrashekar, K. Satisha, **2009**, Eur. J. Med. Chem., 44, 4739-4746.
6. P. Karegouder, MS Karthikeyan, DJ Prasad, M. Mahalinga, BS Holla, NS Kumari, **2008**, 43, 261-267.
7. SM Sondhi, N. Singh, K. Bajaj, A. Kumar, O. Lozach, L. Meijer, Bioorg. Med. Chem., **2005**, 13, 4291-4299.
8. O. Kouatly, A. Geronikaki, C. Kamoutsis, P. Eleftheriou, Eur. J. Med. Chem., **2009**,44, 1198-1204
9. S. Kumar, S. Singh, Med Chem Res, 2014, 23, 1004-1015.
10. ZY Liu, YM Wang, ZR LI, JD Jiang, DW Boykin, Bioorg. Med. Chem., **2009**,19, 5661-5664.
11. D. Havrylyuk, L. Mosula, B. Zimenkvosky, R. Lesyk, Eur. J. Med. Chem., **2010**, 45, 5012-5021.
12. Y Lu, C. Li, Z. Wang, C. Ross, D. Miller, J. Med. Chem, **2009**, 52, 1701-1711.
13. T Lino, D. Tsukahara, M. Chiba, Y. Nagata, T. Nishimura, Bioorg. Med. Chem., **2009**, 17, 2733-2743.
14. RK Rawal, R. Katti, C. Pannecouque, E.D. Clercq, Eur. J. Med. Chem, **2008**, 43, 2800-2806.
15. M. Barreca, A. Chimirri, L. Luca, A. Monforte, A. Rao, M. Witvrouwc, Bioorg. Med. Chem.**2001**, 11, 1793-1795.
16. A. Grozav, L. Gaina, V. Pileczki, O. Crisan, L. Silaghi-Dumitrescu, B. Therrien, V. Zaharia, I. Neagoe. Int. J. Mol. Sci.**2014**, 15, 22059-22072.
17. KZ Laczkowski, K. Misiura, M. Switalska, AB Laczkowska, B. Fernandez, T. Plech, Anticancer Agents Med Chem. **2014**, 14(9), 1271-81.
18. B. Kaur, D. Chakraborty, ApplBiochem, Biotechnol, **2013**, 169, 1353-1372.
19. J. Walton, J. Mayer, A. Narbad, Photochemistry, **2003**, 63(5), 505-515.
20. A. Converti, B. Aliakbarian, J. Dominguez, P. Perego, Braz. Jou. Of Microbiology, **2010**, 41(3), 519-530.