

Supporting Information

A green synthesis of novel derivatives of thiazole-5-one using magnetic supported copper nanocatalyst ($\gamma\text{-Fe}_2\text{O}_3\text{@HAp@CPTMS@AT@Cu(II)$)

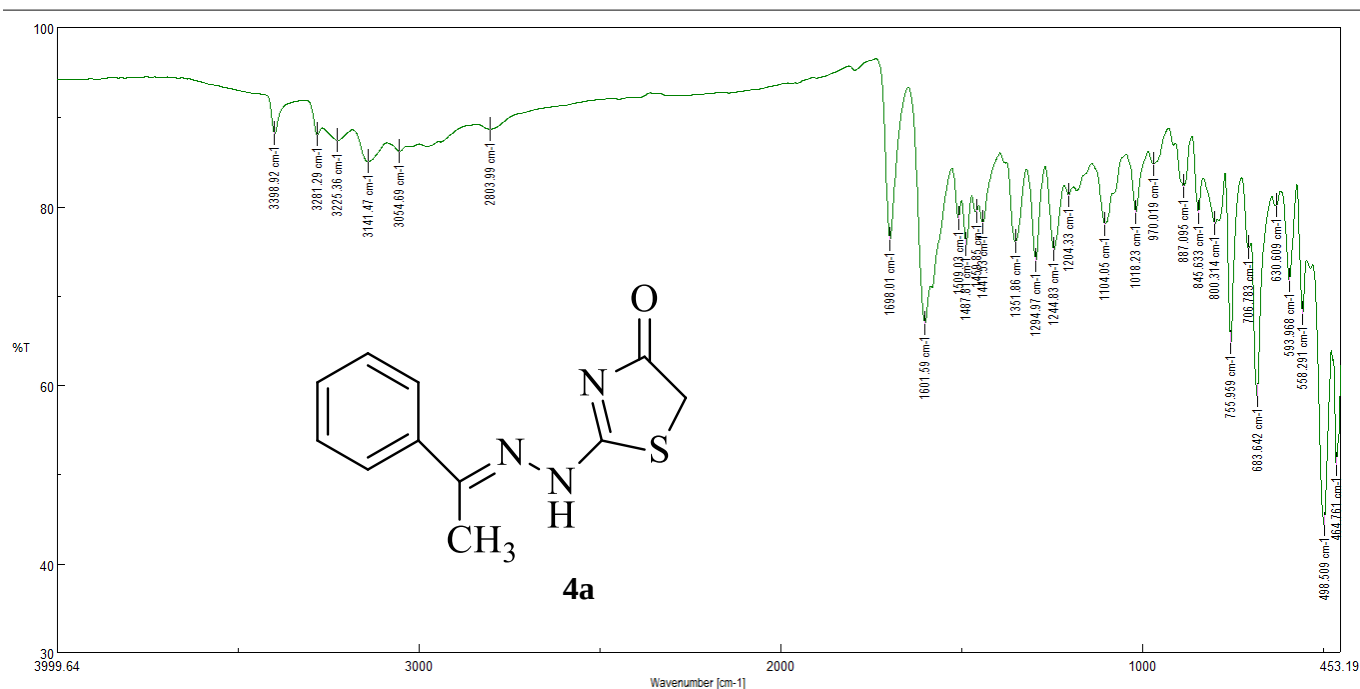
Navid Ghorbani Dehshal^a, Manouchehr Mamaghani^{a*}, Parivash Jahanshahi^a, Iman Rezaei^a

^a Department of Chemistry, Faculty of Sciences, University of Guilan, P.O. Box 41335-1914, Rasht, Iran

*Corresponding author; E-mail address: m-chem41@guilan.ac.ir and mchem41@gmail.com

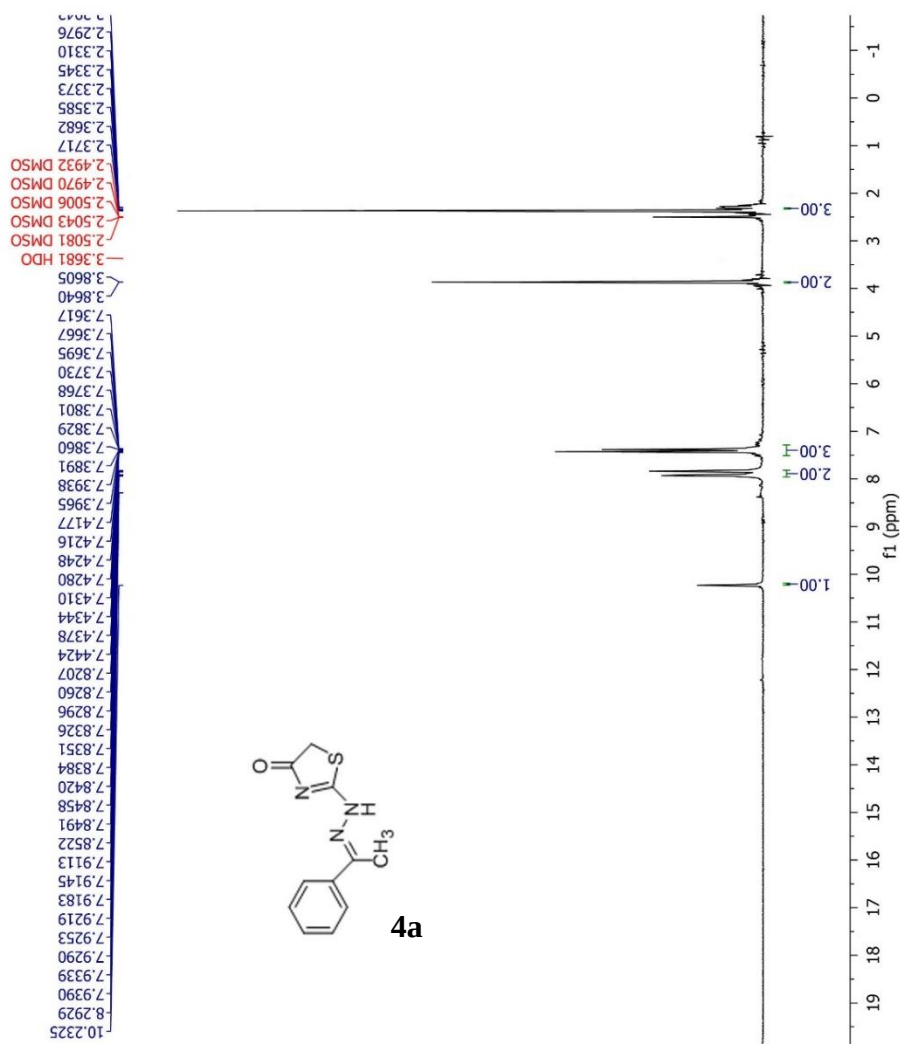
¹H & ¹³C NMR and FT-IR of Compounds 4a-j:

(FT-IR)



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28 Spectral Size	65536

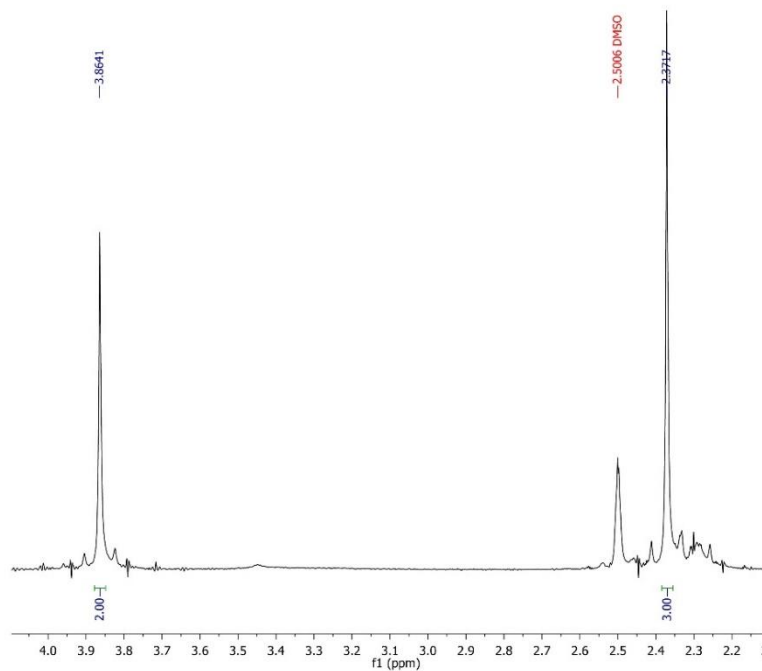
(¹H NMR)



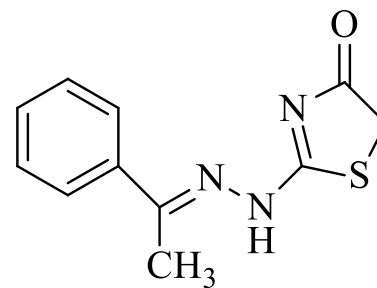
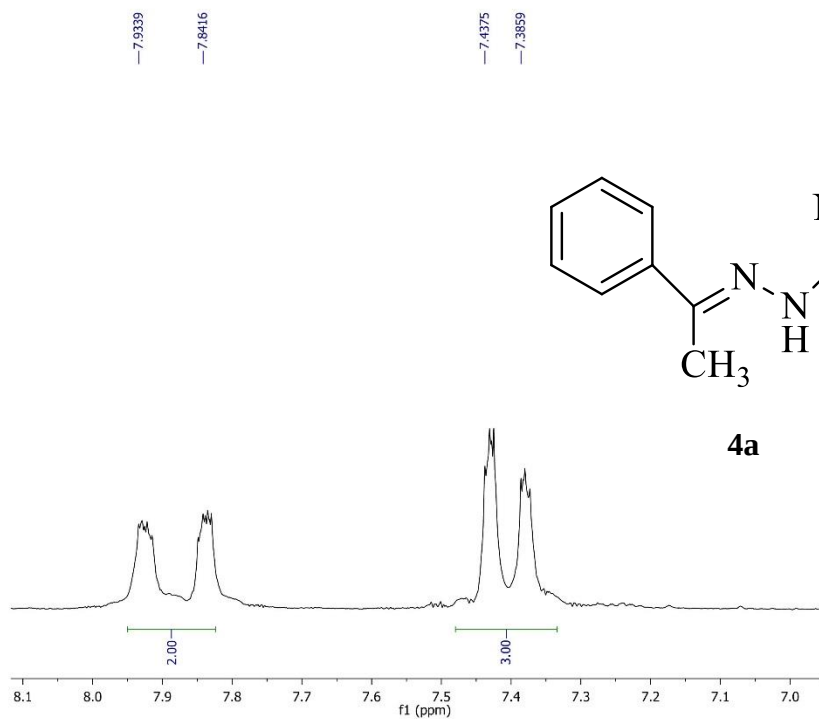
(¹H NMR)



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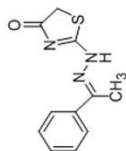


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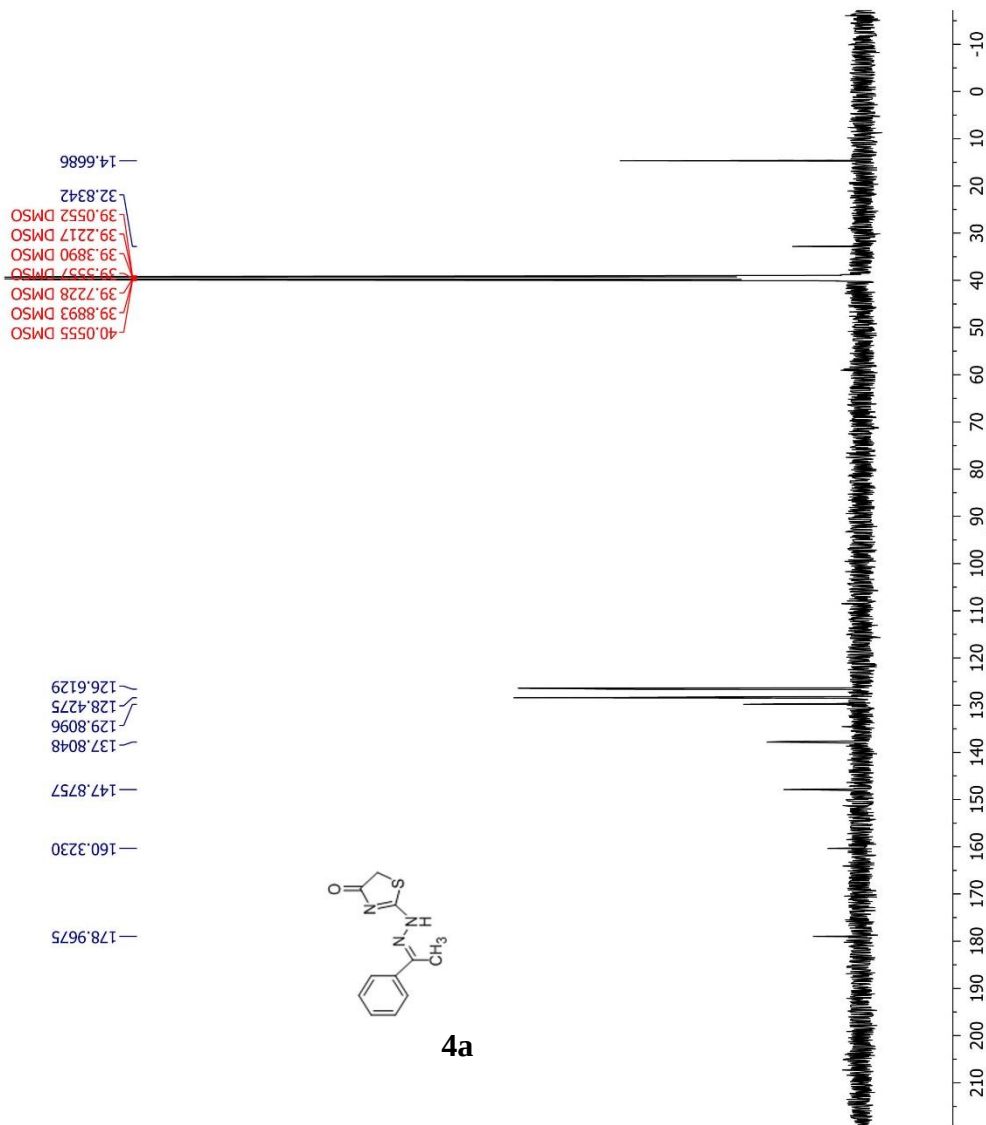


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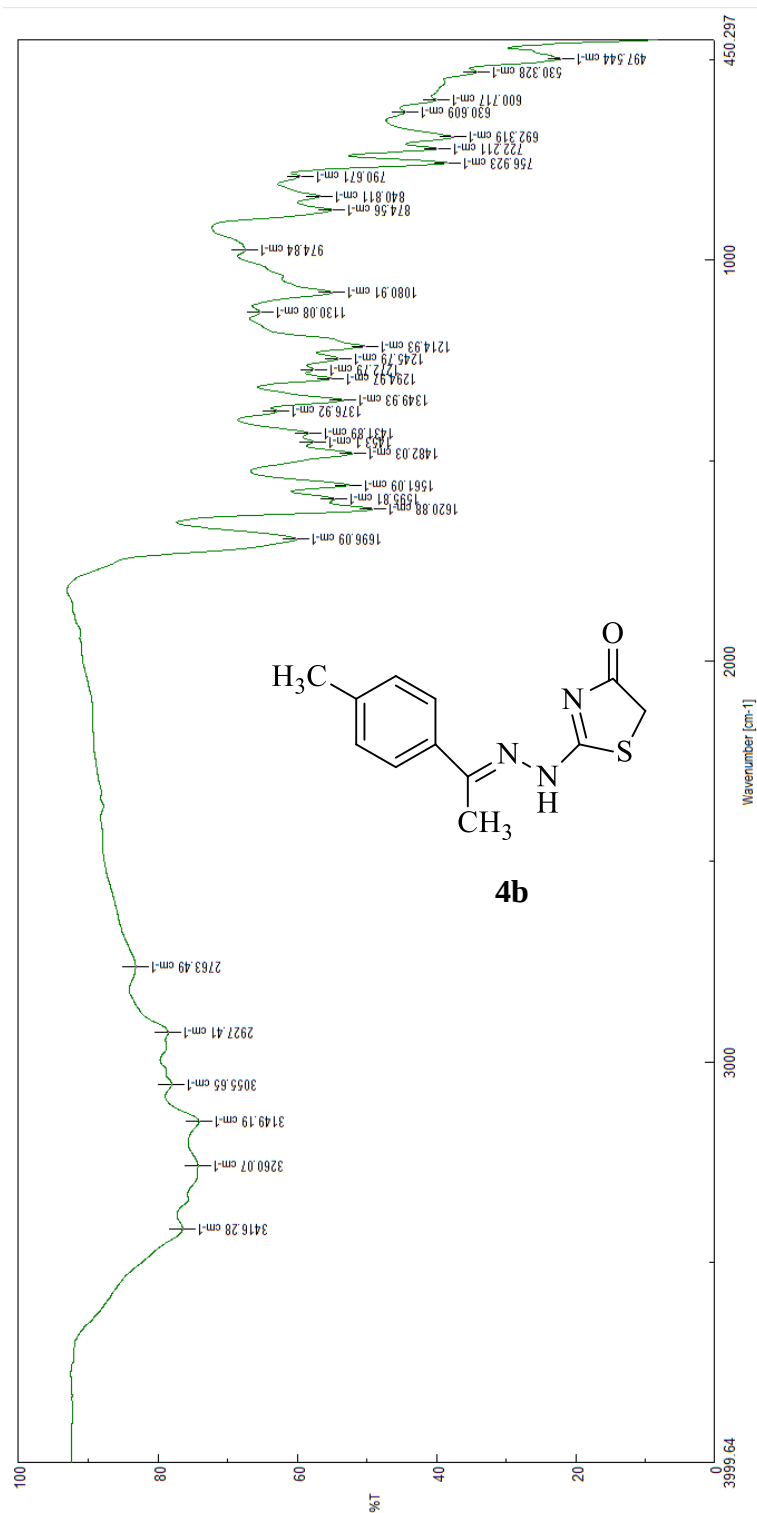


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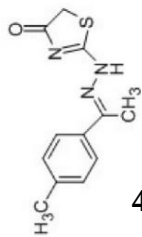


(¹³C NMR)

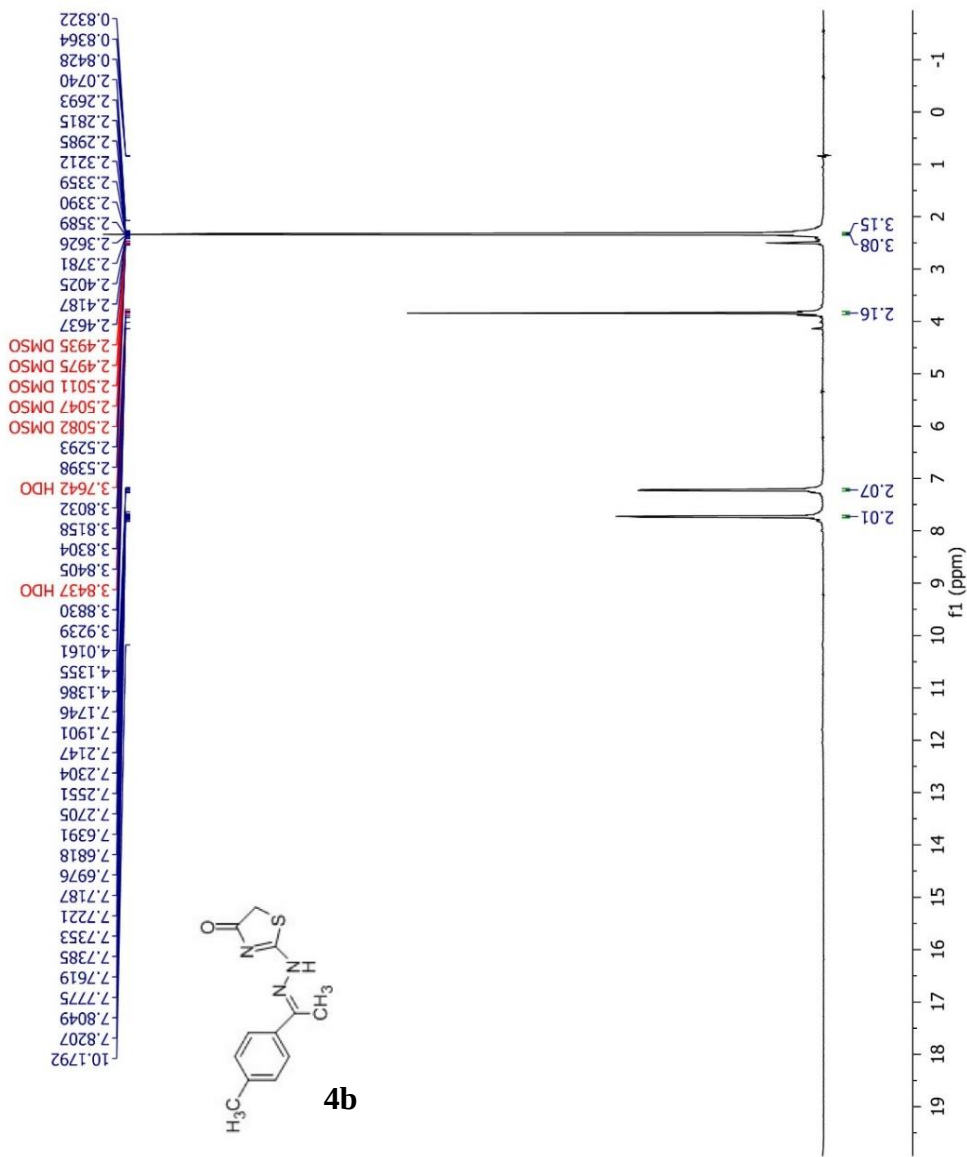
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8 Author	
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27 Spectral Size	65536



4b

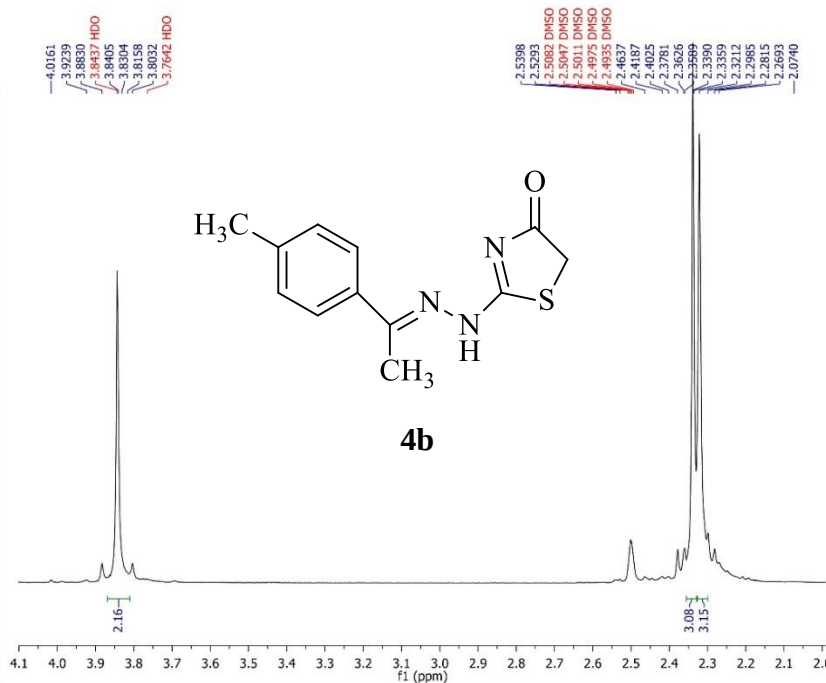


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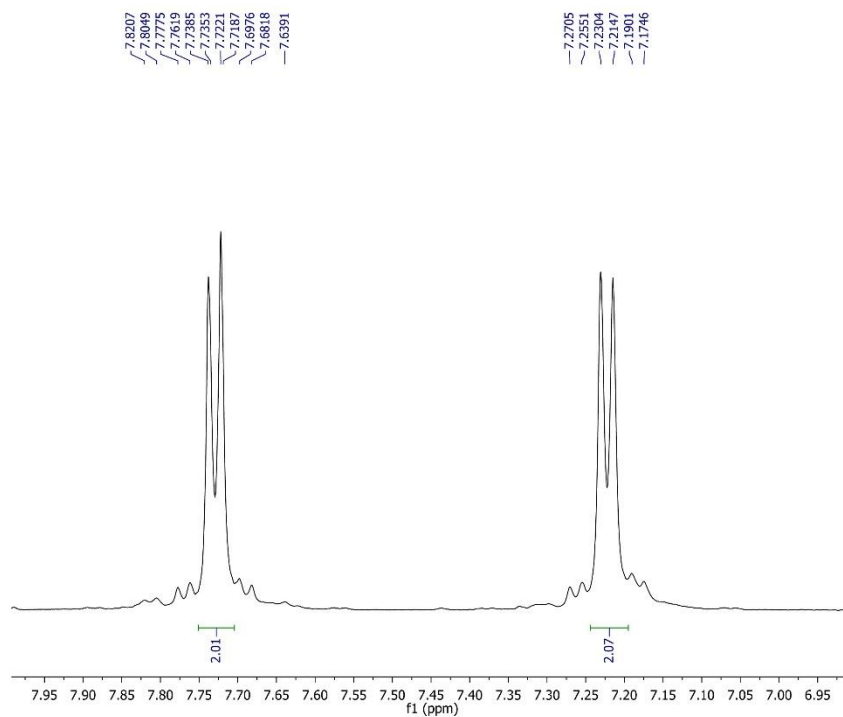
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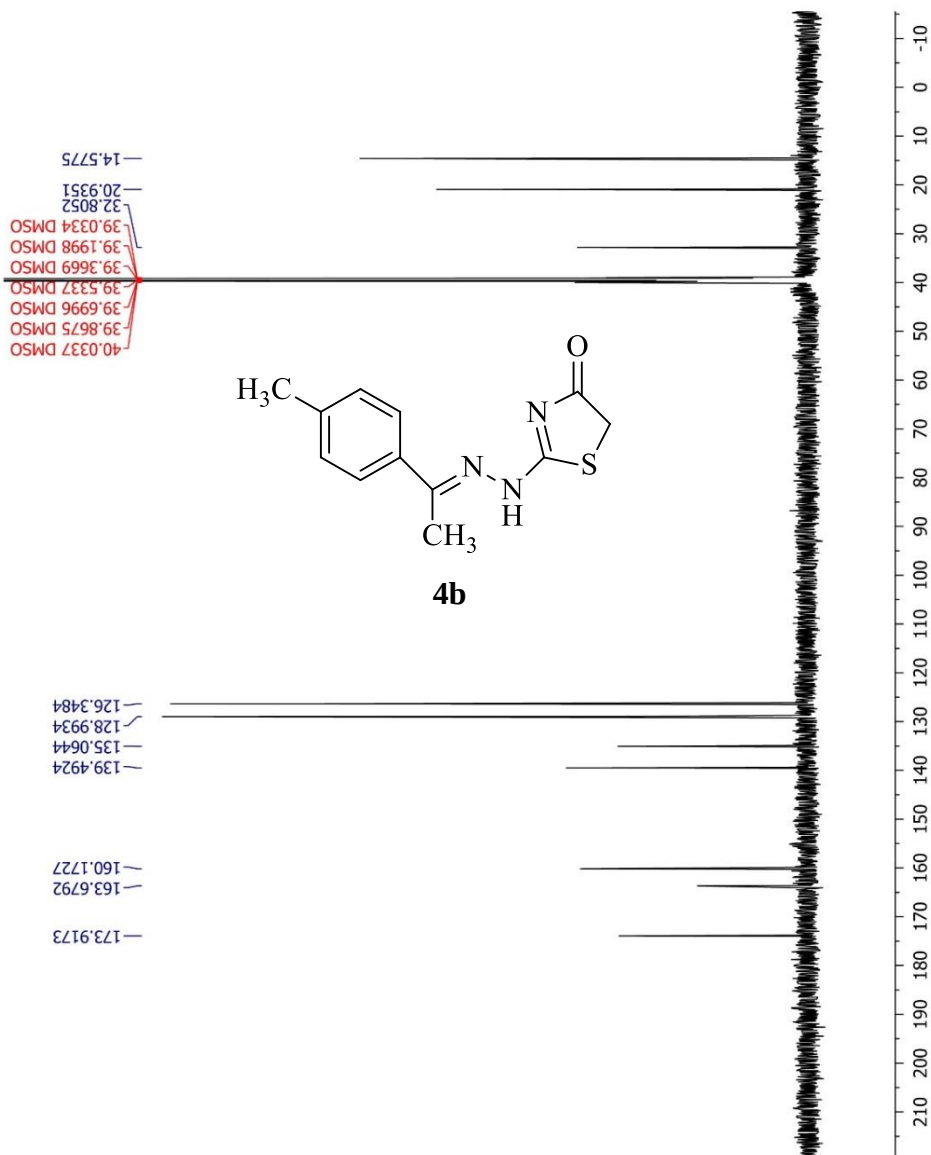


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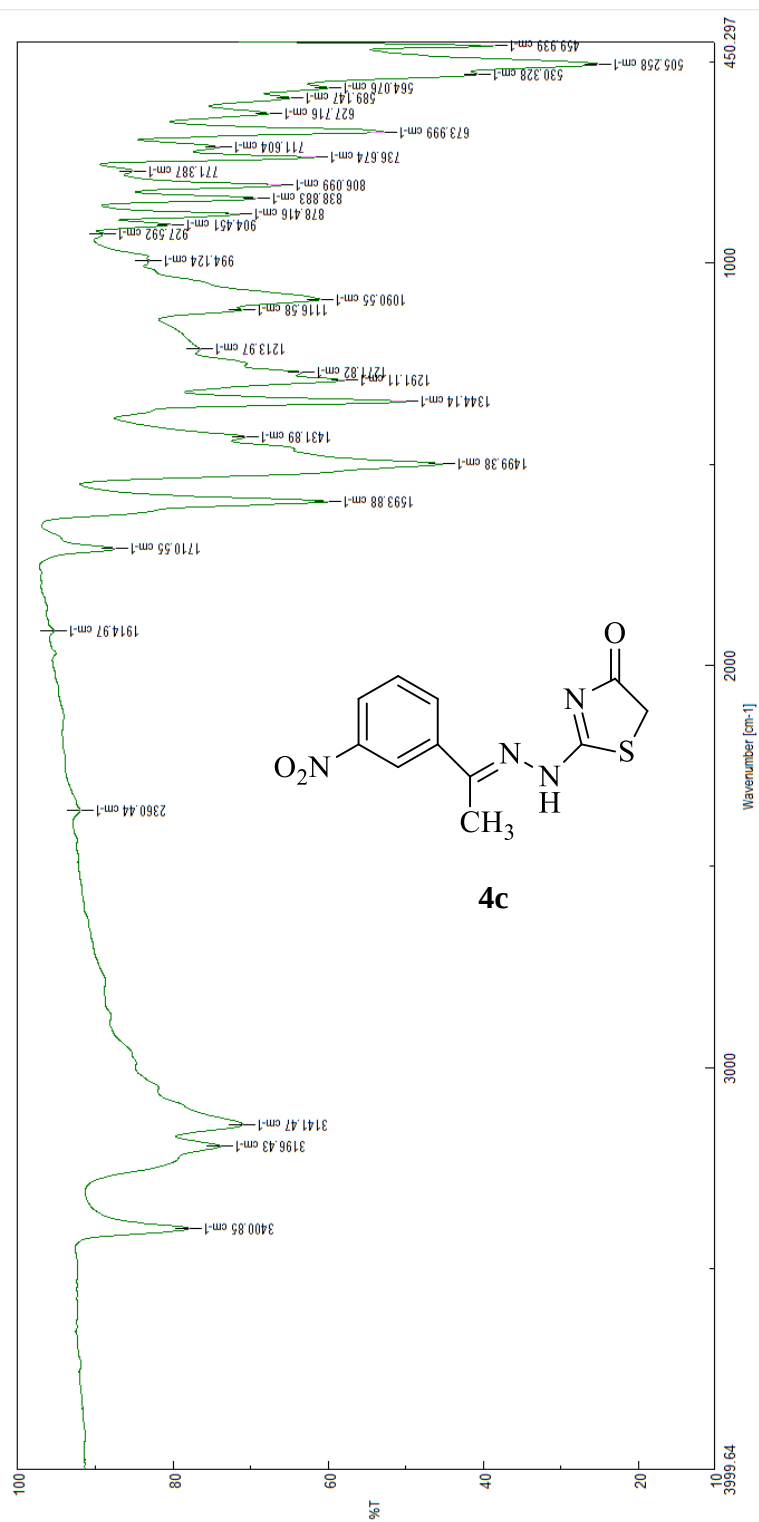


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5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
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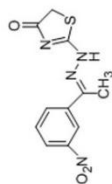
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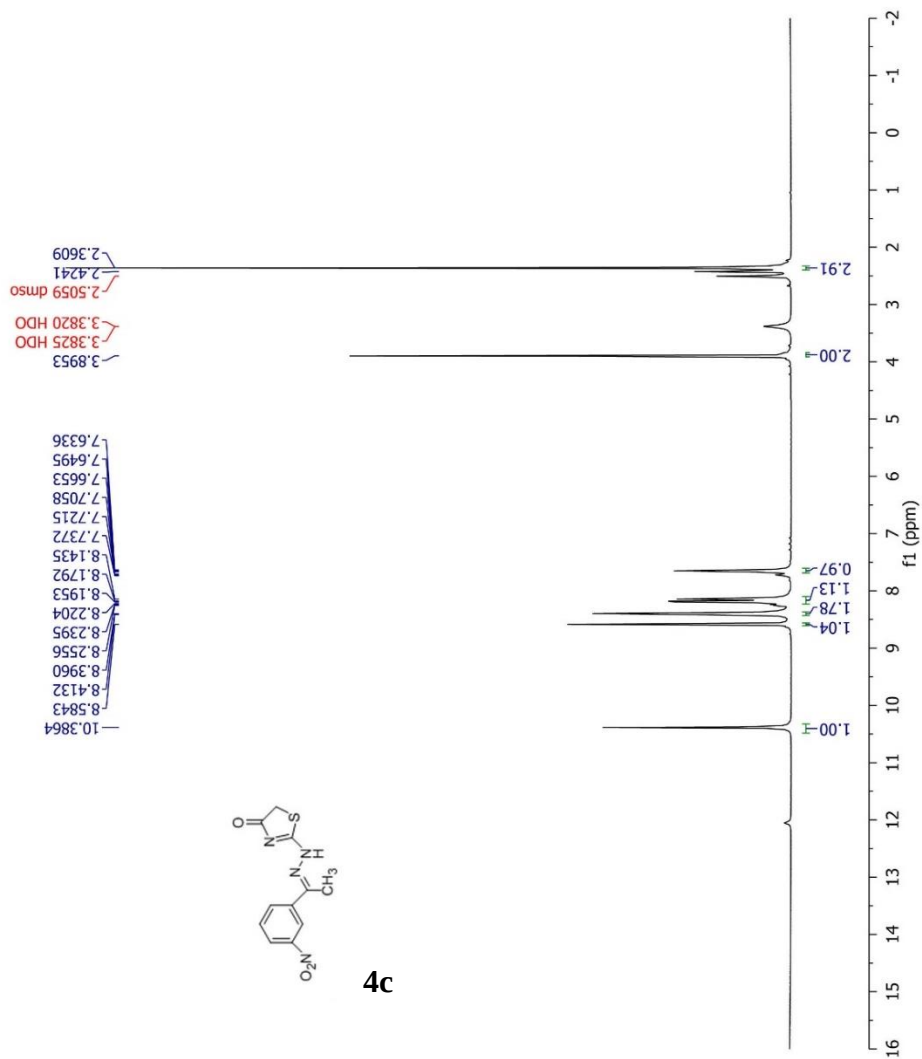
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4c



(¹H NMR)

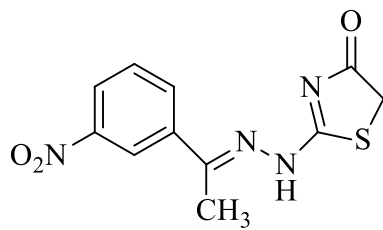
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7 Instrument	inova
8 Author	
9 Solvent	dmso
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11 Experiment	1D
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25 Nucleus	¹ H
26 Acquired Size	16384
27 Spectral Size	65536

7.7372
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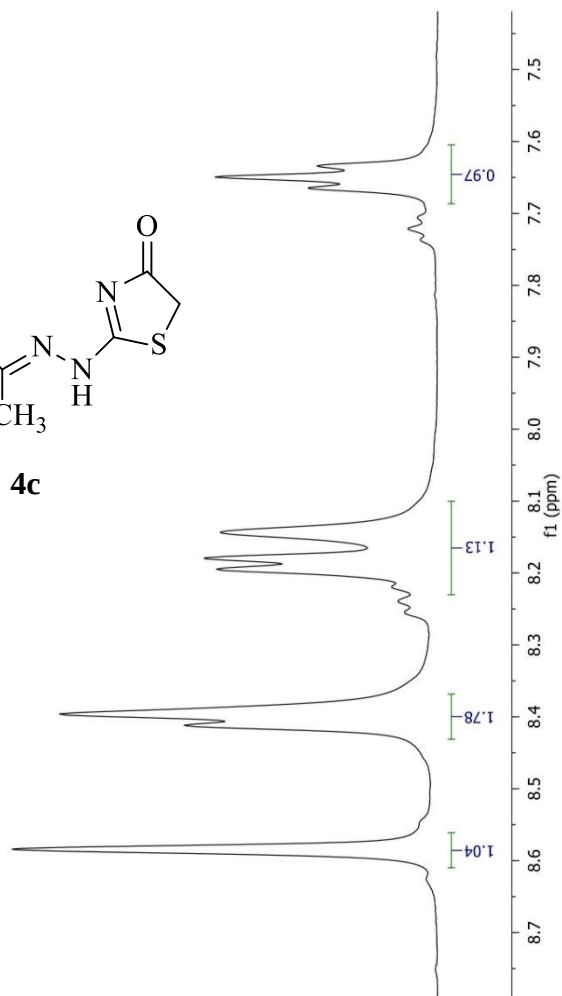
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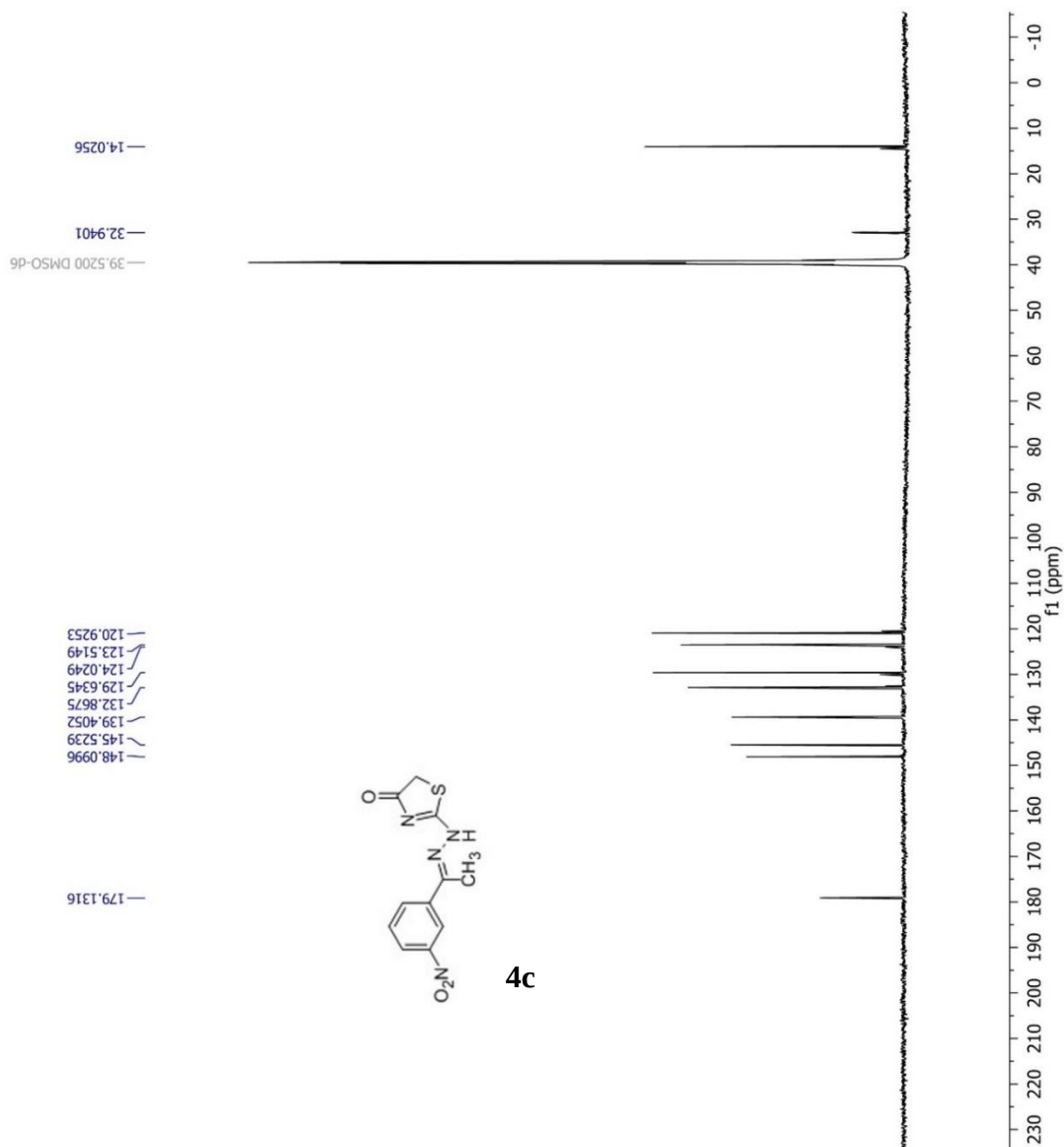
4c

(¹H NMR)

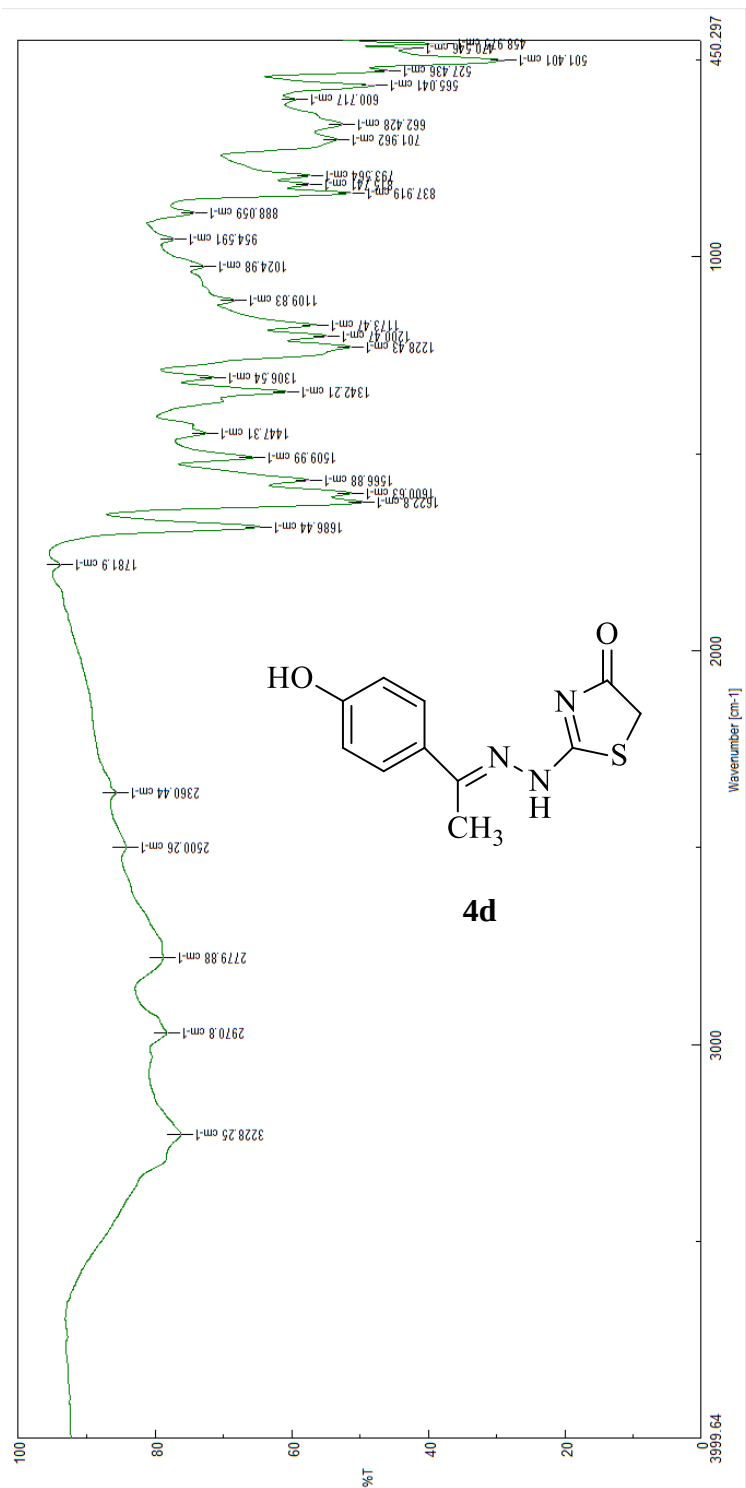


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24 Lowest Frequency	-1880.5
25 Nucleus	¹³ C
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27 Spectral Size	65536

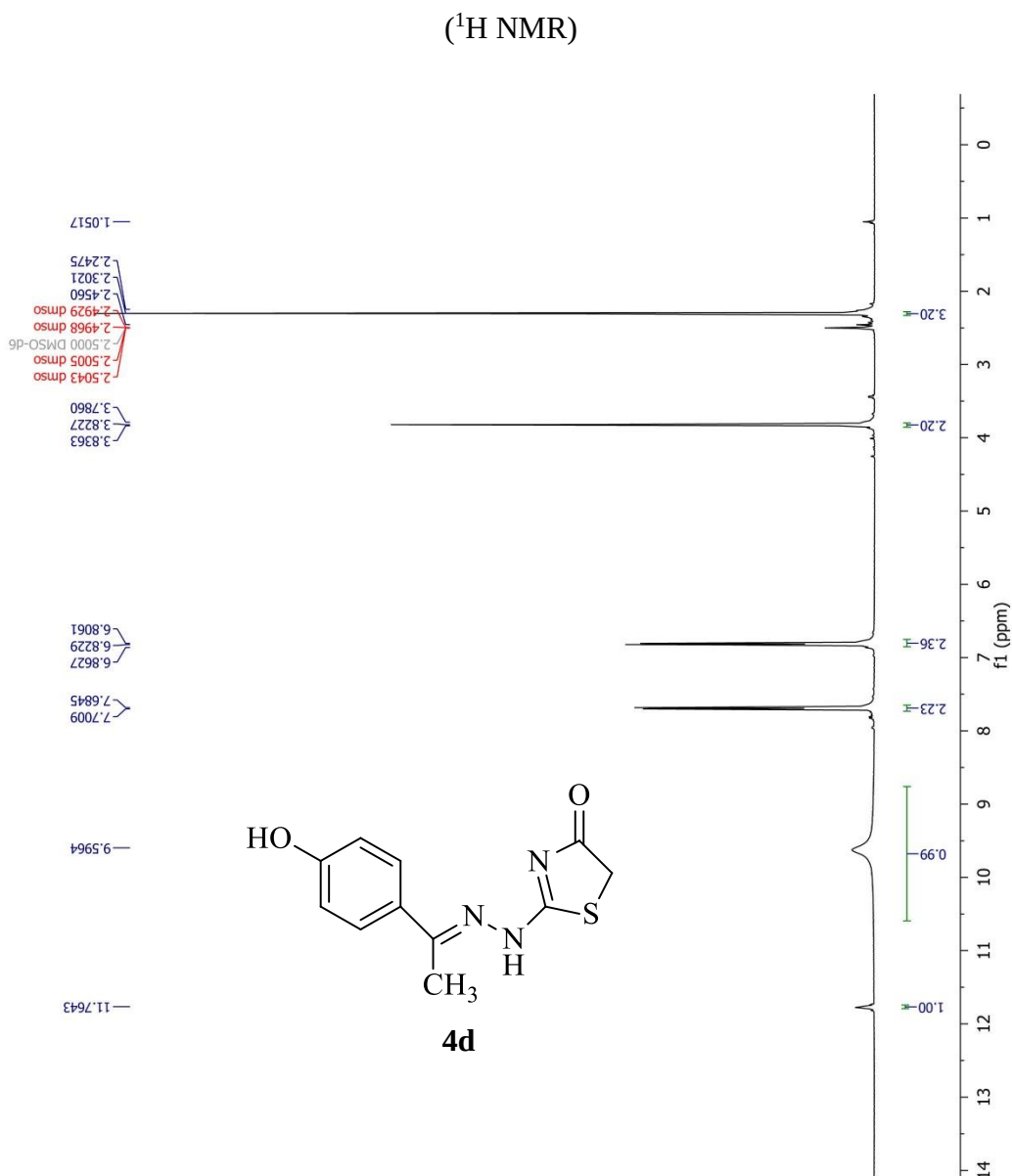
(¹³C NMR)



(FT-IR)



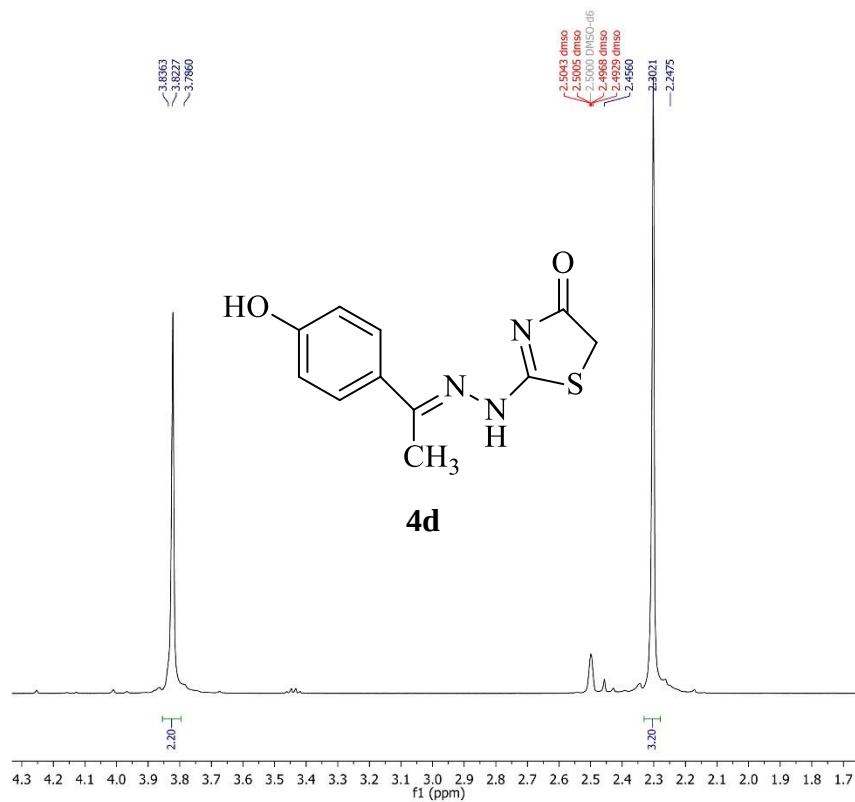
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8 Author	
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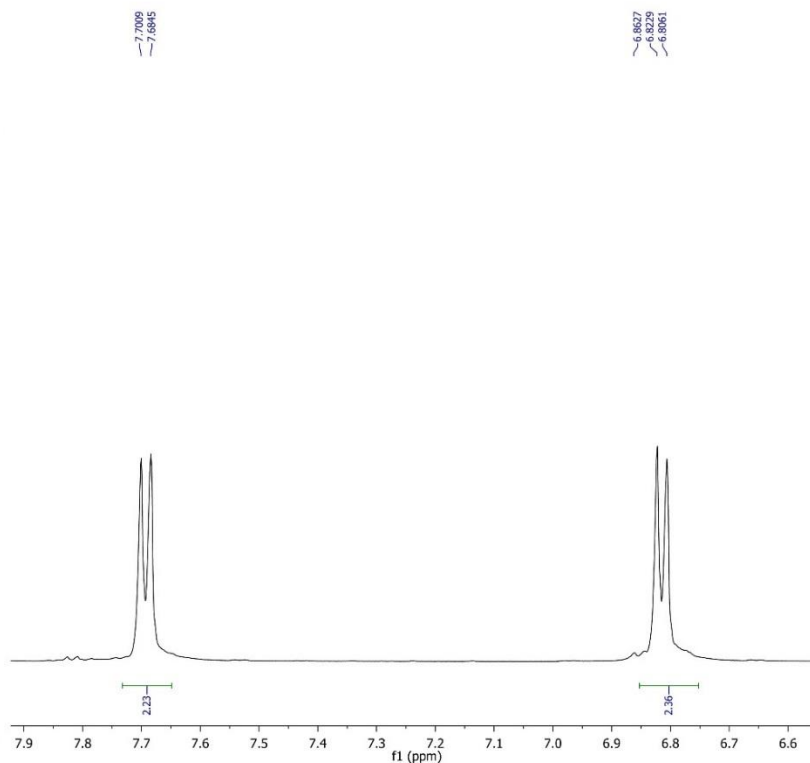
¹H NMR



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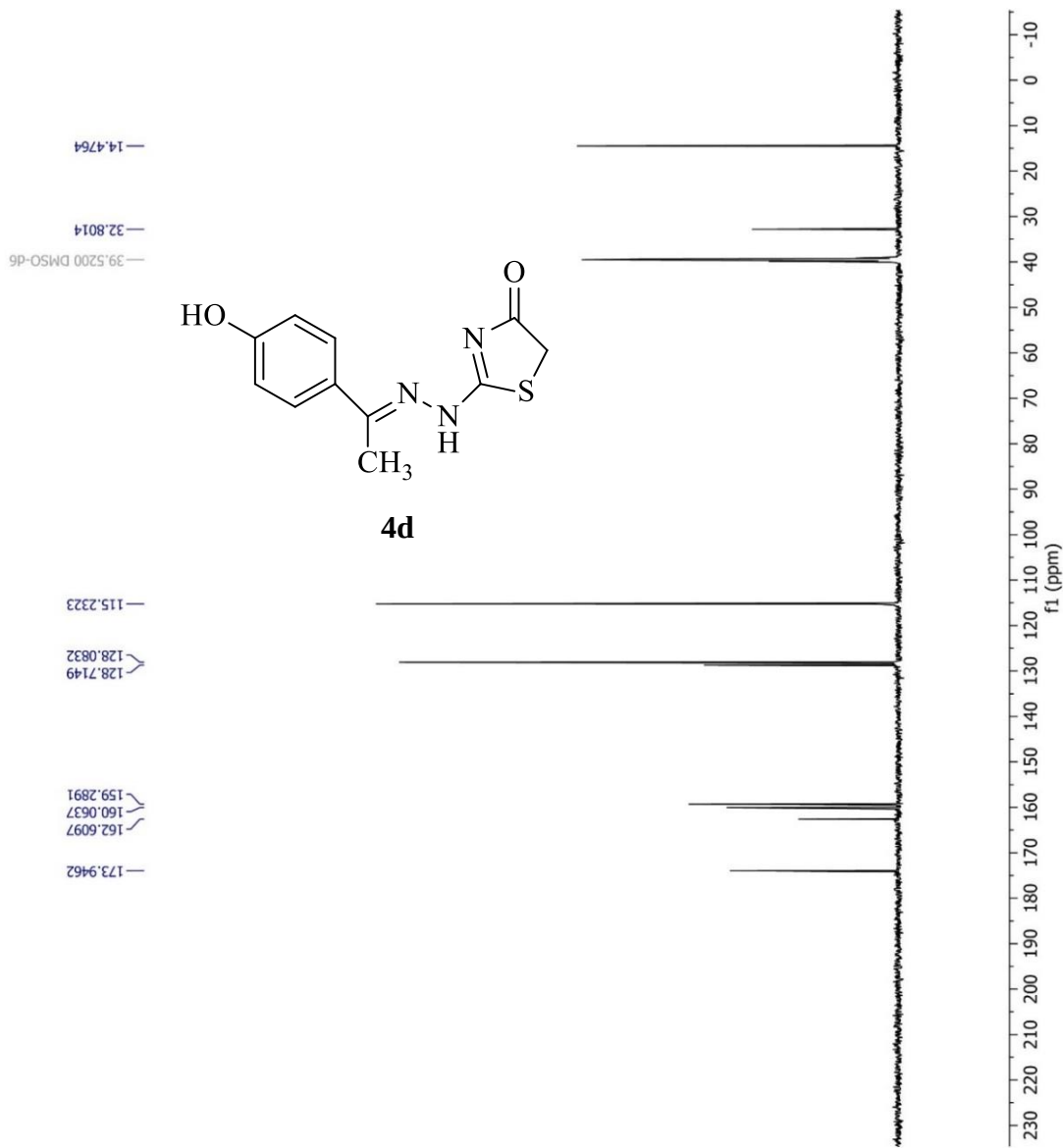


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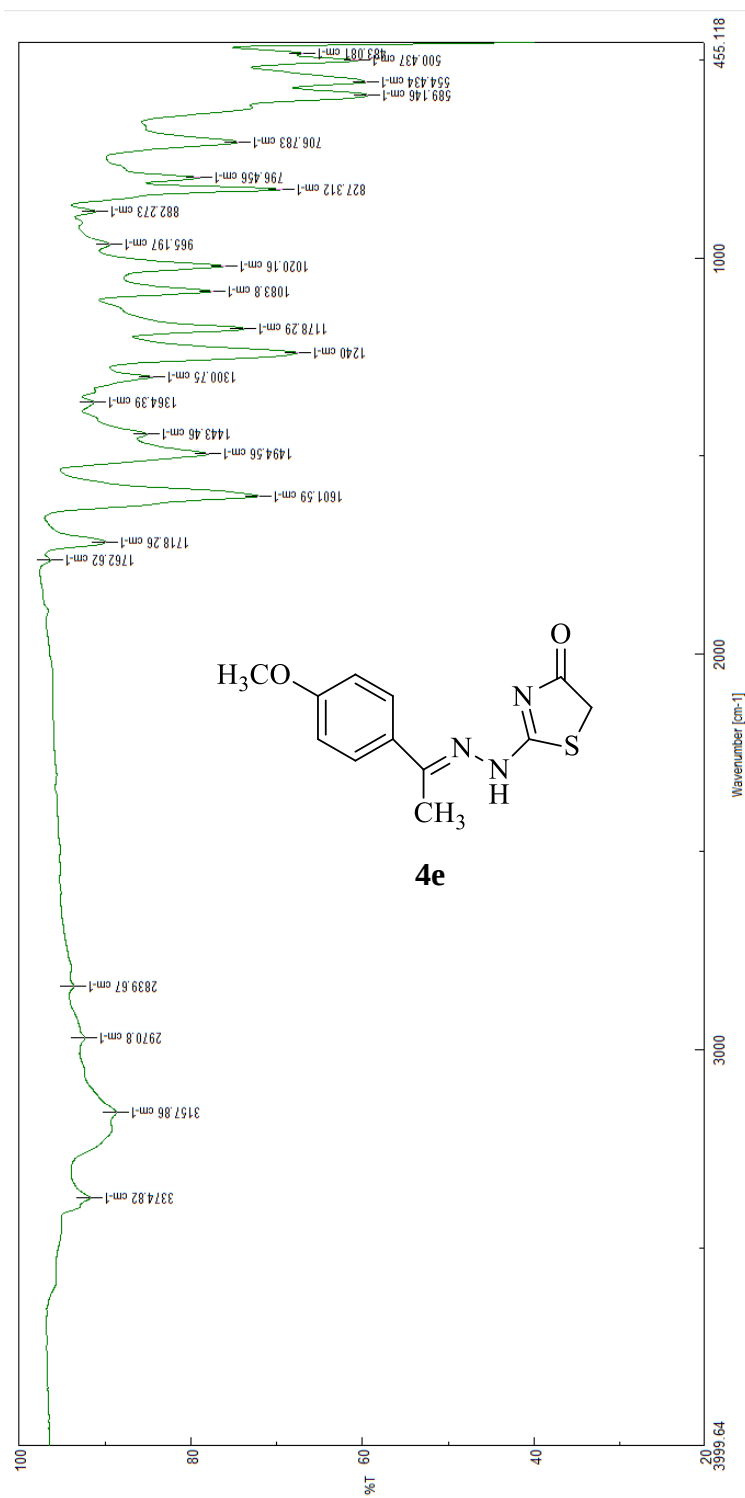


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7 Instrument	inova
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9 Solvent	dimso
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14 Receiver Gain	60
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24 Lowest Frequency	-1880.5
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(¹³C NMR)

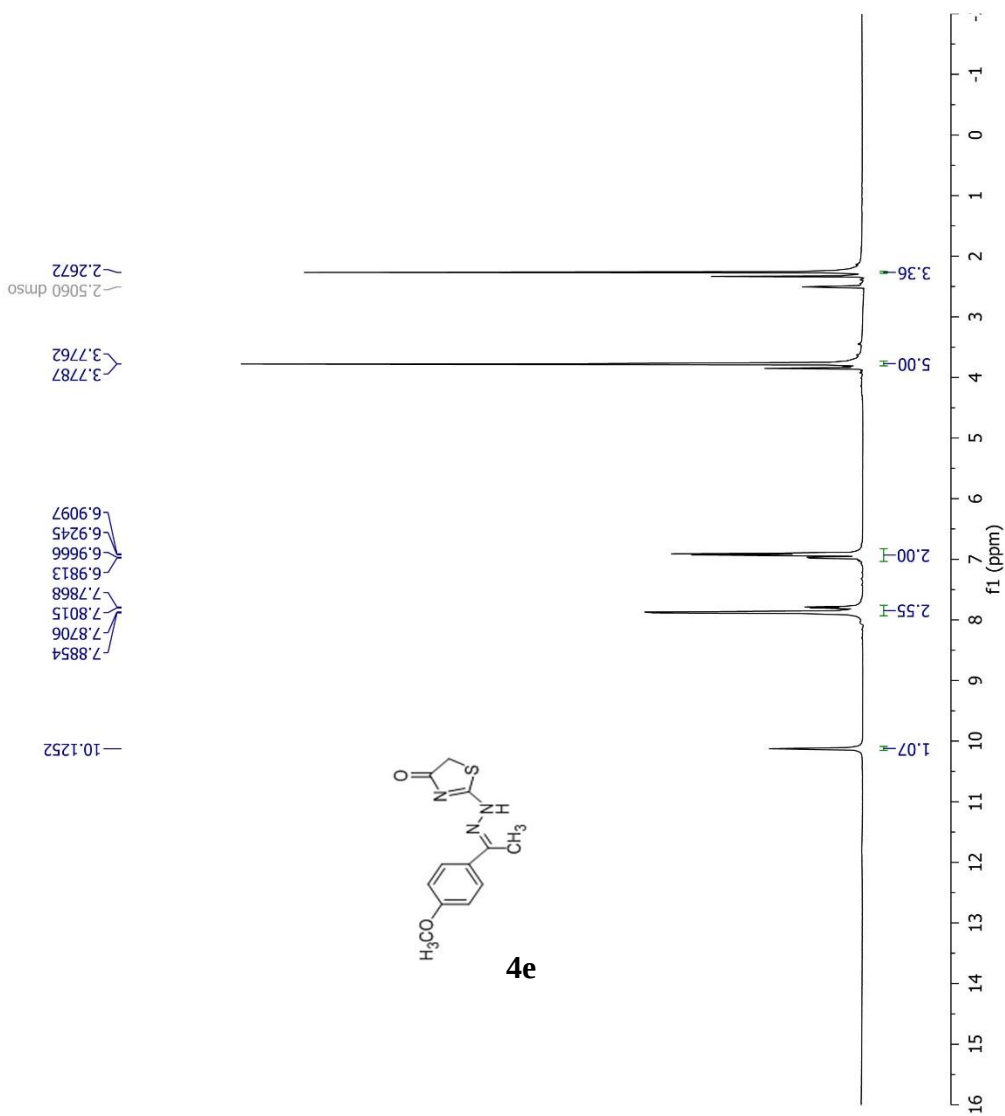


(FT-IR)



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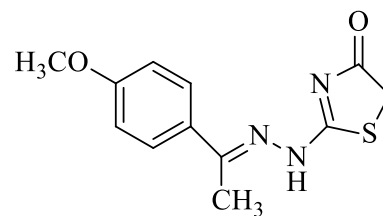
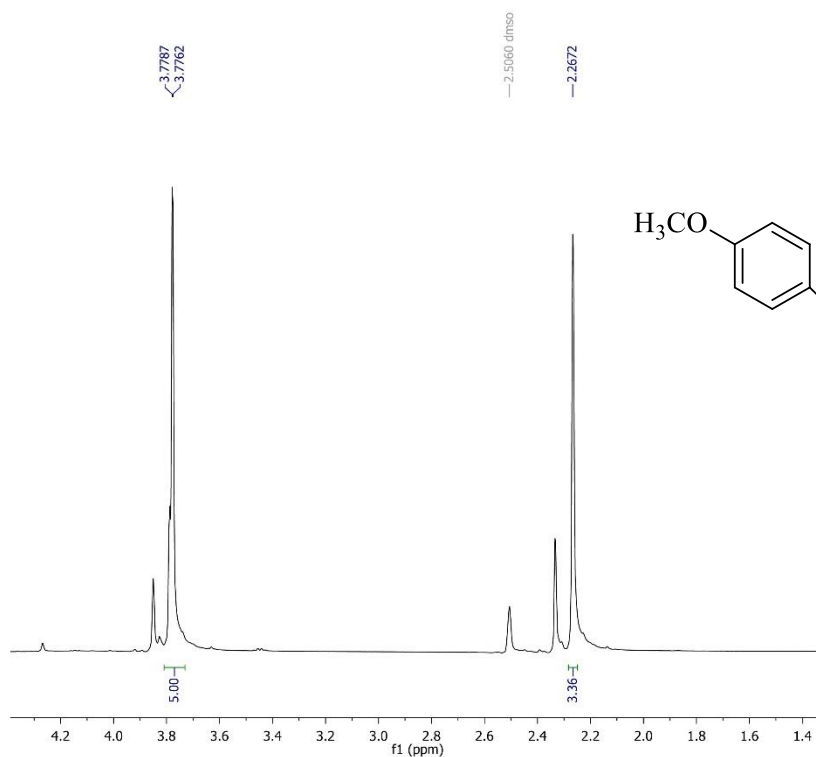
¹H NMR



¹H NMR



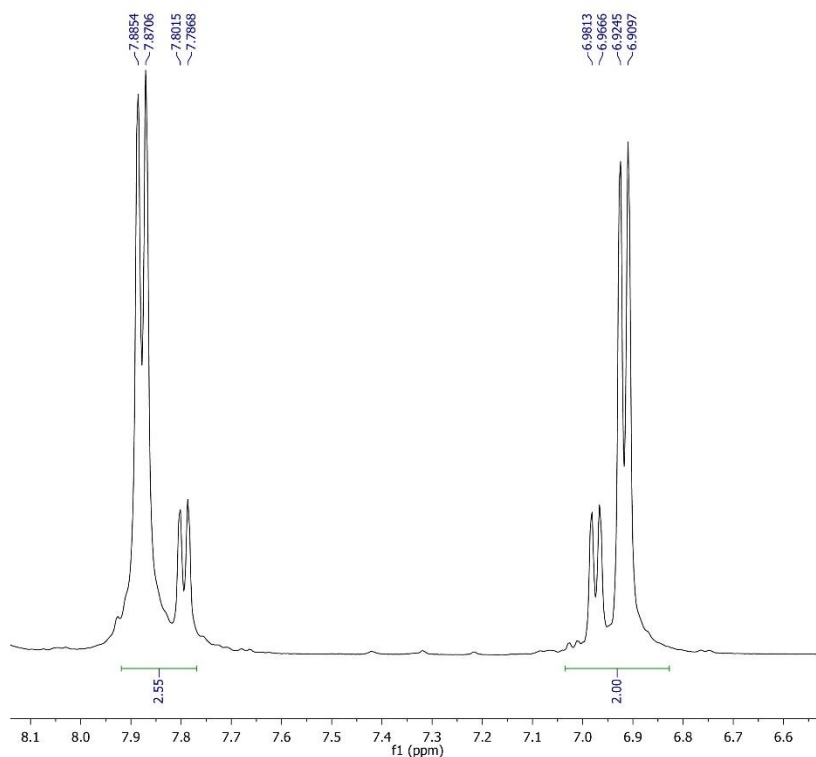
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4e

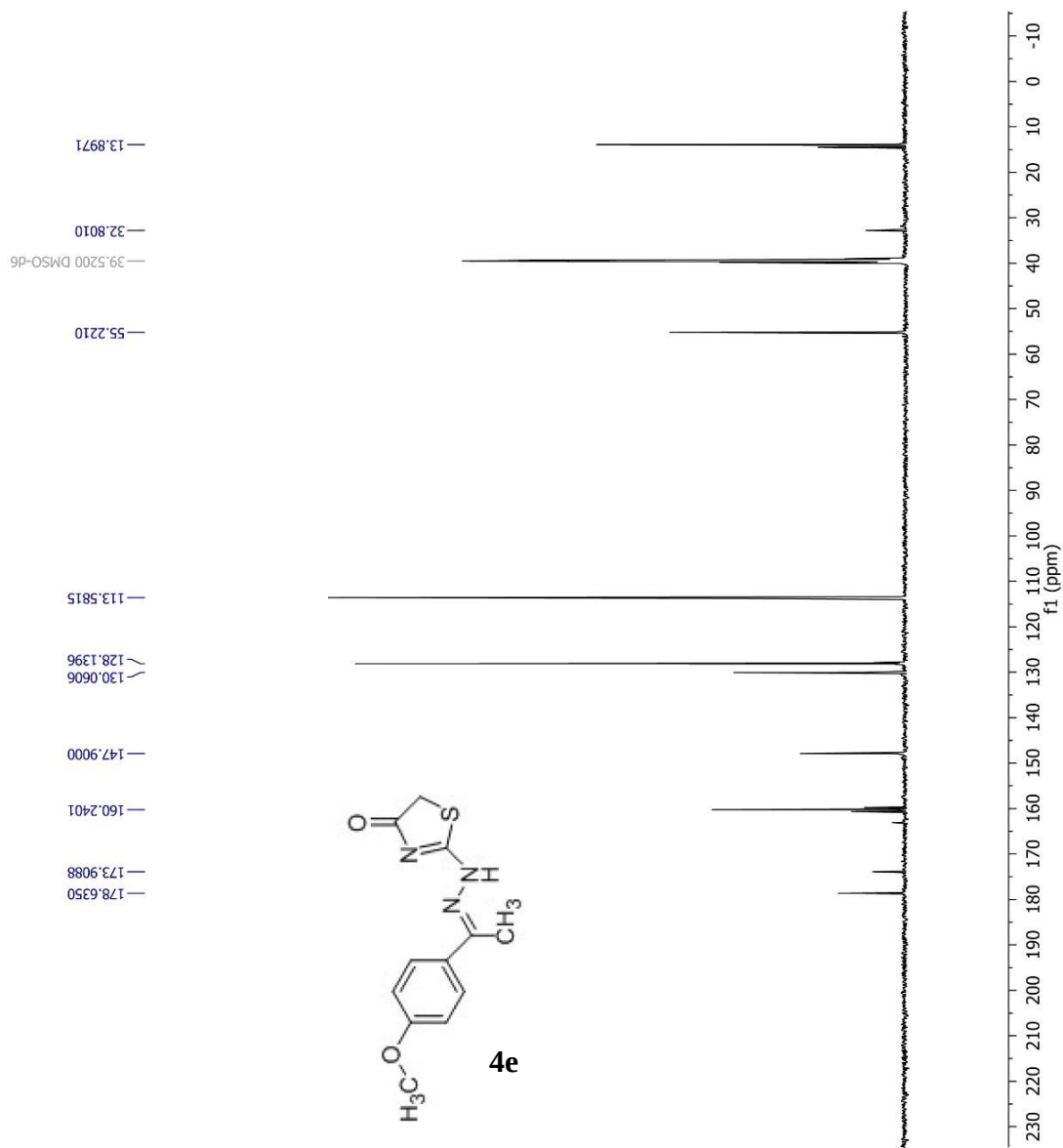


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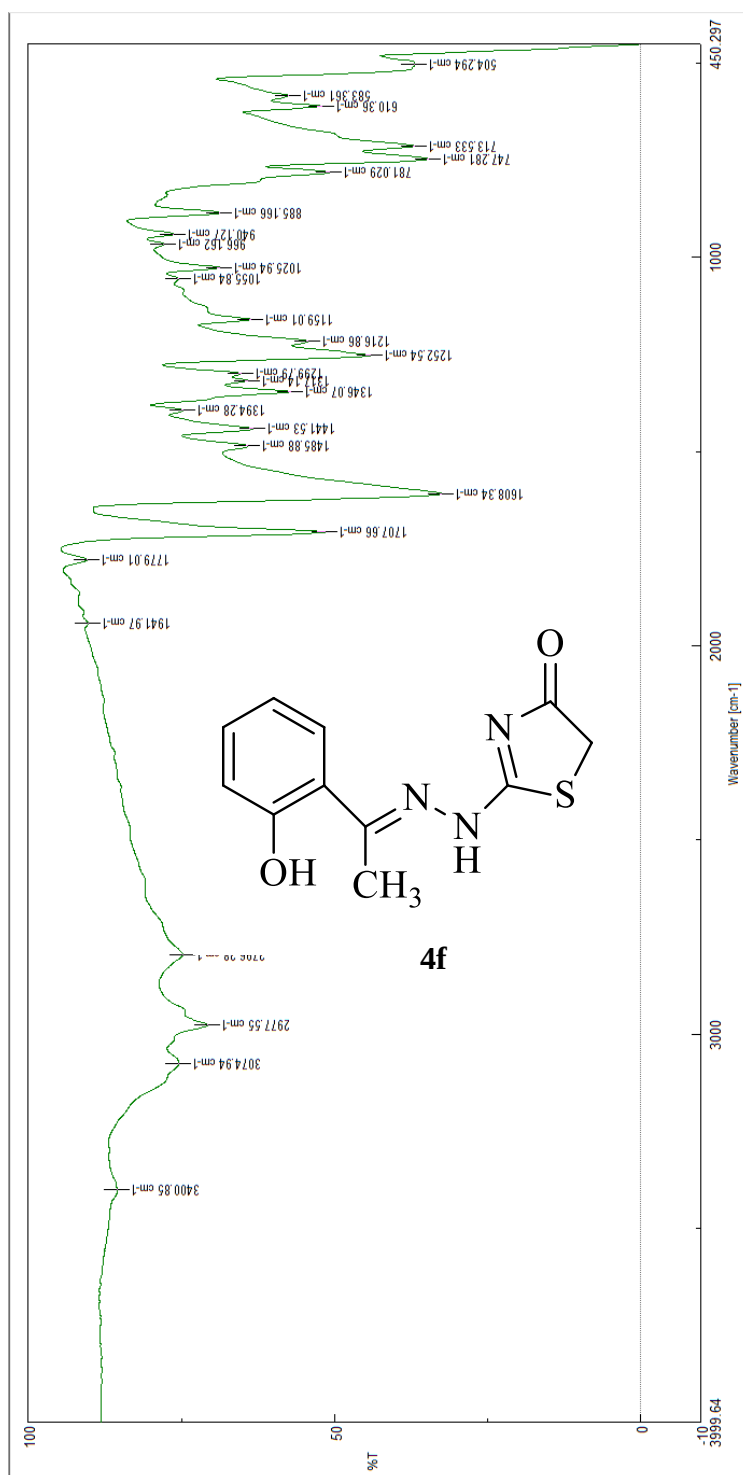


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1 Data File Name	D:/NMR/1400/1400-02/400-02-19-1/ Navid-Ghorbani/ Navid-Ghorbani/ 4-C.fid/ fid
2 Title	4-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dimso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	400
14 Receiver Gain	60
15 Relaxation Delay	1.0000
16 Pulse Width	7.5000
17 Presaturation	
18 Acquisition Time	1.0437
19 Acquisition Date	2021-05-09T12:30:50
20 Modification Date	2021-05-09T12:44:39
21 Class	
22 Spectrometer Frequency	125.59
23 Spectral Width	31397.2
24 Lowest Frequency	-1880.5
25 Nucleus	¹³ C
26 Acquired Size	32768
27 Spectral Size	65536

(¹³C NMR)

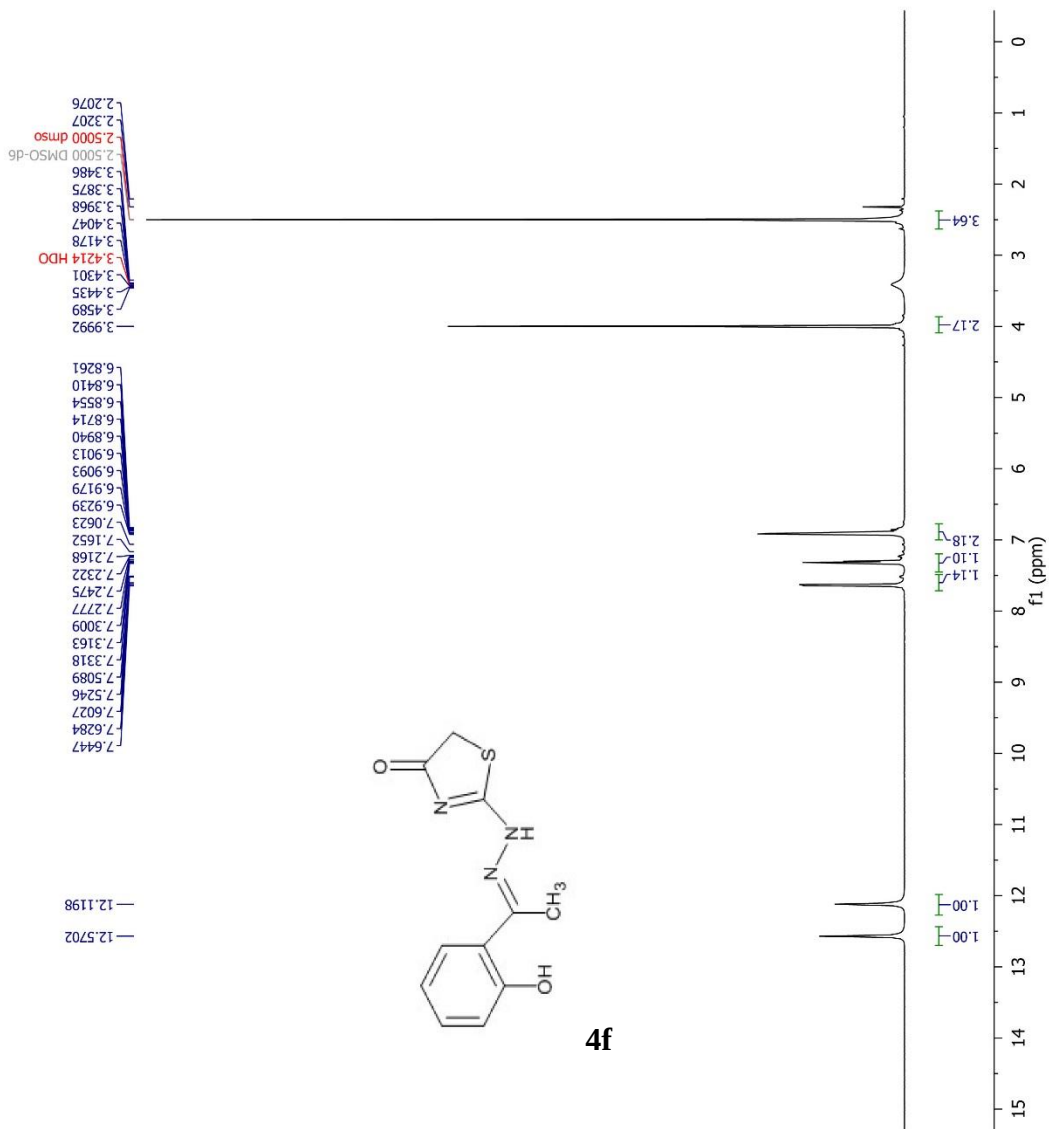


(FT-IR)

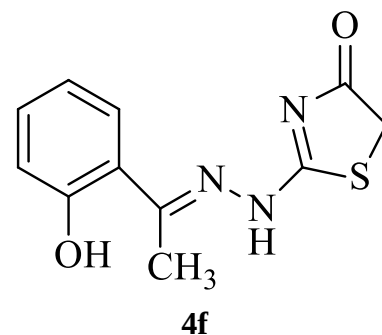


Parameter	Value
1 Data File Name	D:/ NMR/ 1400/ 1400-02/ 400-02-27/ Navid- Ghorbani/ 8-H.fid/ fid
2 Title	8-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	16
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation	
18 Acquisition Time	1.8225
19 Acquisition Date	2021-05-17T17:29:19
20 Modification Date	2021-05-17T17:30:21
21 Class	
22 Spectrometer	499.41
23 Frequency	8989.8
24 Spectral Width	-993.1
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536

(¹H NMR)

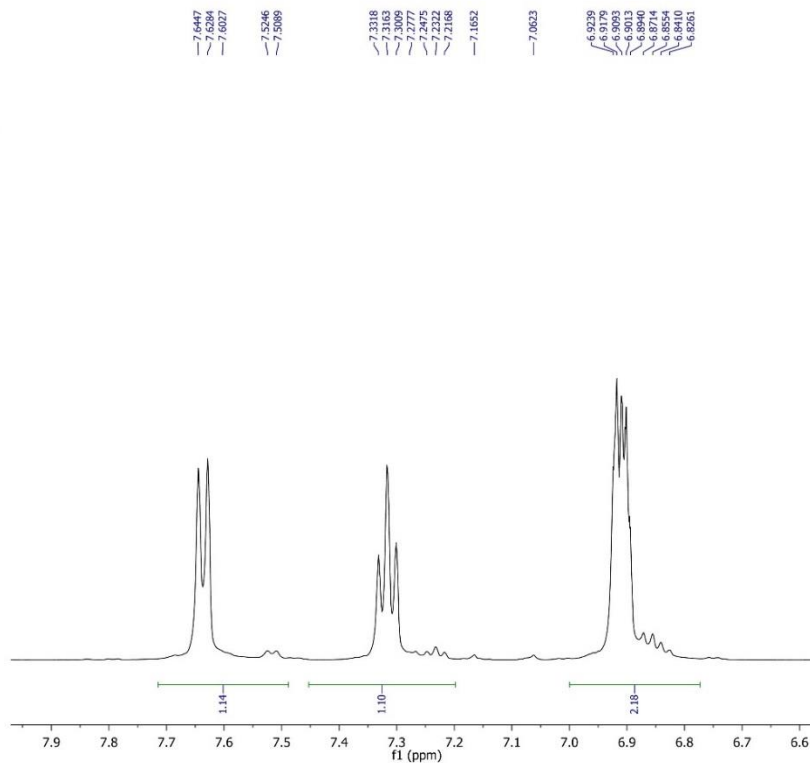


 آرشیو ملی
 مرکزی



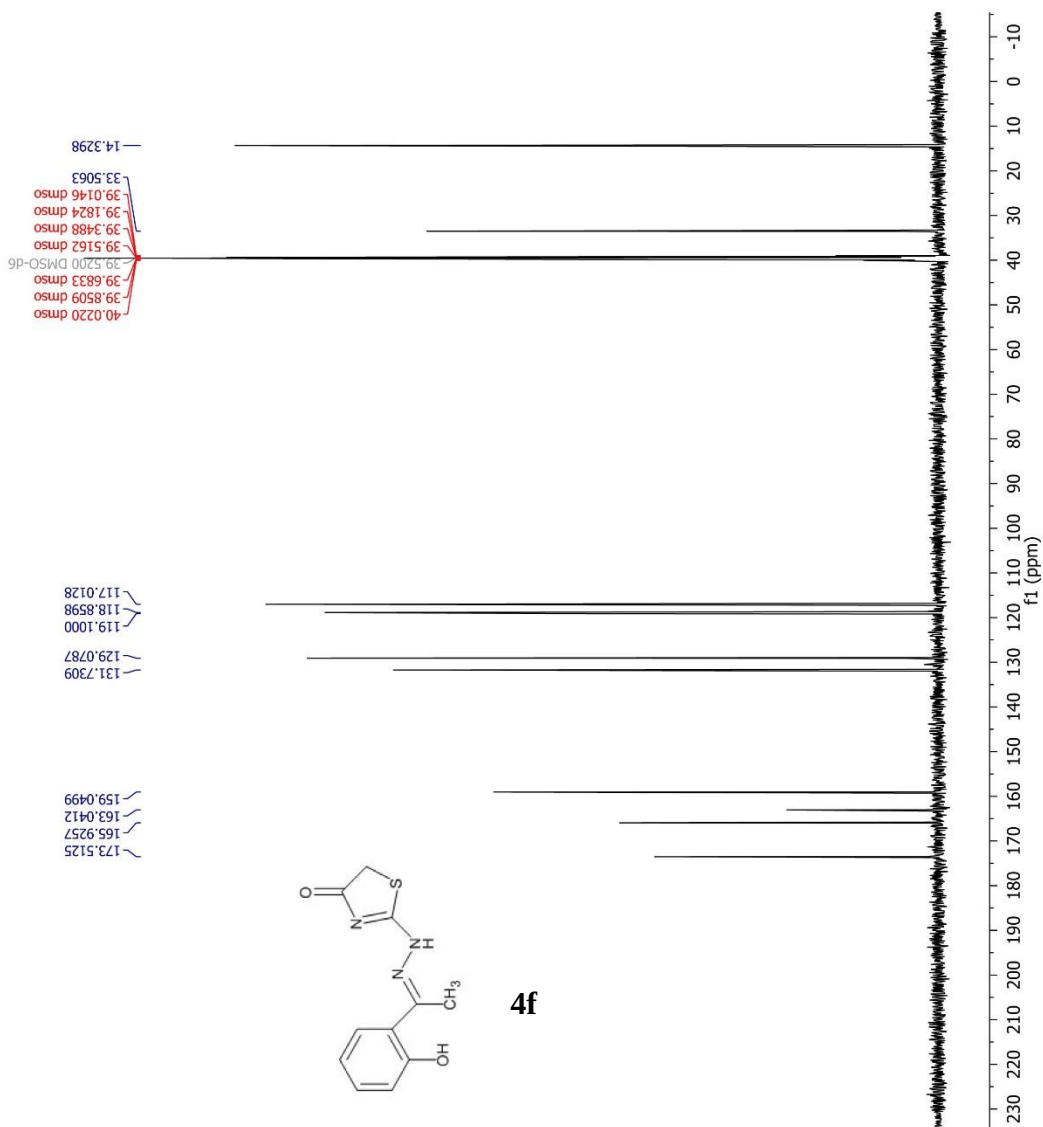

 آرشیو ملی
 مرکزی

Parameter	Value
1 Data File Name	D:/NMR/ 1400/ 1400-02/ 400-02-27/ Navid- Ghorbani/ 8-H.fid/ fid
2 Title	8-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Experiment	1D
12 Probe	1D
13 Number of Scans	16
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation Frequency	
18 Acquisition Time	1.8225
19 Acquisition Date	2021-05-17T17:29:19
20 Modification Date	2021-05-17T17:30:21
21 Class	
22 Spectrometer Frequency	499.41
23 Spectral Width	8989.8
24 Lowest Frequency	-993.1
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536



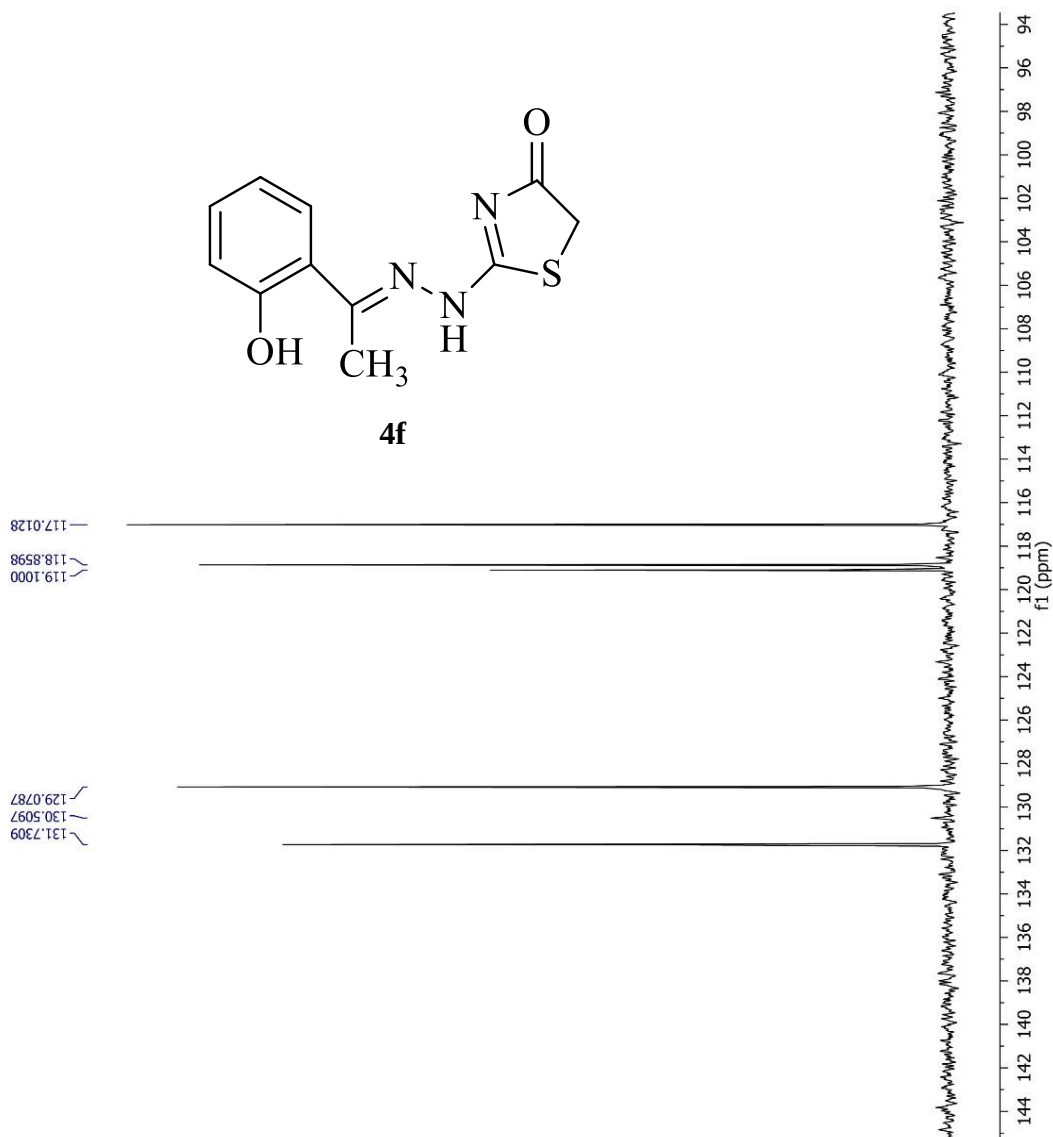
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1 Data File Name	D:/NMR/1400/1400-02/400-02-27/Navid-Ghorbani/ 8-C.fid/ fid
2 Title	8-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmsO
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	208
14 Receiver Gain	60
15 Relaxation Delay	1.0000
16 Pulse Width	7.5000
17 Presaturation	
18 Acquisition Time	1.0437
19 Acquisition Date	2021-05-17T17:30:41
20 Modification Date	2021-05-17T17:38:15
21 Class	
22 Spectrometer	125.59
23 Frequency	31397.2
24 Spectral Width	-1880.5
25 Lowest Frequency	13C
26 Nucleus	32768
27 Acquired Size	65536

(¹³C NMR)

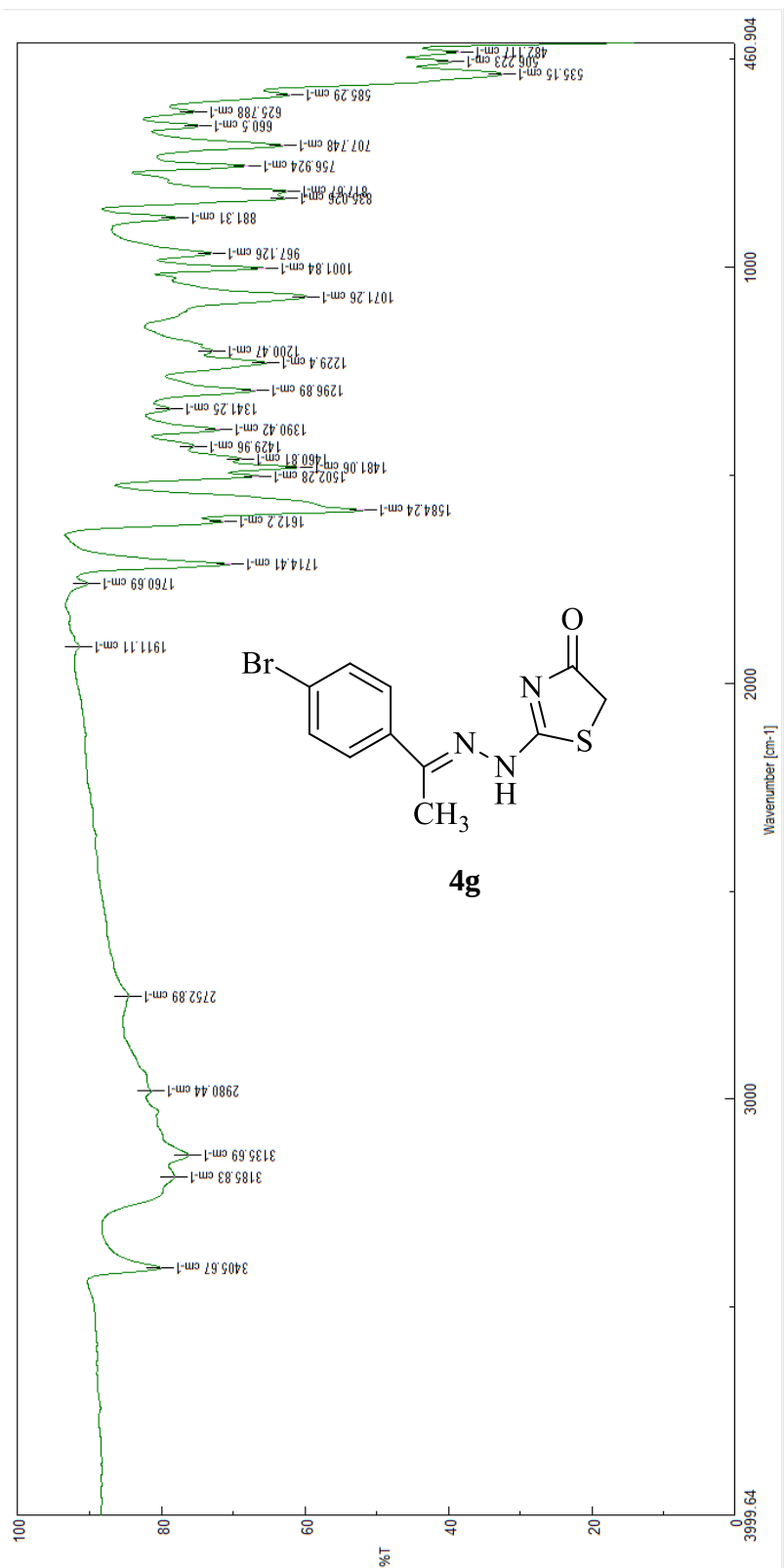


Parameter	Value
1 Data File Name	D:/NMR/1400/1400-02/400-02-27/Navid-Ghorbani/ 8-C.fid/ fid
2 Title	8-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	208
14 Receiver Gain	60
15 Relaxation Delay	1.0000
16 Pulse Width	7.5000
17 Presaturation	Frequency
18 Acquisition Time	1.0437
19 Acquisition Date	2021-05-17T17:30:41
20 Modification Date	2021-05-17T17:38:15
21 Class	
22 Spectrometer Frequency	125.59
23 Spectral Width	31397.2
24 Lowest Frequency	-1880.5
25 Nucleus	¹³ C
26 Acquired Size	32768
27 Spectral Size	65536

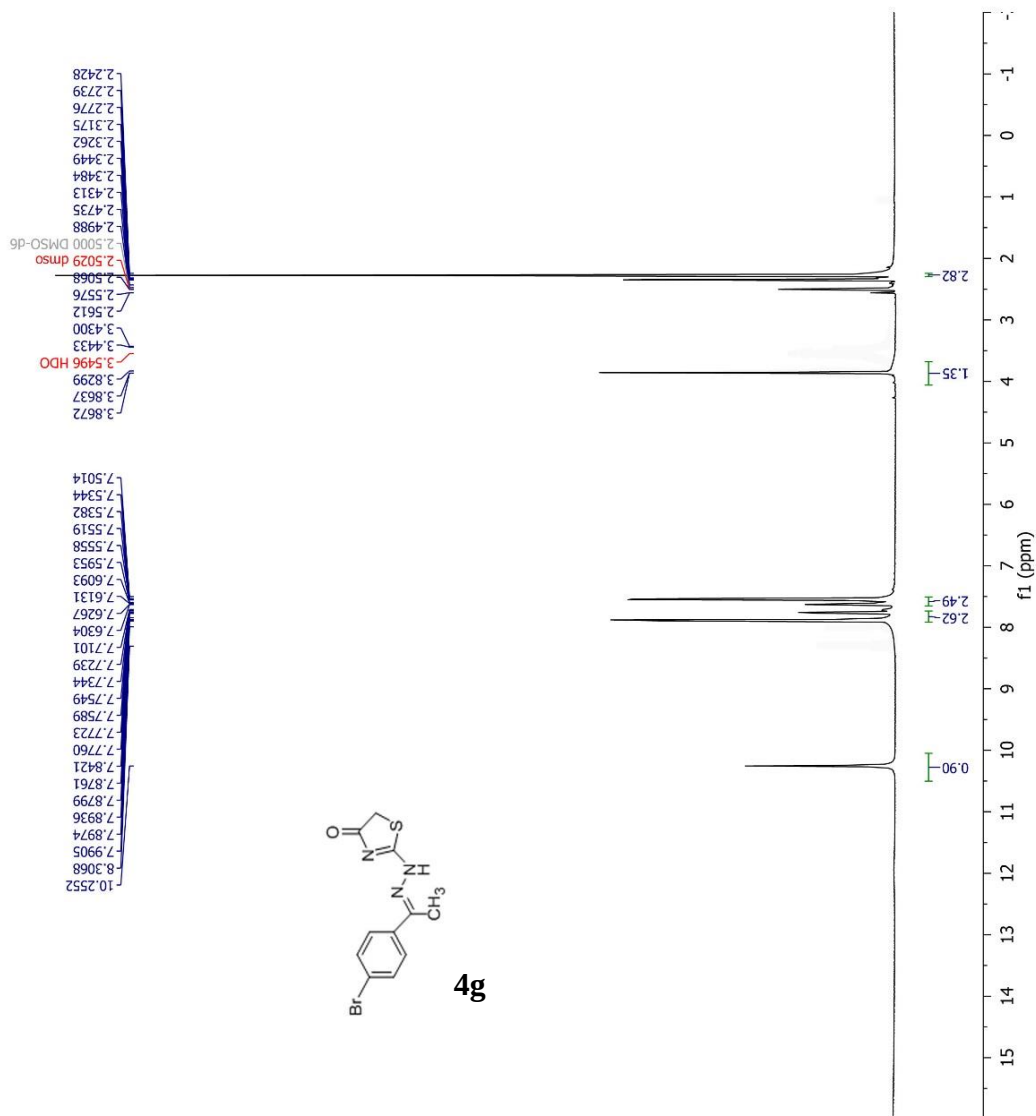
(¹³C NMR)



(FT-IR)



Parameter	Value
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2 Title	10-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	8
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation	
18 Acquisition Time	1.8225
19 Acquisition Date	2021-05-17T17:40:36
20 Modification Date	2021-05-17T17:40:52
21 Class	
22 Spectrometer	499.41
23 Frequency	8989.8
24 Spectral Width	-993.1
25 Lowest	Frequency
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536

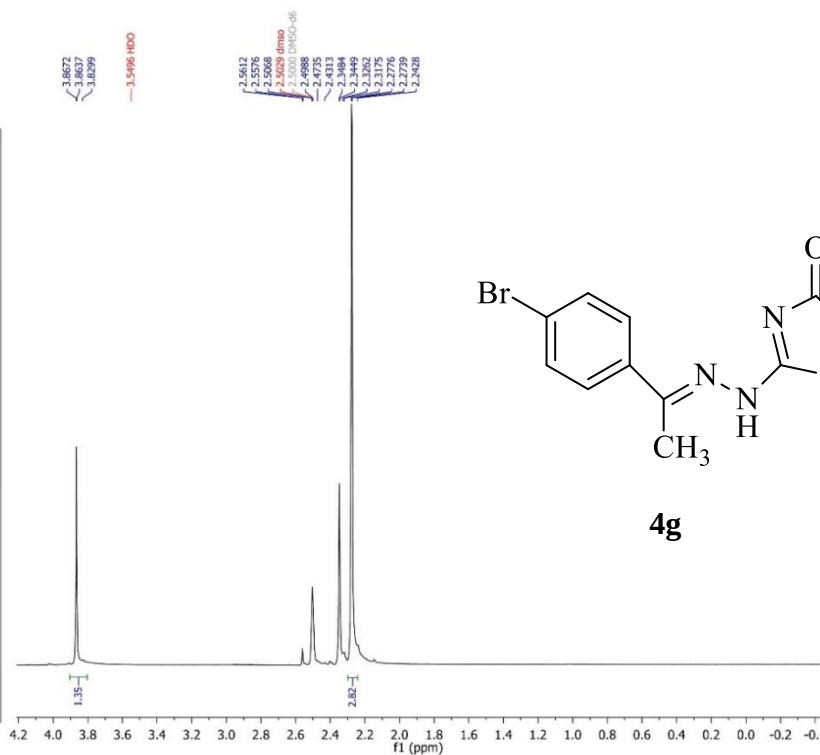


(¹H NMR)

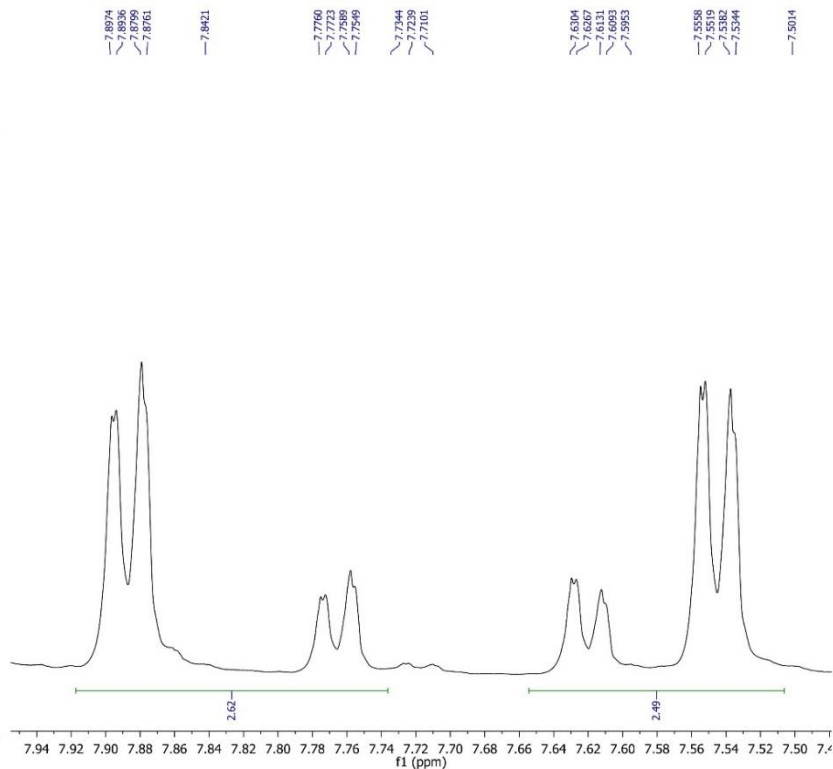
(¹H NMR)



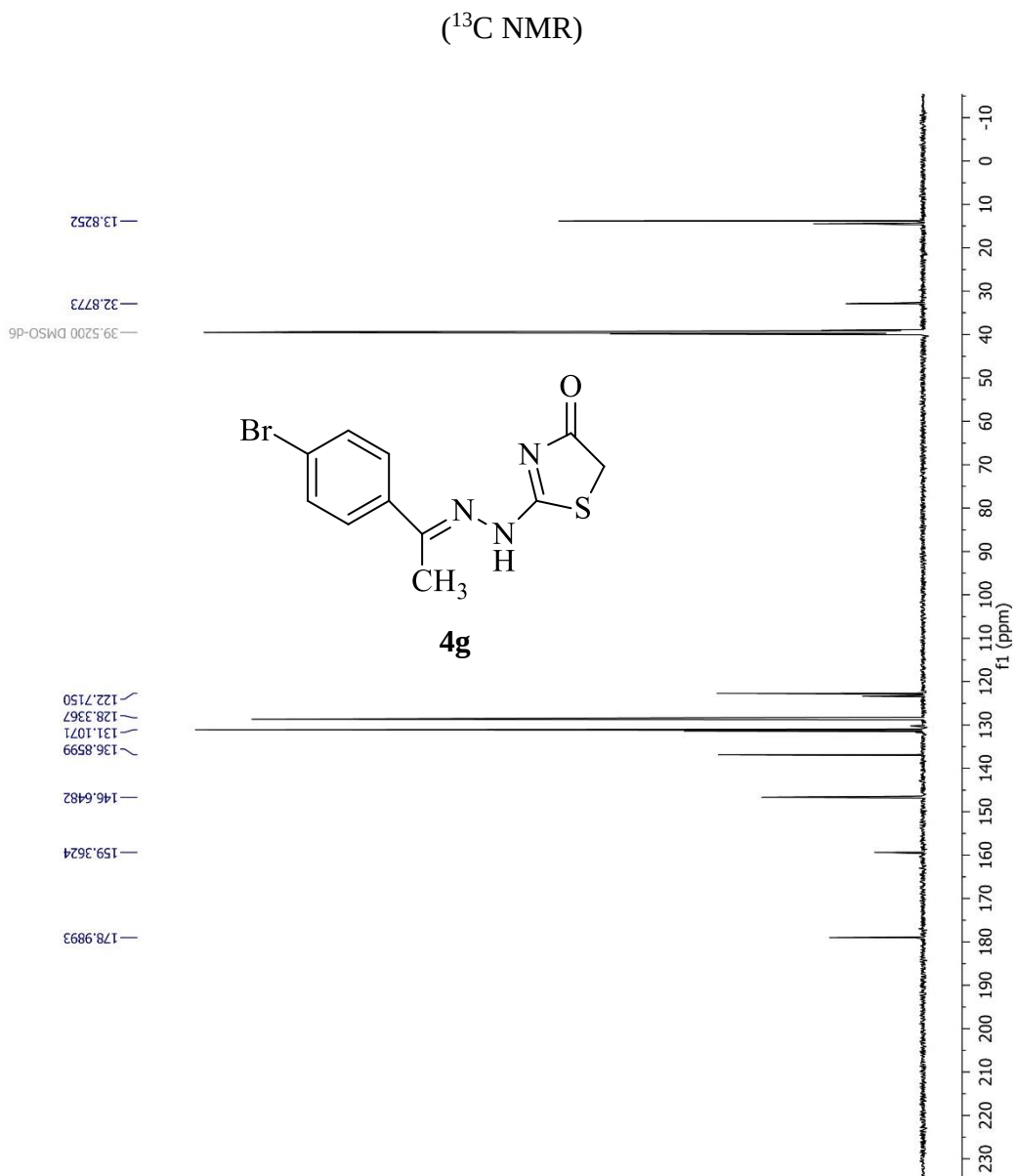
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2 Title	10-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dms
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	8
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation Frequency	
18 Acquisition Time	1.8225
19 Acquisition Date	2021-05-17T17:40:36
20 Modification Date	2021-05-17T17:40:52
21 Class	
22 Spectrometer	499.41
23 Frequency	9989.8
24 Lowest Frequency	-993.1
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536



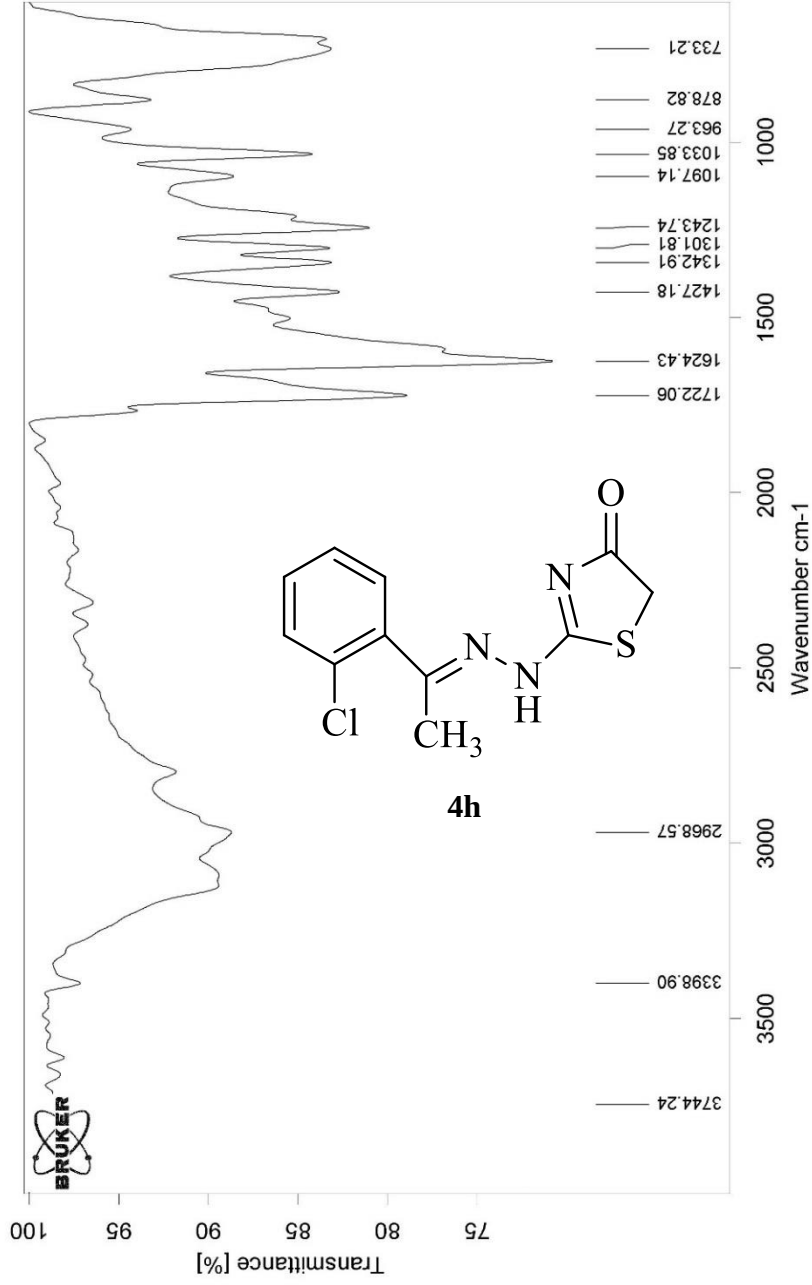
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2 Title	10-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dms
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	8
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation Frequency	
18 Acquisition Time	1.8225
19 Acquisition Date	2021-05-17T17:40:36
20 Modification Date	2021-05-17T17:40:52
21 Class	
22 Spectrometer	499.41
23 Frequency	9989.8
24 Lowest Frequency	-993.1
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536



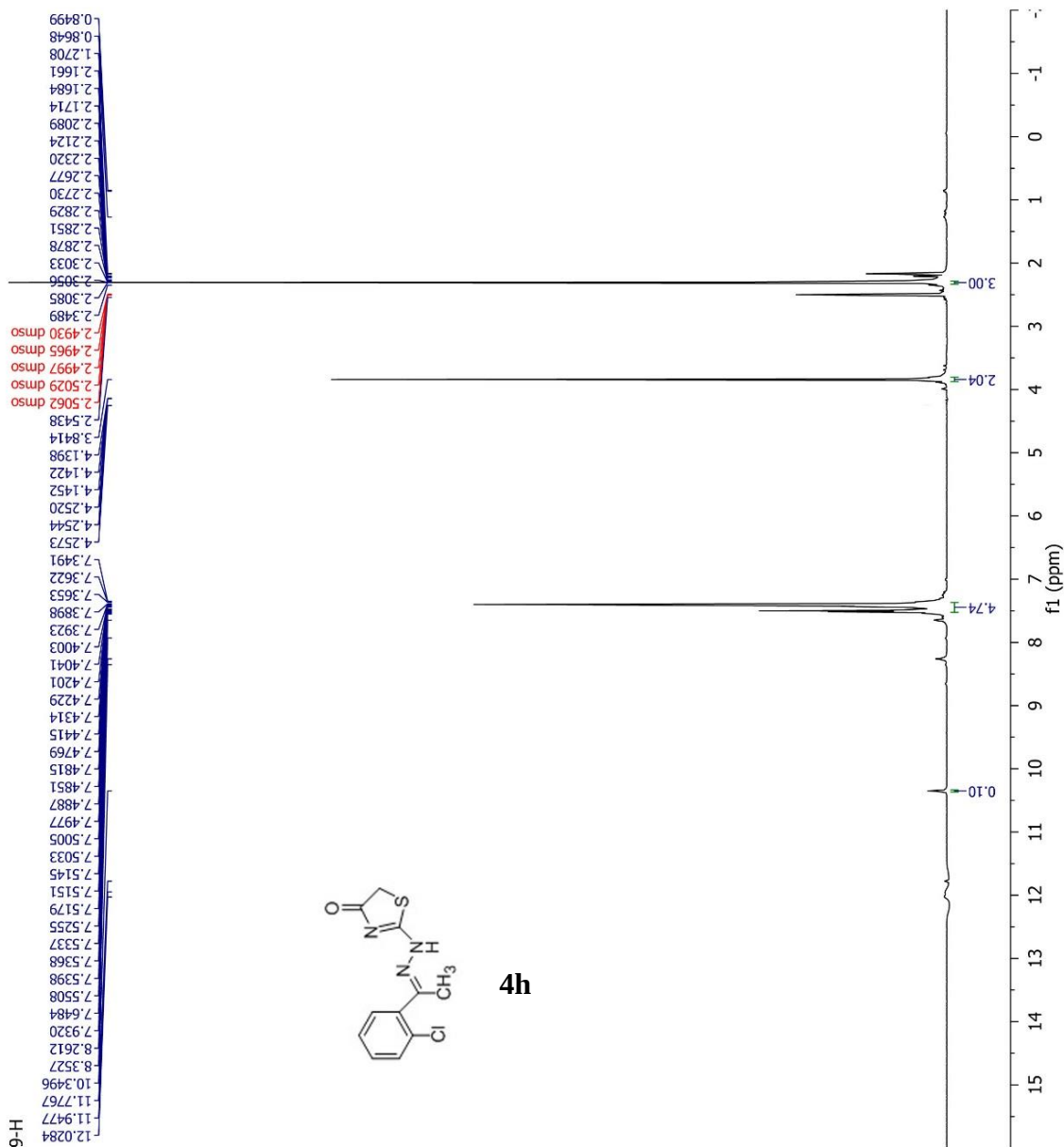
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1 Data File Name	D:/NMR/1400/1400-02/400-02-27/Navid-Ghorbani/ 10-C.fid/ fid
2 Title	10-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dimso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	1024
14 Receiver Gain	60
15 Relaxation Delay	1.0000
16 Pulse Width	7.5000
17 Presaturation	Frequency
18 Acquisition Time	1.0437
19 Acquisition Date	2021-05-17T17:41:01
20 Modification Date	2021-05-17T18:16:19
21 Class	
22 Spectrometer	125.59
Frequency	
23 Spectral Width	31397.2
24 Lowest	-1880.5
Frequency	
25 Nucleus	¹³ C
26 Acquired Size	32768
27 Spectral Size	65536



(FT-IR)



Parameter	Value
1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/9-H.fid/ fid
2 Title	9-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dms0
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	16
15 Receiver Gain	30
16 Relaxation Delay	1.0000
17 Pulse Width	5.0000
18 Presaturation	
19 Acquisition Time	1.8227
20 Acquisition Date	2021-08-02T12:17:37
21 Modification Date	2021-08-02T12:18:12
22 Class	
23 Spectrometer	499.39
24 Spectral Width	8988.8
25 Lowest	-998.8
26 Nucleus	1H
27 Acquired Size	16384
28 Spectral Size	65536

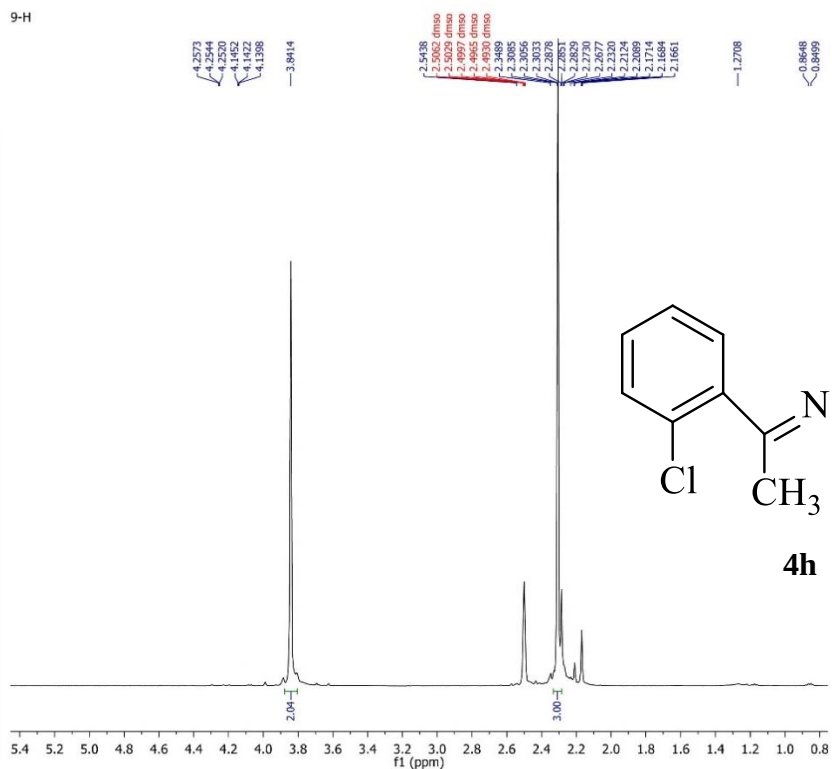


(¹H NMR)

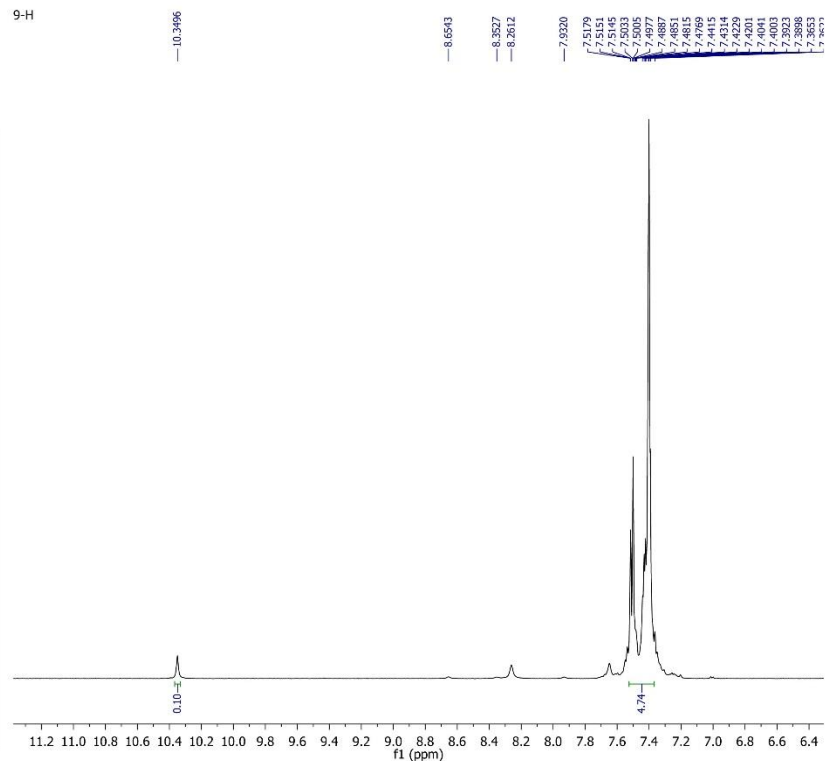
^1H NMR



Parameter	Value
1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/9-H.fid/ fid
2 Title	9-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmsd
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	16
15 Receiver Gain	30
16 Relaxation Delay	1.0000
17 Pulse Width	5.0000
18 Presaturation Frequency	
19 Acquisition Time	1.8227
20 Acquisition Date	2021-08-02T12:17:37
21 Modification Date	2021-08-02T12:18:12
22 Class	
23 Spectrometer Frequency	499.39
24 Spectral Width	8988.8
25 Lowest Frequency	-998.8
26 Nucleus	^1H
27 Acquired Size	16384
28 Spectral Size	65536

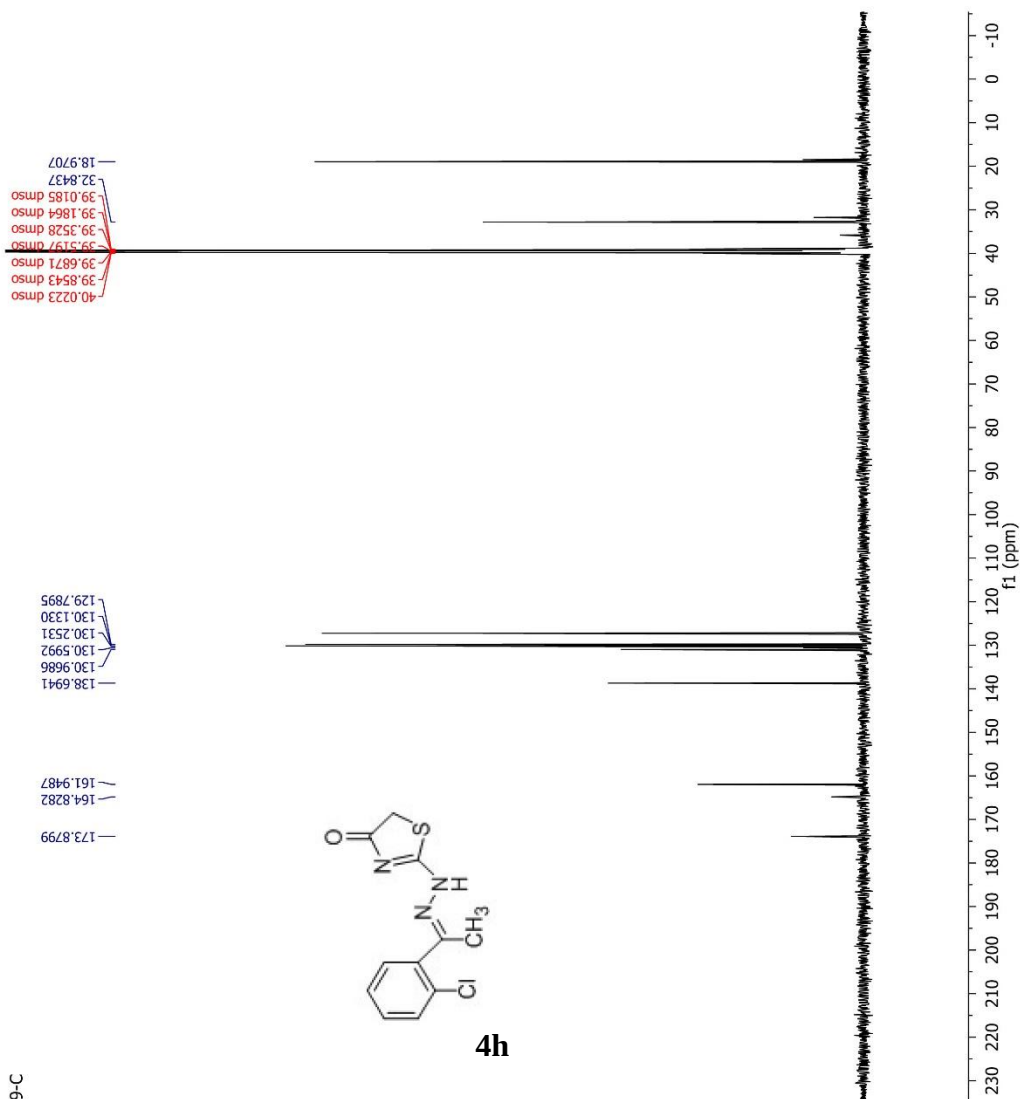


Parameter	Value
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3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmsd
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	16
15 Receiver Gain	30
16 Relaxation Delay	1.0000
17 Pulse Width	5.0000
18 Presaturation Frequency	
19 Acquisition Time	1.8227
20 Acquisition Date	2021-08-02T12:17:37
21 Modification Date	2021-08-02T12:18:12
22 Class	
23 Spectrometer Frequency	499.39
24 Spectral Width	8988.8
25 Lowest Frequency	-998.8
26 Nucleus	^1H
27 Acquired Size	16384
28 Spectral Size	65536



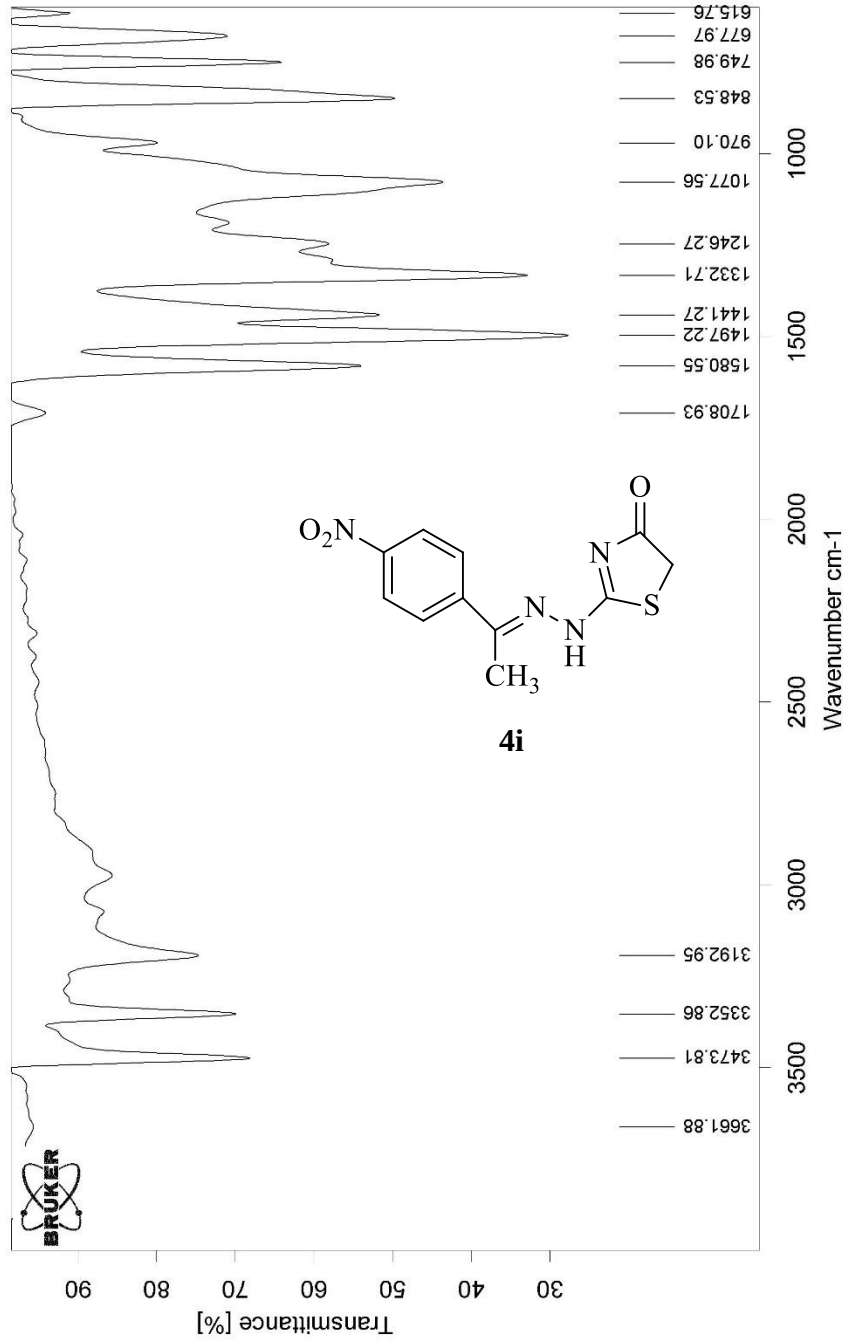
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1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/ 9-C.fid/ fid
2 Title	9-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	720
15 Receiver Gain	60
16 Relaxation Delay	1.0000
17 Pulse Width	7.5000
18 Presaturation	
19 Frequency	1.0437
20 Acquisition Time	2021-08-02T12:18:21
21 Modification Date	2021-08-02T12:43:06
22 Class	
23 Spectrometer	125.58
24 Frequency	31397.2
25 Spectral Width	-1885.9
26 Lowest Frequency	
27 Nucleus	13C
28 Acquired Size	32768
29 Spectral Size	65536

9-C



(¹³C NMR)

(FT-IR)

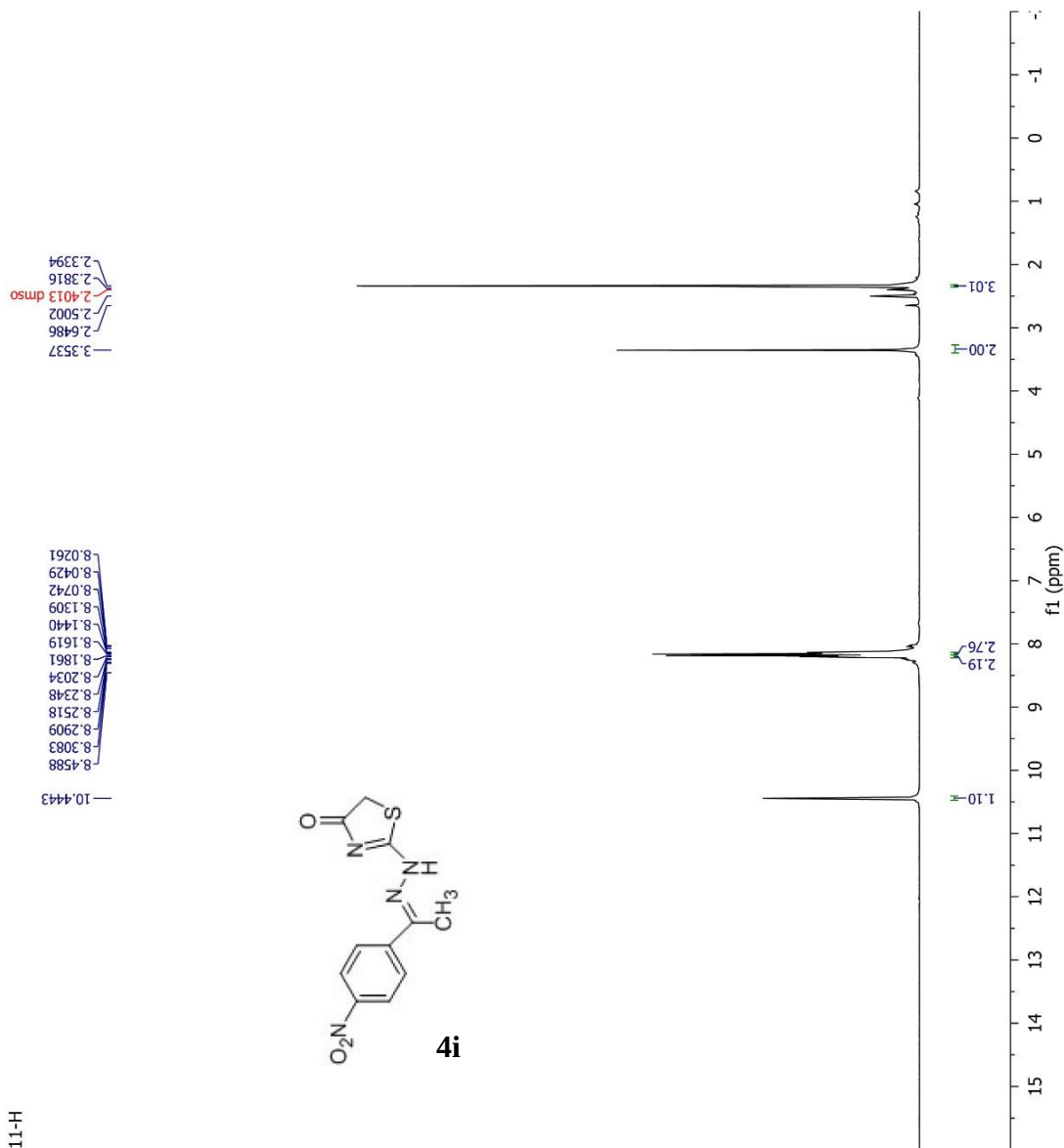


11-H



Parameter	Value
1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/11-H.fid/ fid
2 Title	11-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmsO
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	16
15 Receiver Gain	30
16 Relaxation Delay	1.0000
17 Pulse Width	5.0000
18 Presaturation Frequency	
19 Acquisition Time	1.8227
20 Acquisition Date	2021-08-02T12:46:17
21 Modification Date	2021-08-02T12:46:38
22 Class	
23 Spectrometer Frequency	499.39
24 Spectral Width	8988.8
25 Lowest Frequency	-998.8
26 Nucleus	¹ H
27 Acquired Size	16384
28 Spectral Size	65536

(¹H NMR)

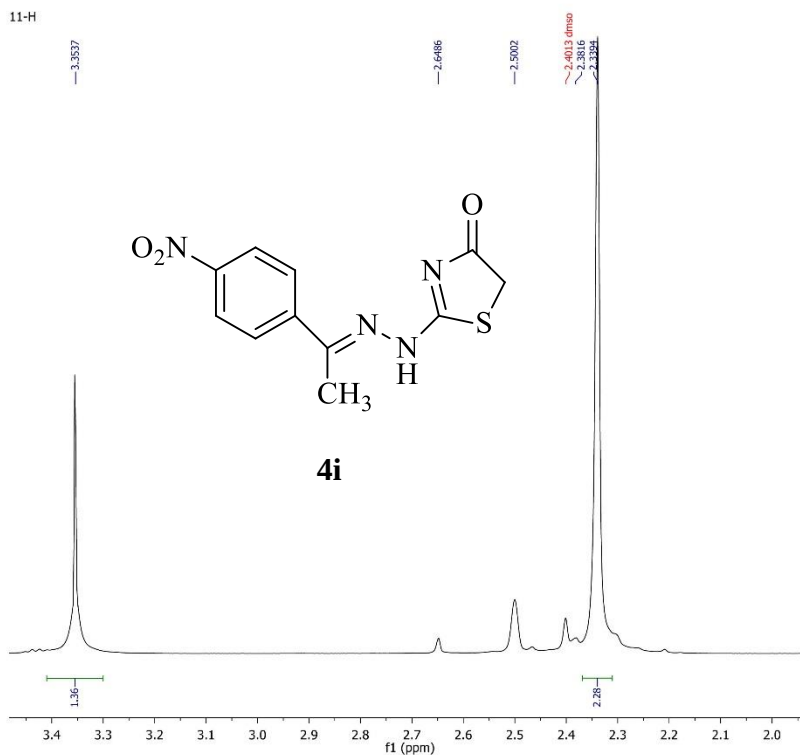


^1H NMR



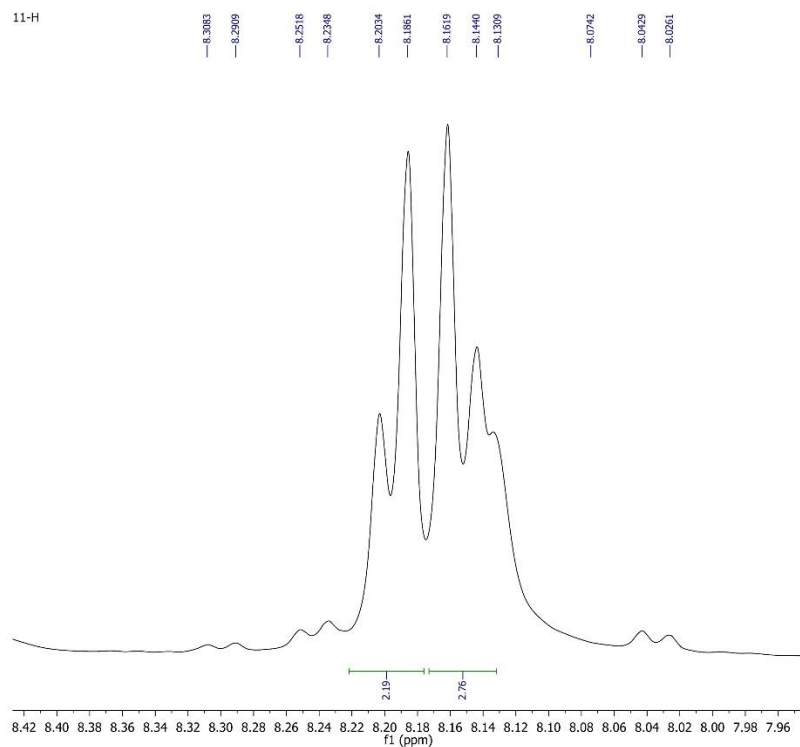
11-H

Parameter	Value
1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/11-H.fid/ fid
2 Title	11-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	16
15 Receiver Gain	30
16 Relaxation Delay	1.0000
17 Pulse Width	5.0000
18 Presaturation Frequency	
19 Acquisition Time	1.8227
20 Acquisition Date	2021-08-02T12:46:17
21 Modification Date	2021-08-02T12:46:38
22 Class	
23 Spectrometer Frequency	499.39
24 Spectral Width	8988.8
25 Lowest Frequency	-998.8
26 Nucleus	^1H
27 Acquired Size	16384
28 Spectral Size	65536



11-H

Parameter	Value
1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/11-H.fid/ fid
2 Title	11-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	16
15 Receiver Gain	30
16 Relaxation Delay	1.0000
17 Pulse Width	5.0000
18 Presaturation Frequency	
19 Acquisition Time	1.8227
20 Acquisition Date	2021-08-02T12:46:17
21 Modification Date	2021-08-02T12:46:38
22 Class	
23 Spectrometer Frequency	499.39
24 Spectral Width	8988.8
25 Lowest Frequency	-998.8
26 Nucleus	^1H
27 Acquired Size	16384
28 Spectral Size	65536

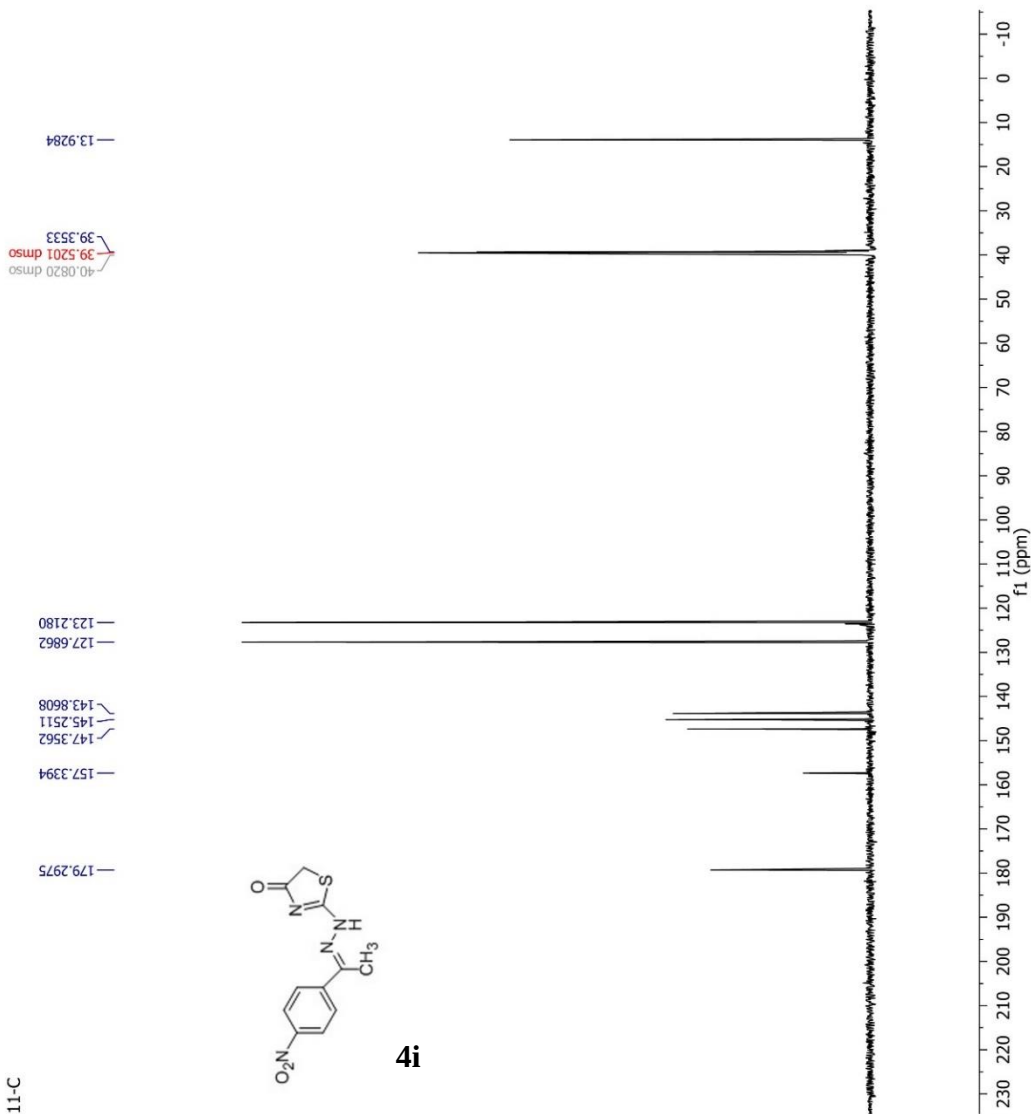




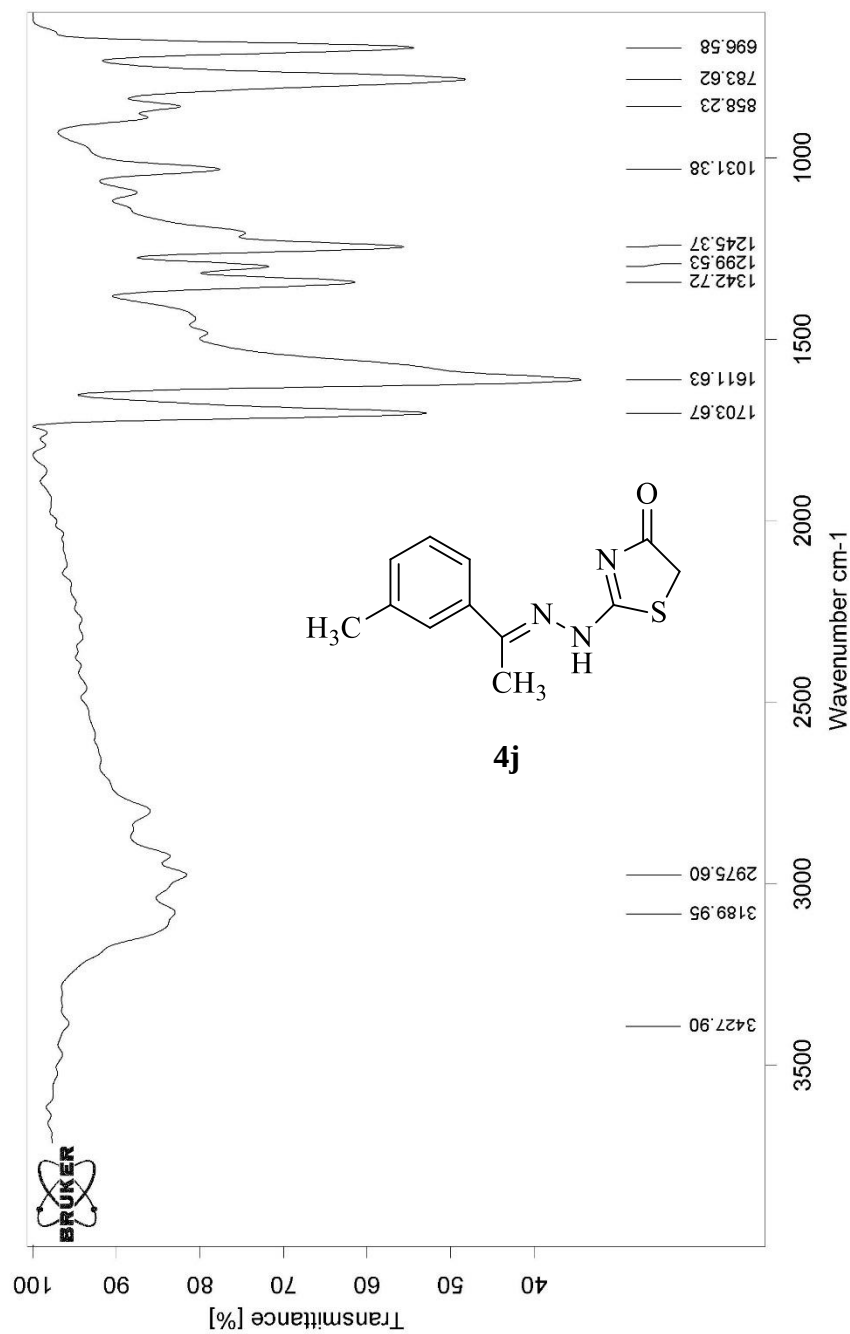
مرکزی کتابخانه
آرشیو اسنادی

Parameter	Value
1 Data File Name	C:/Users/mostafa/Desktop/Navid-Ghorbani/ 11-C.fid/ fid
2 Title	11-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dms0
10 Temperature	25.0
11 Pulse Sequence	s2pul
12 Experiment	1D
13 Probe	ID
14 Number of Scans	256
15 Receiver Gain	60
16 Relaxation Delay	1.0000
17 Pulse Width	7.5000
18 Presaturation	
19 Acquisition Time	1.0437
20 Acquisition Date	2021-08-02T12:46:58
21 Modification	2021-08-02T12:55:54
22 Class	
23 Spectrometer	125.58
24 Spectral Width	31397.2
25 Lowest	-1885.9
26 Nucleus	13C
27 Acquired Size	32768
28 Spectral Size	65536

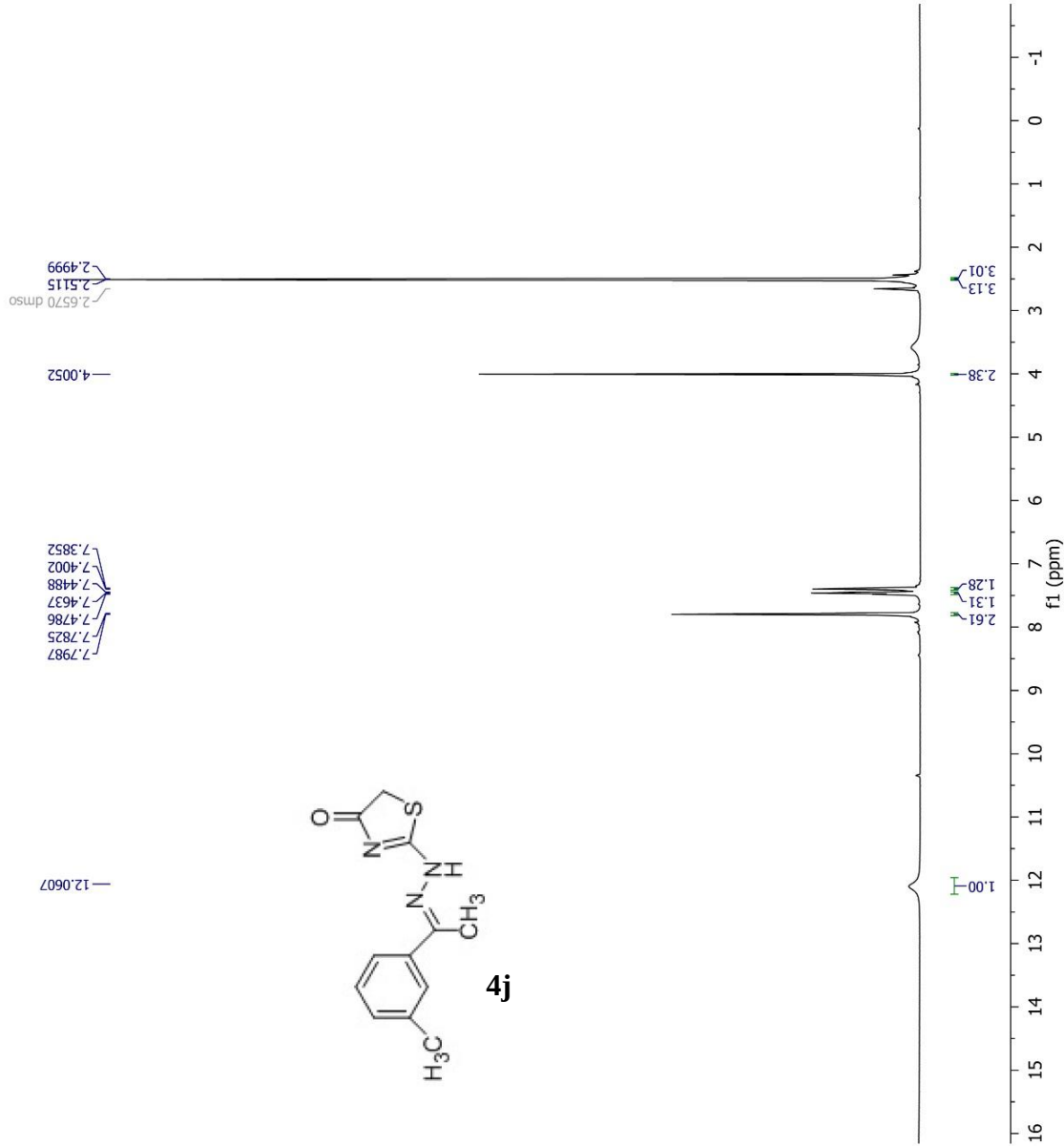
11-C



(FT-IR)



Parameter	Value
1 Data File Name	D:/ NMR/ 1400/ 1400-05/ 400-05-31/ 400-05-31/ navid-ghorbani/ 12-H.fid
2 Title	12-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dmso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	16
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation Frequency	
18 Acquisition Time	1.8227
19 Acquisition Date	2021-08-22T16:17:55
20 Modification Date	2021-08-22T16:18:30
21 Class	
22 Spectrometer Frequency	499.37
23 Spectral Width	8988.8
24 Lowest Frequency	-929.3
25 Nucleus	¹ H
26 Acquired Size	16384
27 Spectral Size	65536

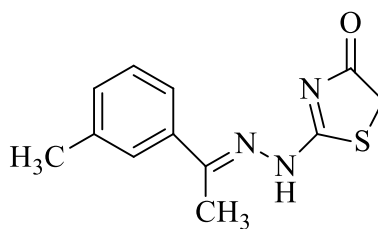


(¹H NMR)

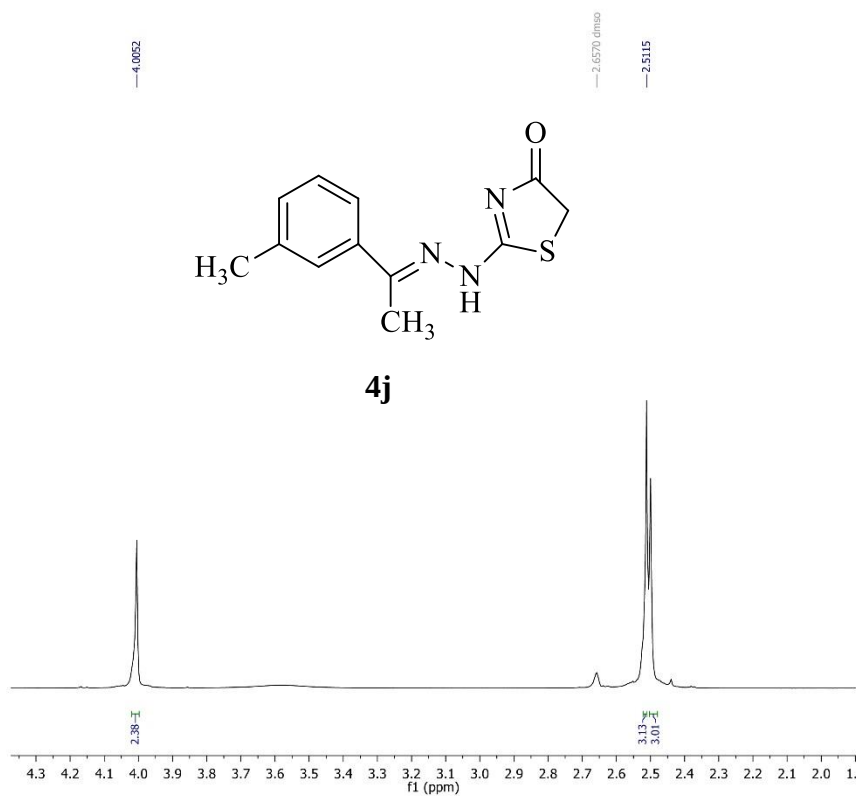
(¹H NMR)



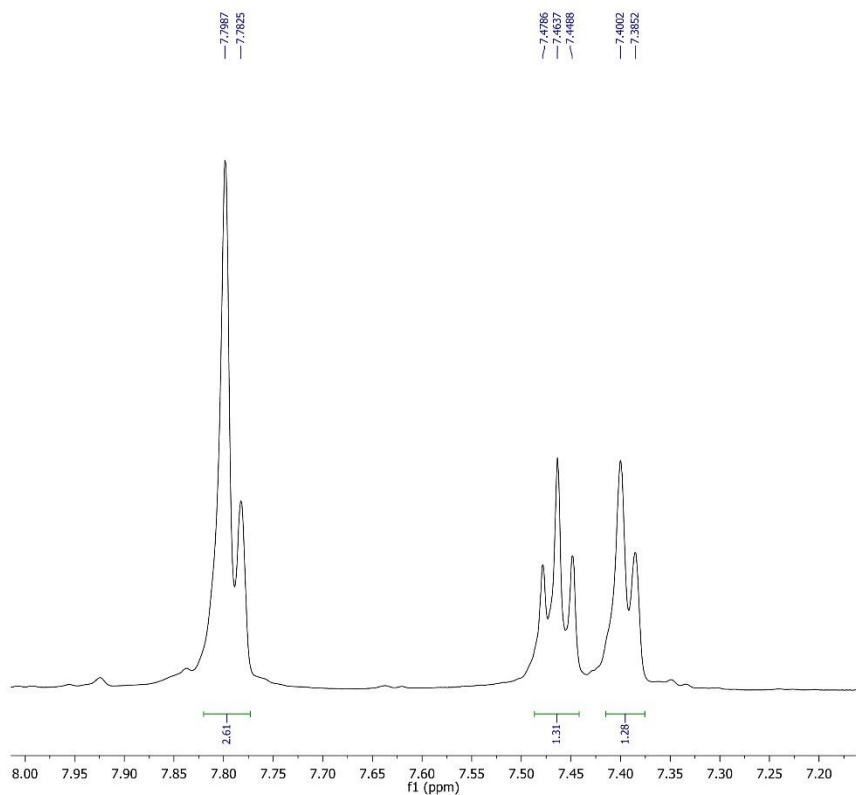
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3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dms
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	16
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation Frequency	
18 Acquisition Time	1.8227
19 Acquisition Date	2021-08-22T16:17:55
20 Modification Date	2021-08-22T16:18:30
21 Class	
22 Spectrometer Frequency	499.37
23 Spectral Width	8988.8
24 Lowest Frequency	-929.3
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536



4j



Parameter	Value
1 Data File Name	D:/ NMR/ 1400/ 1400-05/ 400-05-31/ 400-05-31/ navid-ghorban/ 12-H.fid/ fid
2 Title	12-H
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dms
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	16
14 Receiver Gain	30
15 Relaxation Delay	1.0000
16 Pulse Width	5.0000
17 Presaturation Frequency	
18 Acquisition Time	1.8227
19 Acquisition Date	2021-08-22T16:17:55
20 Modification Date	2021-08-22T16:18:30
21 Class	
22 Spectrometer Frequency	499.37
23 Spectral Width	8988.8
24 Lowest Frequency	-929.3
25 Nucleus	1H
26 Acquired Size	16384
27 Spectral Size	65536



Parameter	Value
1 Data File Name	D:/ NMR/ 1400/ 1400-05/ 400-05-31/ 400-05-31/ navid-ghorbani/ 12-C.fid/ fid
2 Title	12-C
3 Comment	
4 Origin	Varian
5 Owner	
6 Site	
7 Instrument	inova
8 Author	
9 Solvent	dimso
10 Temperature	25.0
11 Experiment	1D
12 Probe	ID
13 Number of Scans	624
14 Receiver Gain	60
15 Relaxation Delay	1.0000
16 Pulse Width	7.5000
17 Presaturation Frequency	
18 Acquisition Time	1.0437
19 Acquisition Date	2021-08-22T16:18:36
20 Modification Date	2021-08-22T16:40:07
21 Class	
22 Spectrometer Frequency	125.58
23 Spectral Width	31397.2
24 Lowest Frequency	-1886.2
25 Nucleus	¹³ C
26 Acquired Size	32768
27 Spectral Size	65536

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