Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

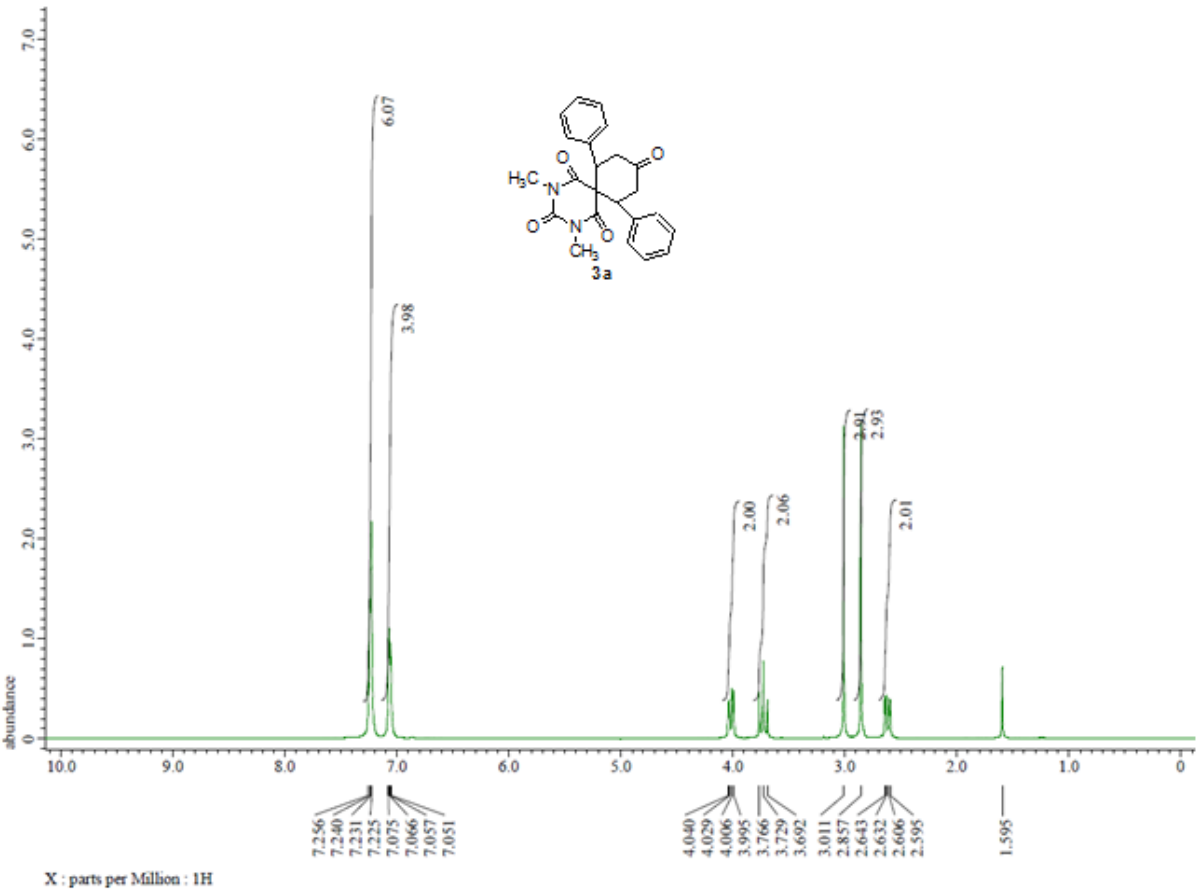
An efficient catalyst free synthesis of nitrogen containing spiro heterocycles *via* [5 + 1] double Michael addition reaction

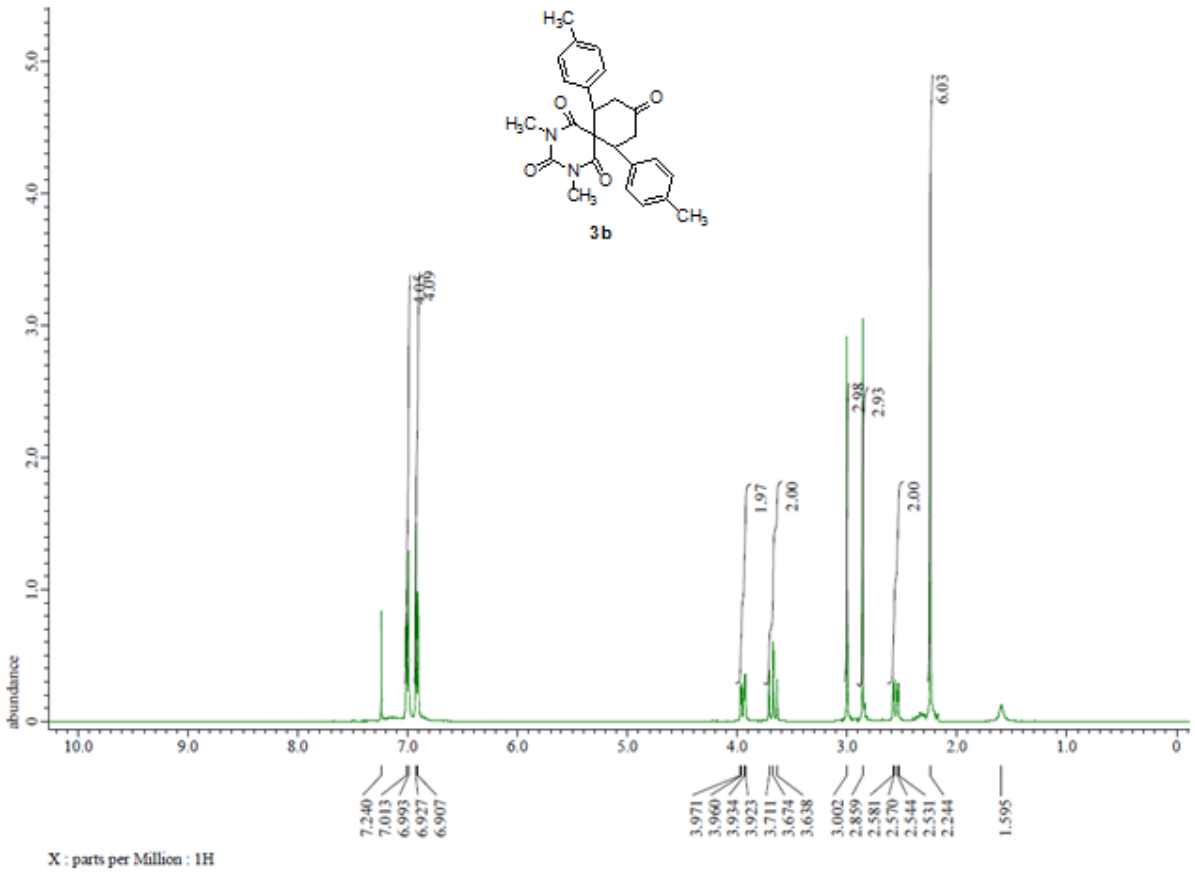
Komal Aggarwal[a], Kanika Vij[a] and Jitender M. Khurana[a]*

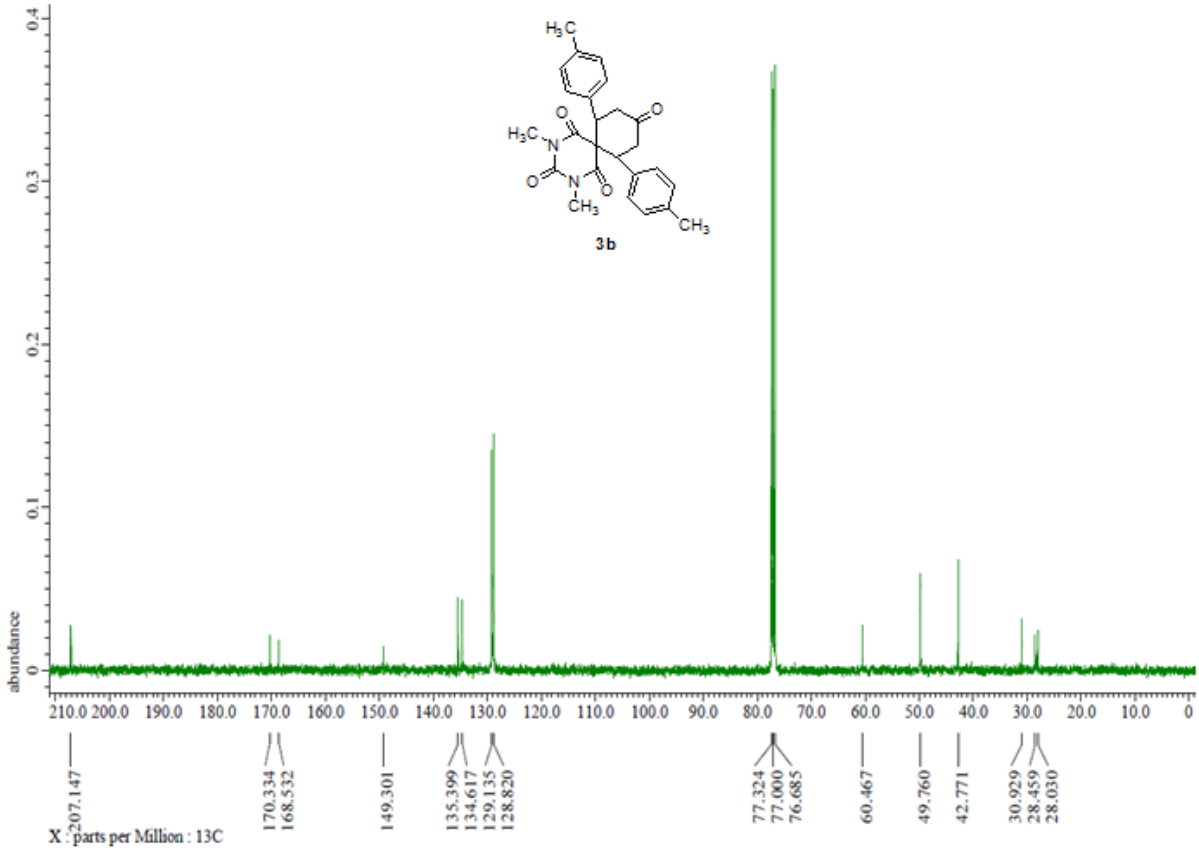
[a]Department of Chemistry, University of Delhi, Delhi-110007, India

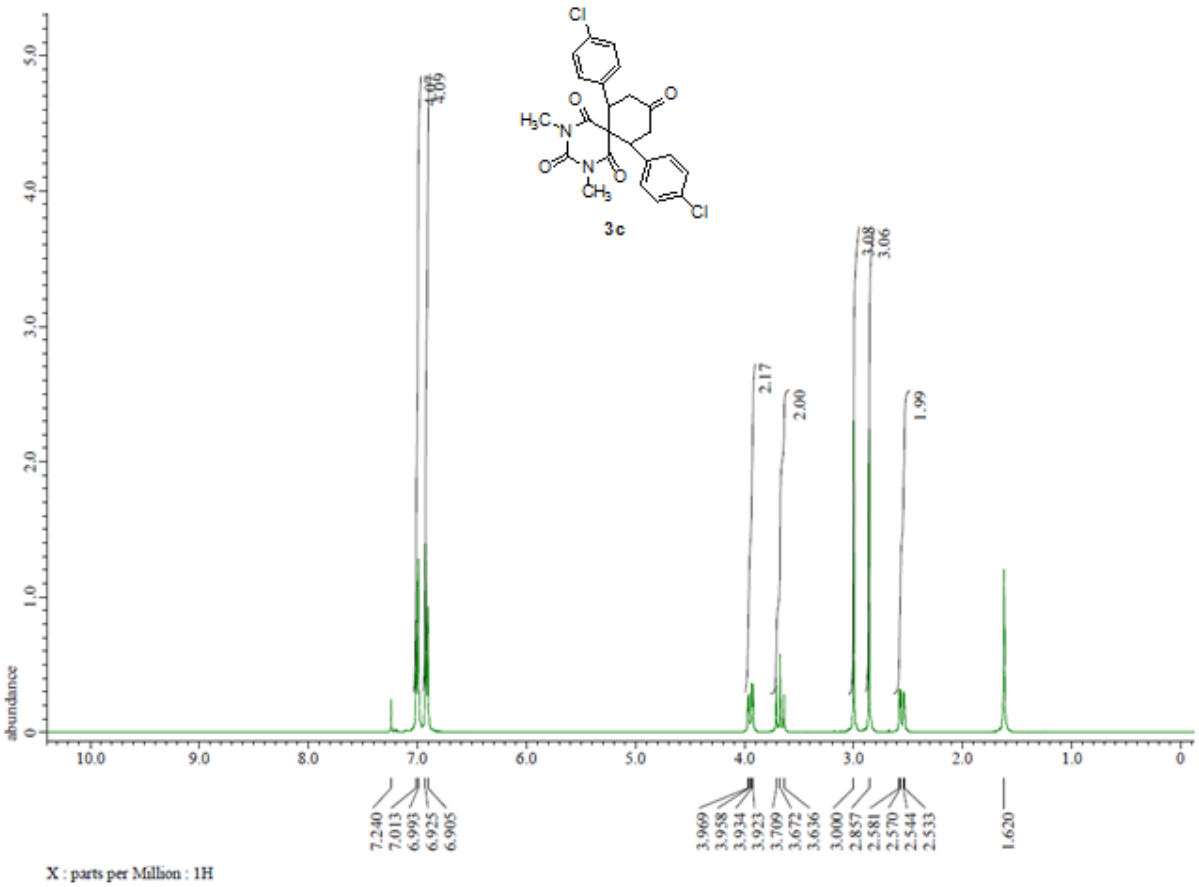
*Corresponding author. Tel.: +91 11 2766772; fax: +91 1 27667624

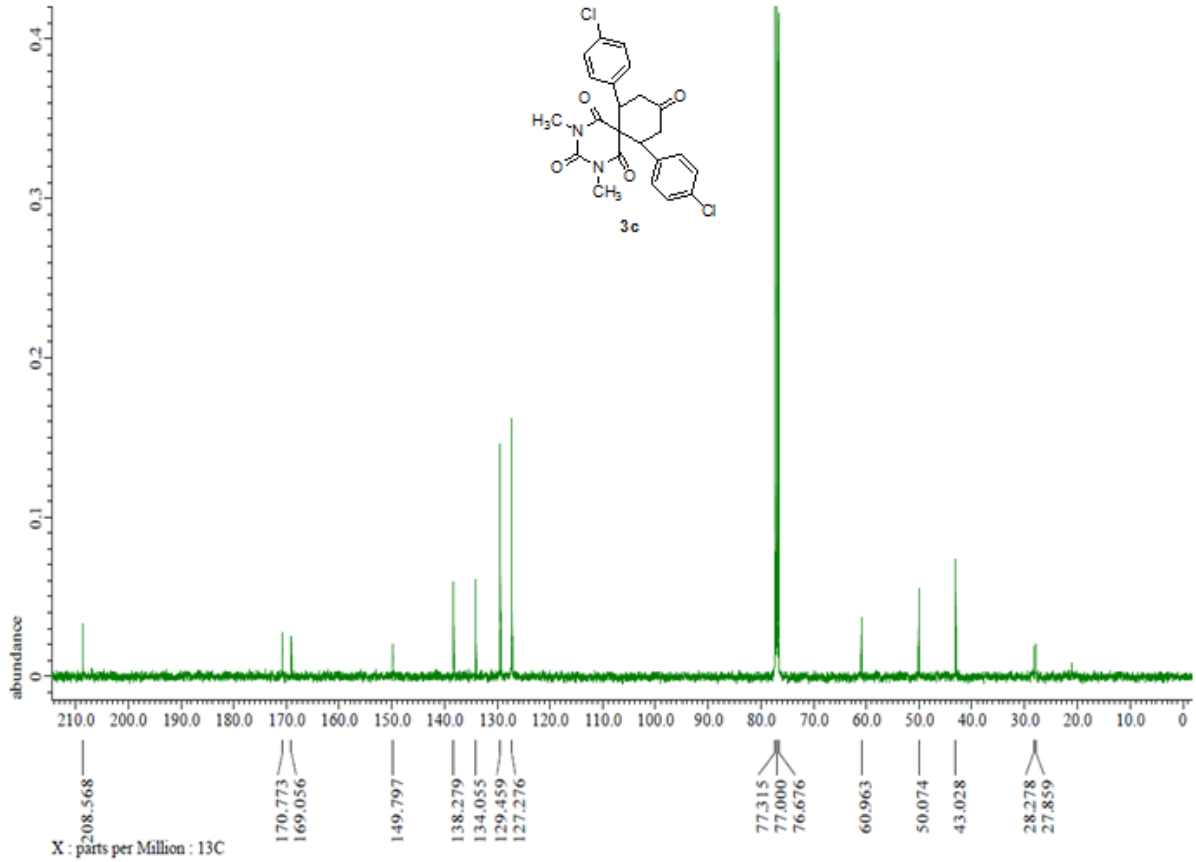
E-mail addresses: jmkhurana1@yahoo.co.in, jmkhurana@chemistry.du.ac.in

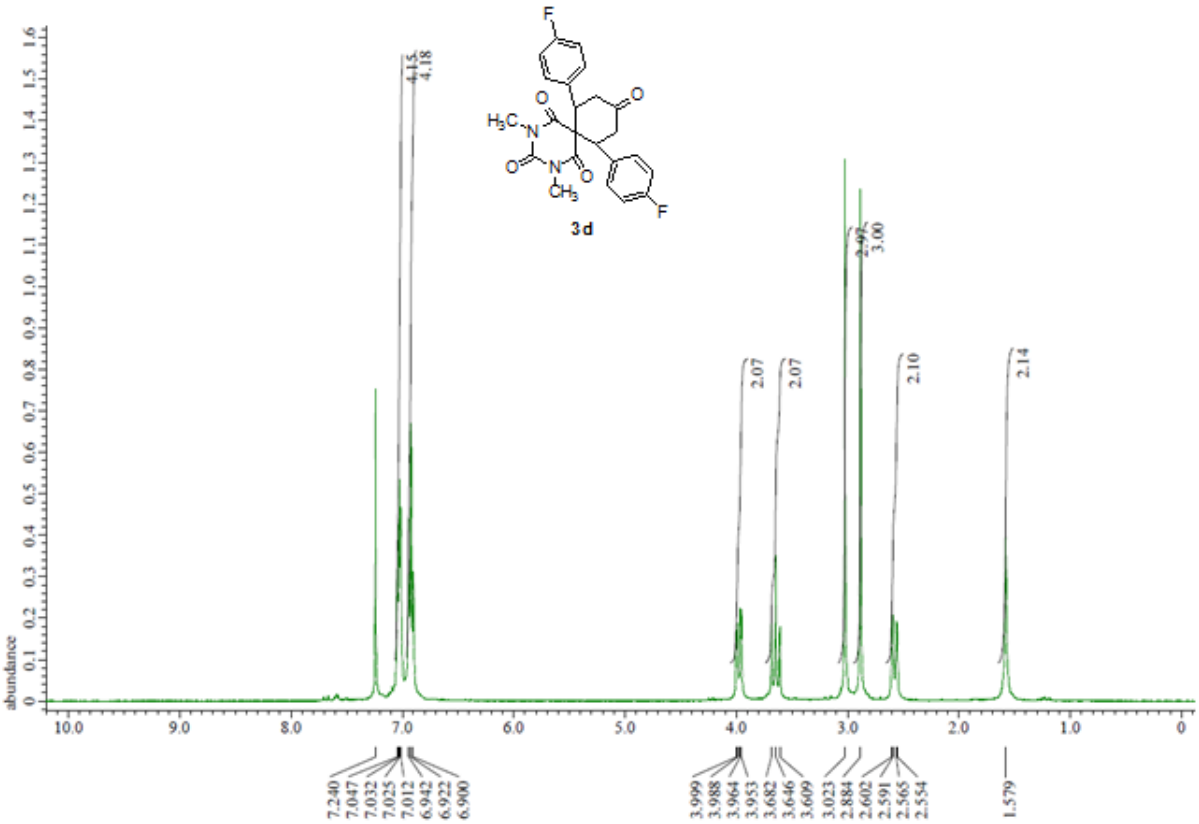


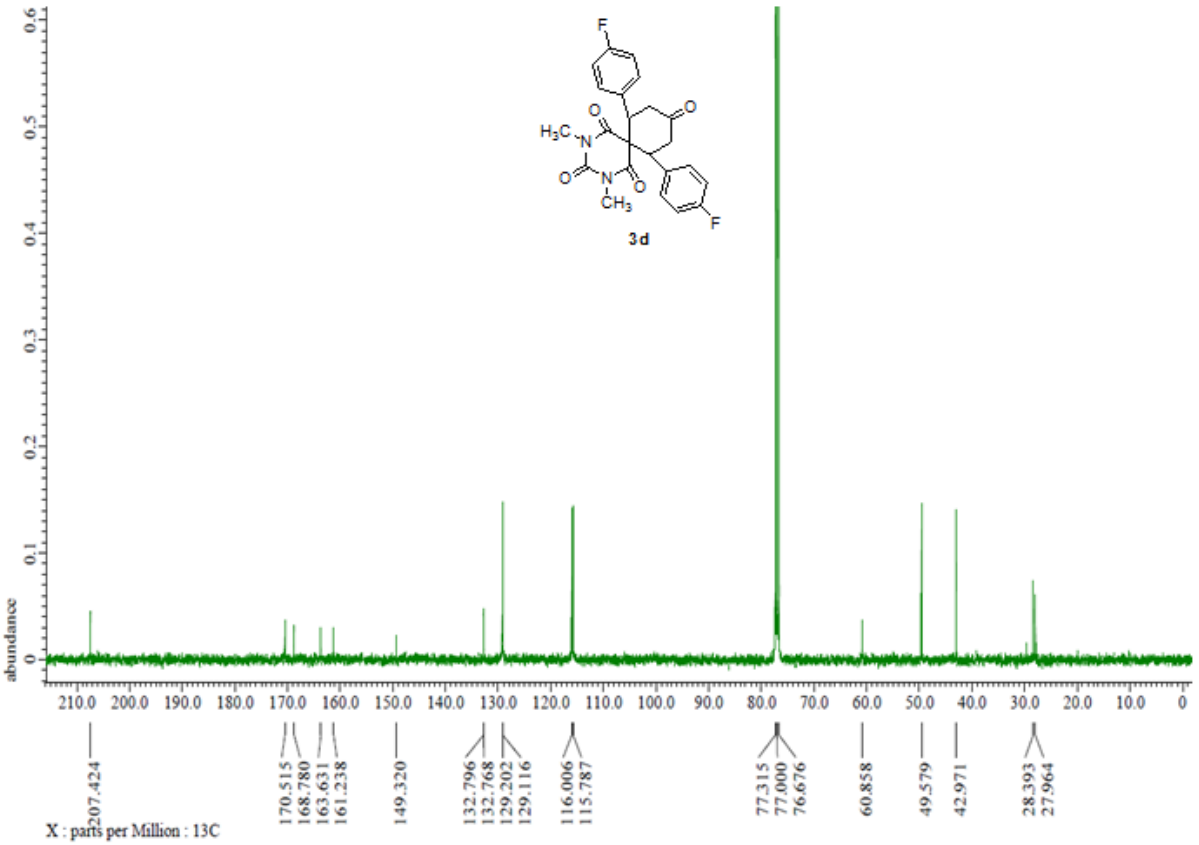

H3C
O
O
H3C
N
O
N
O
CH3
CH3
3b
6.03
4.05
4.05
2.98
2.93
1.97
2.00
2.00
abundance
5.0
4.0
3.0
2.0
1.0
0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.240
7.013
6.993
6.927
6.907
3.971
3.960
3.934
3.923
3.711
3.674
3.638
3.002
2.859
2.581
2.570
2.544
2.531
2.244
1.595
X : parts per Million : 1H

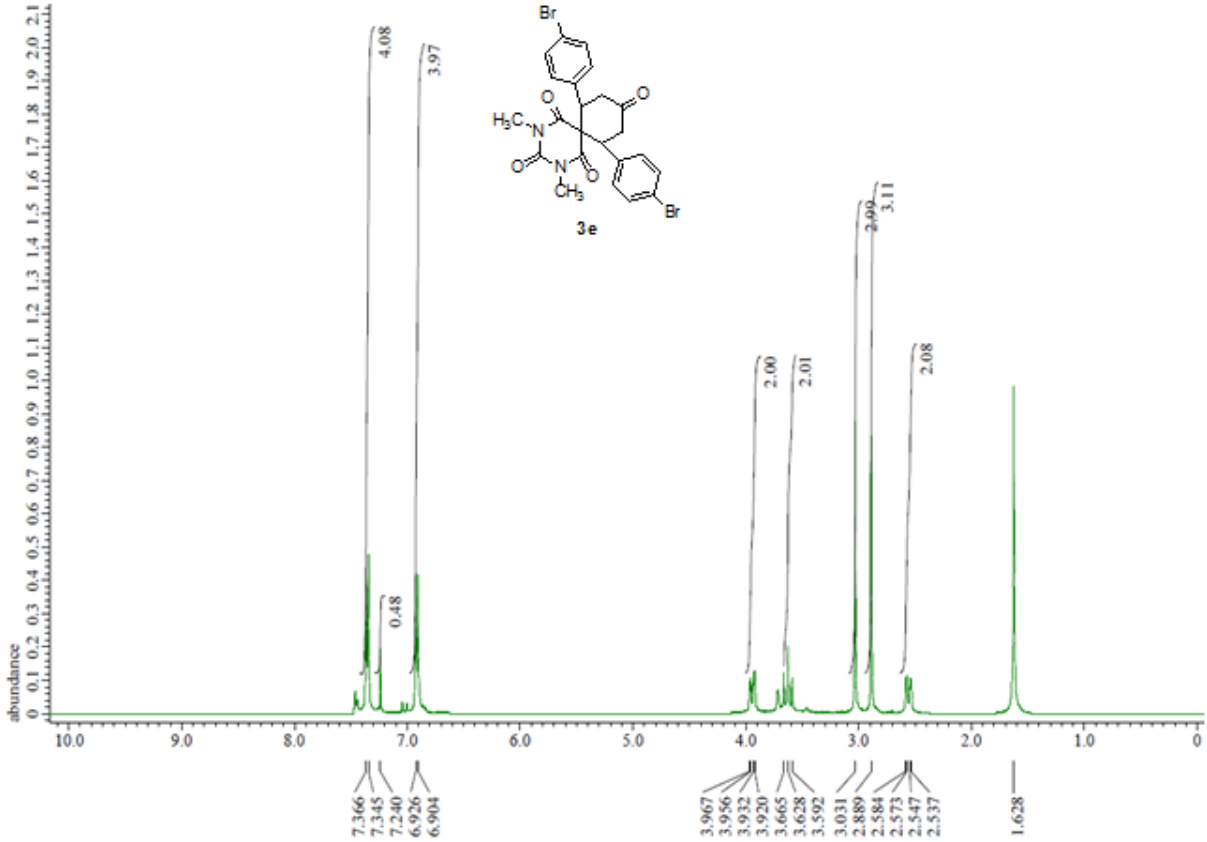

3b
abundance
X : parts per Million : 13C
207.147
170.334
168.532
149.301
135.399
134.617
129.135
128.820
77.324
77.000
76.685
60.467
49.760
42.771
30.929
28.459
28.030


3c
abundance
X : parts per Million : 1H
7.240
7.013
6.993
6.925
6.905
3.969
3.958
3.934
3.923
3.709
3.672
3.636
3.000
2.857
2.581
2.570
2.544
2.533
1.620
2.17
2.00
1.99

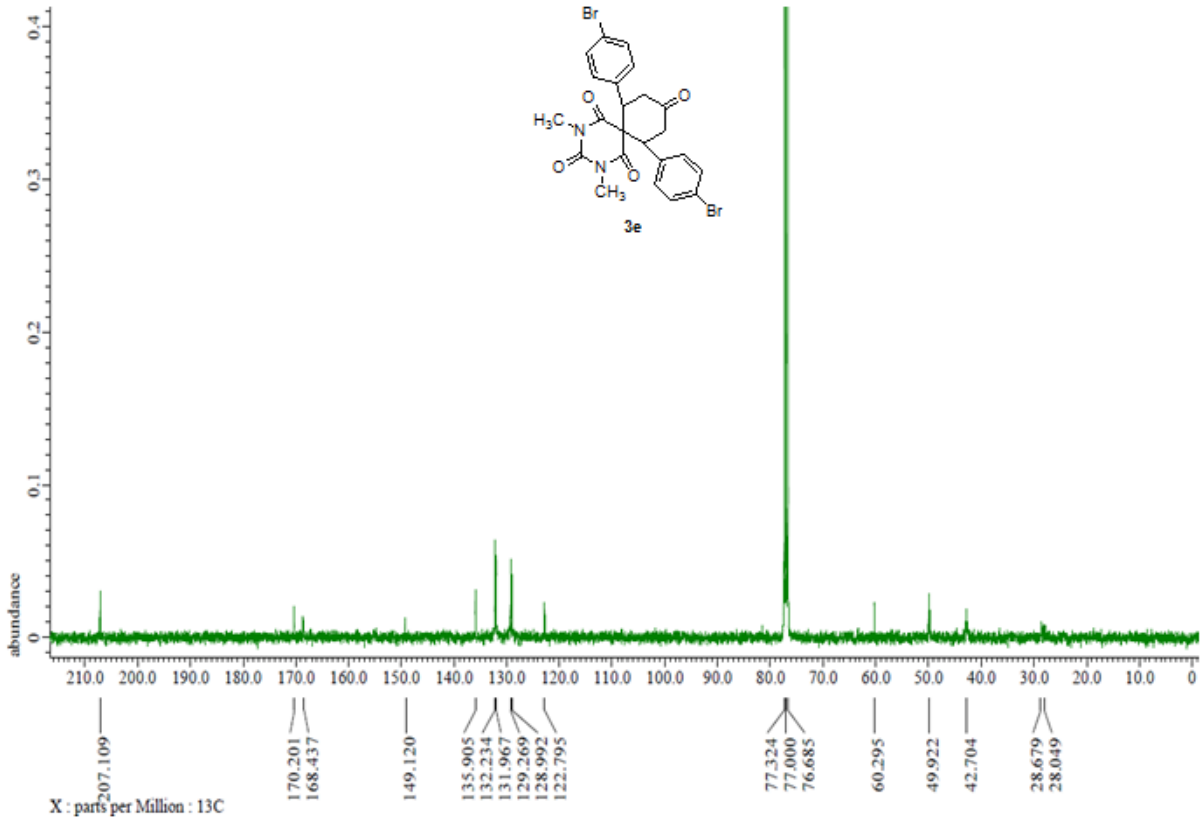

Cl
O
O
H3C
N
O
N
O
CH3
Cl
3c
abundance
0.4
0.3
0.2
0.1
0
210.0 200.0 190.0 180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0
208.568
170.773
169.056
149.797
138.279
134.055
129.459
127.276
77.315
77.000
76.676
60.963
50.074
43.028
28.278
27.859
X : parts per Million : 13C

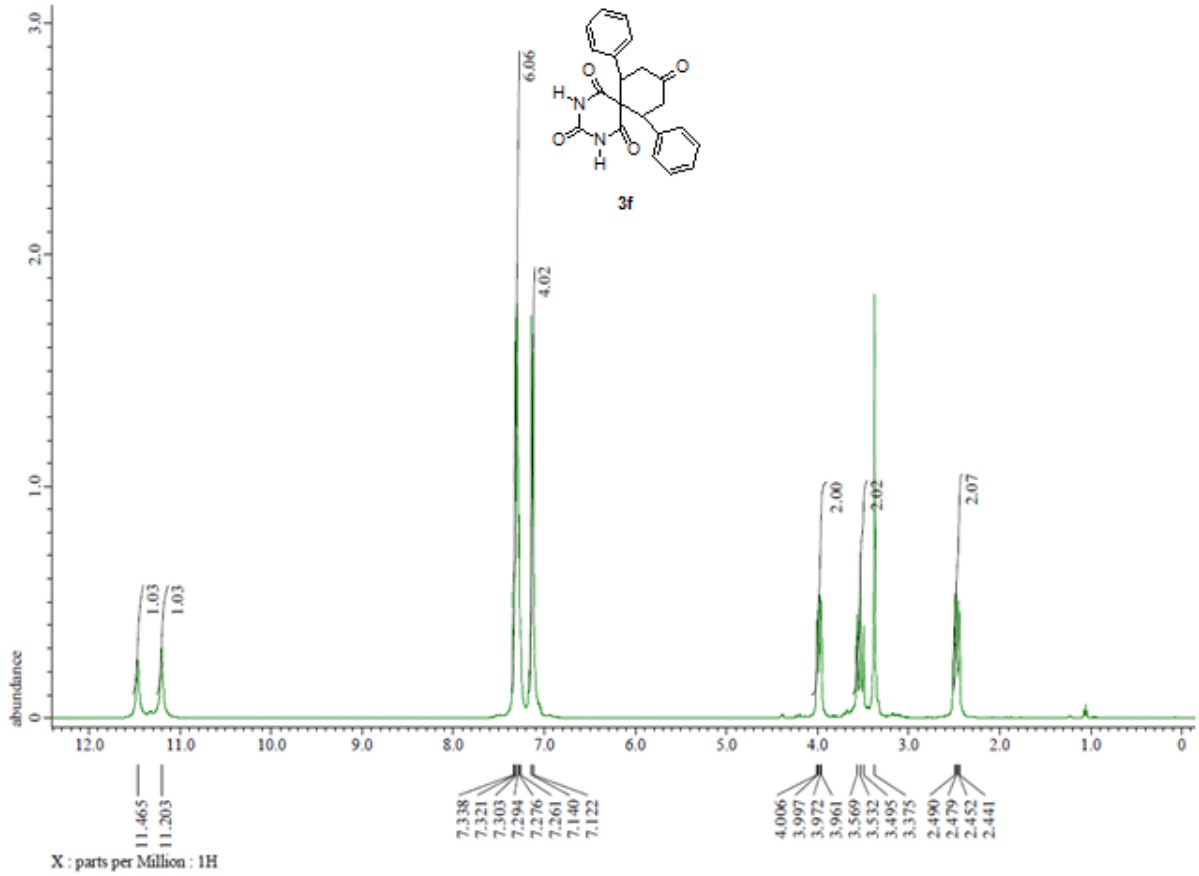

3d
abundance
4.15
4.18
2.07
2.07
2.97
3.00
2.10
2.14
7.240
7.047
7.032
7.025
7.012
6.942
6.922
6.900
3.999
3.988
3.964
3.953
3.682
3.646
3.609
3.023
2.884
2.602
2.591
2.565
2.554
1.579
X : parts per Million : 1H

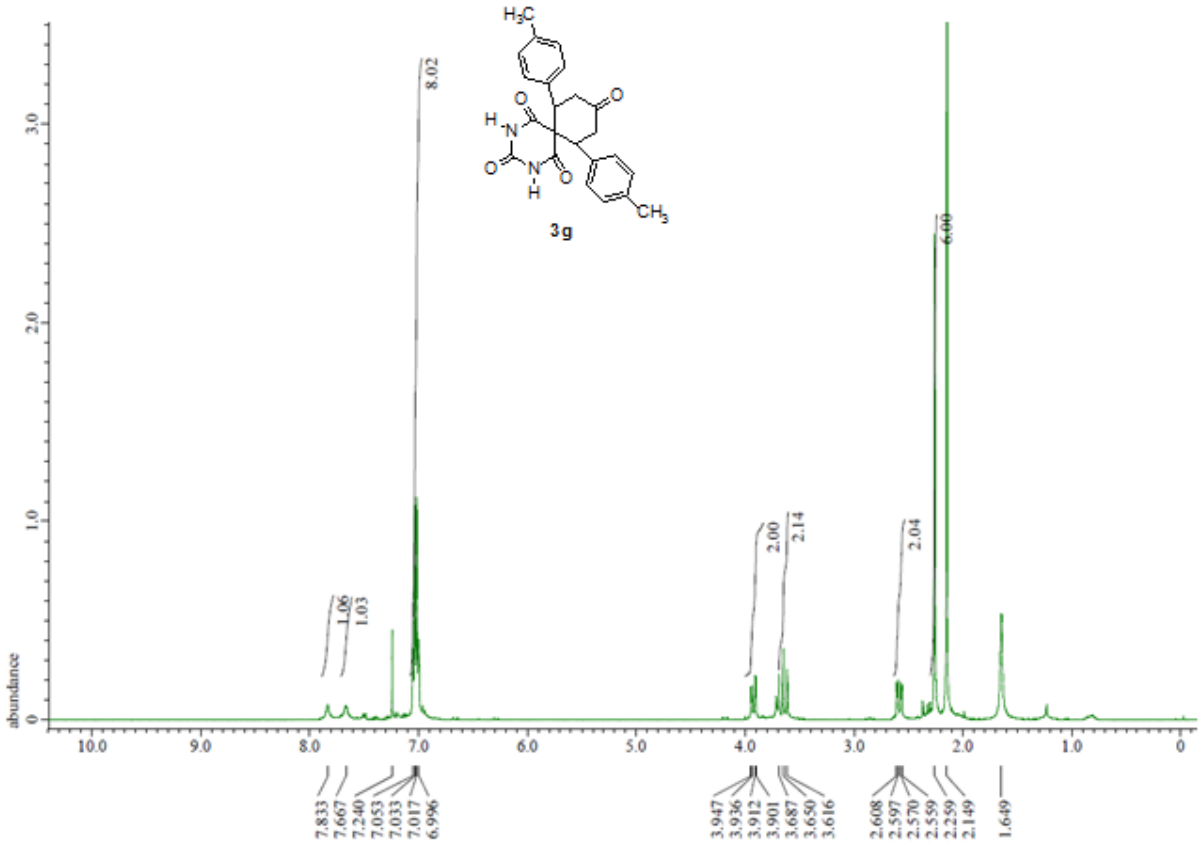

3d
abundance
207.424
170.515
168.780
163.631
161.238
149.320
132.796
132.768
129.202
129.116
116.006
115.787
77.315
77.000
76.676
60.858
49.579
42.971
28.393
27.964
X : parts per Million : 13C

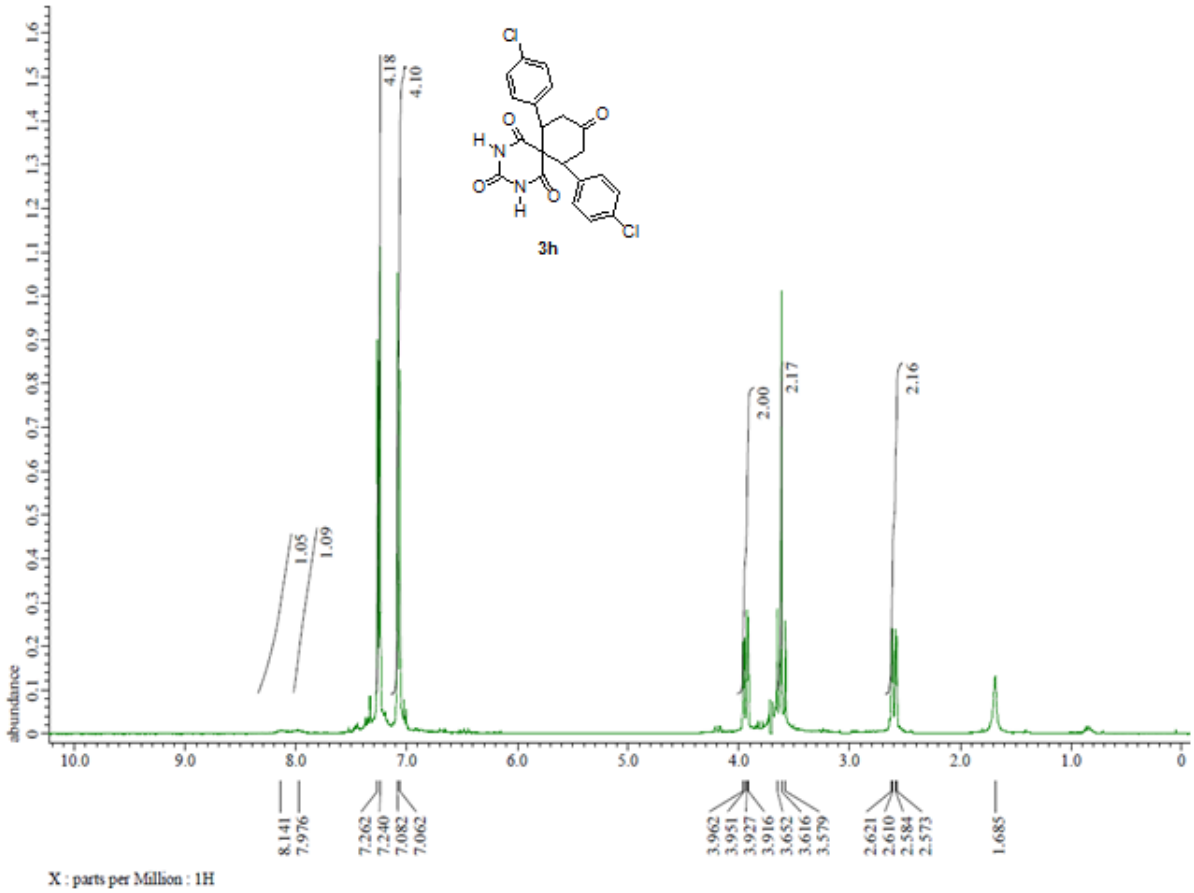


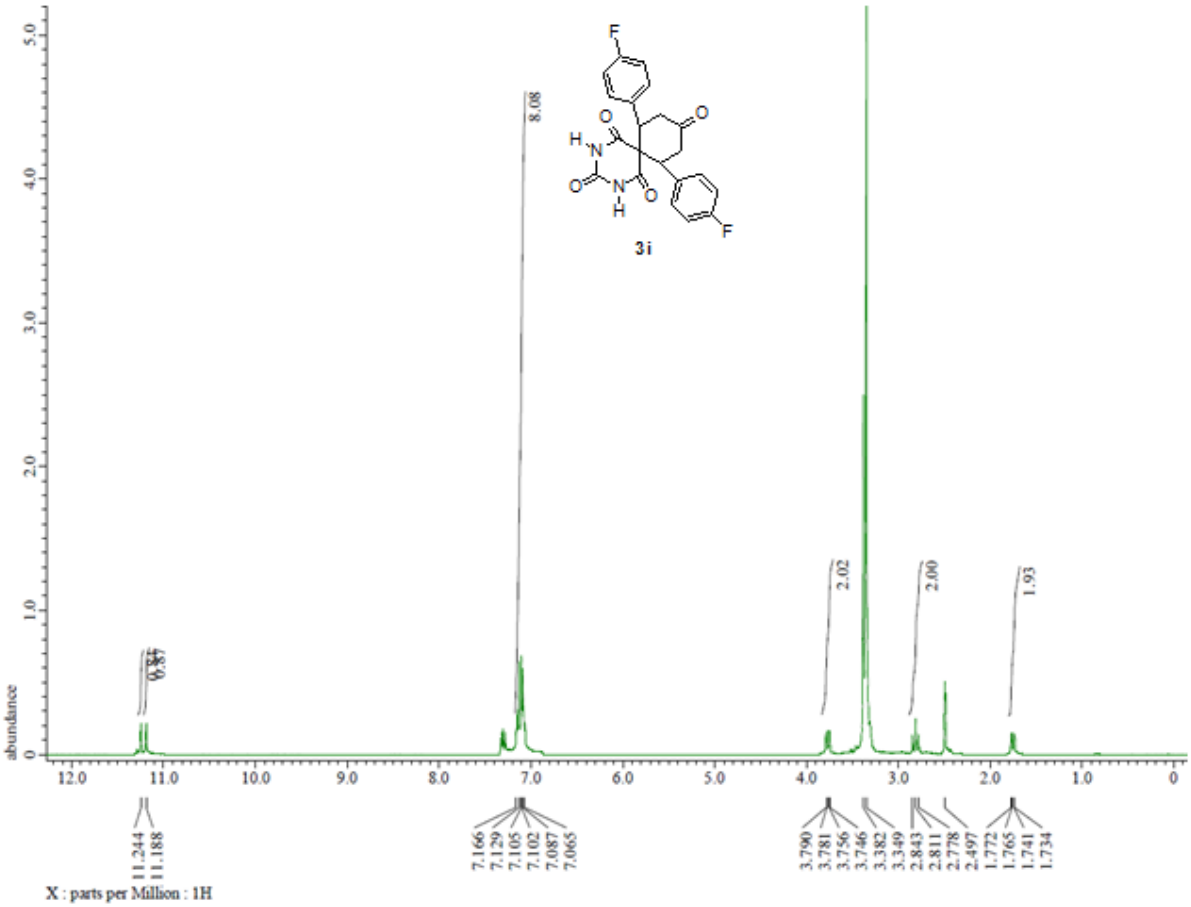
X : parts per Million : 1H

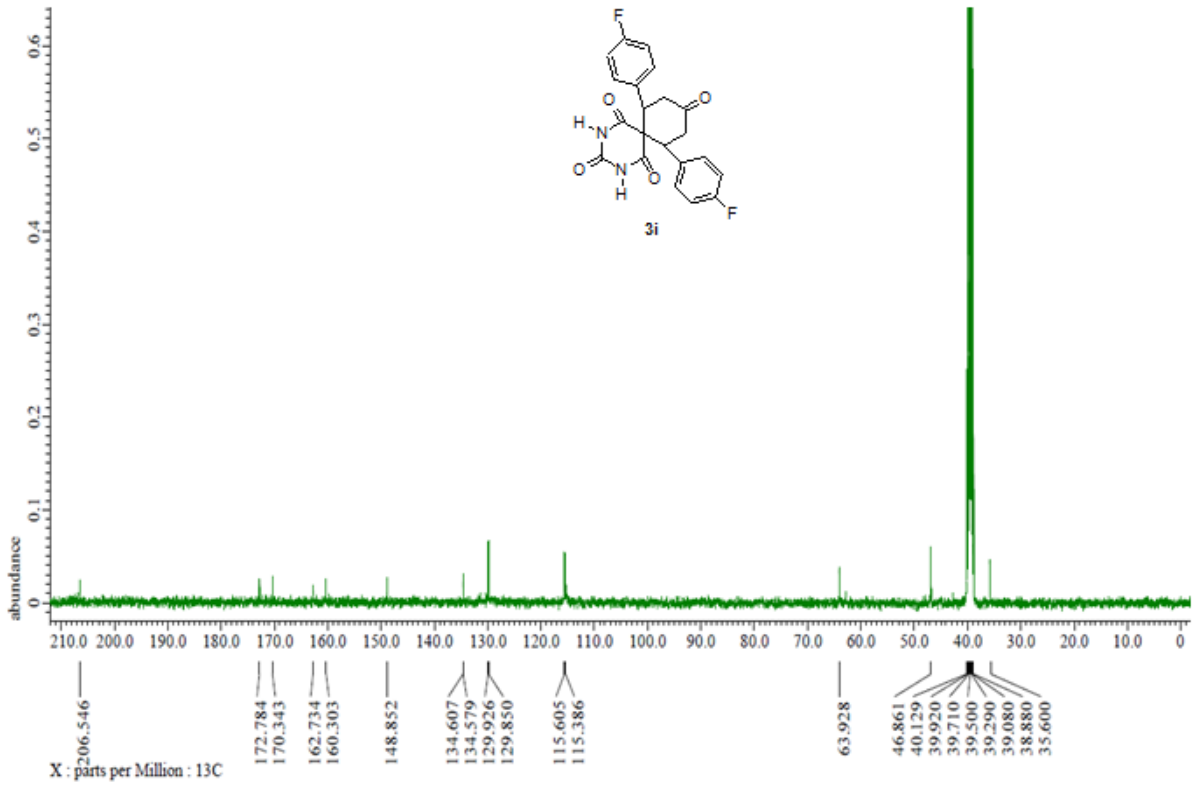

Br
O
O
H3C
N
O
N
O
CH3
Br
3e
abundance
0.4
0.3
0.2
0.1
0
210.0 200.0 190.0 180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0
207.109
170.201
168.437
149.120
135.905
132.234
131.967
129.269
128.992
122.795
77.324
77.000
76.685
60.295
49.922
42.704
28.679
28.049
X : parts per Million : 13C

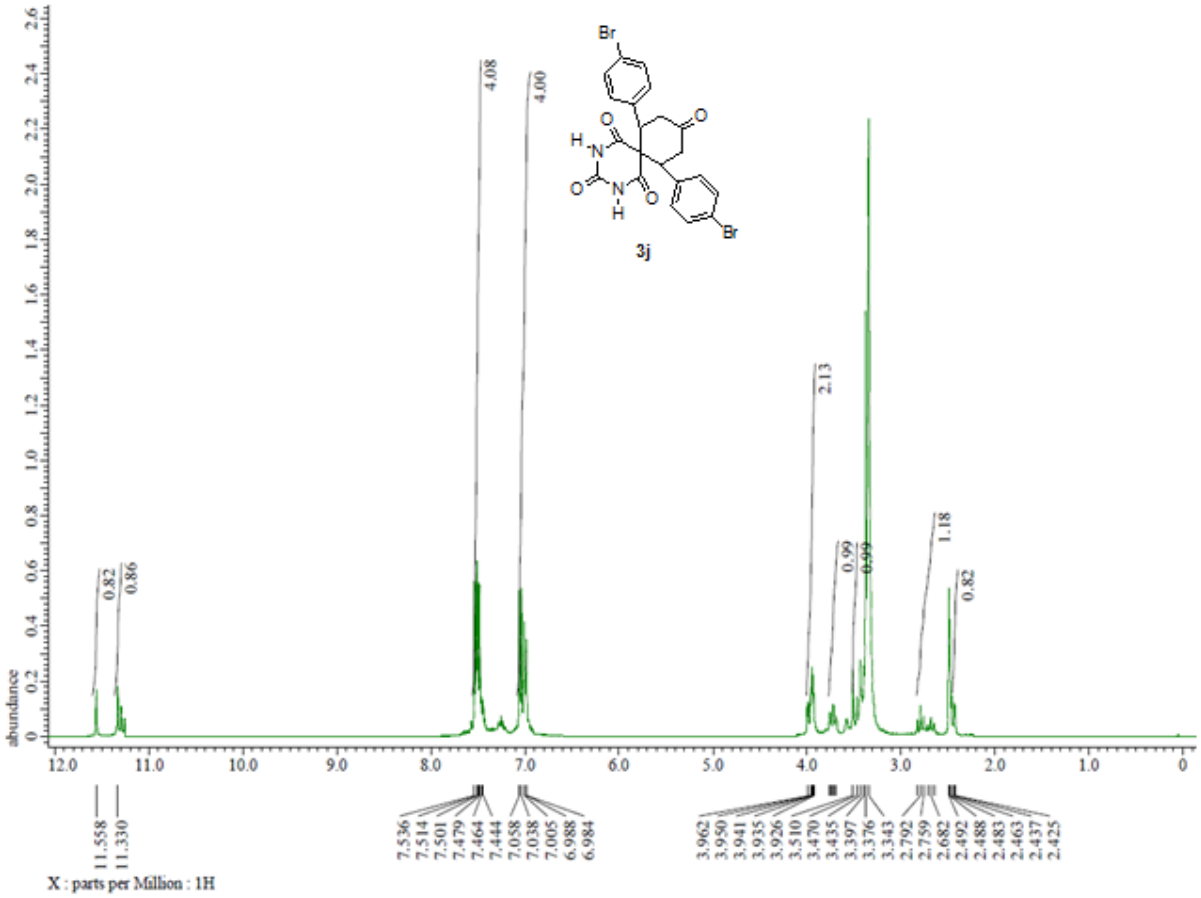

3f
abundance
X : parts per Million : 1H
11.465
11.203
7.338
7.321
7.303
7.294
7.276
7.261
7.140
7.122
4.006
3.997
3.972
3.961
3.569
3.532
3.495
3.375
2.490
2.479
2.452
2.441

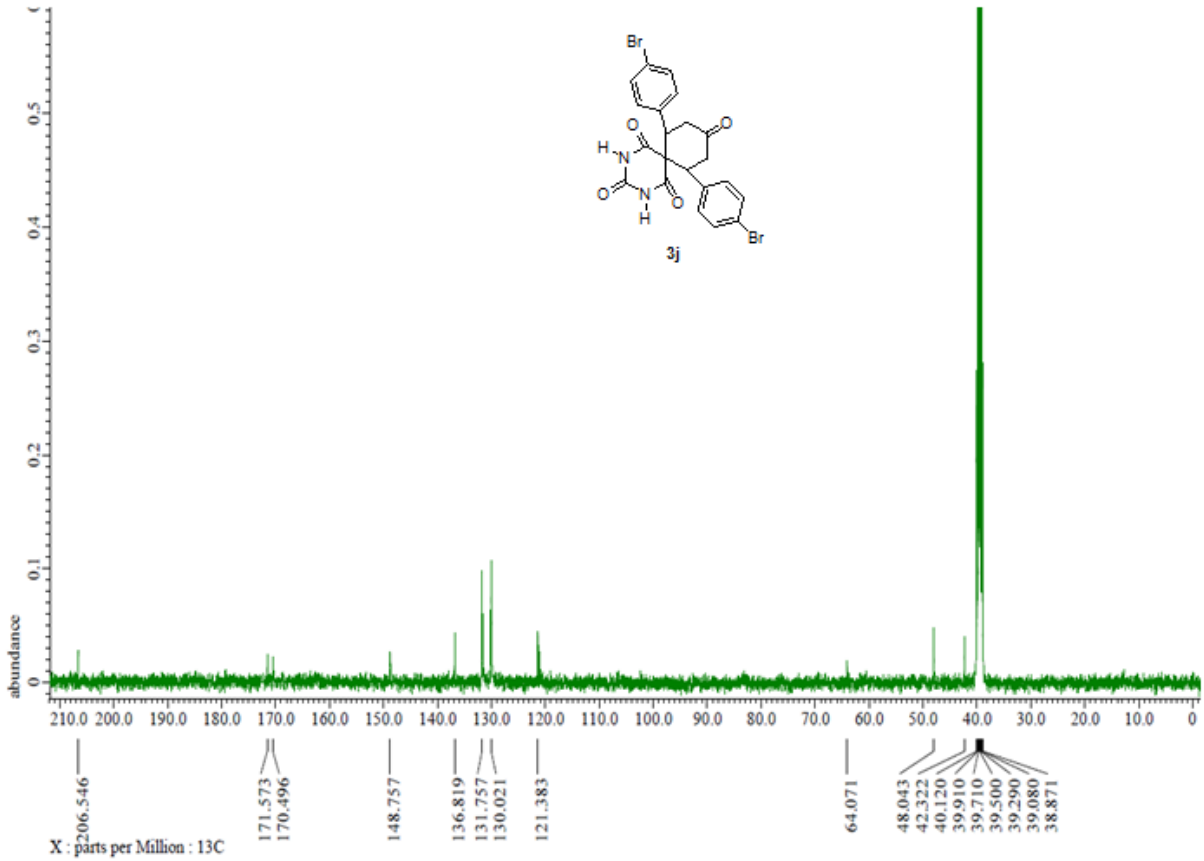

3g
abundance
X : parts per Million : 1H
8.02
6.00
2.14
2.00
2.04
1.06
1.03
7.833
7.667
7.240
7.053
7.033
7.017
6.996
3.947
3.936
3.912
3.901
3.687
3.650
3.616
2.608
2.597
2.570
2.559
2.259
2.149
1.649

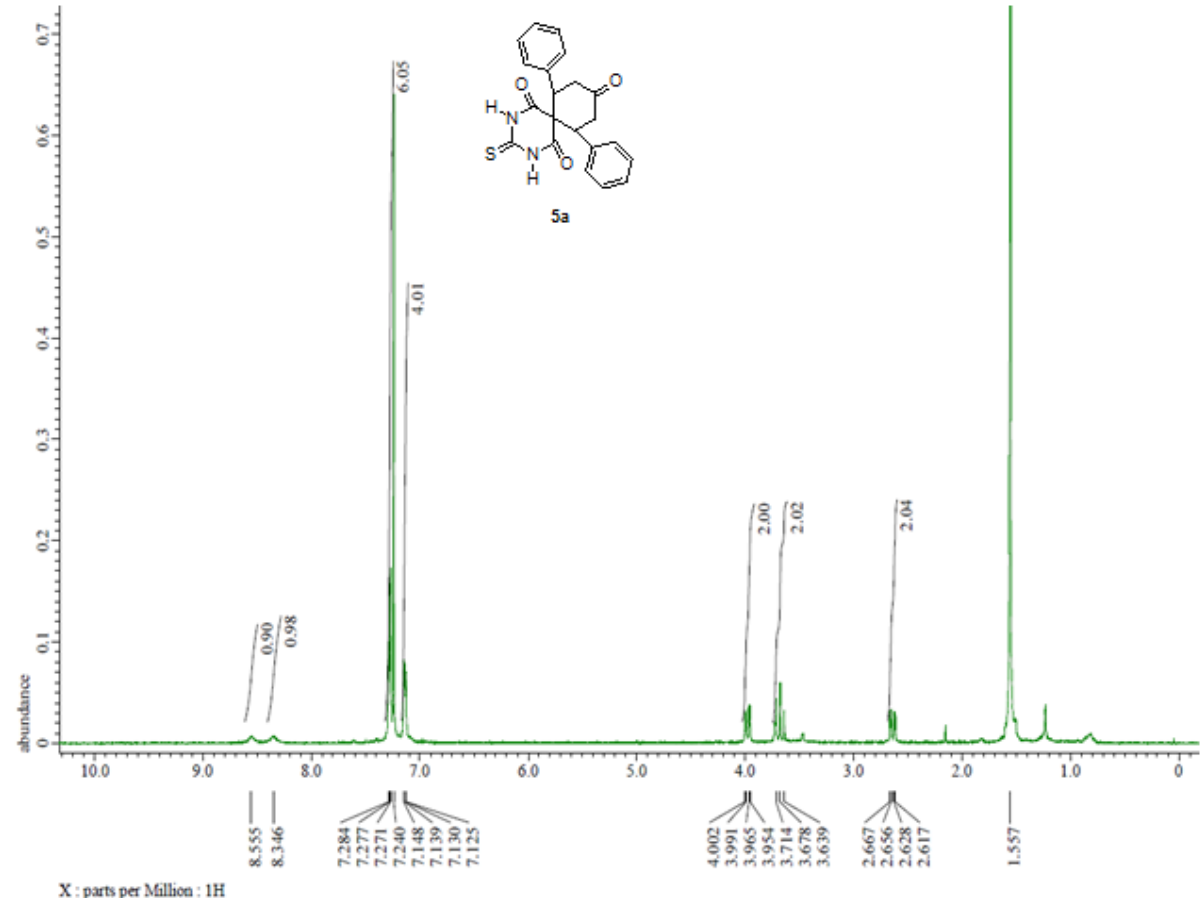

Cl
O
H
N
O
N
H
O
O
Cl
3h
4.18
4.10
1.05
1.09
2.00
2.17
2.16
abundance
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.141
7.976
7.262
7.240
7.082
7.062
3.962
3.951
3.927
3.916
3.652
3.616
3.579
2.621
2.610
2.584
2.573
1.685
X : parts per Million : 1H

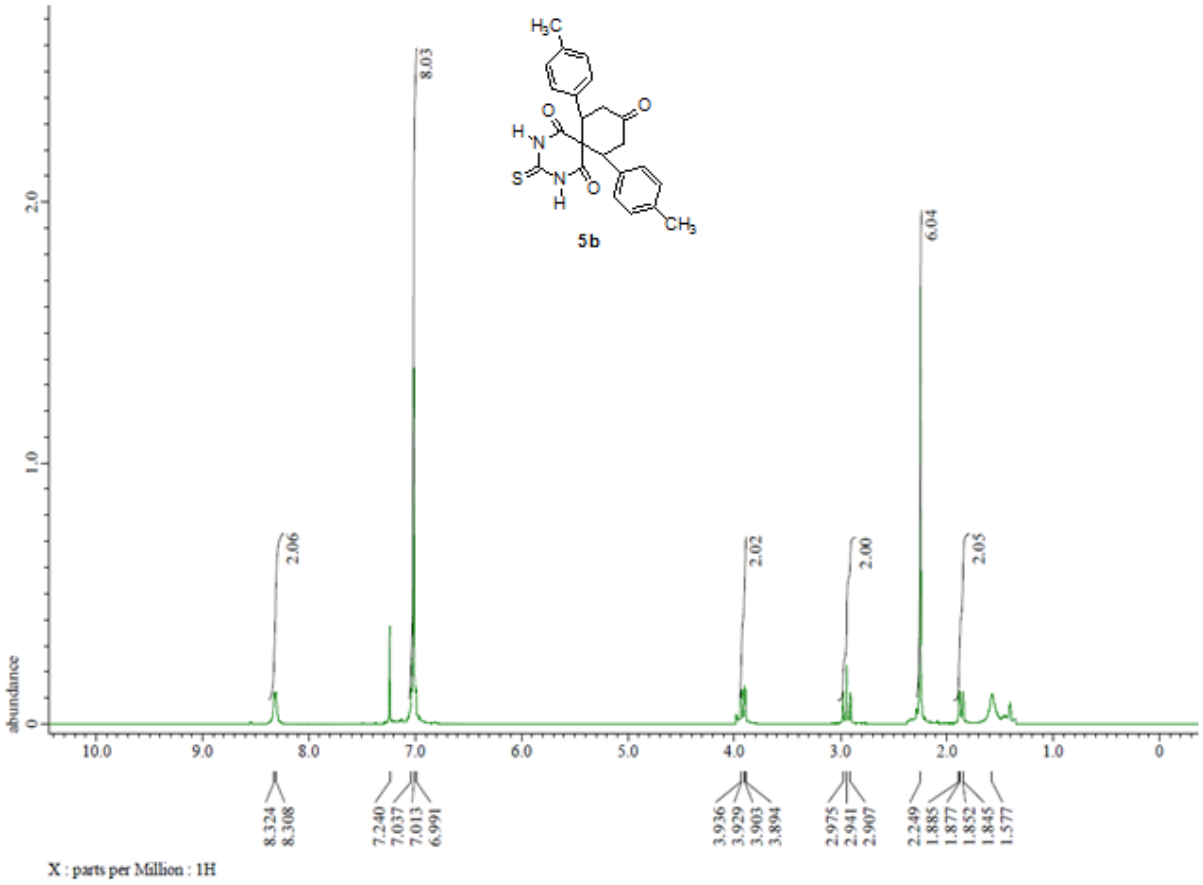

F
O
O
H
N
O
N
H
O
O
F
3i
8.08
2.02
2.00
1.93
abundance
11.244
11.188
7.166
7.129
7.105
7.102
7.087
7.065
3.790
3.781
3.756
3.746
3.382
3.349
2.843
2.811
2.778
2.497
1.772
1.765
1.741
1.734
X : parts per Million : 1H

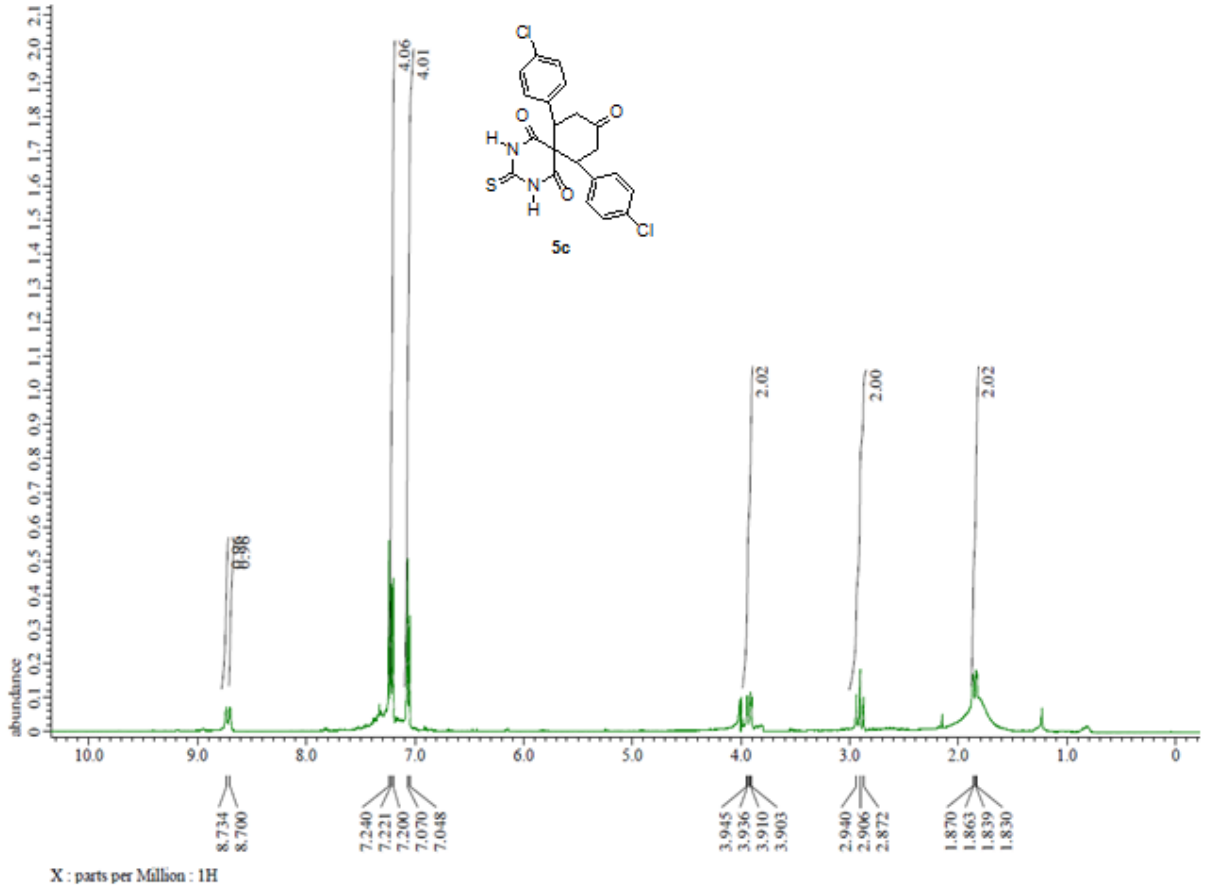

F
O
O
H
N
O
N
H
O
O
F
3i
abundance
206.546
172.784
170.343
162.734
160.303
148.852
134.607
134.579
129.926
129.850
115.605
115.386
63.928
46.861
40.129
39.920
39.710
39.500
39.290
39.080
38.880
35.600
X : parts per Million : 13C

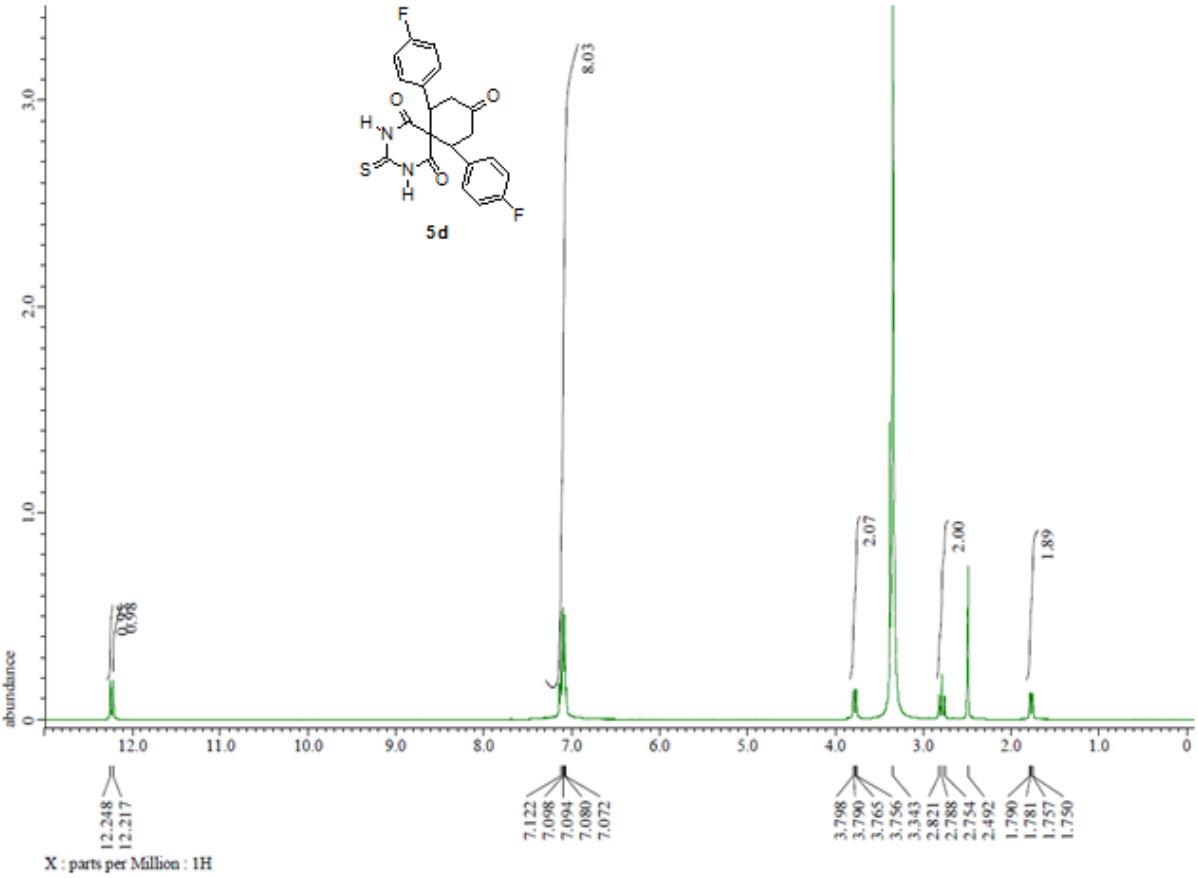

Br
O
H
N
O
N
H
O
O
Br
3j
4.08
4.00
2.13
0.99
0.99
1.18
0.82
0.82
0.86
abundance
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
11.558
11.330
7.536
7.514
7.501
7.479
7.464
7.444
7.058
7.038
7.005
6.988
6.984
3.962
3.950
3.941
3.935
3.926
3.510
3.470
3.435
3.397
3.376
3.343
2.792
2.759
2.682
2.492
2.488
2.483
2.463
2.437
2.425
X : parts per Million : 1H

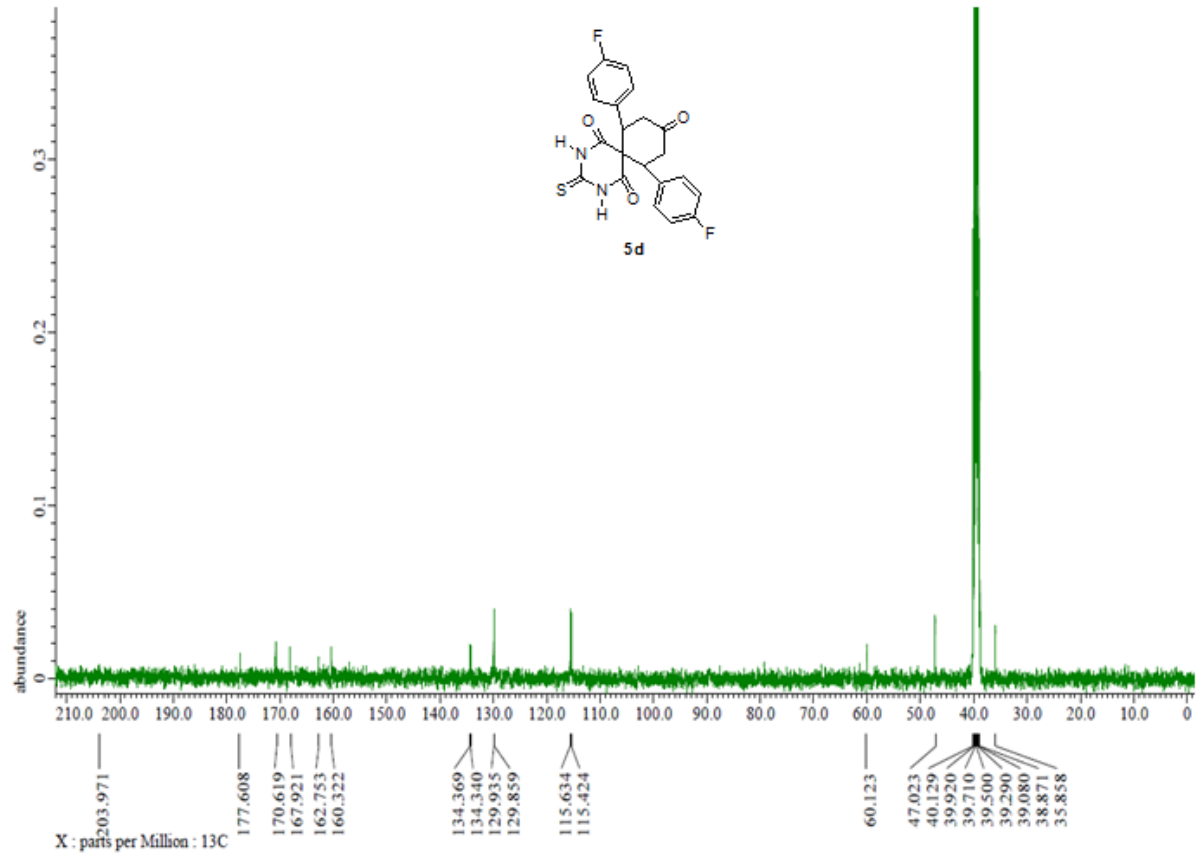

Br
O
H
N
O
N
H
O
O
Br
3j
abundance
0
0.1
0.2
0.3
0.4
0.5
210.0 200.0 190.0 180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0
206.546
171.573
170.496
148.757
136.819
131.757
130.021
121.383
64.071
48.043
42.322
40.120
39.910
39.710
39.500
39.290
39.080
38.871
X : parts per Million : 13C

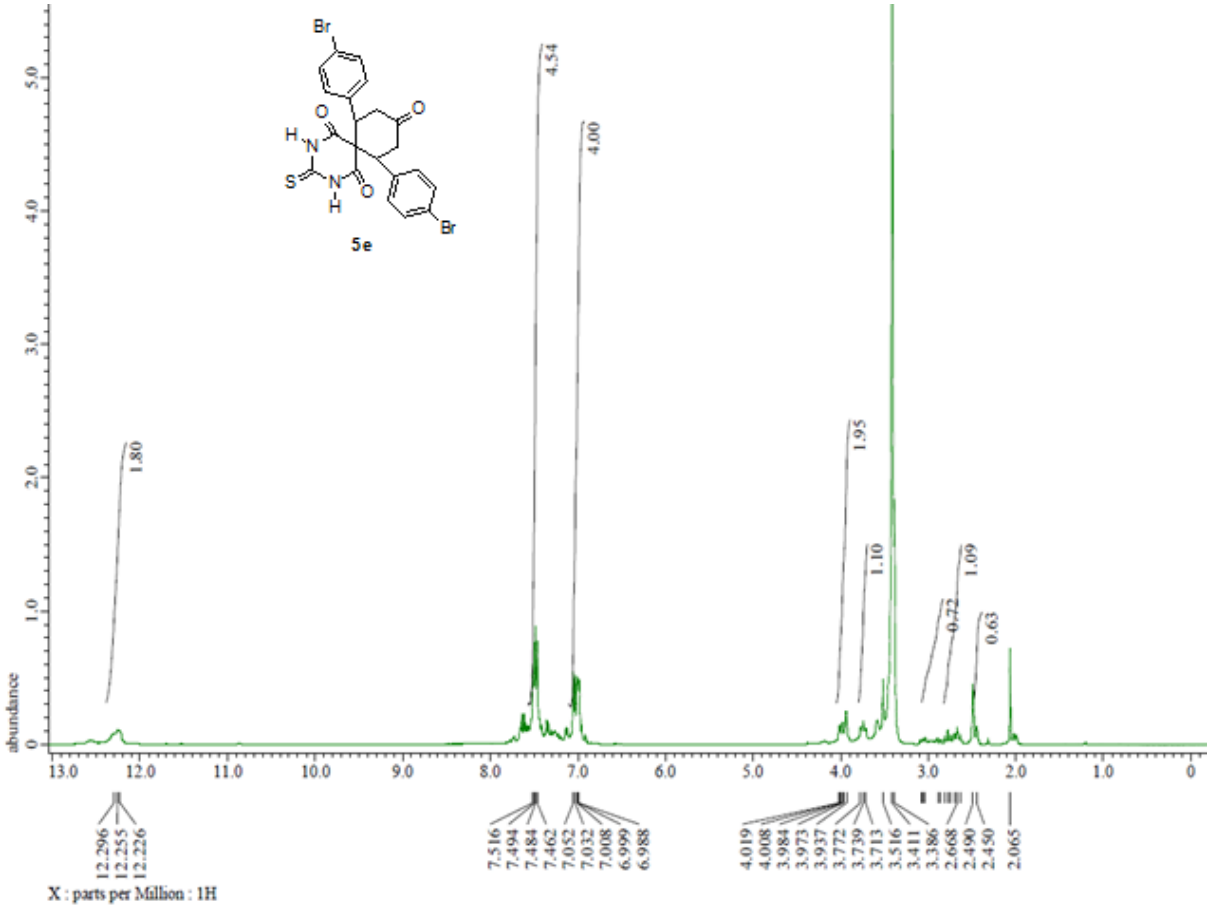

O
H
N
S
N
H
O
O
5a
6.05
4.01
2.00
2.02
2.04
0.90
0.98
abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0
8.555
8.346
7.284
7.277
7.271
7.240
7.148
7.139
7.130
7.125
4.002
3.991
3.965
3.954
3.714
3.678
3.639
2.667
2.656
2.628
2.617
1.557
X : parts per Million : 1H

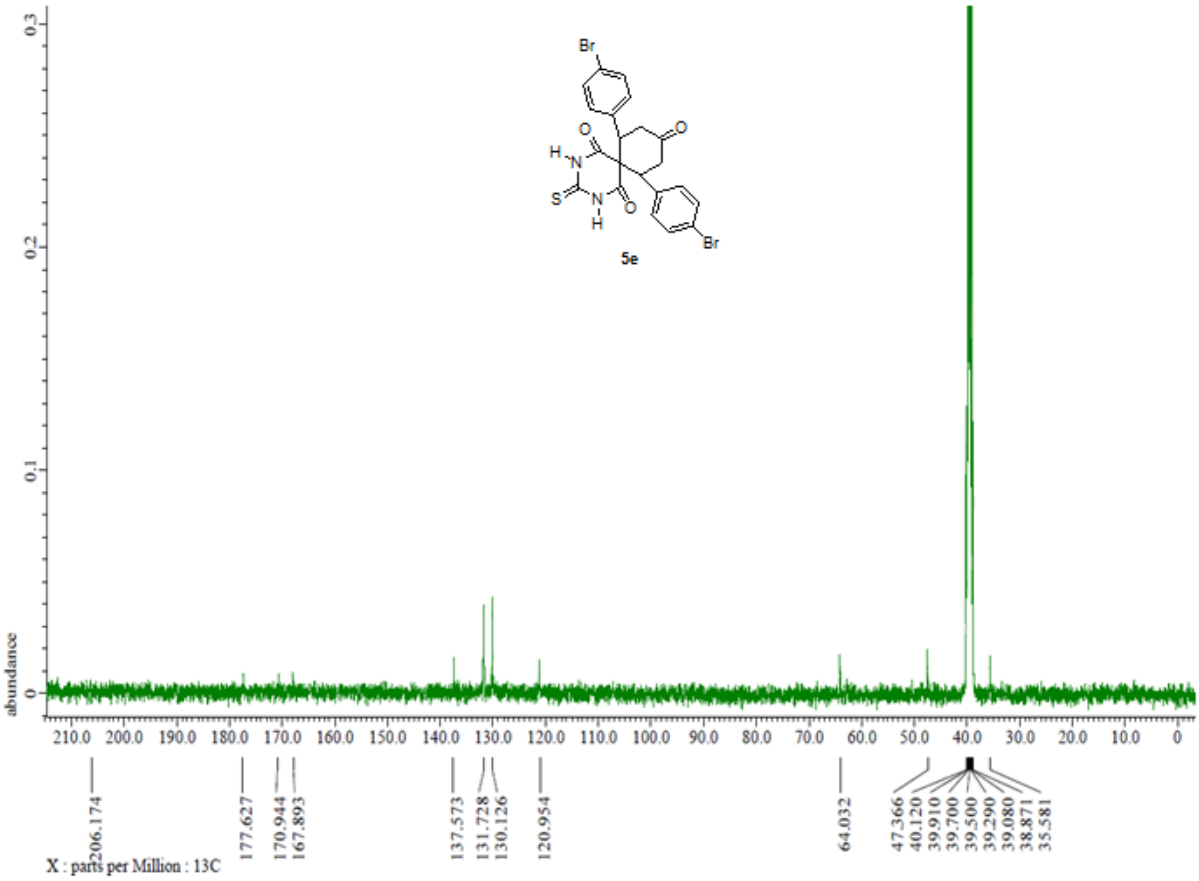

H3C
O
O
H
N
S
N
H
O
CH3
5b
8.03
6.04
2.06
2.02
2.00
2.05
abundance
2.0
1.0
0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.324
8.308
7.240
7.037
7.013
6.991
3.936
3.929
3.903
3.894
2.975
2.941
2.907
2.249
1.885
1.877
1.852
1.845
1.577
X : parts per Million : 1H

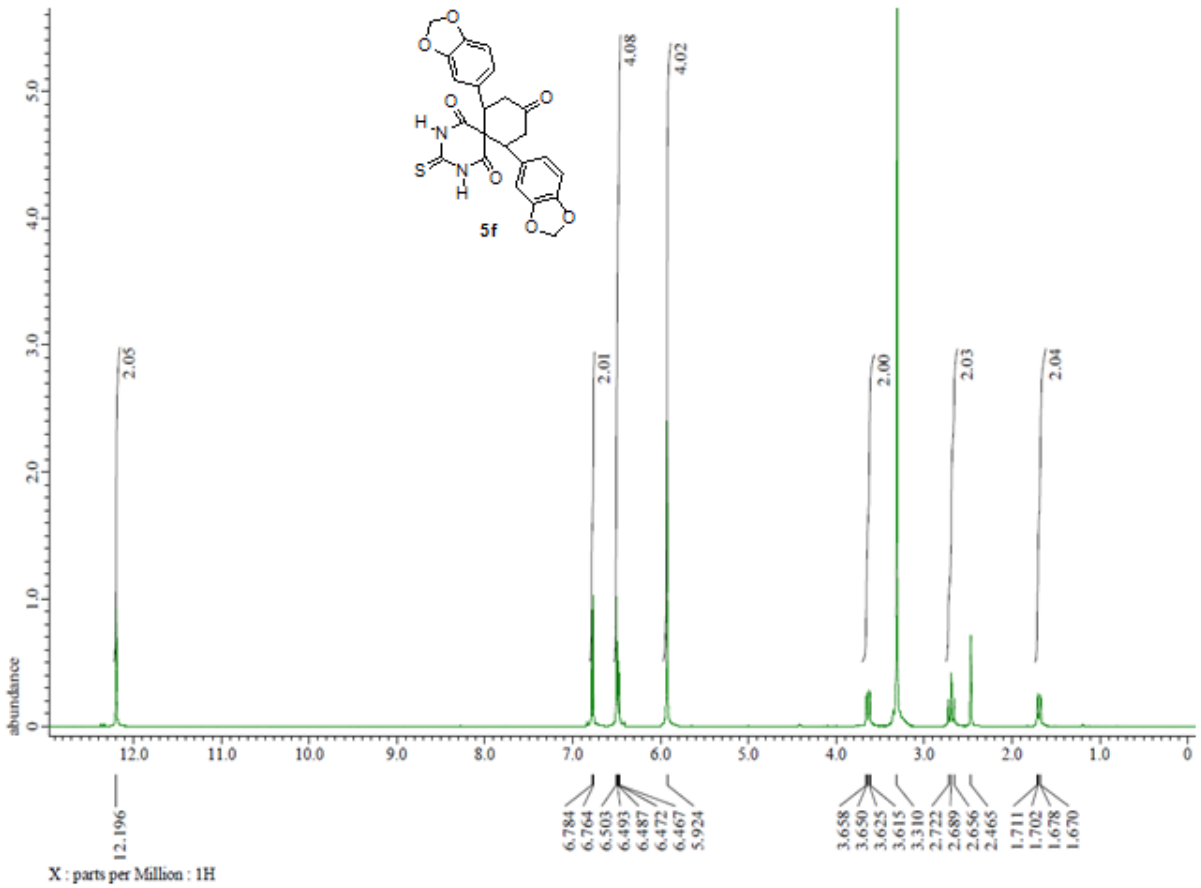

abundance
4.06
4.01
2.02
2.00
2.02
0.98
0.98
5c
8.734
8.700
7.240
7.221
7.200
7.070
7.048
3.945
3.936
3.910
3.903
2.940
2.906
2.872
1.870
1.863
1.839
1.830
X : parts per Million : 1H

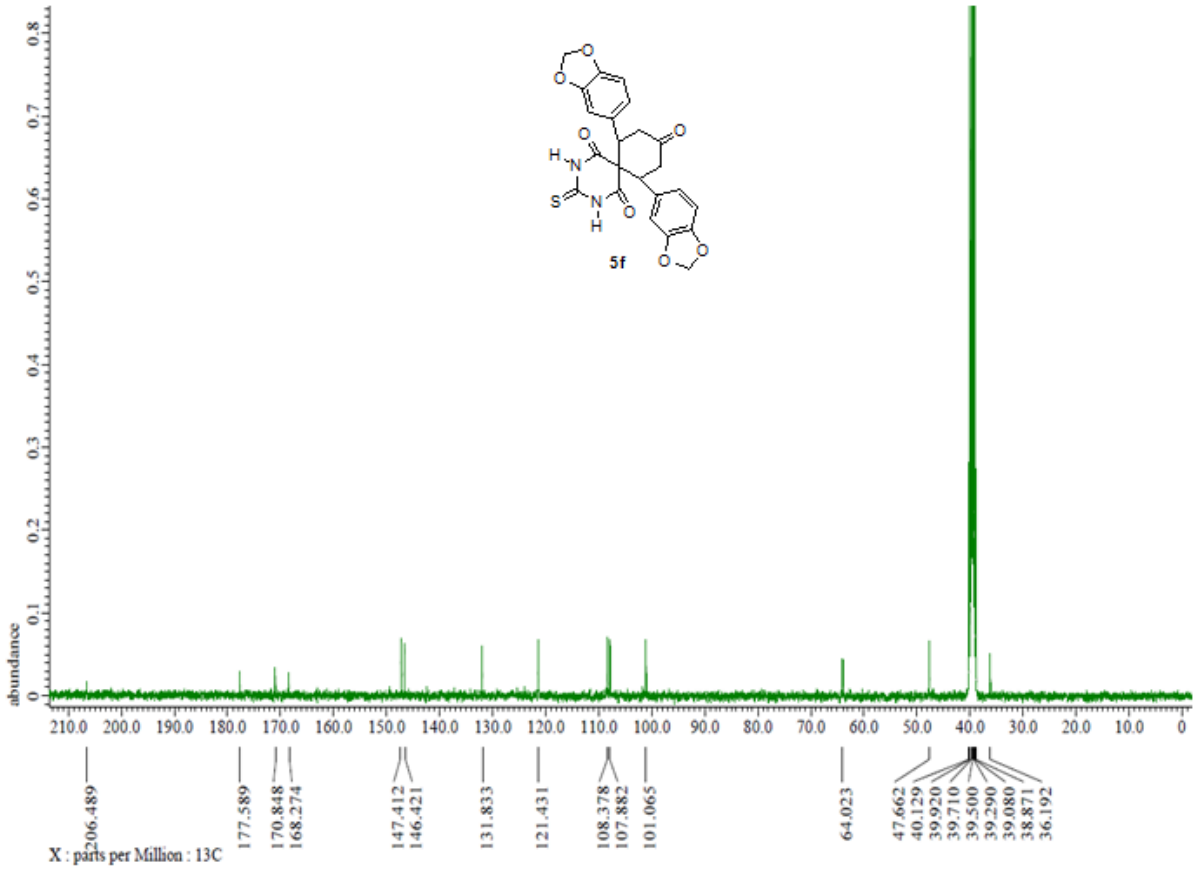

5d
abundance
X : parts per Million : 1H
12.248
12.217
7.122
7.098
7.094
7.080
7.072
3.798
3.790
3.765
3.756
3.343
2.821
2.788
2.754
2.492
1.790
1.781
1.757
1.750
8.03
2.07
2.00
1.89

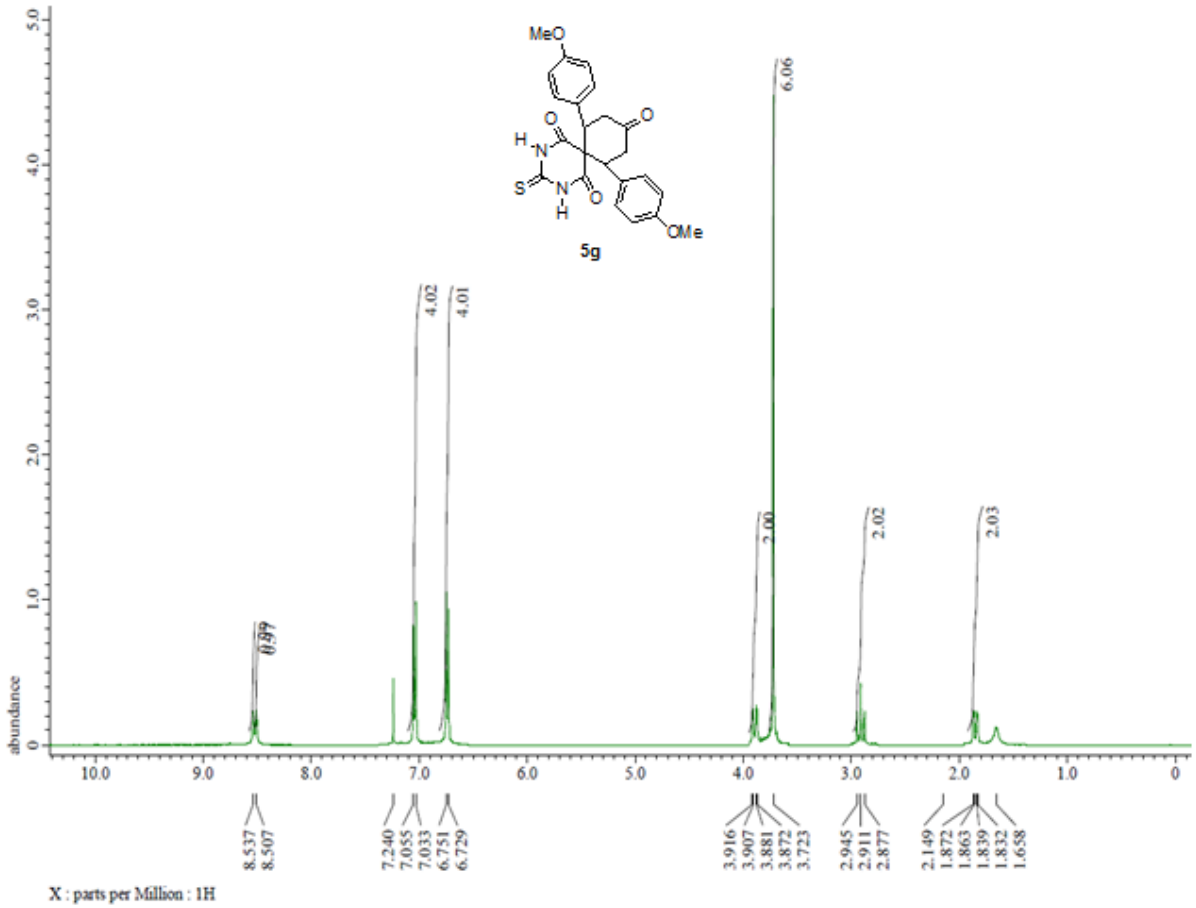

5d
abundance
X : parts per Million : 13C
203.971
177.608
170.619
167.921
162.753
160.322
134.369
134.340
129.935
129.859
115.634
115.424
60.123
47.023
40.129
39.920
39.710
39.500
39.290
39.080
38.871
35.858

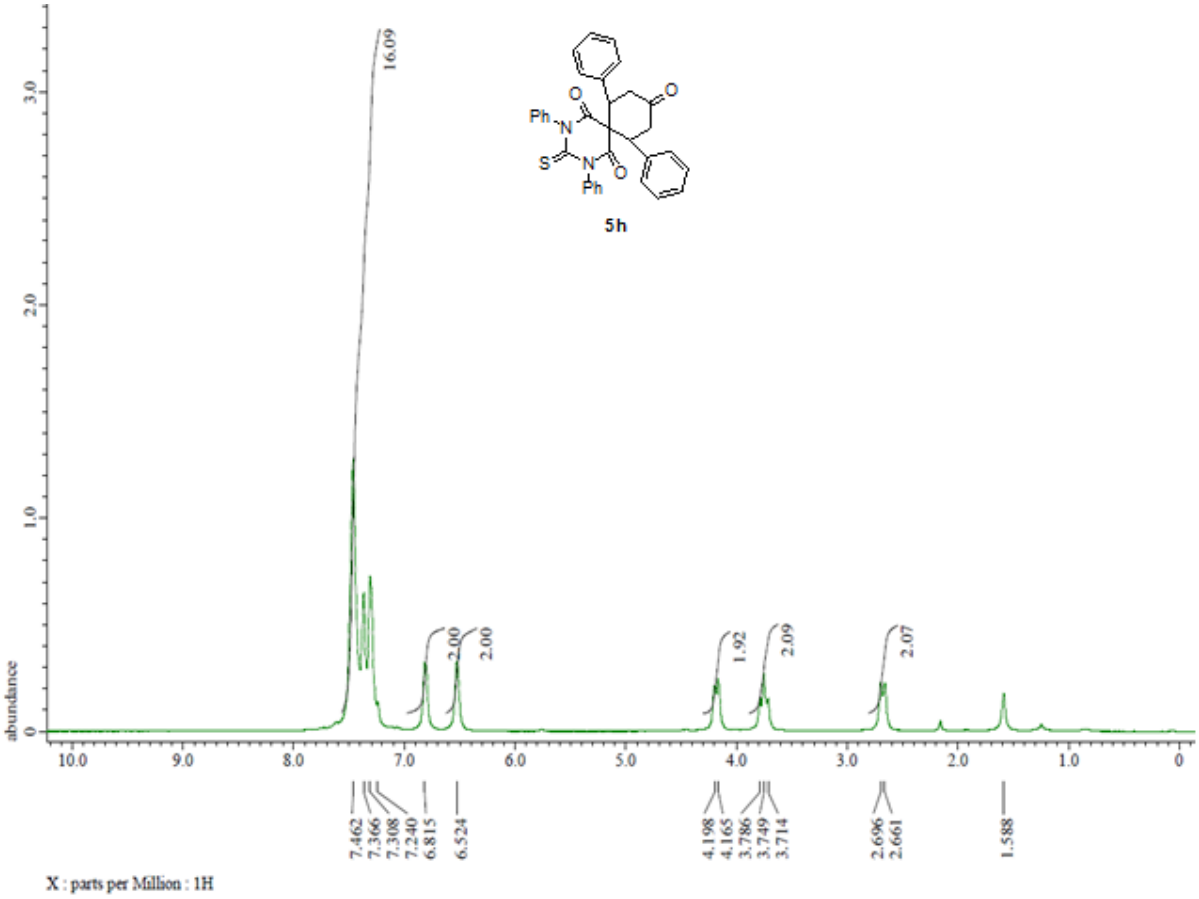

Br
O
H
N
S
N
H
O
O
Br
5e
4.54
4.00
1.95
1.80
1.10
1.09
0.72
0.63
abundance
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
12.296
12.255
12.226
7.516
7.494
7.484
7.462
7.052
7.032
7.008
6.999
6.988
4.019
4.008
3.984
3.973
3.937
3.772
3.739
3.713
3.516
3.411
3.386
2.668
2.490
2.450
2.065
X : parts per Million : 1H


Br
O
O
H
N
S
N
H
O
Br
5e
abundance
0.3
0.2
0.1
0
210.0 200.0 190.0 180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0
206.174
177.627
170.944
167.893
137.573
131.728
130.126
120.954
64.032
47.366
40.120
39.910
39.700
39.500
39.290
39.080
38.871
35.581
X : parts per Million : 13C

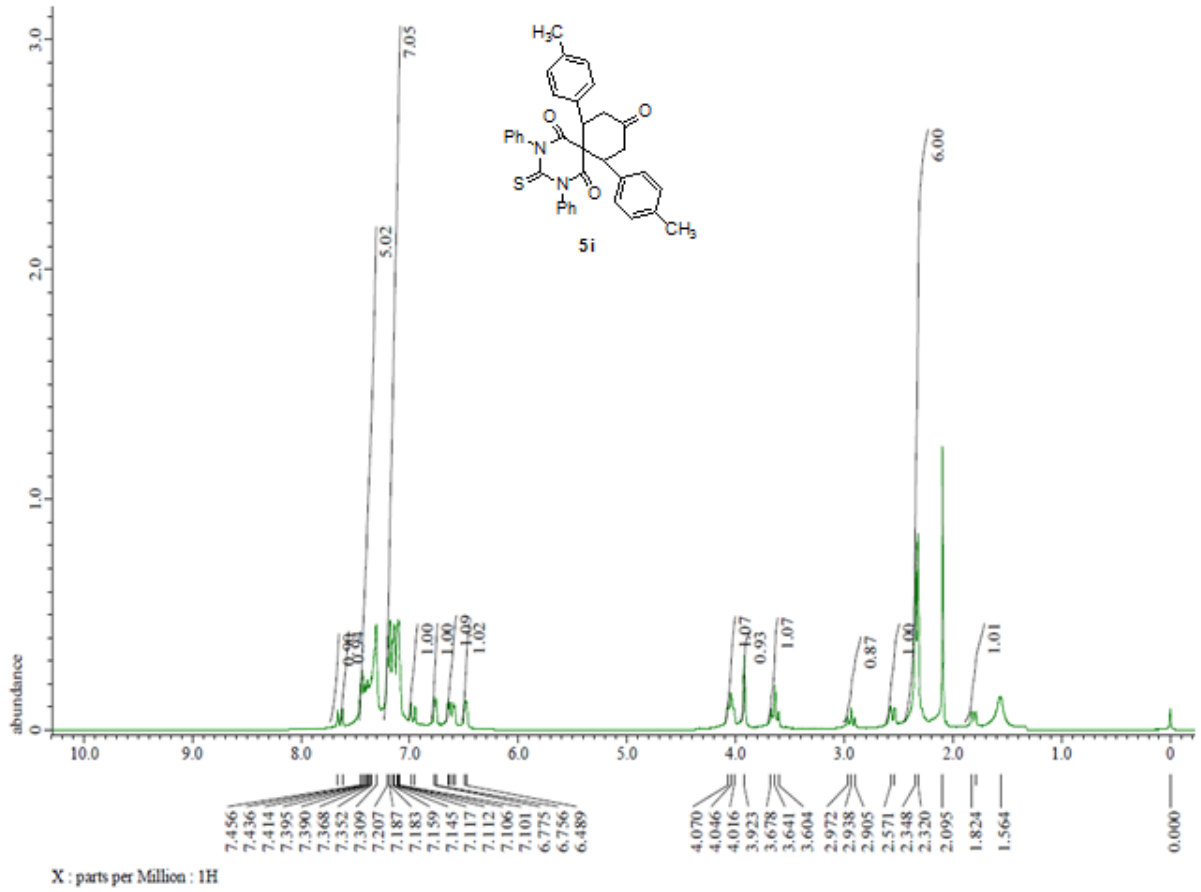

5f
abundance
2.05
2.01
4.08
4.02
2.00
2.03
2.04
12.196
6.784
6.764
6.503
6.493
6.487
6.472
6.467
5.924
3.658
3.650
3.625
3.615
3.310
2.722
2.689
2.656
2.465
1.711
1.702
1.678
1.670
X : parts per Million : 1H

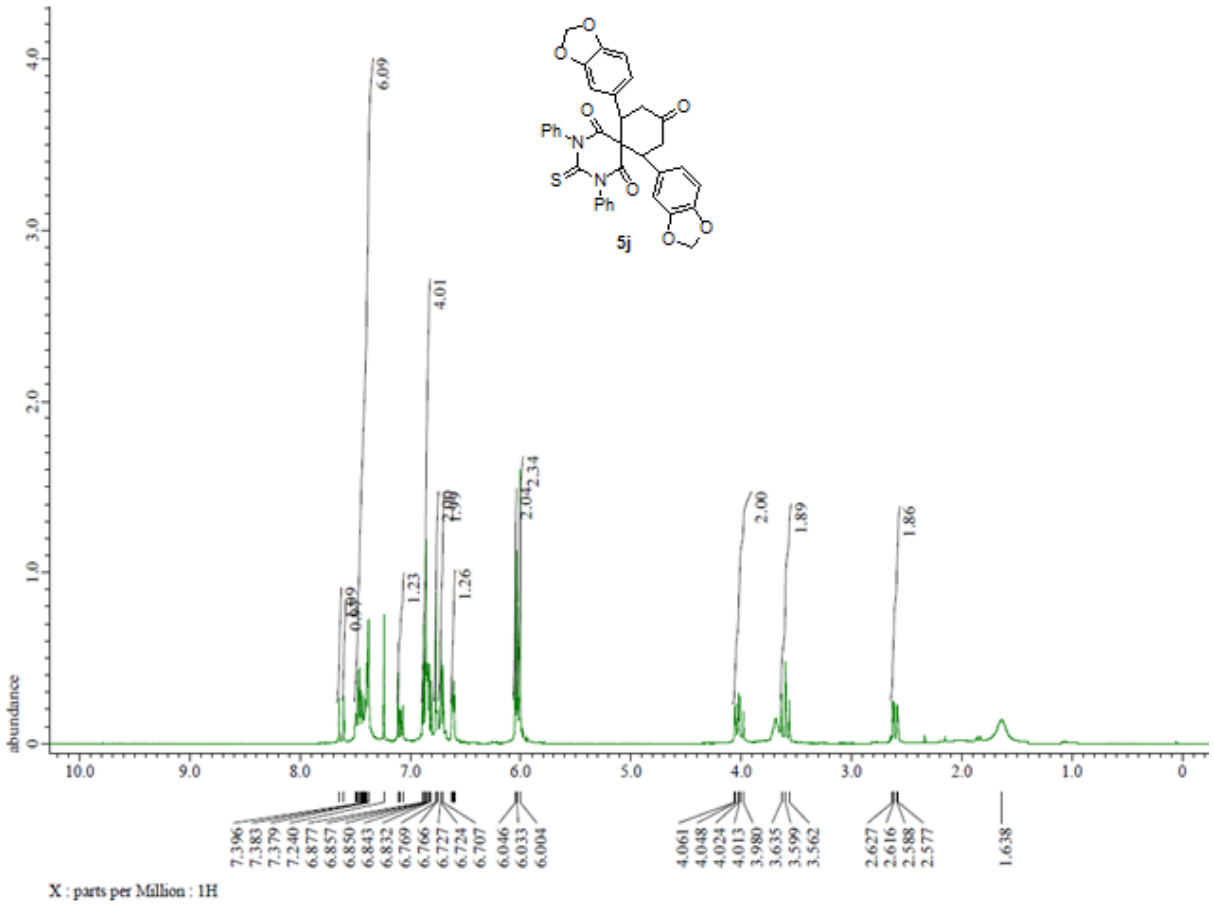

5f
abundance
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
210.0 200.0 190.0 180.0 170.0 160.0 150.0 140.0 130.0 120.0 110.0 100.0 90.0 80.0 70.0 60.0 50.0 40.0 30.0 20.0 10.0 0
206.489
177.589
170.848
168.274
147.412
146.421
131.833
121.431
108.378
107.882
101.065
64.023
47.662
40.129
39.920
39.710
39.500
39.290
39.080
38.871
36.192
X : parts per Million : 13C

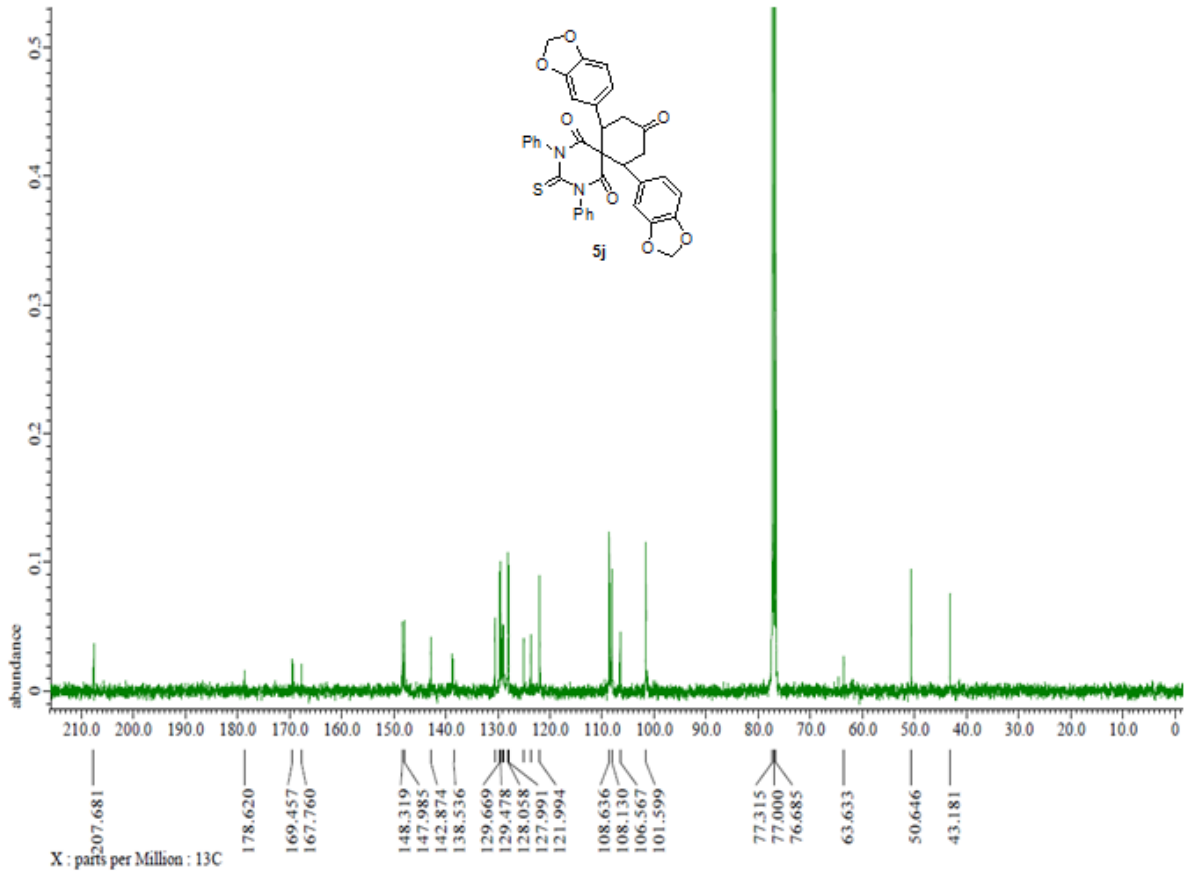

MeO
O
O
H
N
S
N
H
O
OMe
5g
6.06
4.02
4.01
2.00
2.02
2.03
0.99
abundance
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
8.537
8.507
7.240
7.055
7.033
6.751
6.729
3.916
3.907
3.881
3.872
3.723
2.945
2.911
2.877
2.149
1.872
1.863
1.839
1.832
1.658
X : parts per Million : 1H


16.09
2.00
2.00
1.92
2.09
2.07
abundance
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
7.462
7.366
7.308
7.240
6.815
6.524
4.198
4.165
3.786
3.749
3.714
2.696
2.661
1.588
X : parts per Million : 1H

5h


abundance
X : parts per Million : 1H
5i
7.05
5.02
6.00
1.00
1.00
1.09
1.02
1.07
0.93
1.07
0.87
1.00
1.01
7.456
7.436
7.414
7.395
7.390
7.368
7.352
7.309
7.207
7.187
7.183
7.159
7.145
7.117
7.112
7.106
7.101
6.775
6.756
6.489
4.070
4.046
4.016
3.923
3.678
3.641
3.604
2.972
2.938
2.905
2.571
2.348
2.320
2.095
1.824
1.564
0.000


5j
abundance
6.09
4.01
2.34
2.04
2.00
1.89
1.86
1.23
1.26
7.396
7.383
7.379
7.240
6.877
6.857
6.850
6.843
6.832
6.769
6.766
6.727
6.724
6.707
6.046
6.033
6.004
4.061
4.048
4.024
4.013
3.980
3.635
3.599
3.562
2.627
2.616
2.588
2.577
1.638
X : parts per Million : 1H


5j
abundance
0
0.1
0.2
0.3
0.4
0.5
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
207.681
178.620
169.457
167.760
148.319
147.985
142.874
138.536
129.669
129.478
128.058
127.991
121.994
108.636
108.130
106.567
101.599
77.315
77.000
76.685
63.633
50.646
43.181
X : parts per Million : 13C