Synthesis of Benzylic Thioether Containing α-Substituted Thio Compounds *via* Carbene Insertion into S-H Bond: Expeditious Access to a New C-S Bond

Arumugam Jayarani,[a] Gruhapriya Jelakam[a] and Chinnappan Sivasankar*[a]

Catalysis and Energy Laboratory, Department of Chemistry, Pondicherry University (A Central University), R. V. Nagar, Kalapet, Puducherry 605014, India

Email: siva.che@pondiuni.ac.in

Supporting Information

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General procedure for the synthesis of Methyl phenyldiazoacetate.[1]

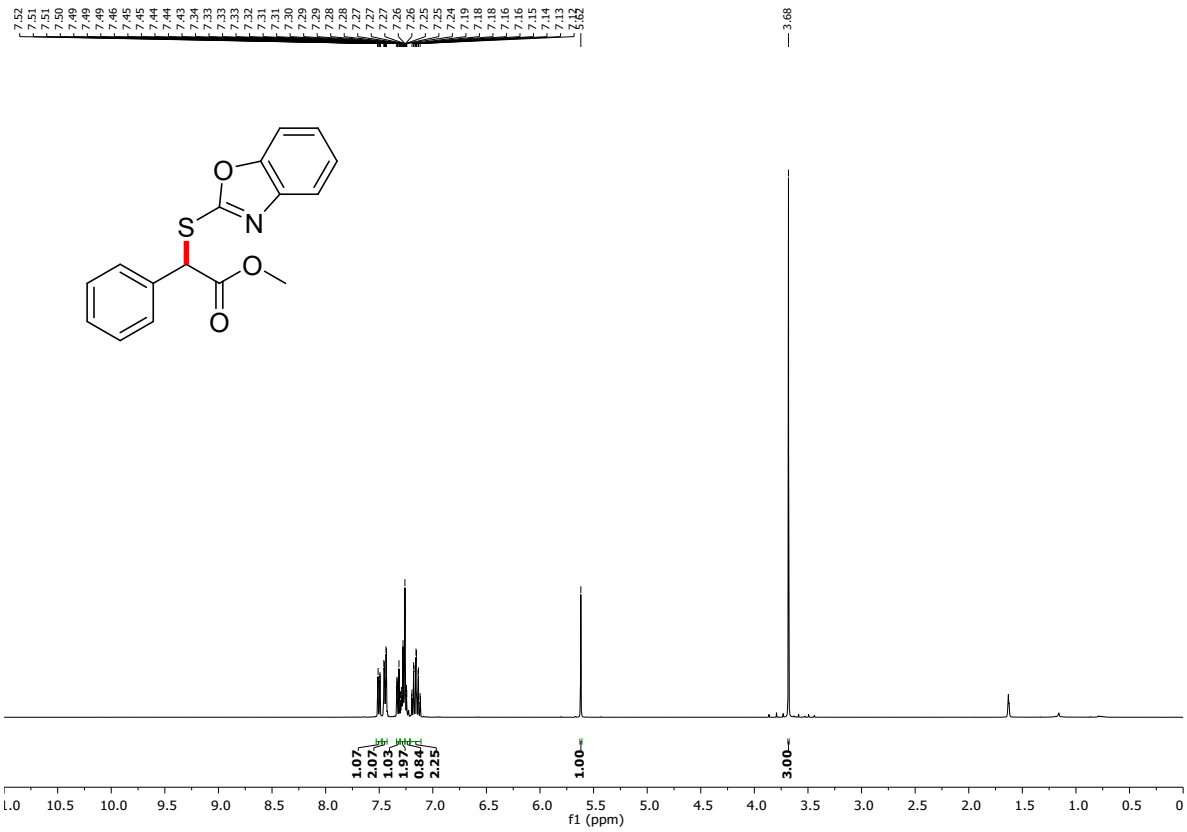
To a solution of phenylacetic acid (16.073 g, 118.05 mmol) in methanol (100 ml) concentrated sulfuric acid (2.0 ml) was slowly added and the reaction mixture was refluxed for 2 h in oil bath. When no more starting material was present as was checked by TLC (hexane:ethyl acetate, 3:1, v/v) the reaction was quenched by pouring the reaction mixture into dichloromethane (300 ml) and washing the organic layer with saturated $NaHCO_3$ solution. The aqueous layer was extracted once with dichloromethane and the combined organic layers were dried ($MgSO_4$), filtered and concentrated in vacuo. The crude product was distilled in vacuo to give 15.907 g **A** as a clear colourless oil.

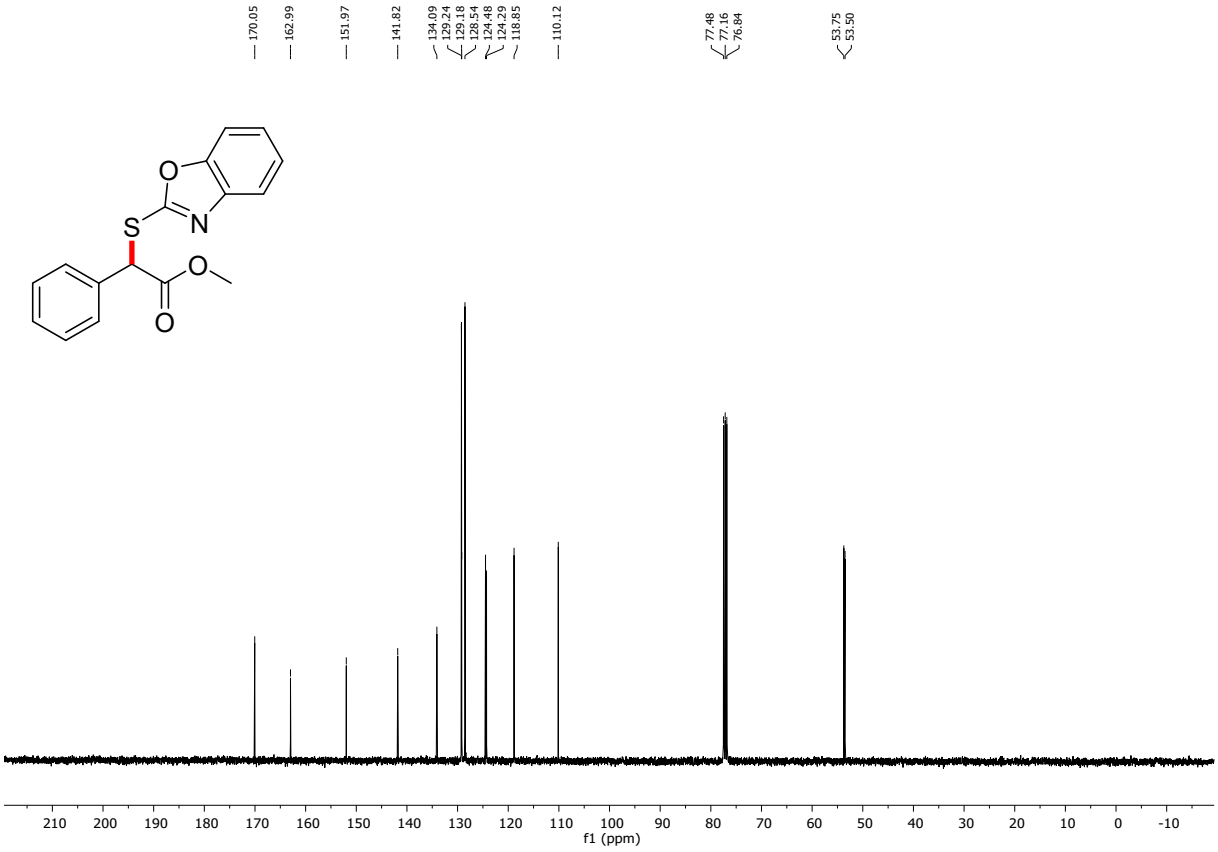
A solution of sodium azide (5.626 g, 86.6 mmol) in distilled water (16 ml) was diluted with ethanol (96 %, 32 ml). To this solution a warm (45 °C) solution of tosylchloride (15.005 g, 78.7 mmol) in ethanol (96 %, 80 ml) was added and the mixture was stirred for 2.5 h. at room temperature, after which it was concentrated in vacuo. The residue was dissolved in diethyl ether, washed twice with water, dried with $MgSO_4$, filtered and concentrated in vacuo to produce 15.246 g product **B** which solidified at 4 °C.

A solution of **A** (4.505 g, 30.0 mmol) and **B** (6.915, 35.0 mmol) in acetonitrile (60 ml) was cooled to 0 °C. Then DBU (6.1 ml, 40.8 mmol) was added and the reaction mixture stirred overnight. The reaction was quenched by adding diethyl ether and saturated NH_4Cl solution. The organic layer was successively washed with NH_4Cl and NaCl solution. The combined aqueous layers were extracted twice with diethyl ether and the combined organic extracts dried ($MgSO_4$), filtered and concentrated in vacuo. The 4-toluenesulfonylamide solid by product was removed by washing the product with hexane: diethyl ether (1:1, v/v). Finally, the product **2** was purified by flash chromatography (hexane: ethyl acetate, 40:1, v/v) and stored in the dark at 4 °C.

CAUTION: Diazo compounds can explode when they rapidly decompose, giving off heat and nitrogen gas, making them potentially dangerous to work with. Handle with care.

^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **3a**:





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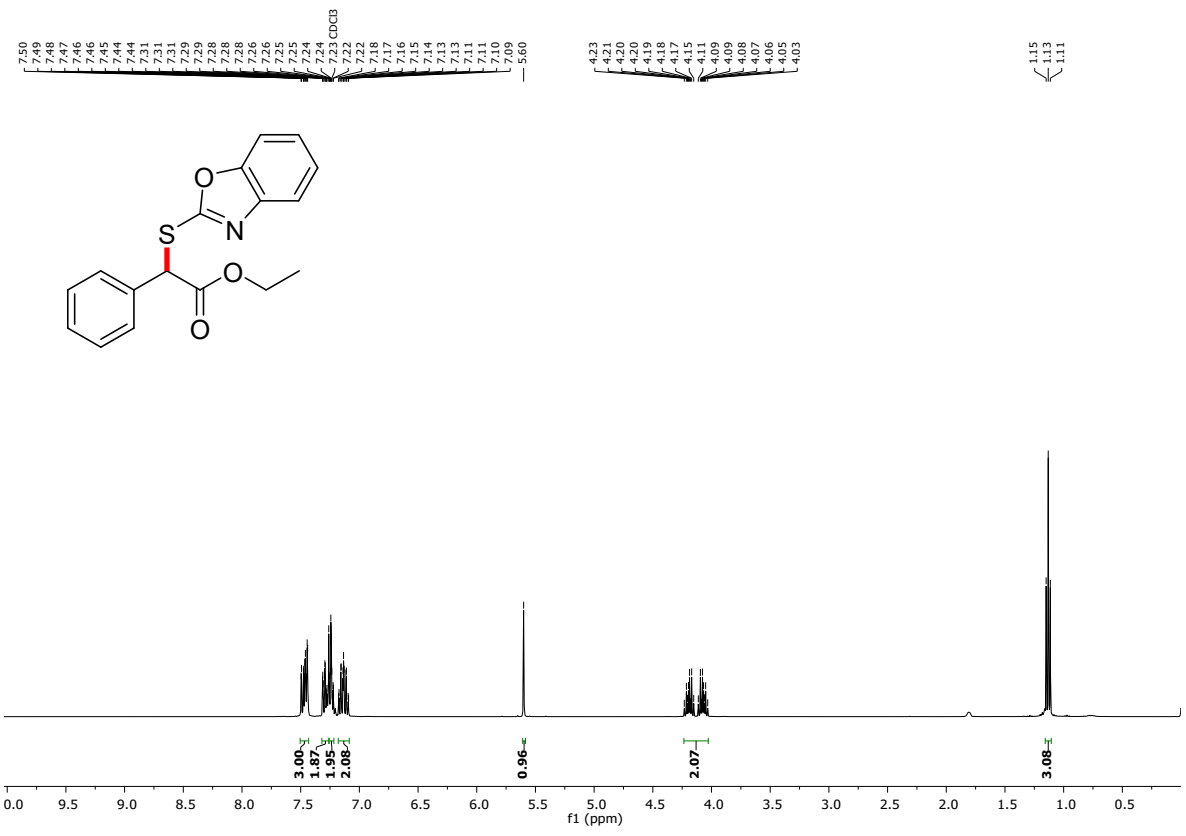

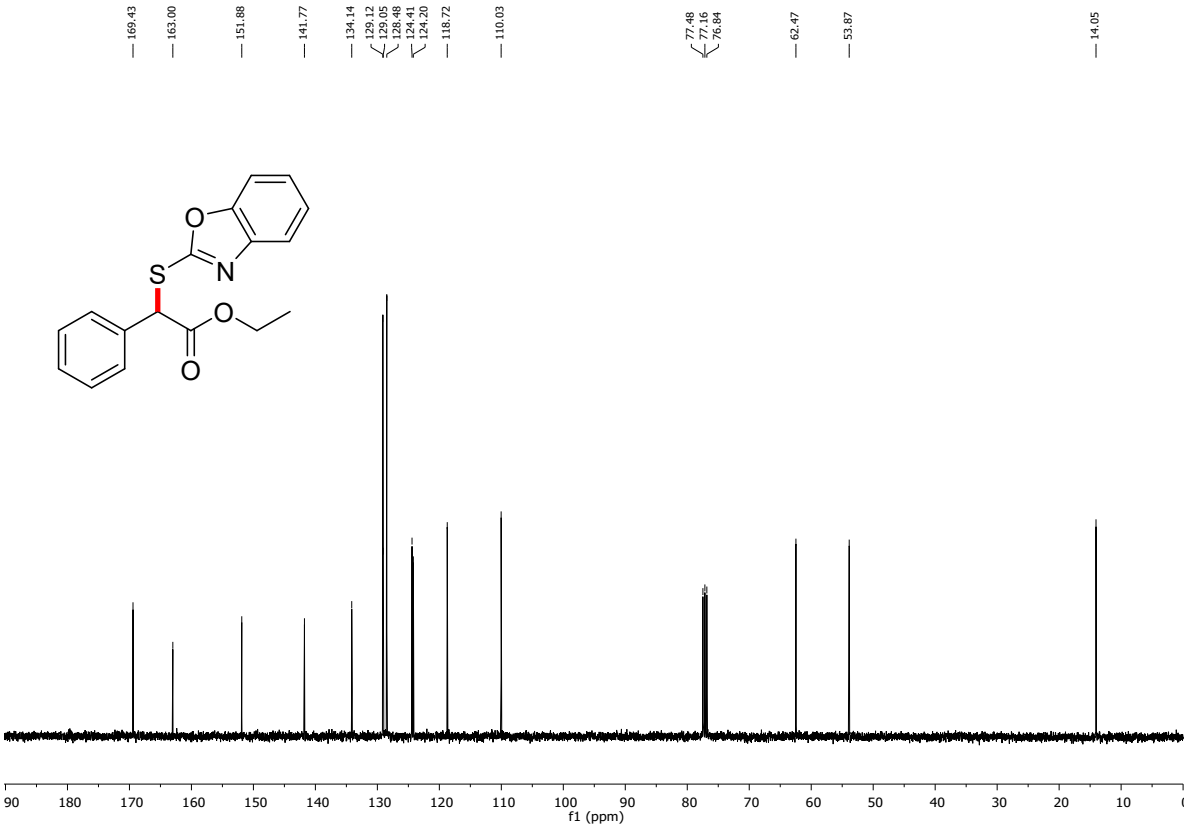

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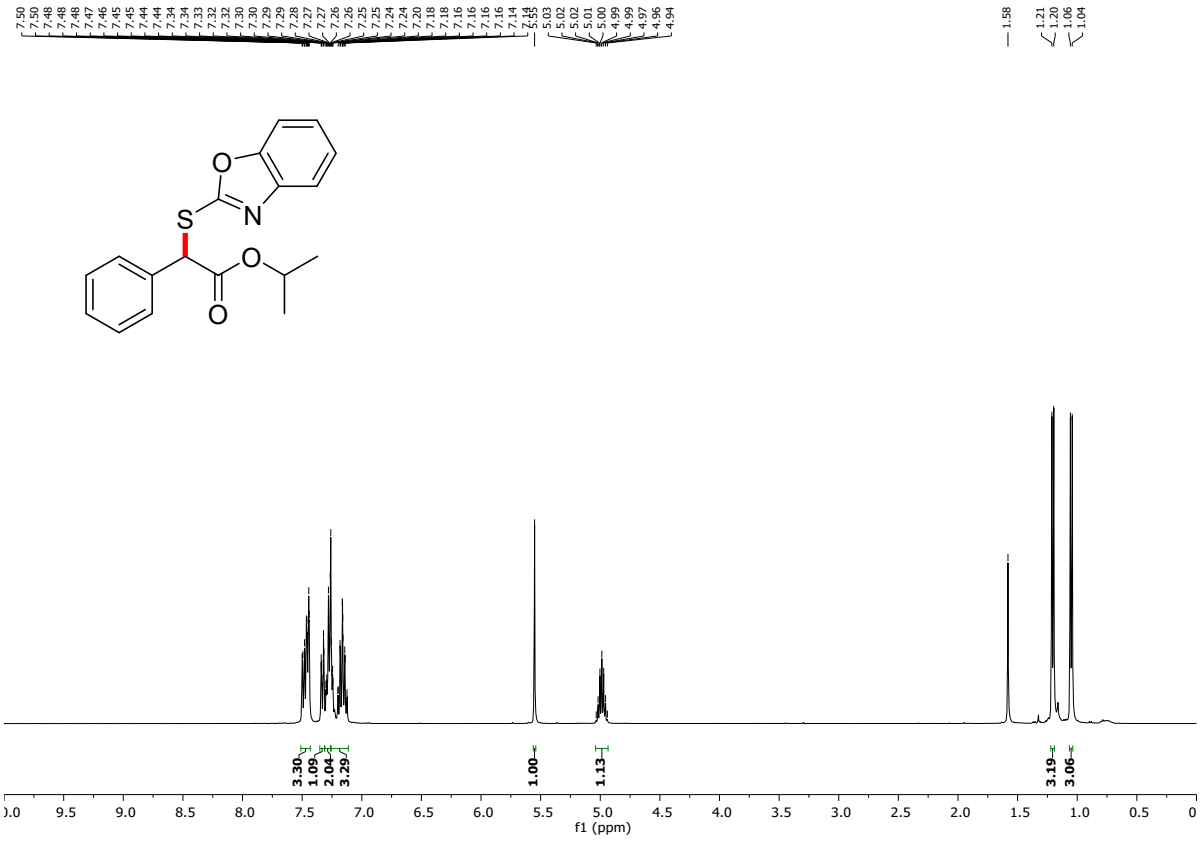

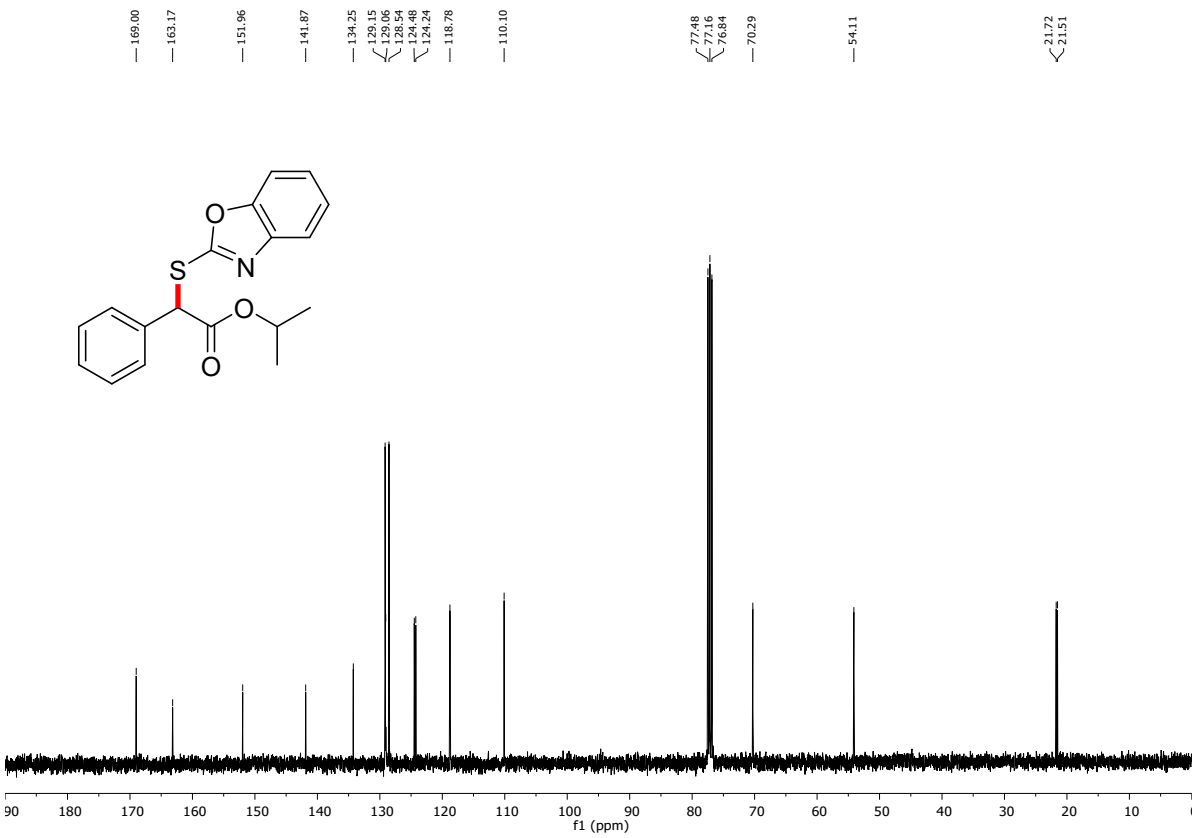

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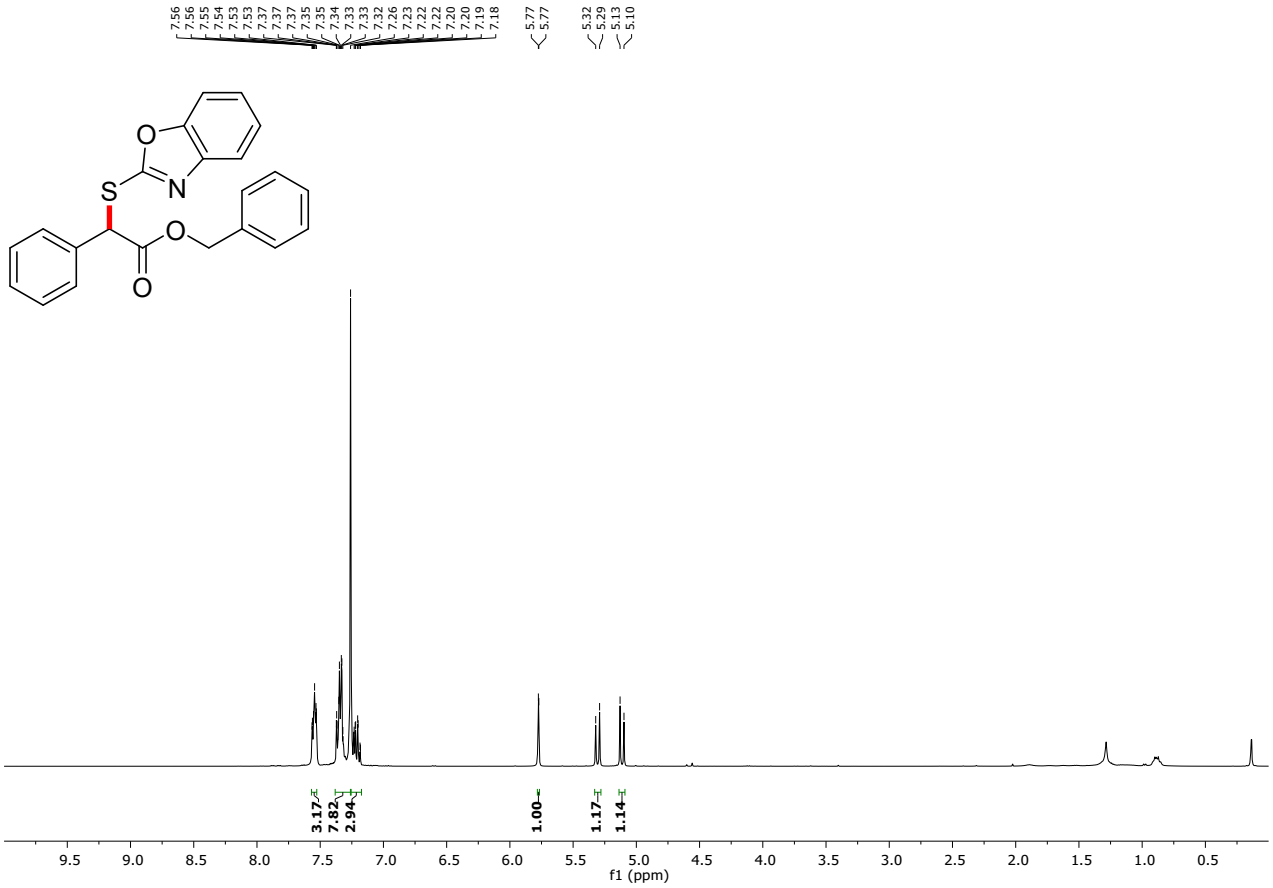

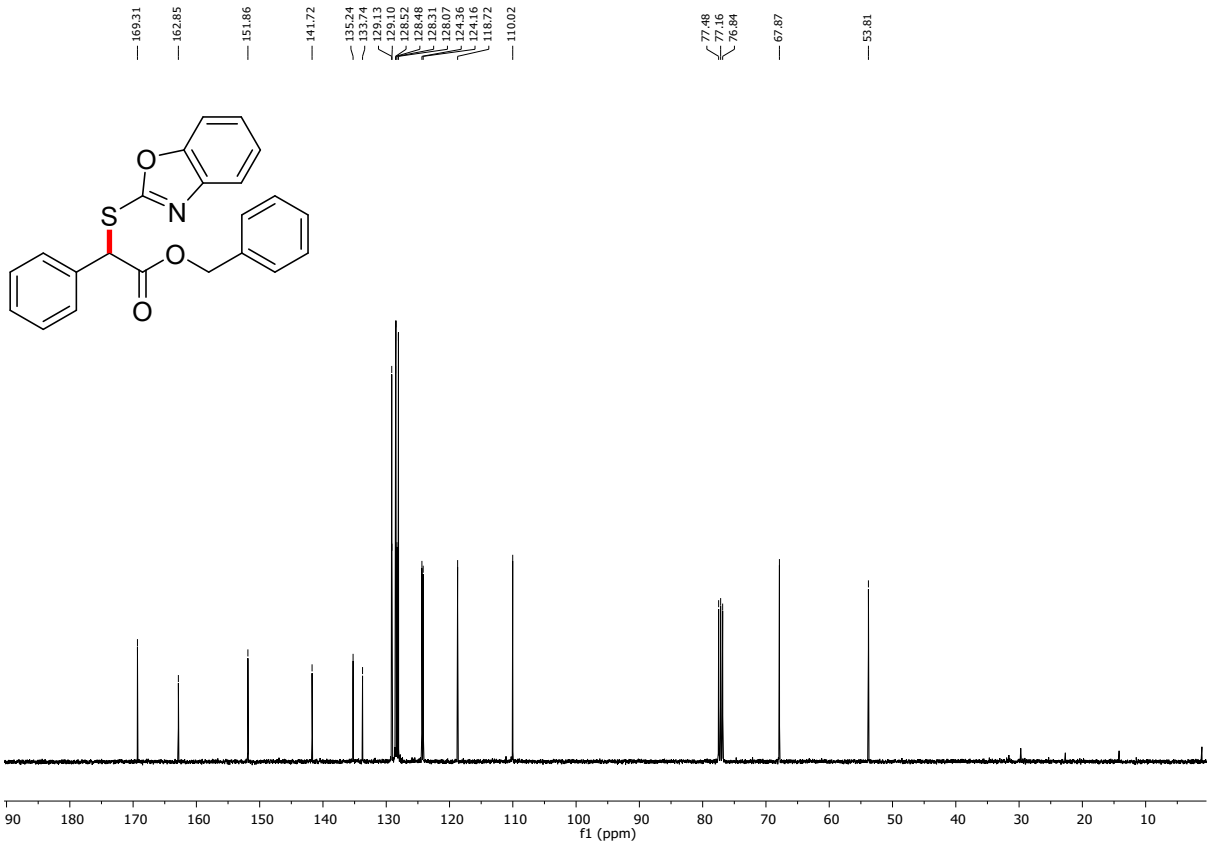

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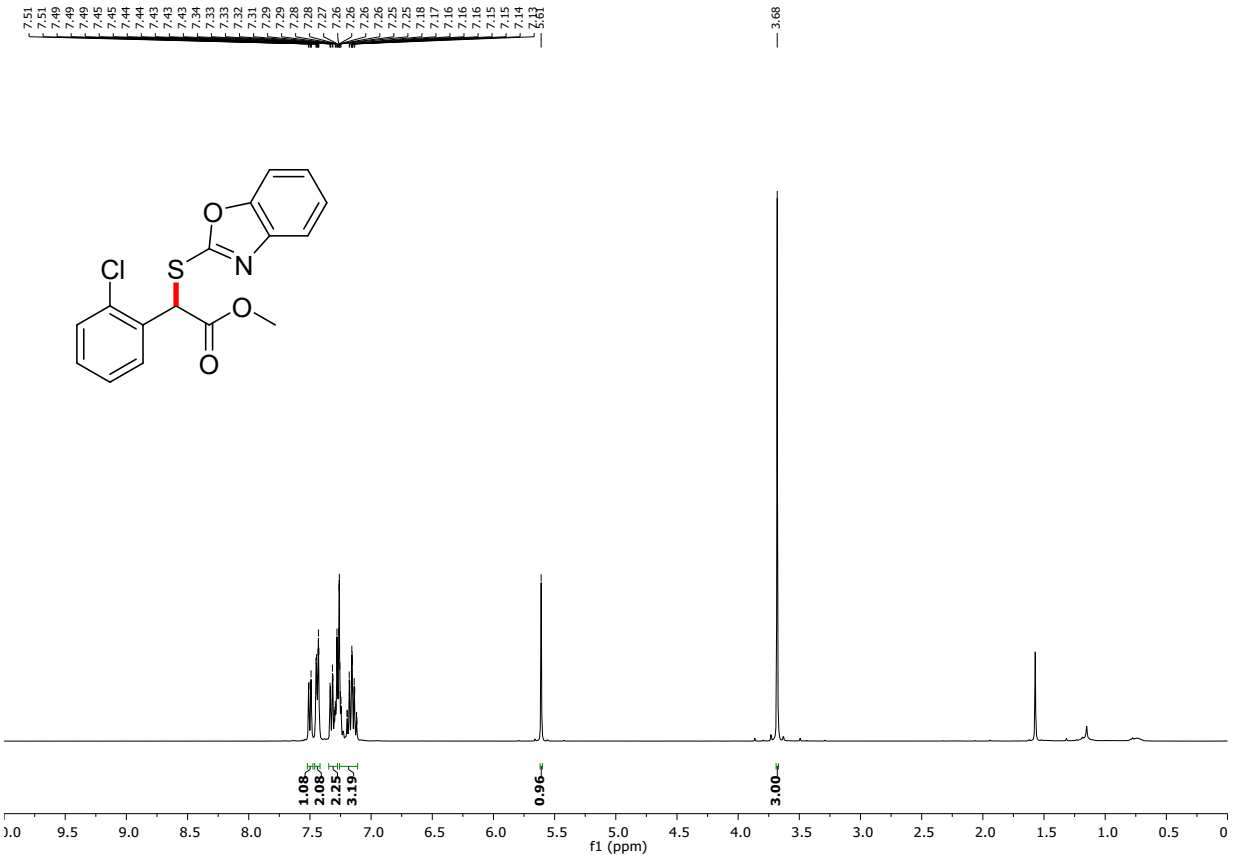
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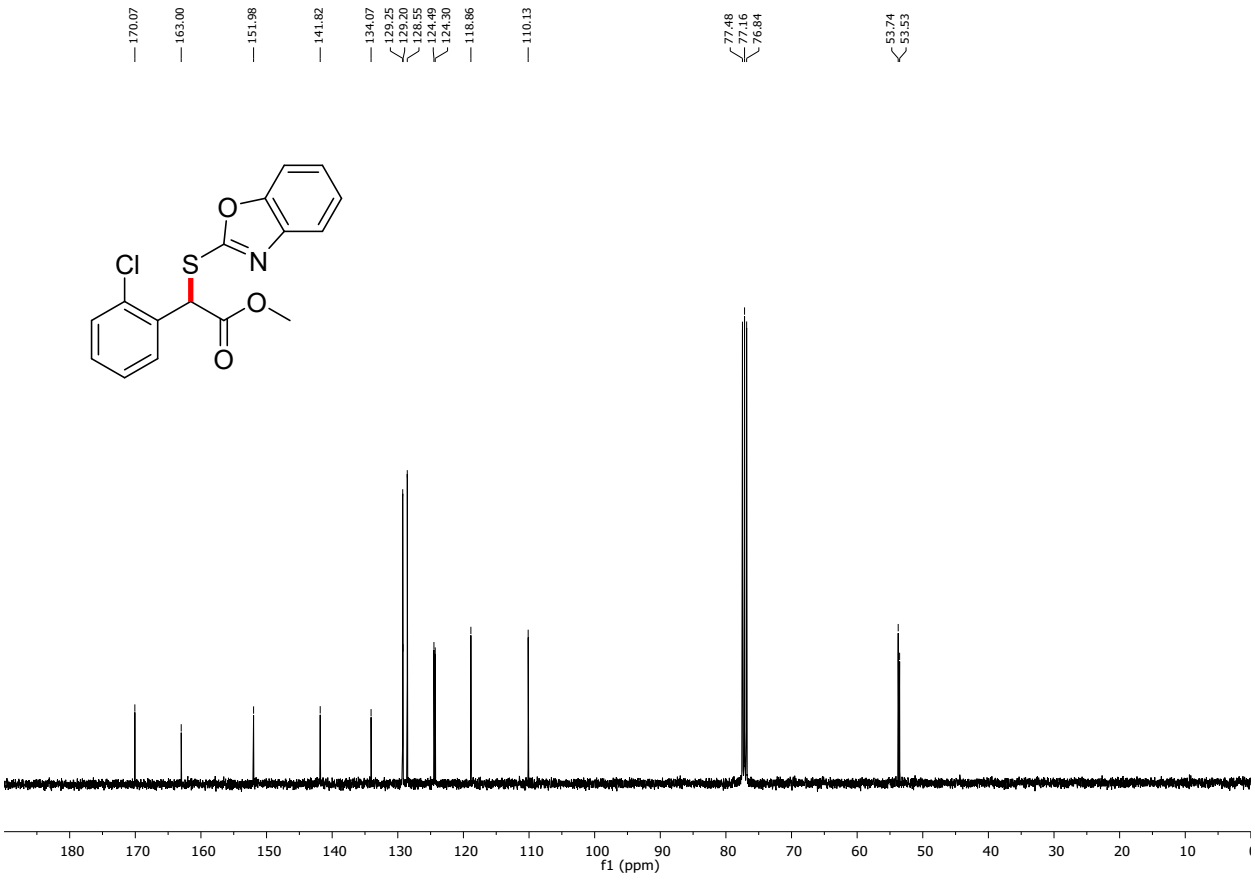
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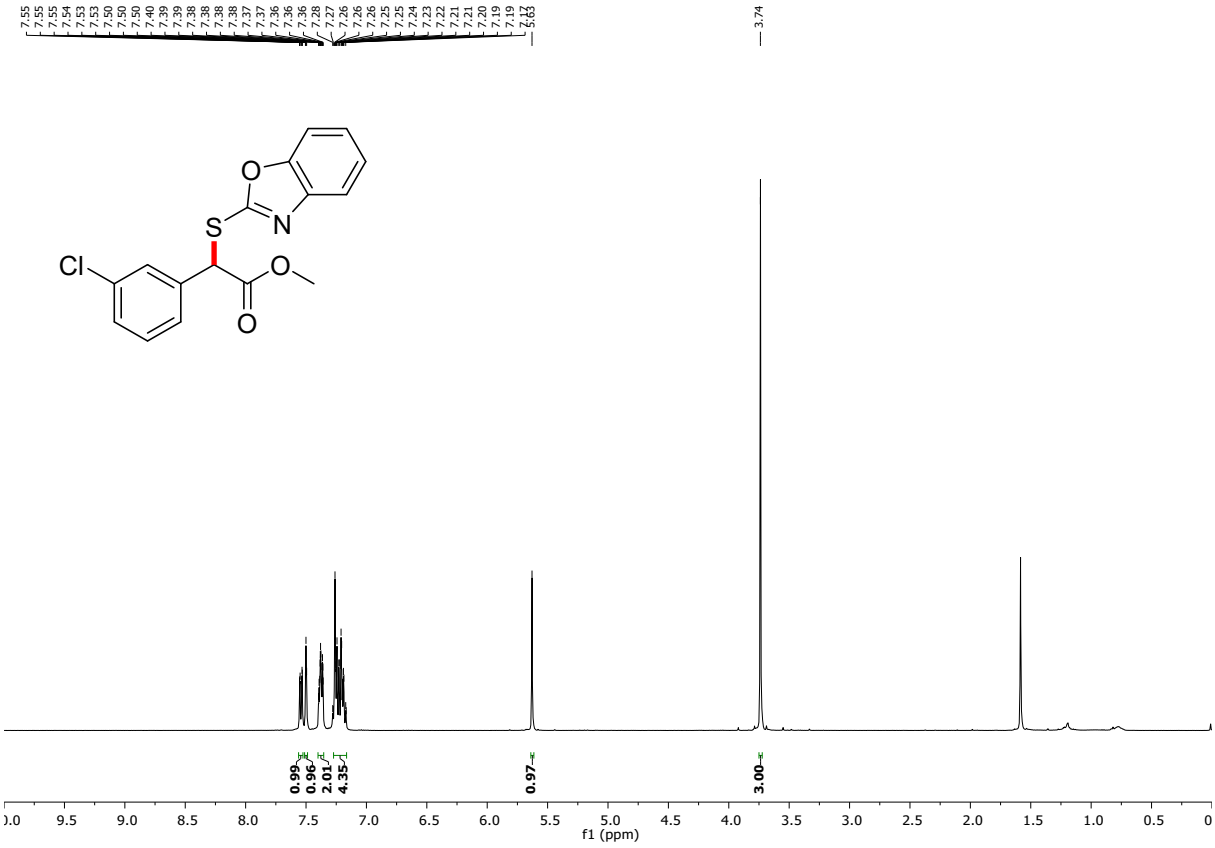

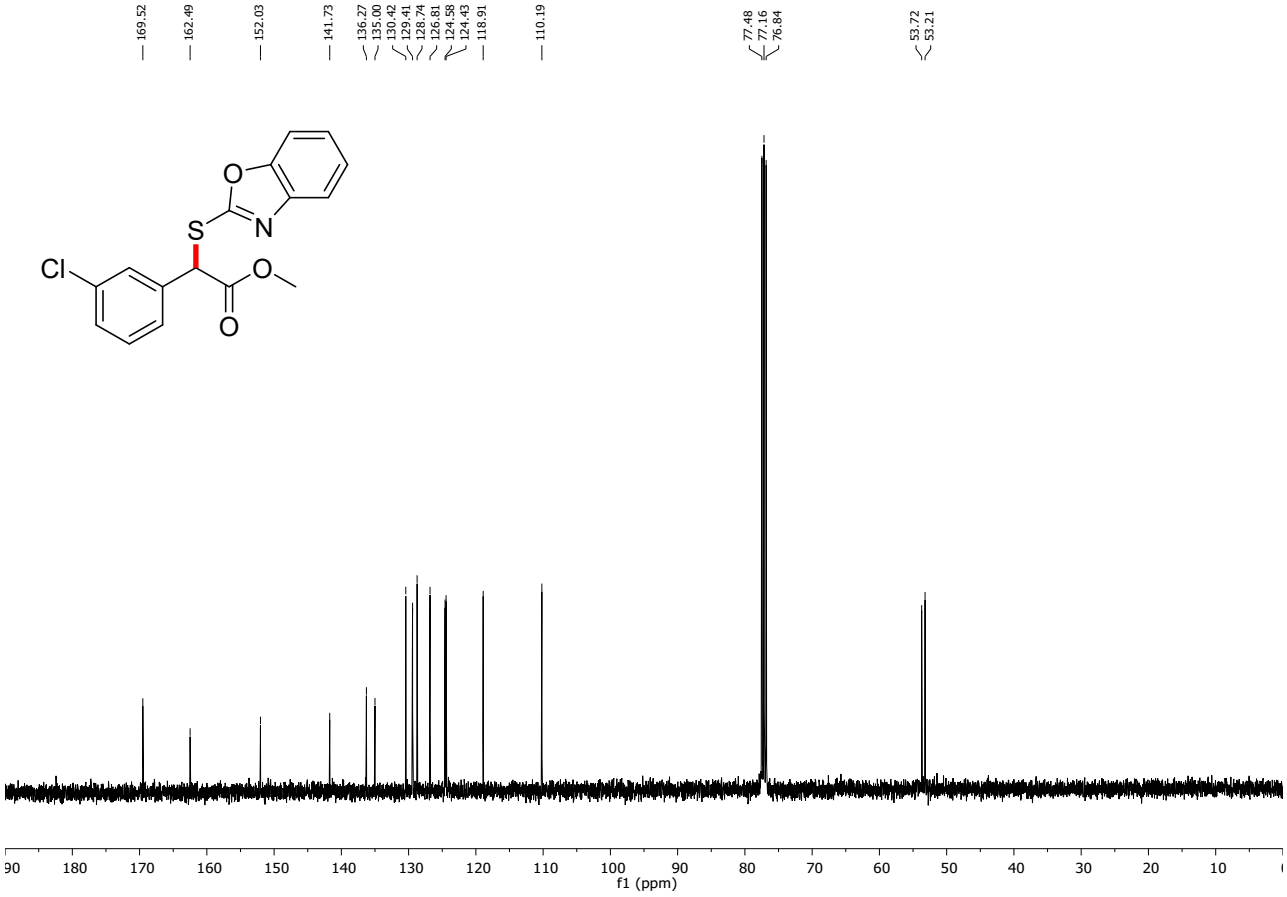

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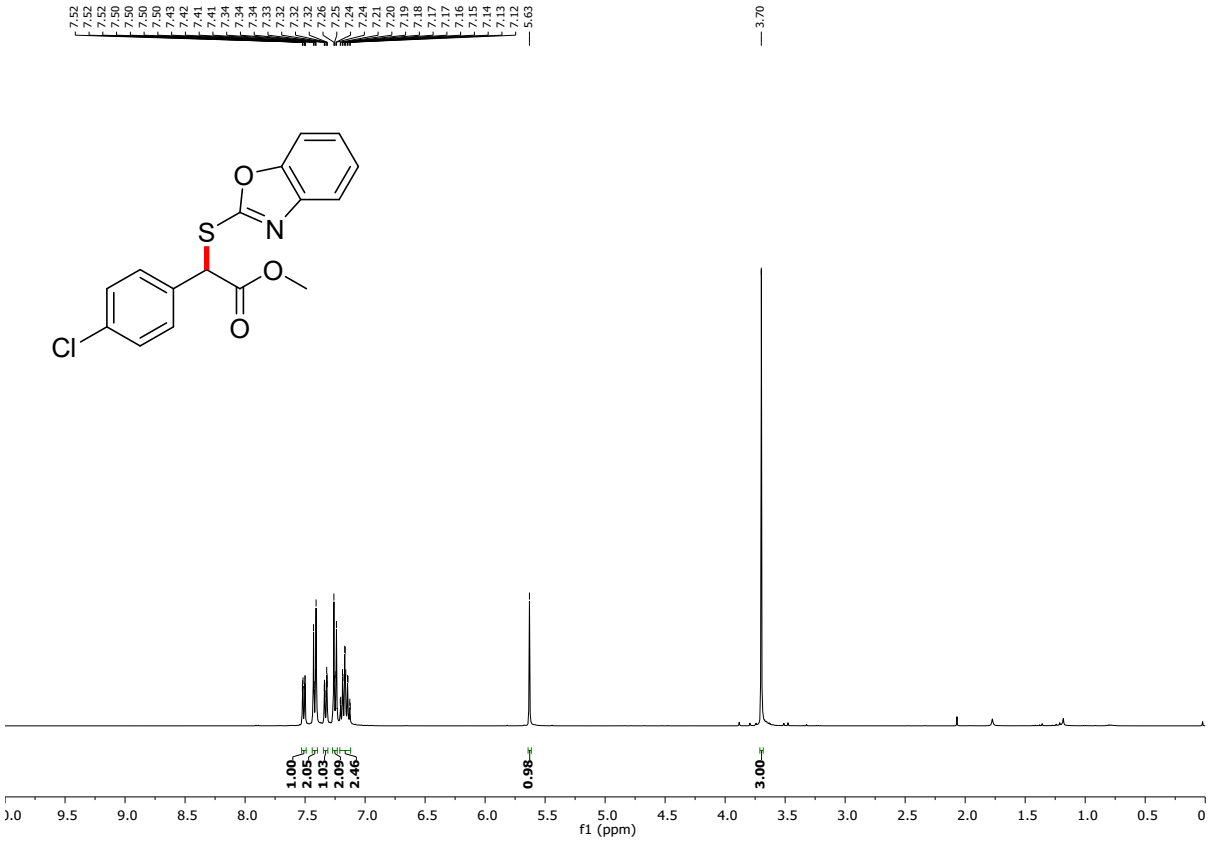

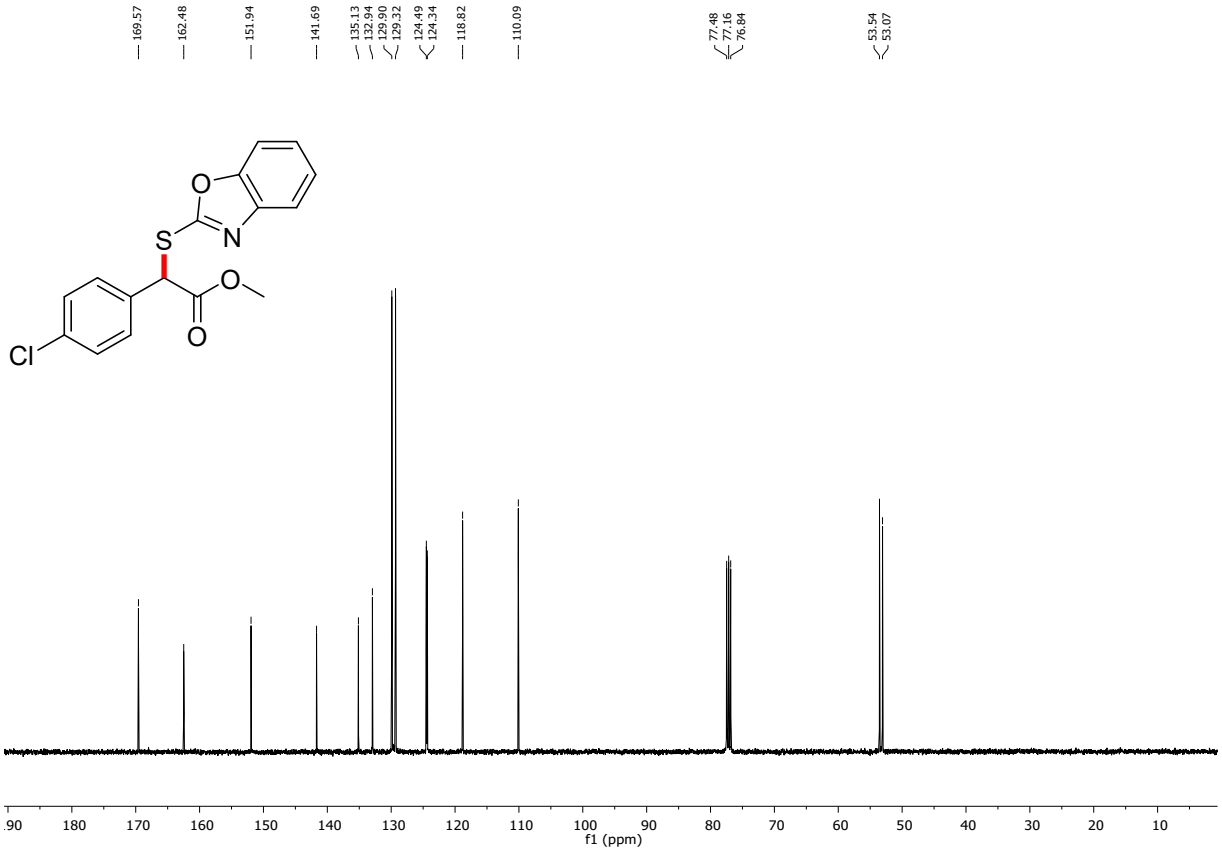

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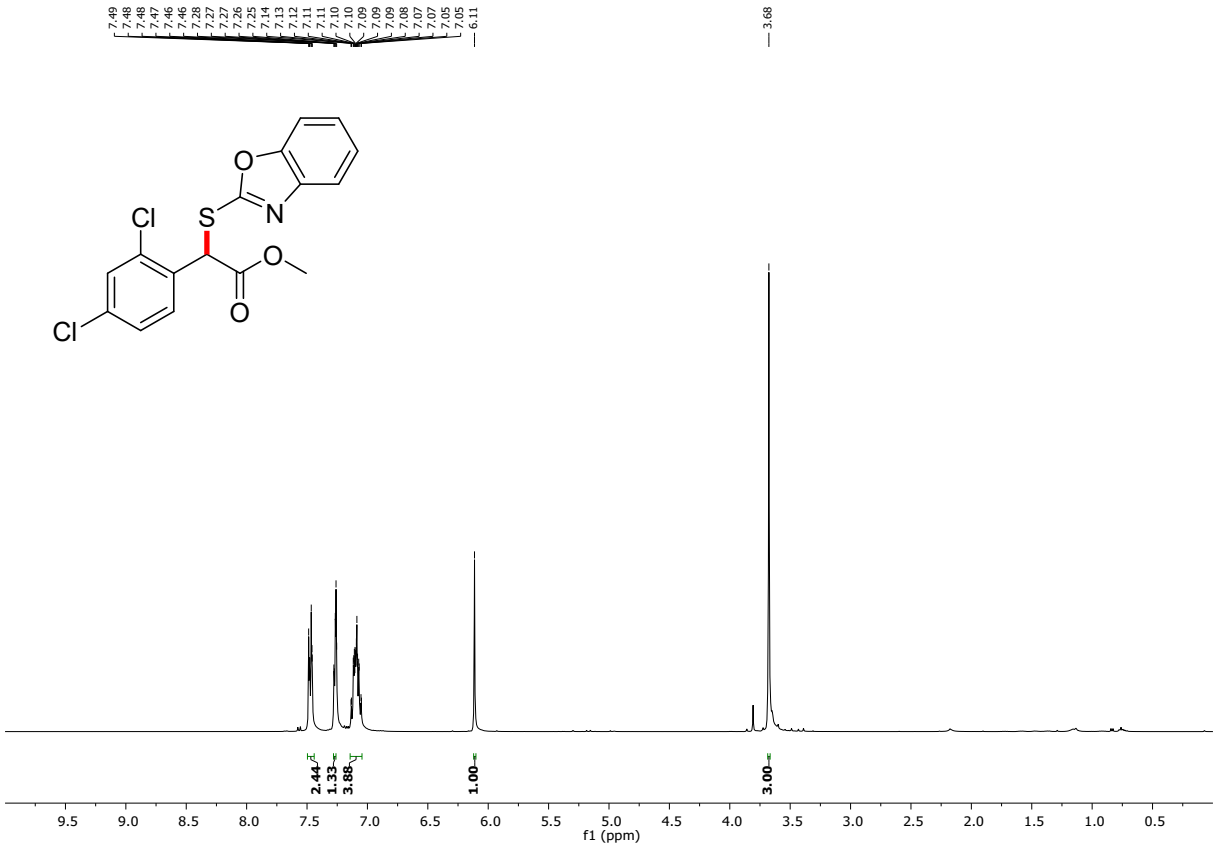
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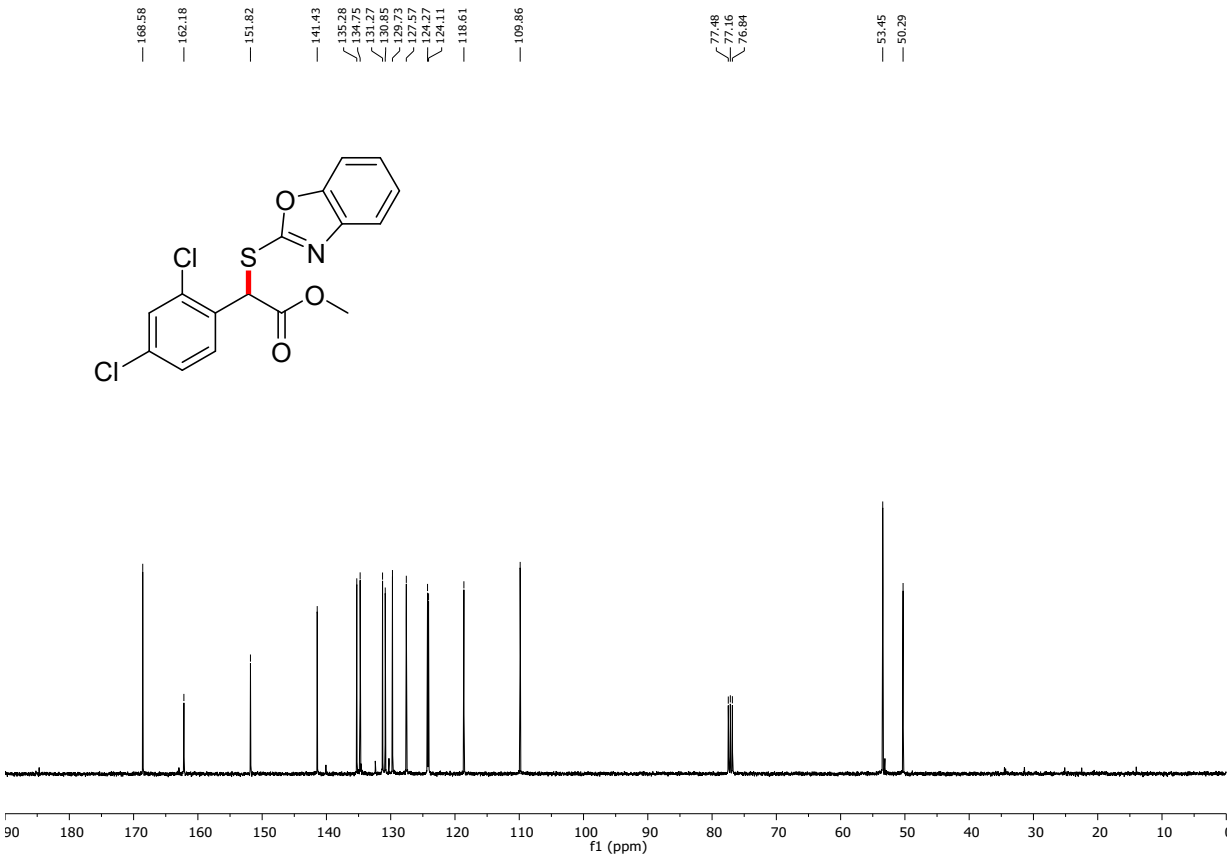
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S
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O
O
Cl
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160
150
140
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120
110
100
90
80
70
60
50
40
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20
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f1 (ppm)

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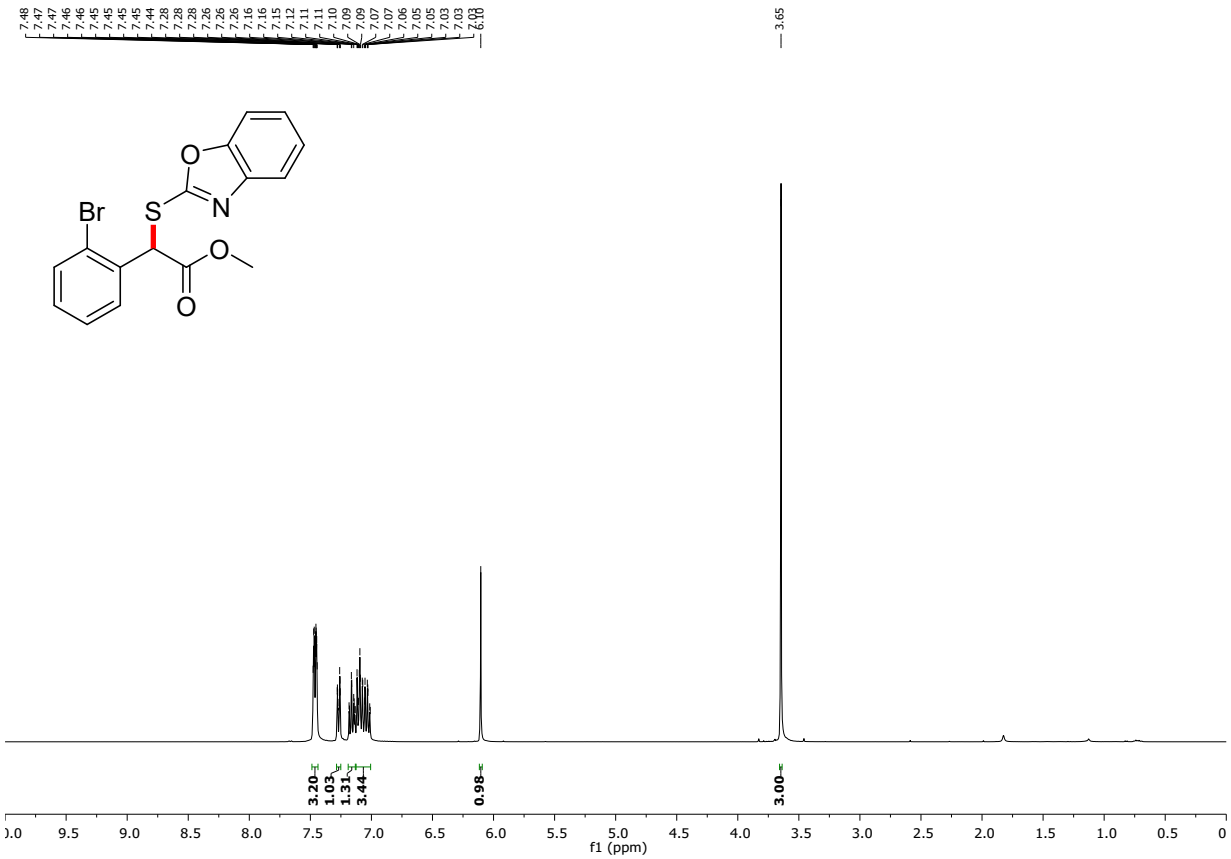

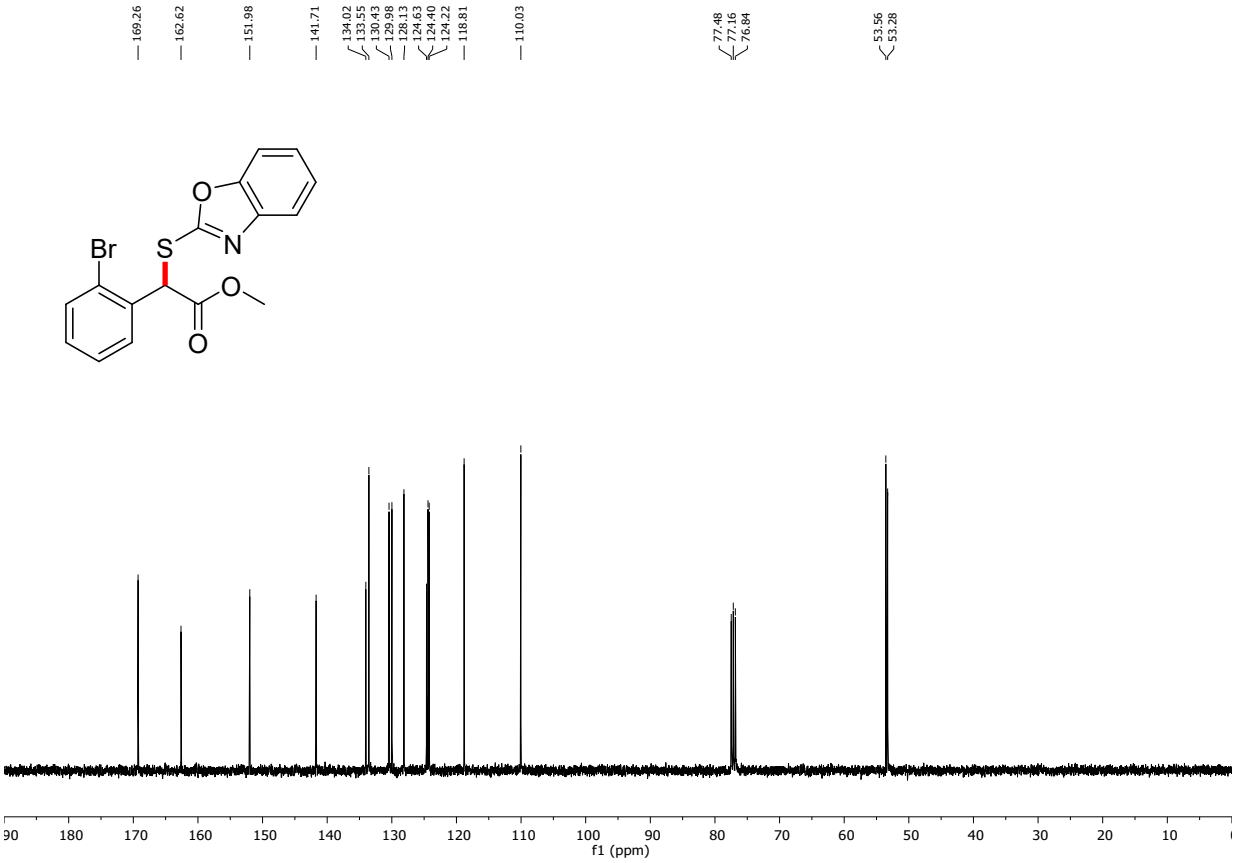

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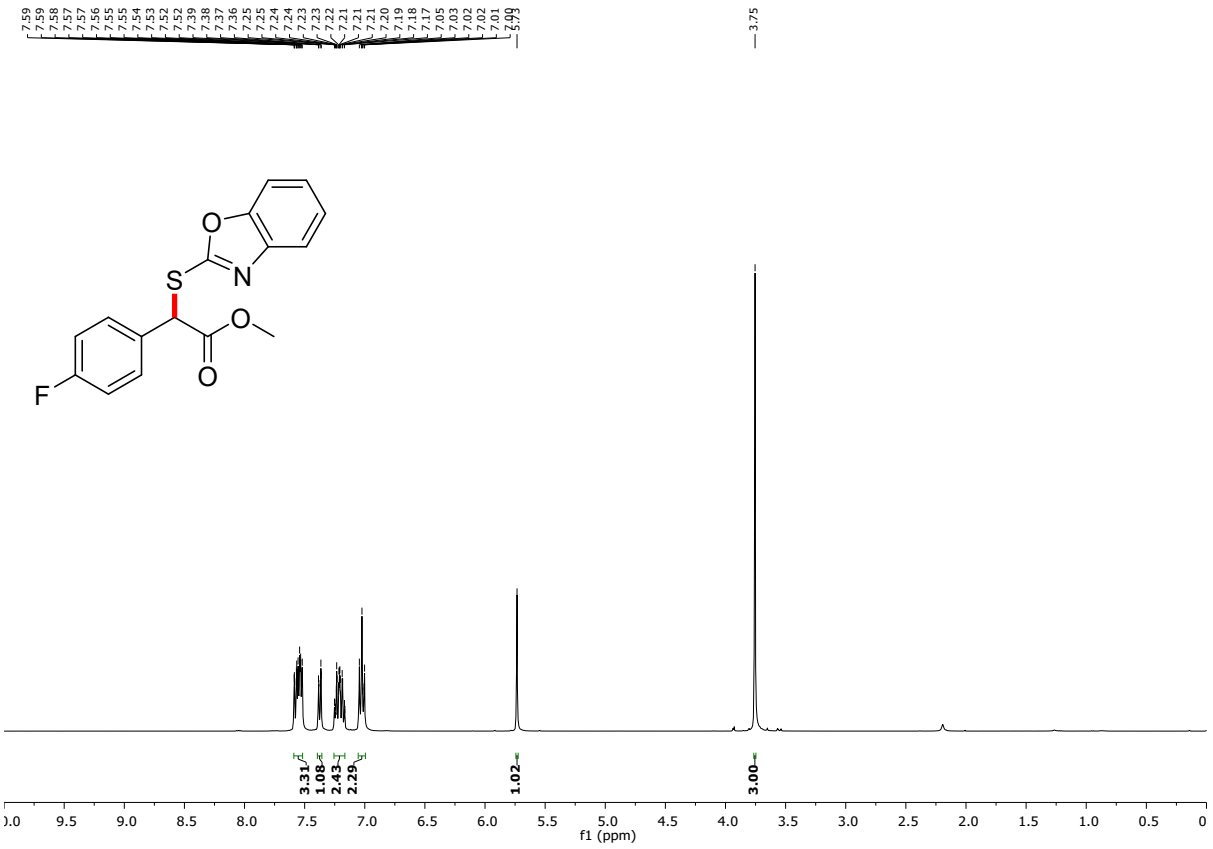

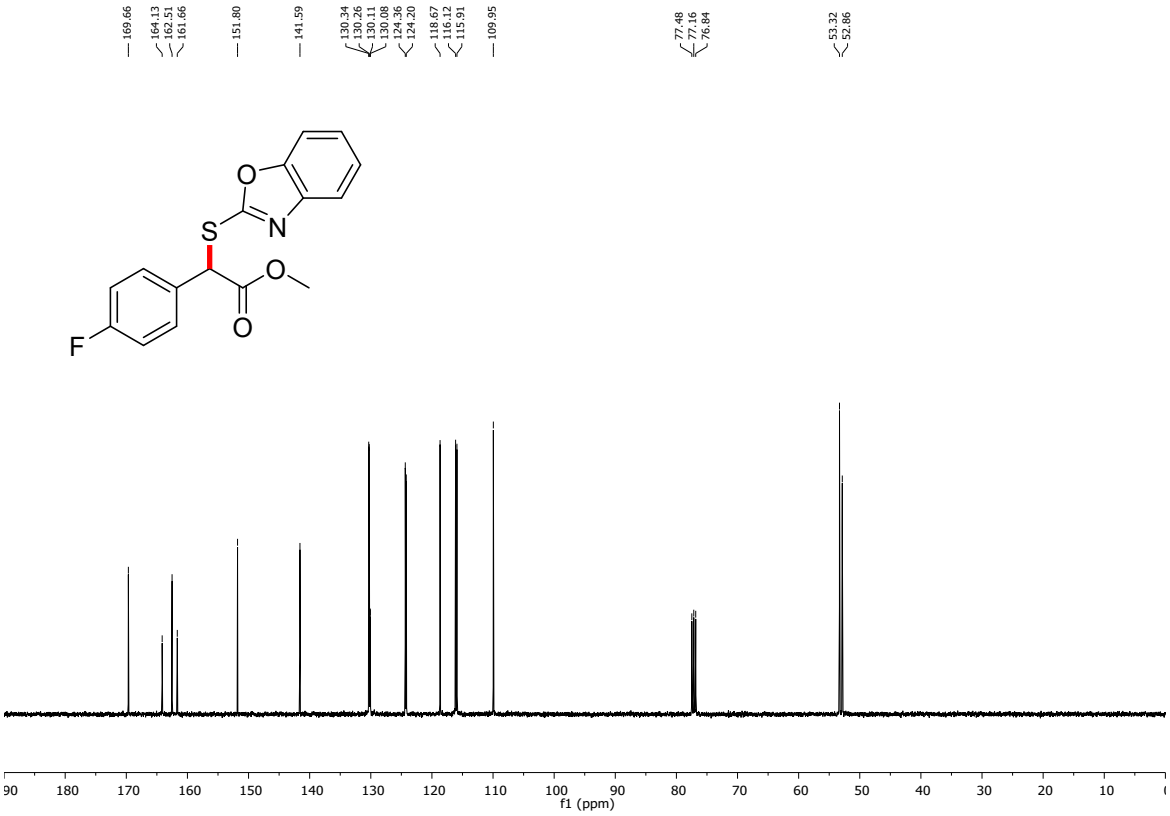

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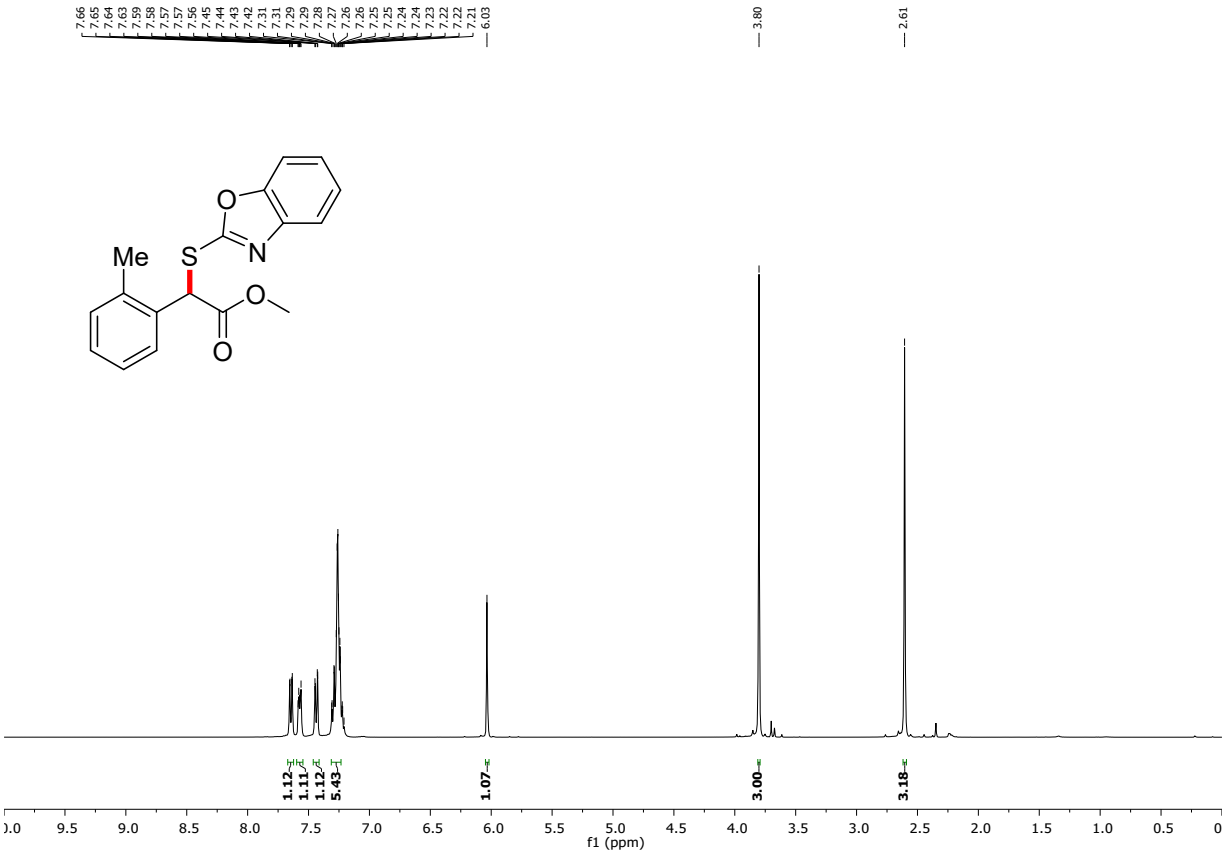

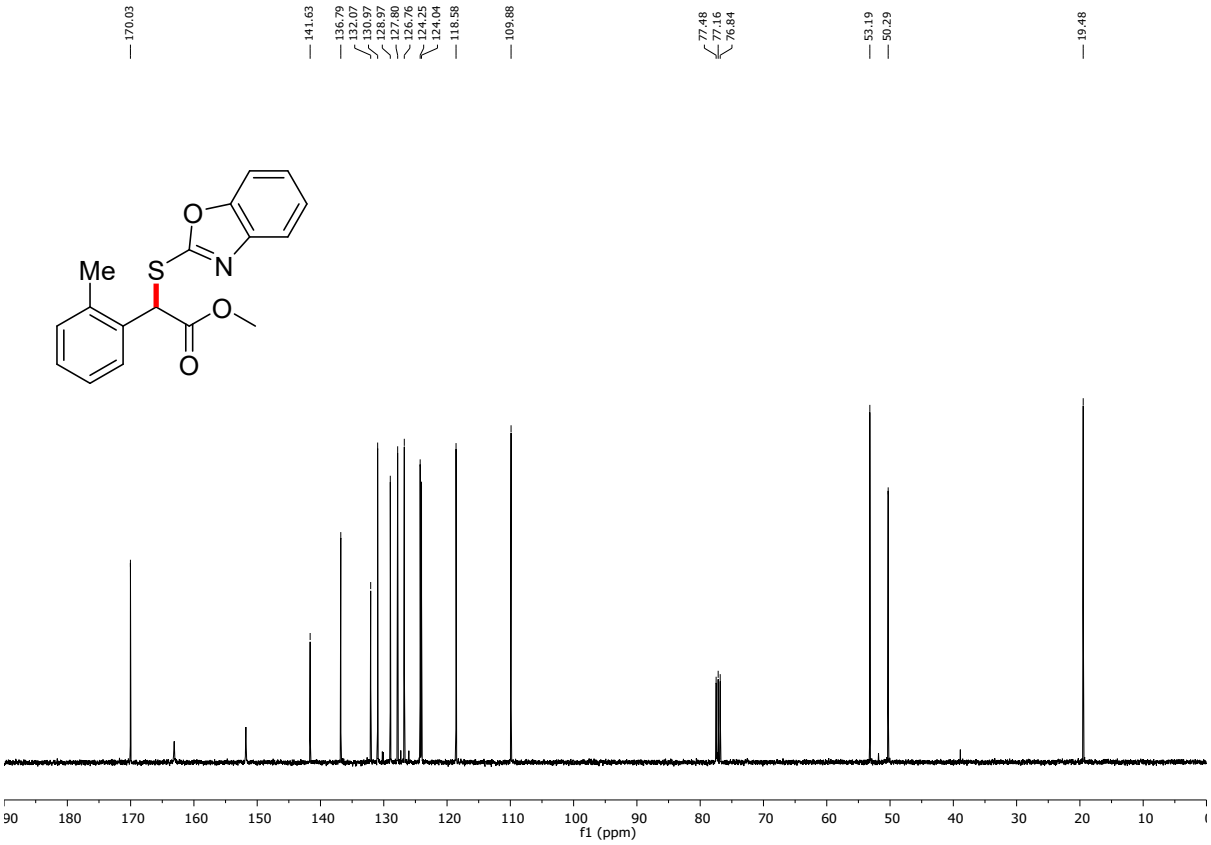

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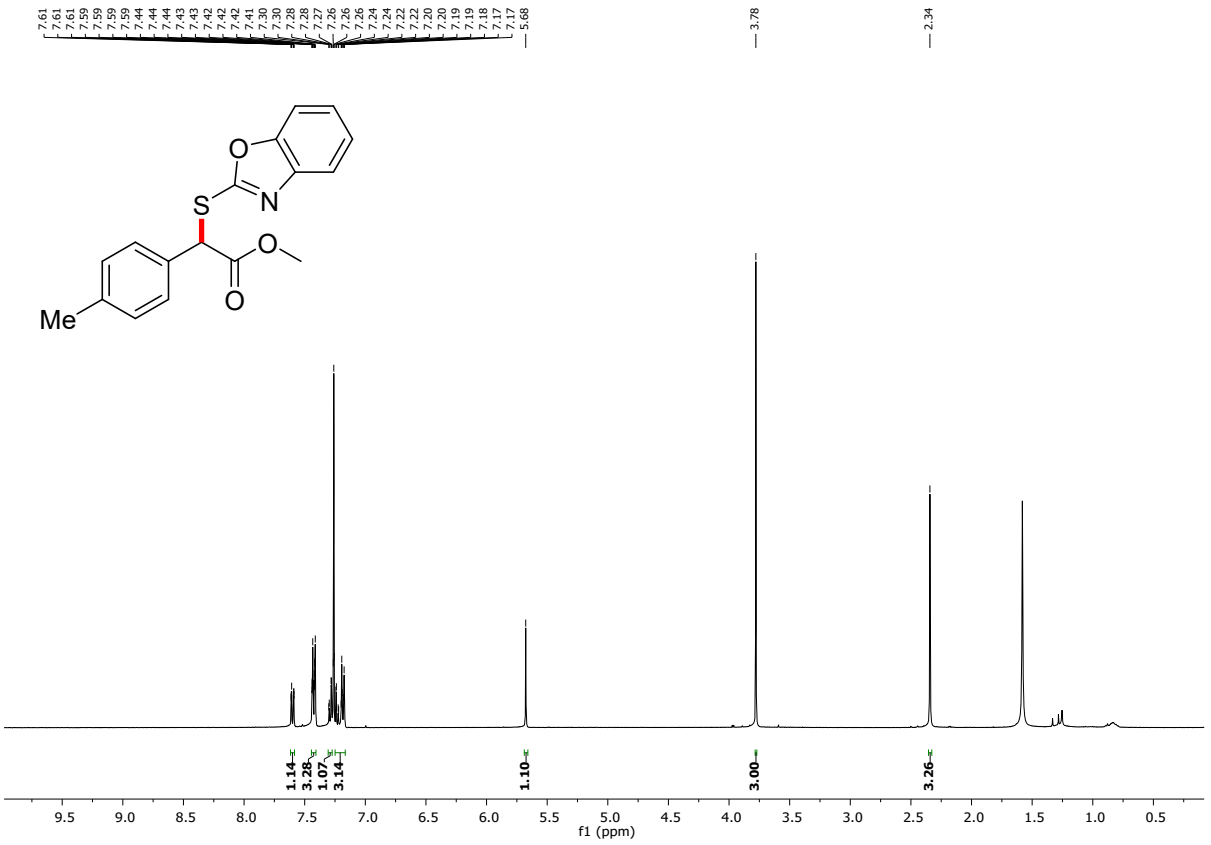

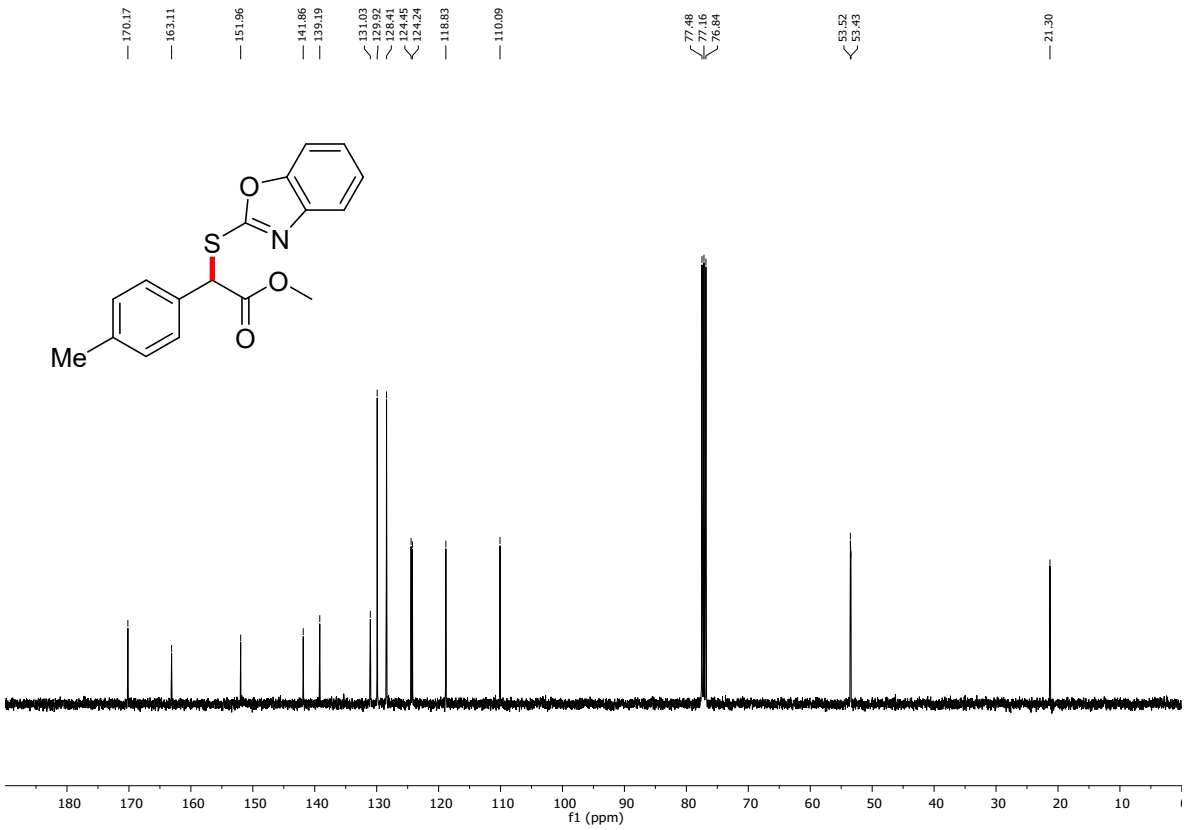

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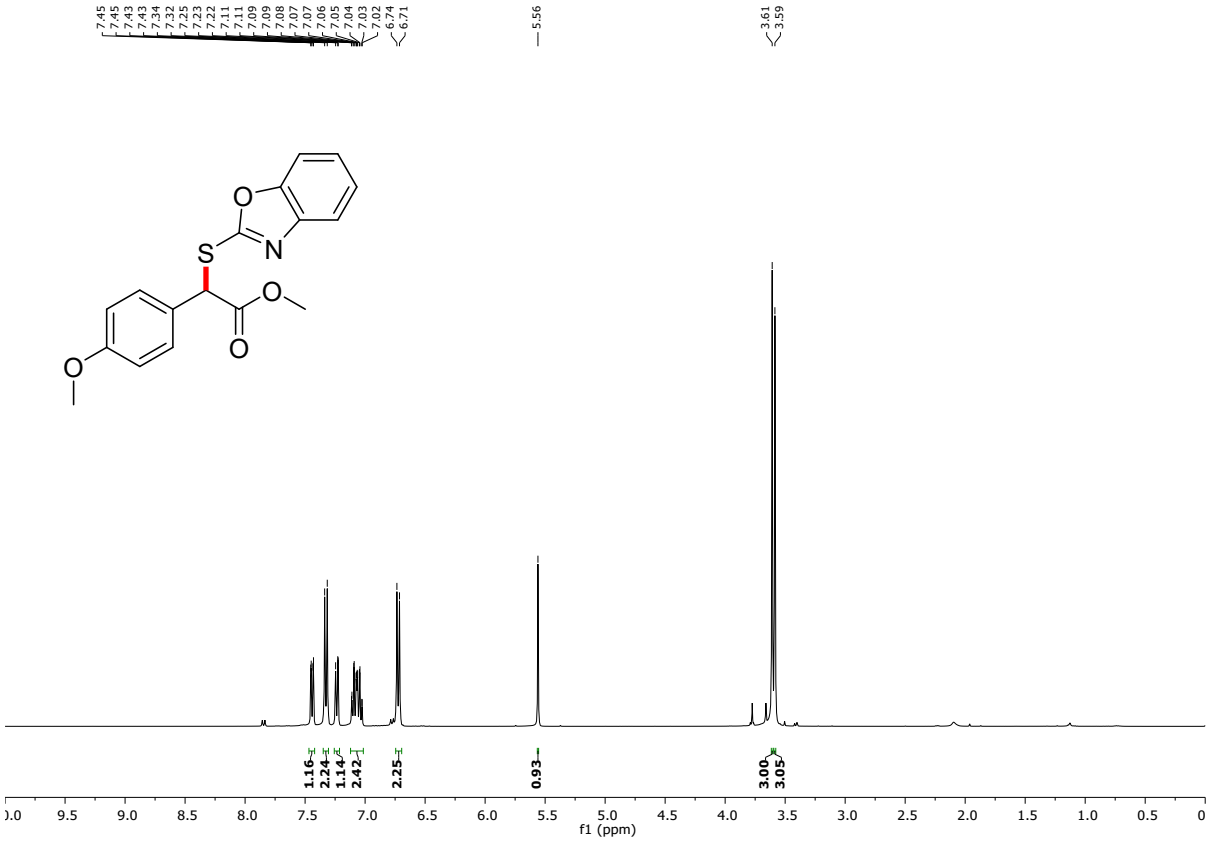

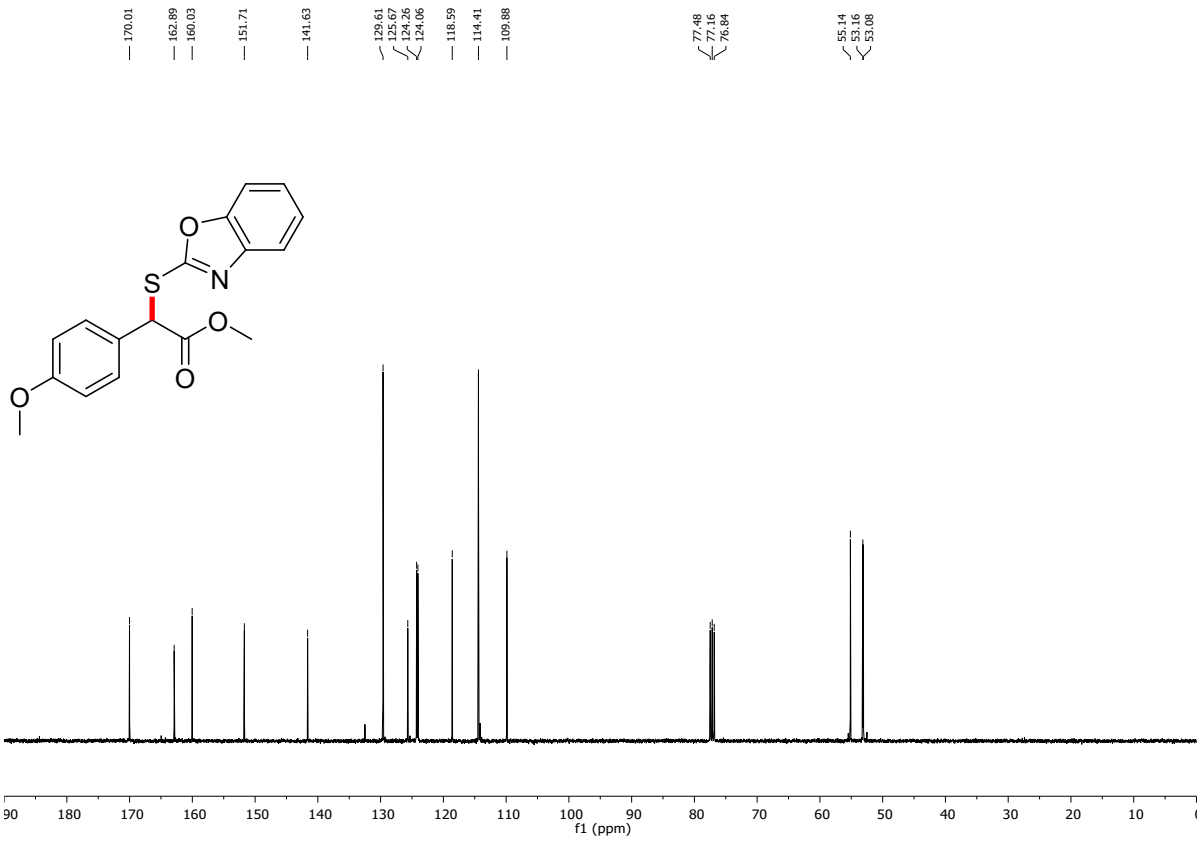

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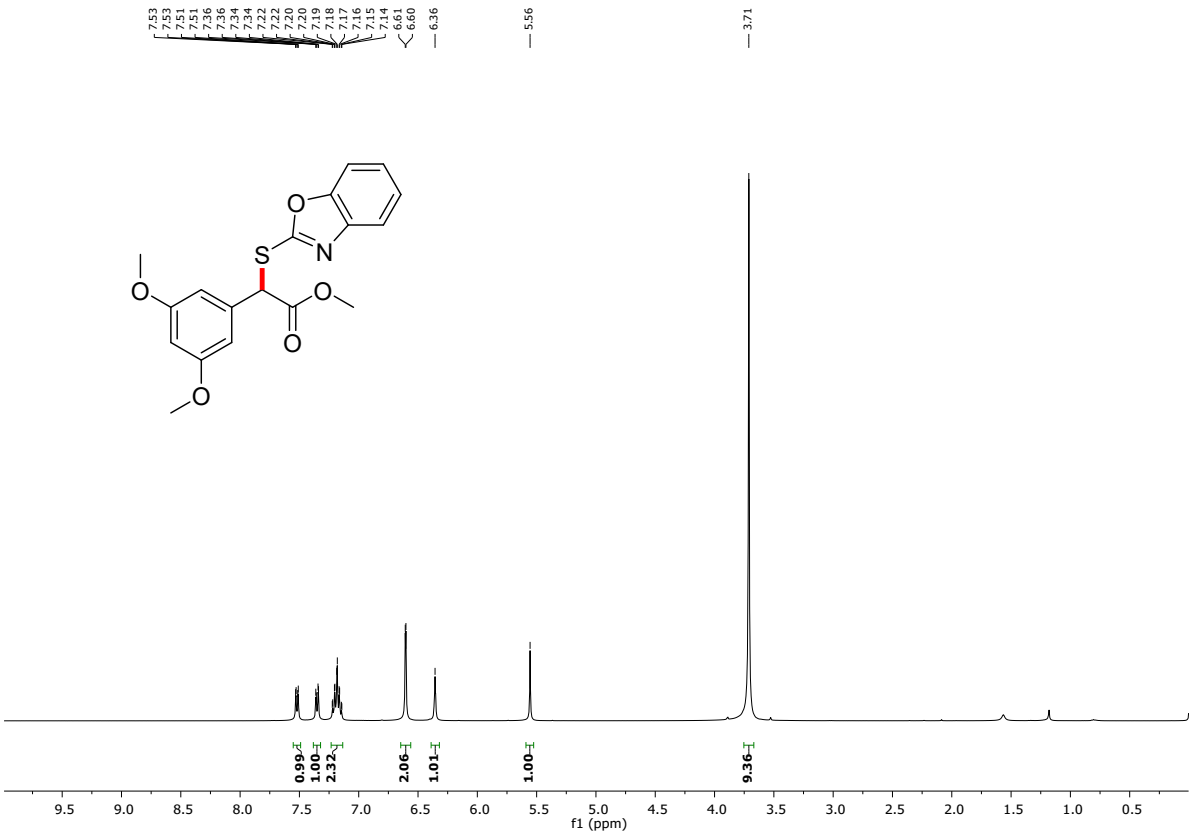

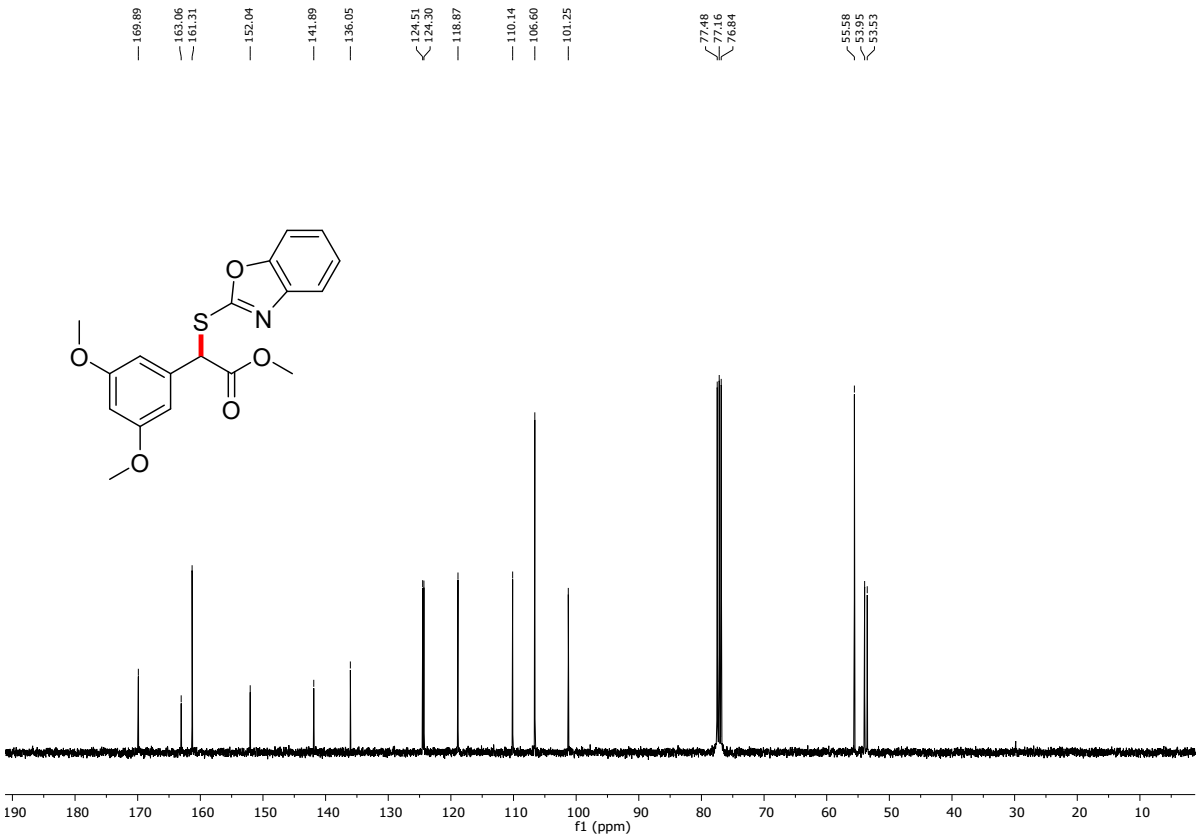

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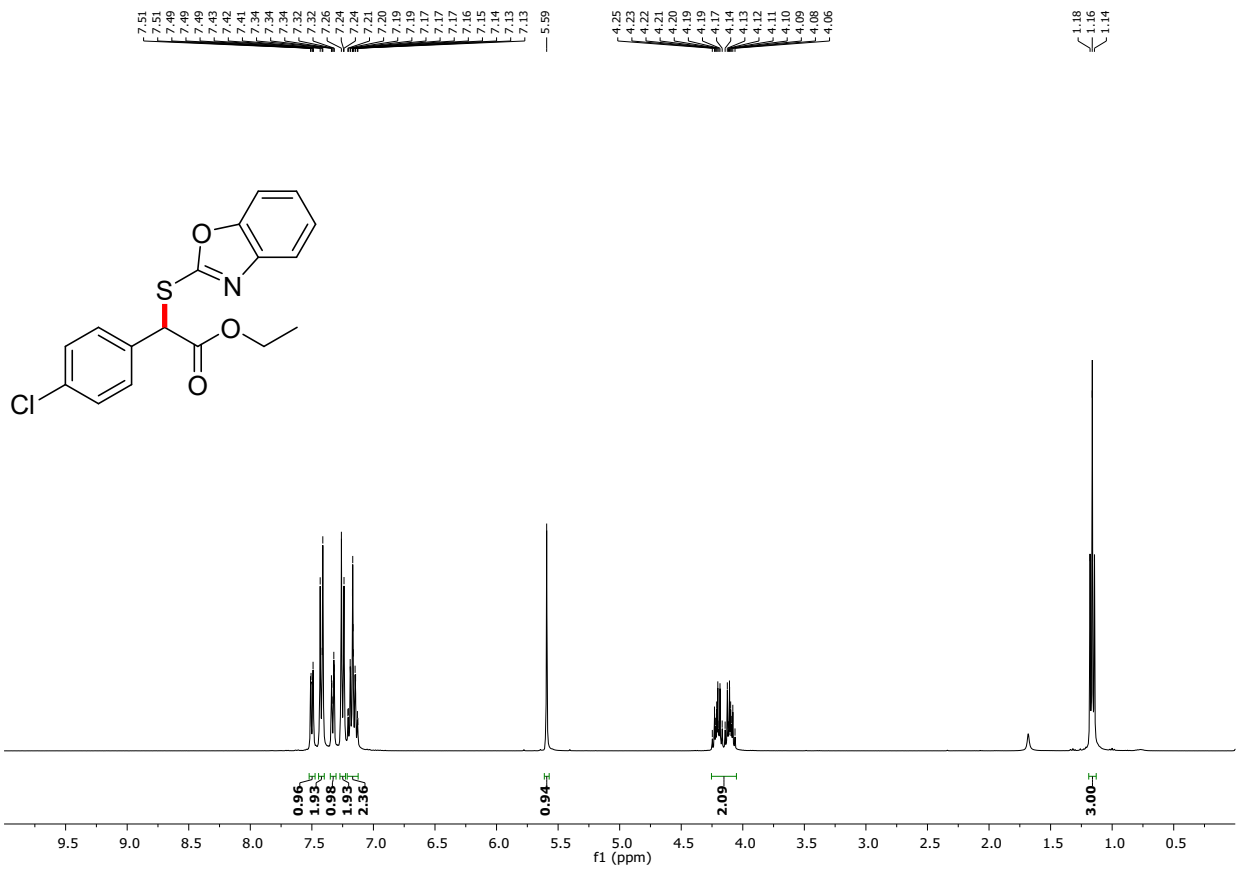
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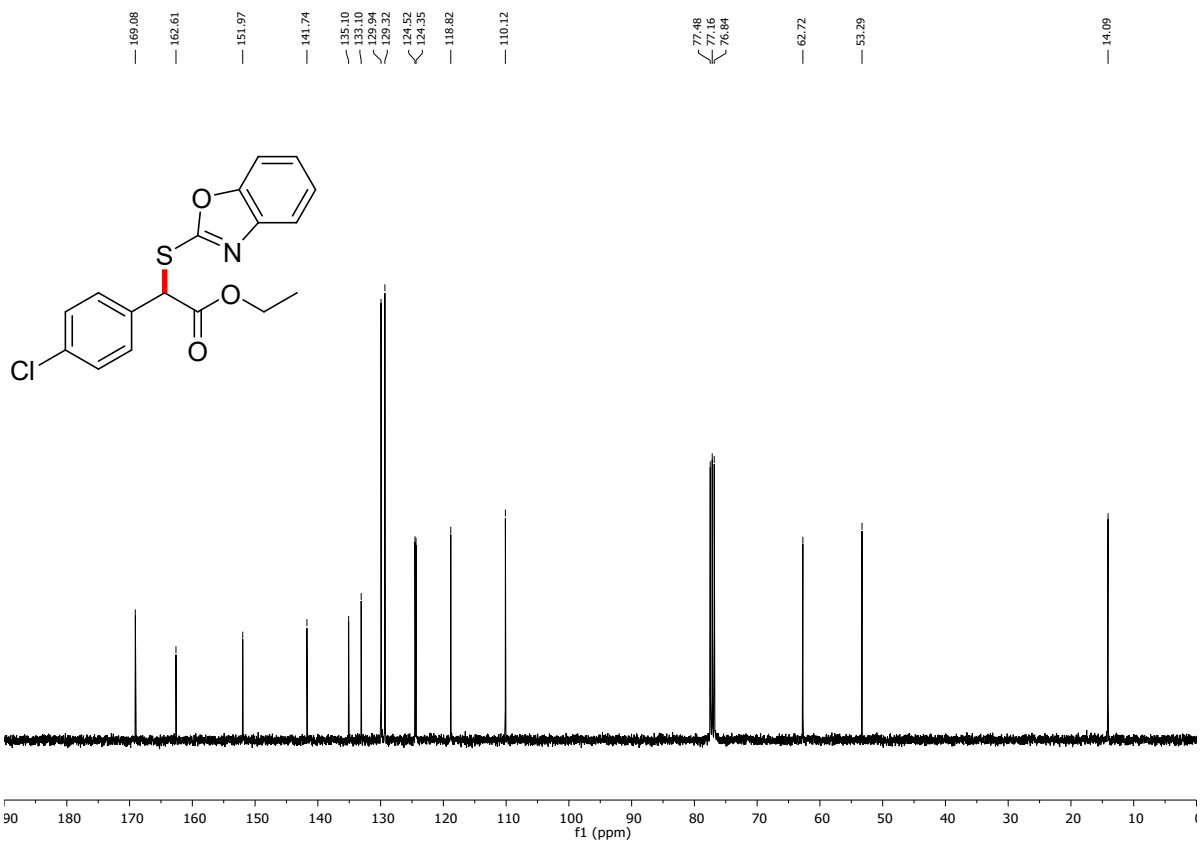
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O
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N
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O
Cl
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f1 (ppm)

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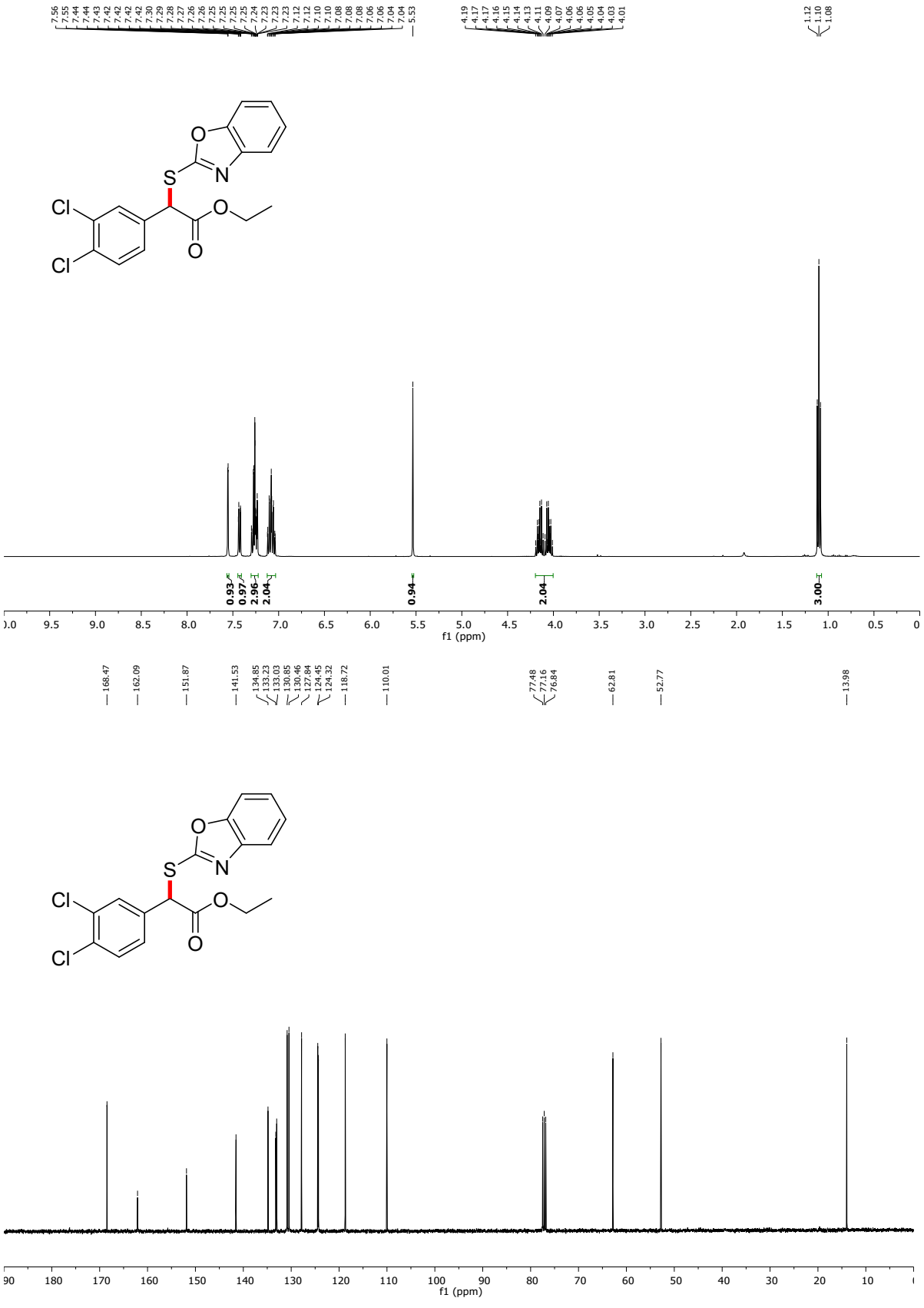

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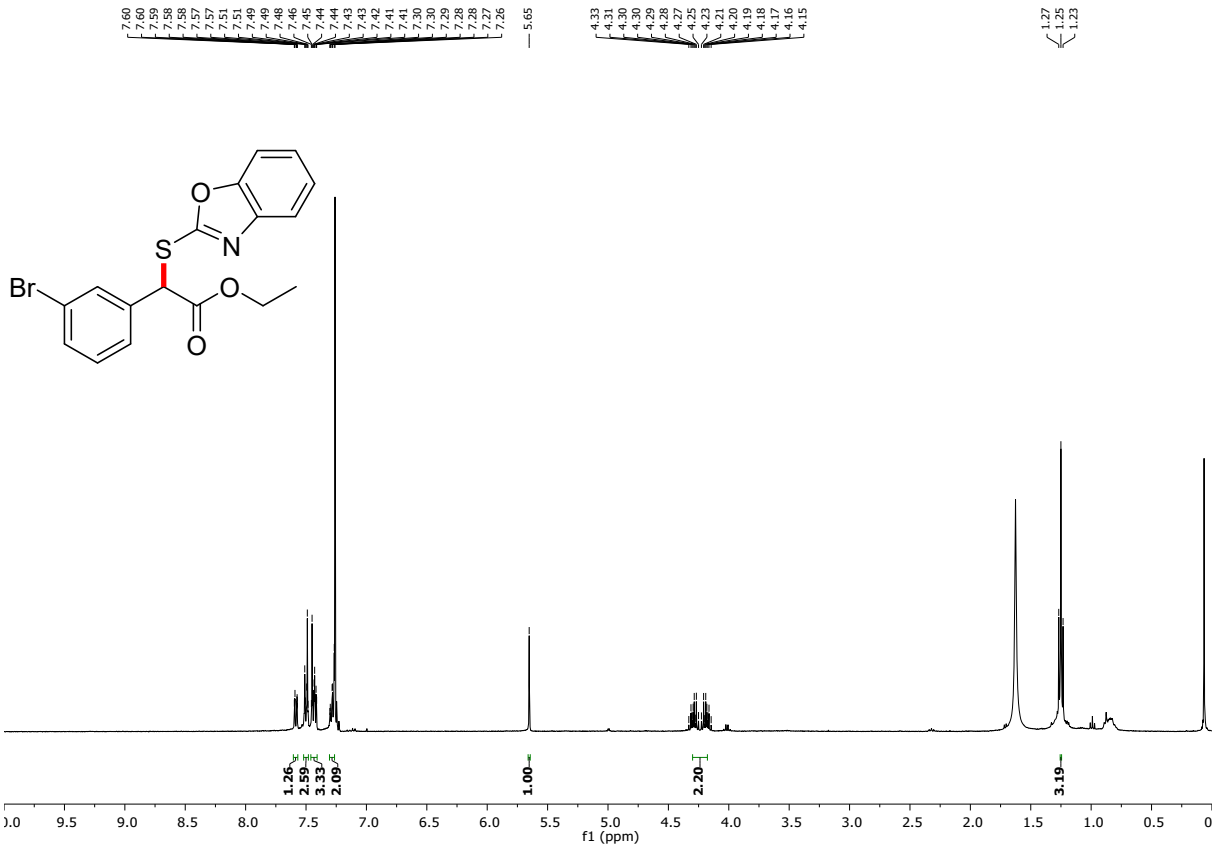

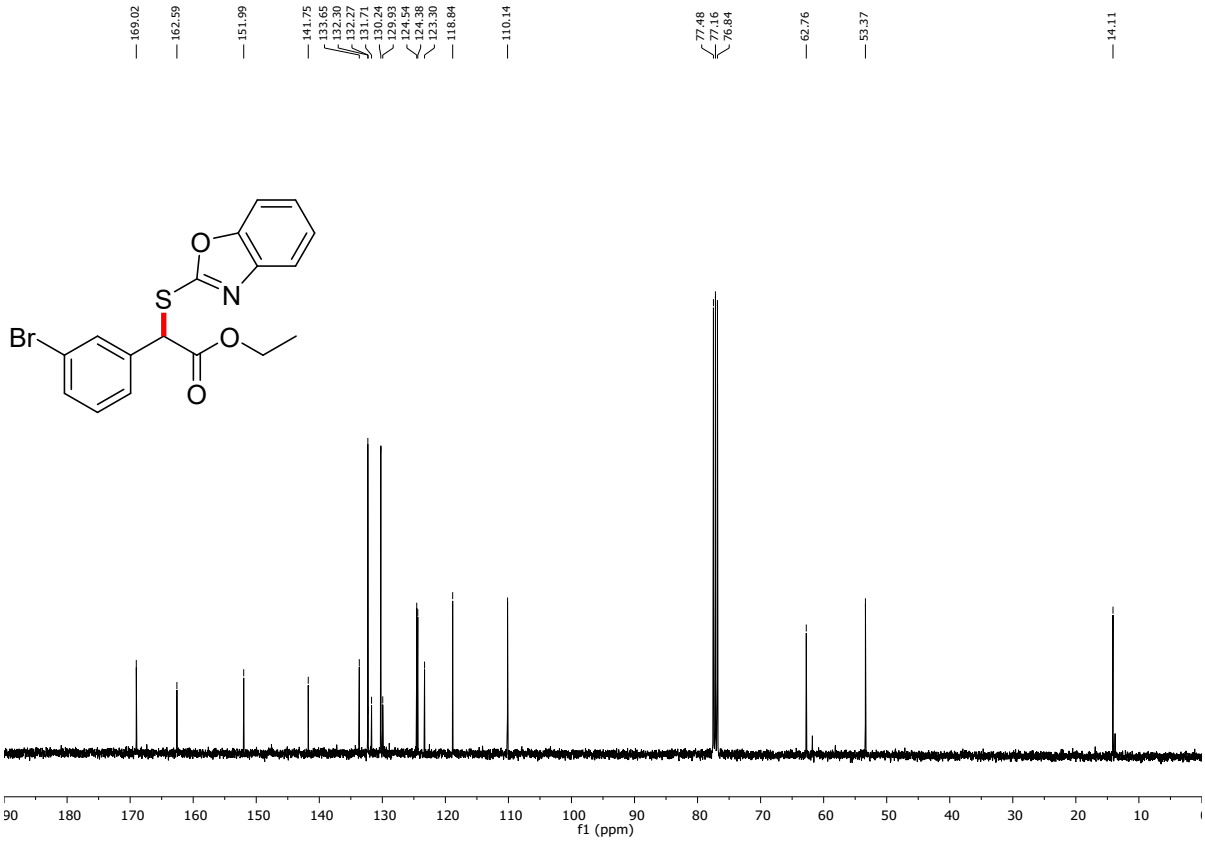

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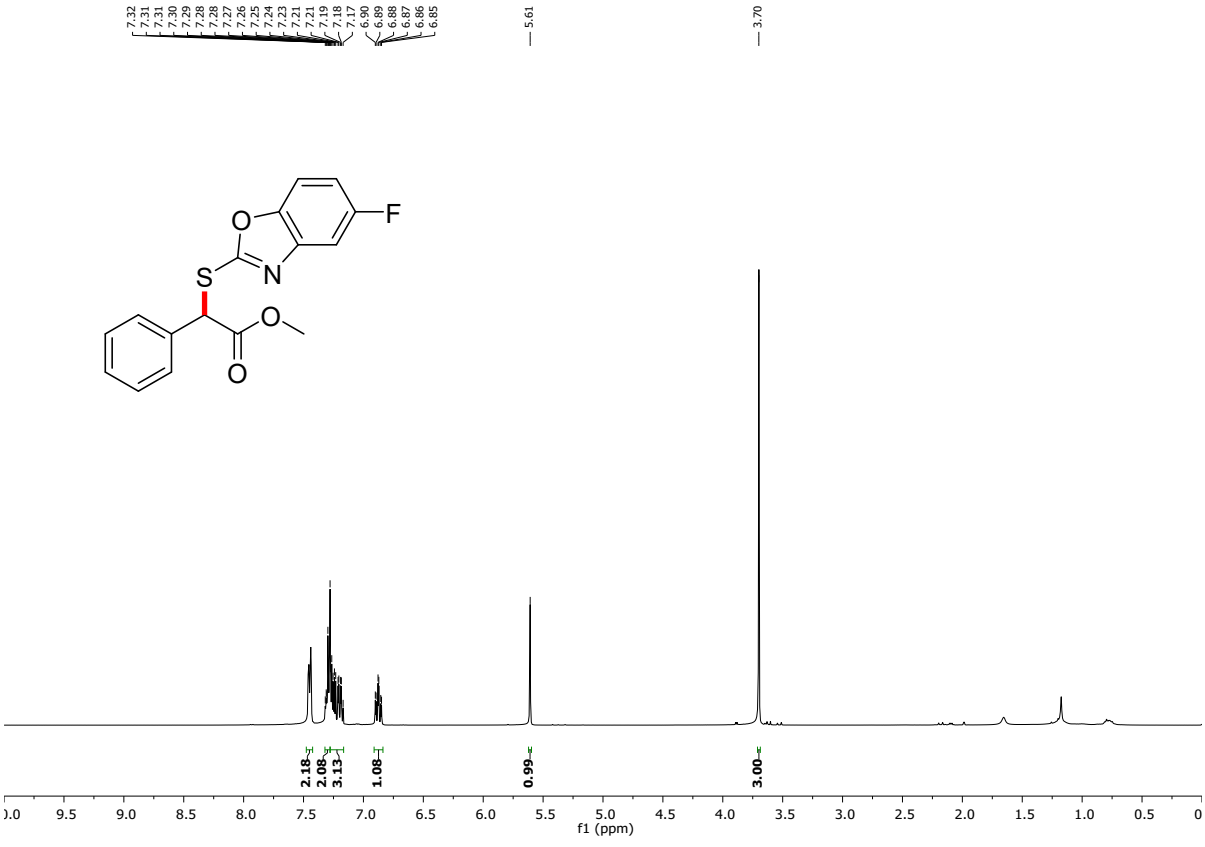

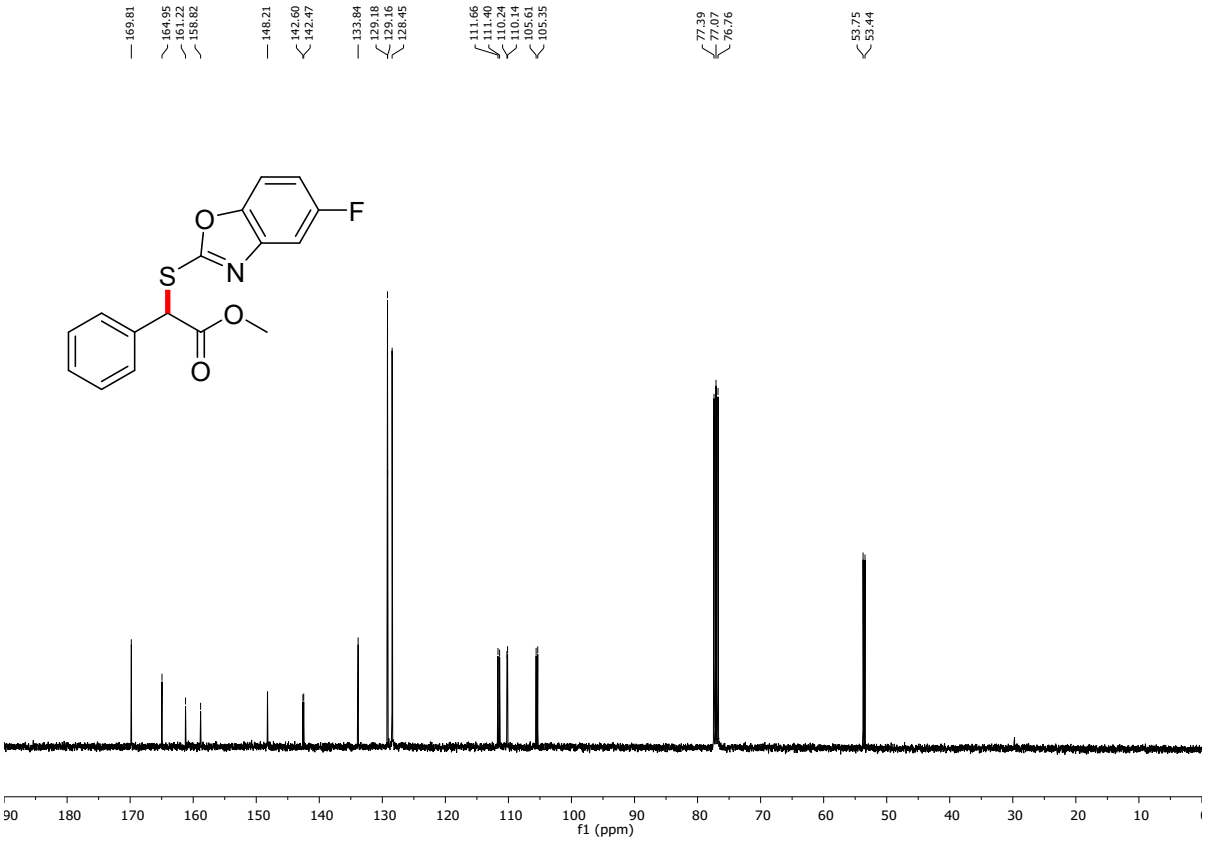

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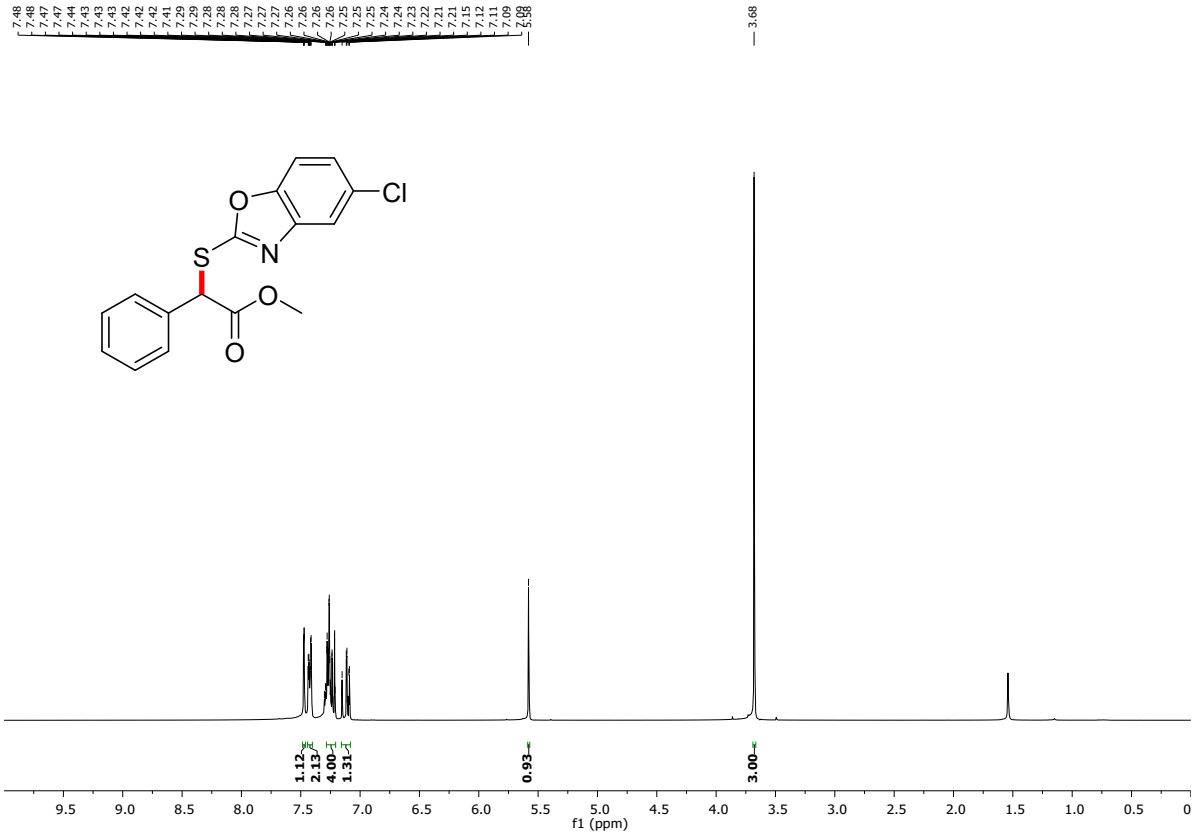
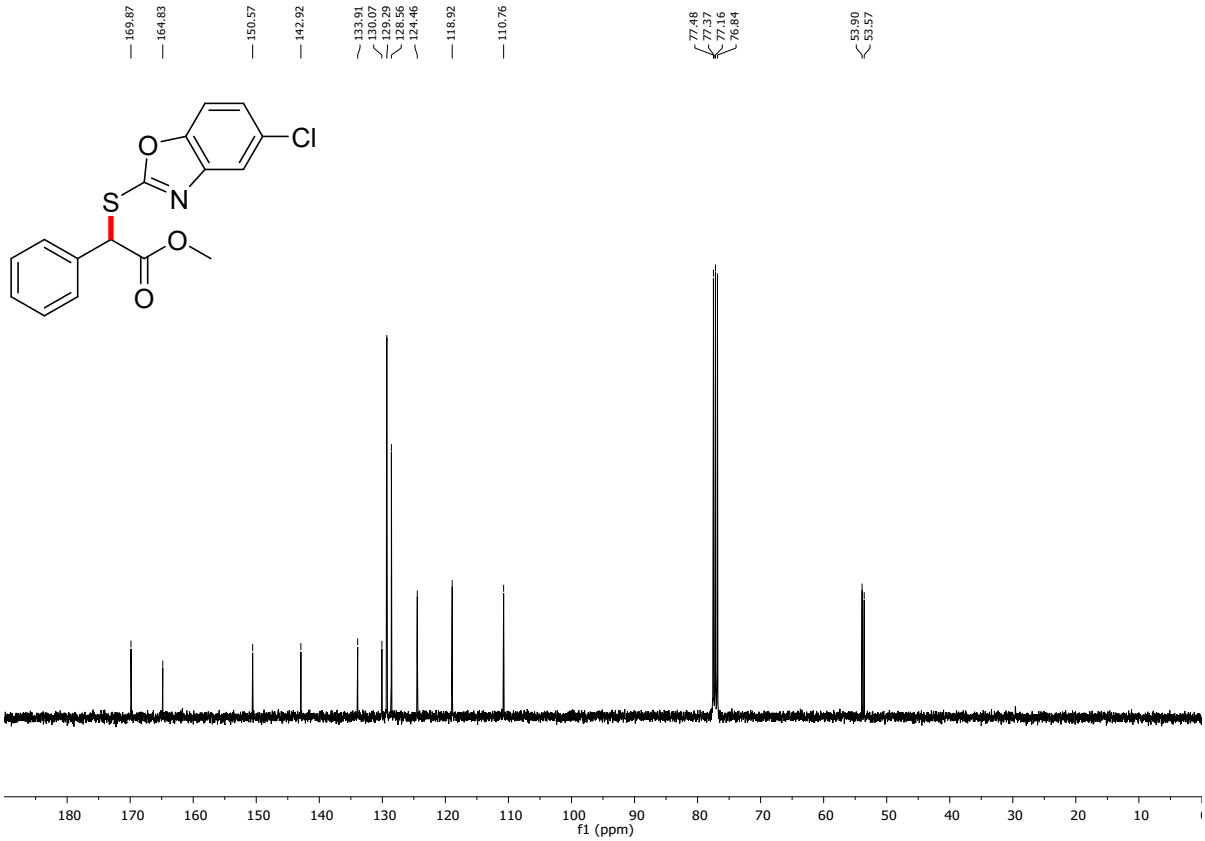
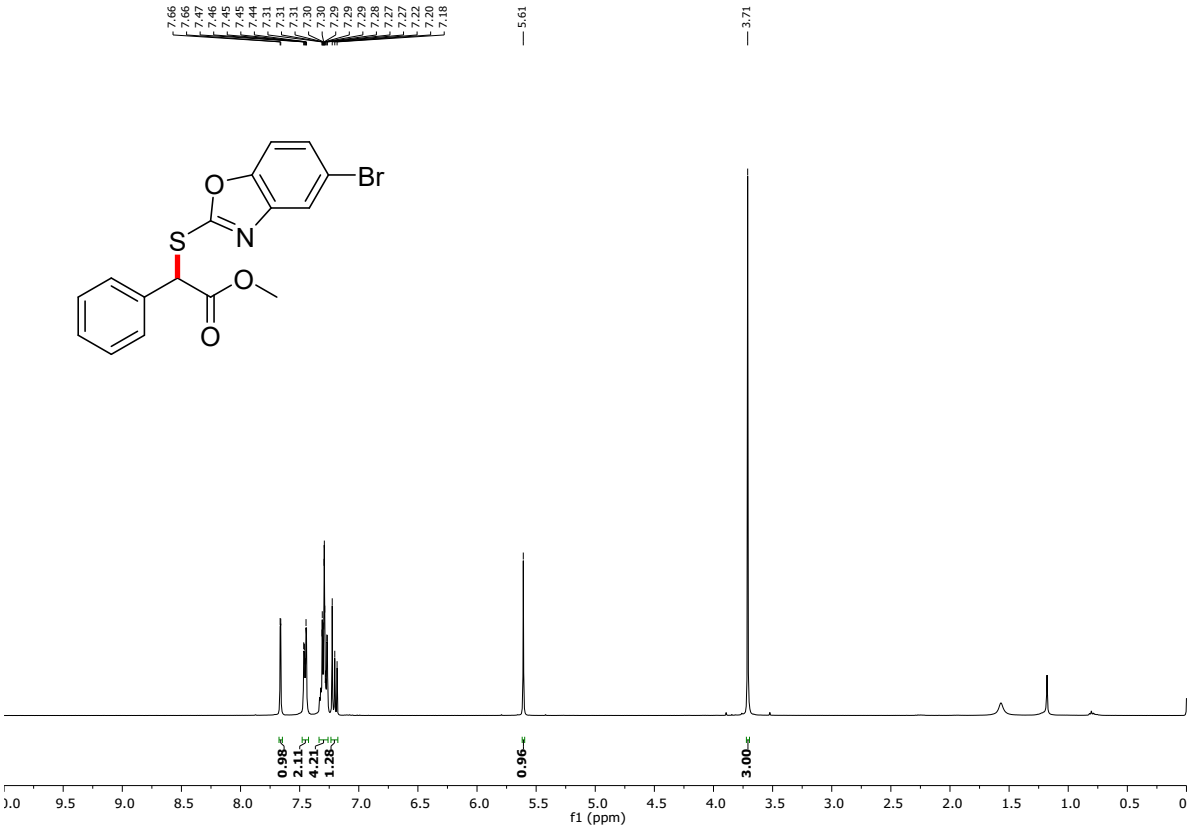
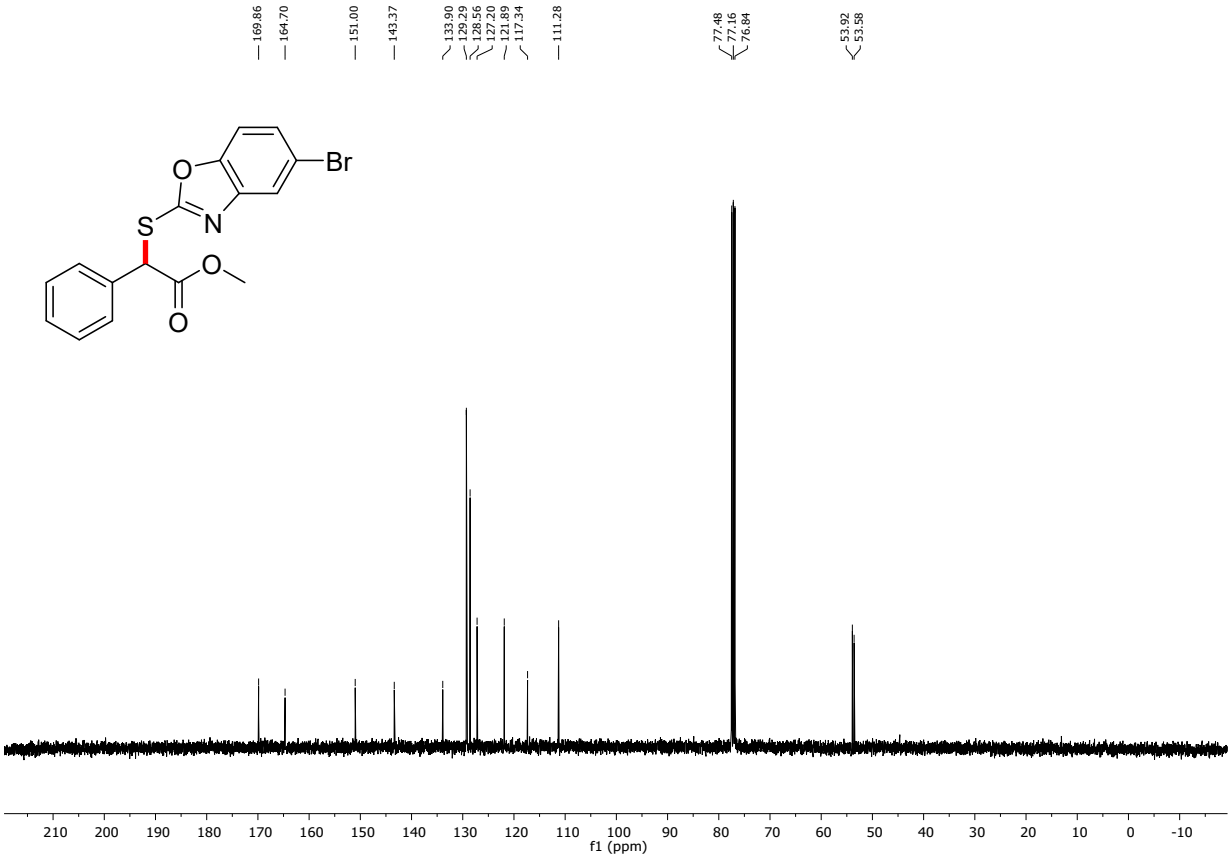


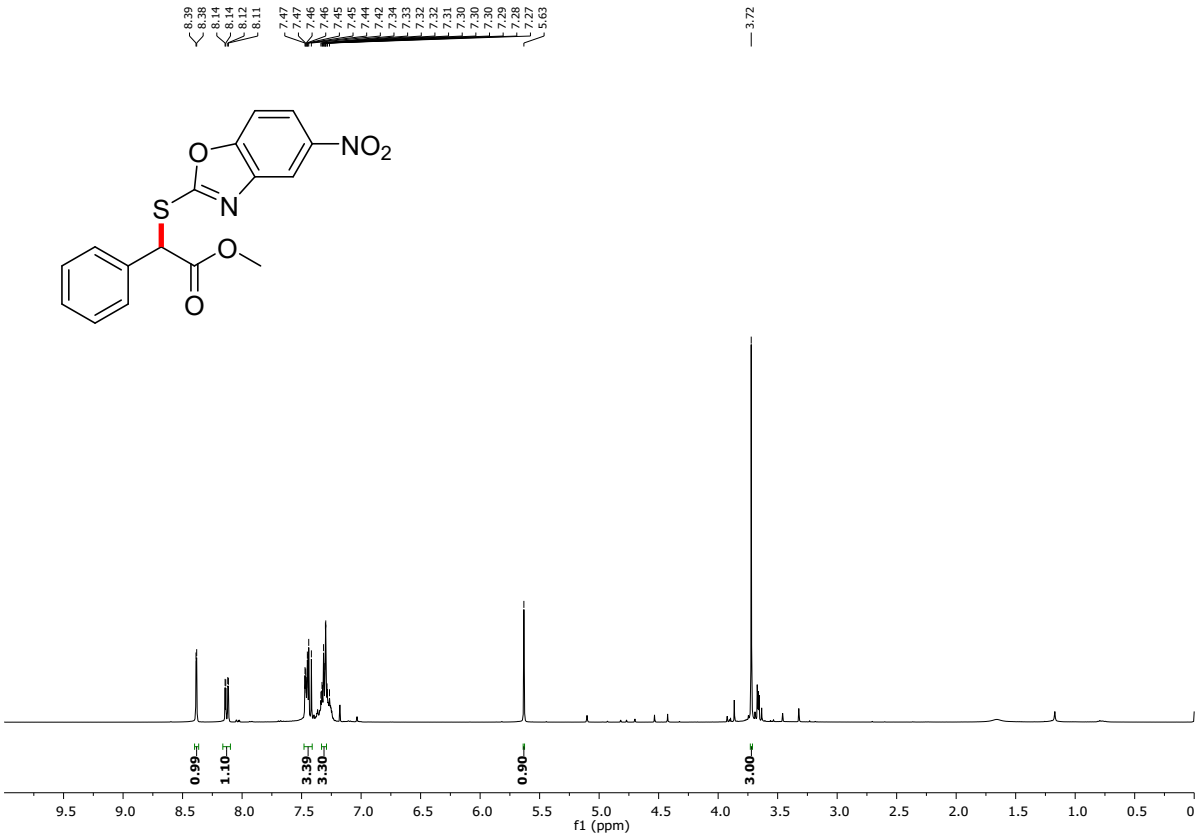


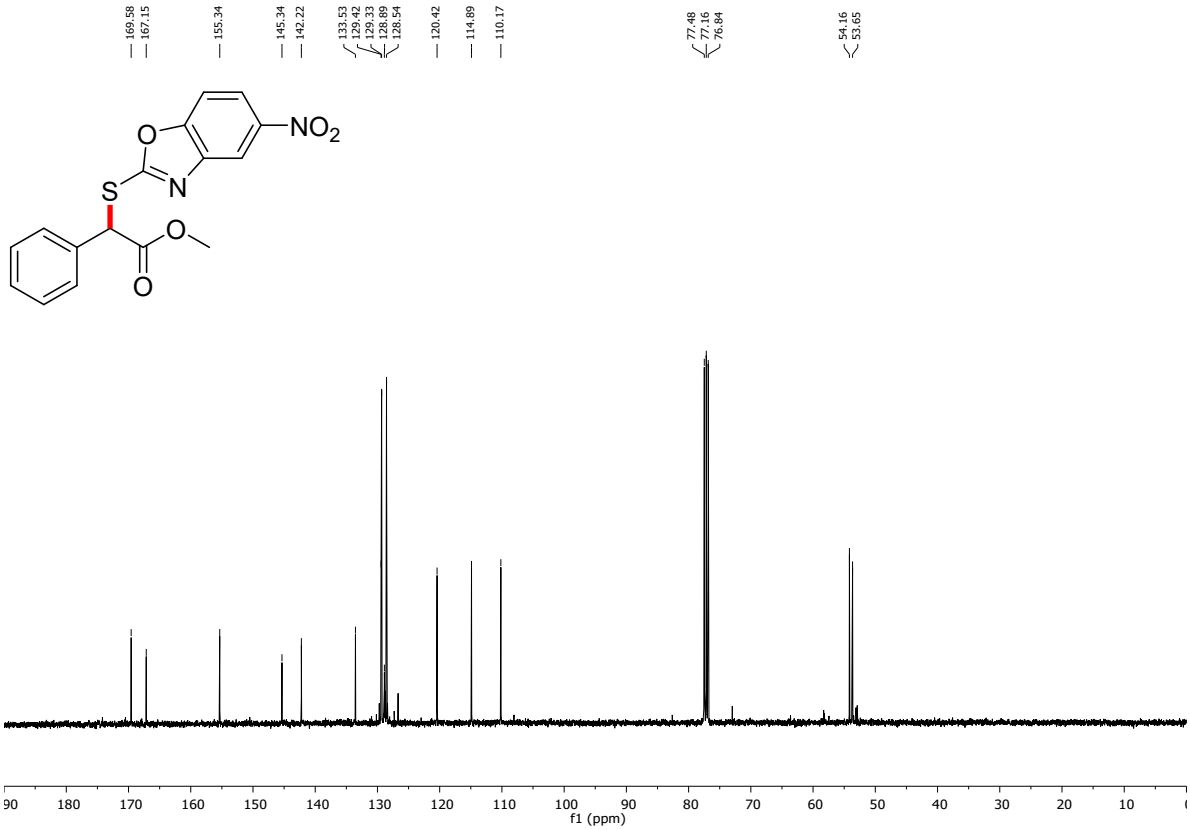
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4c**:



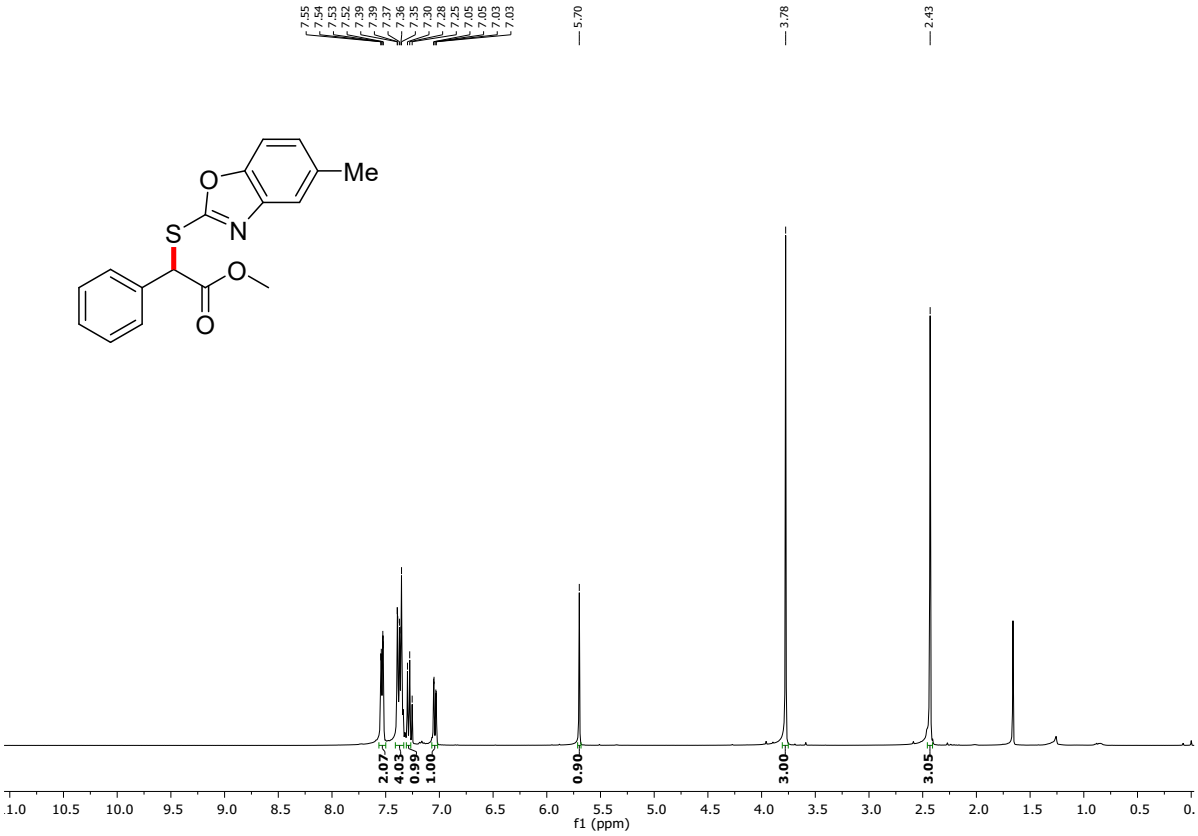


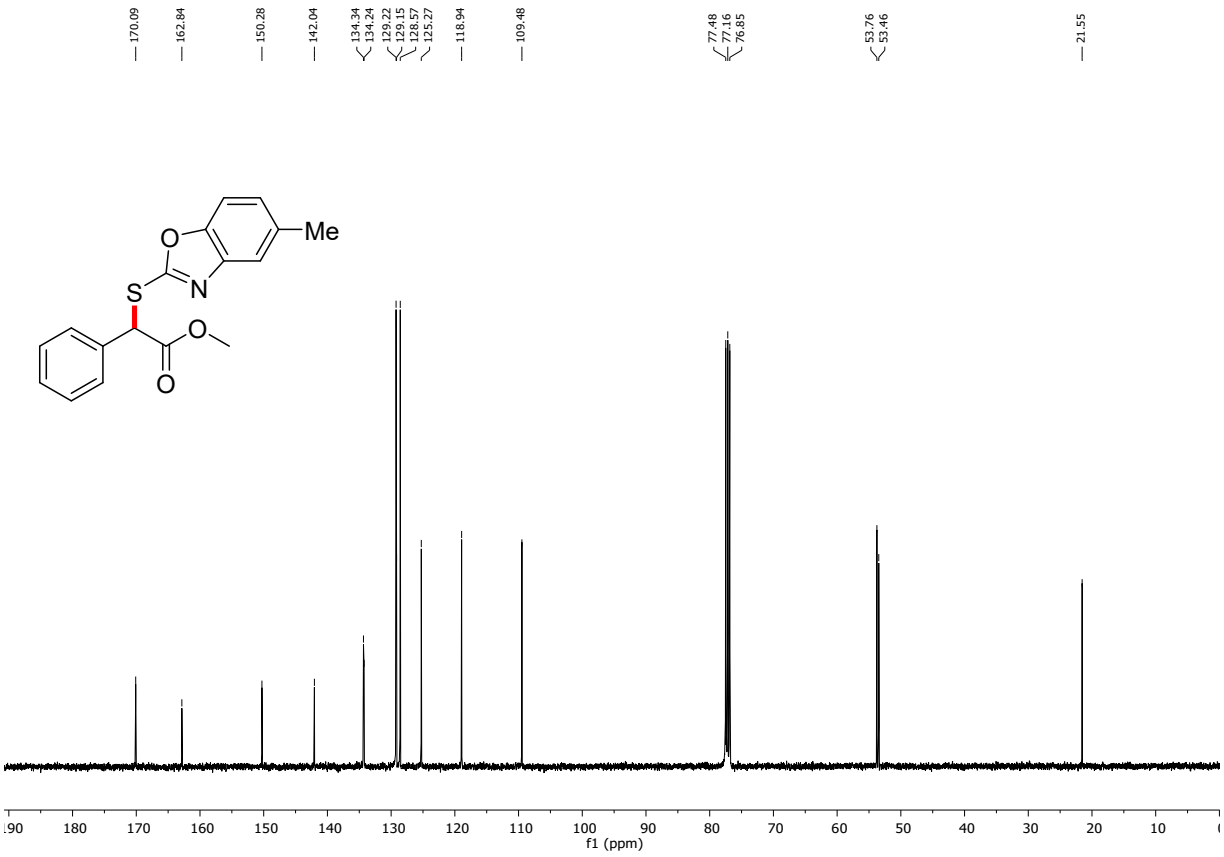
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4d**:



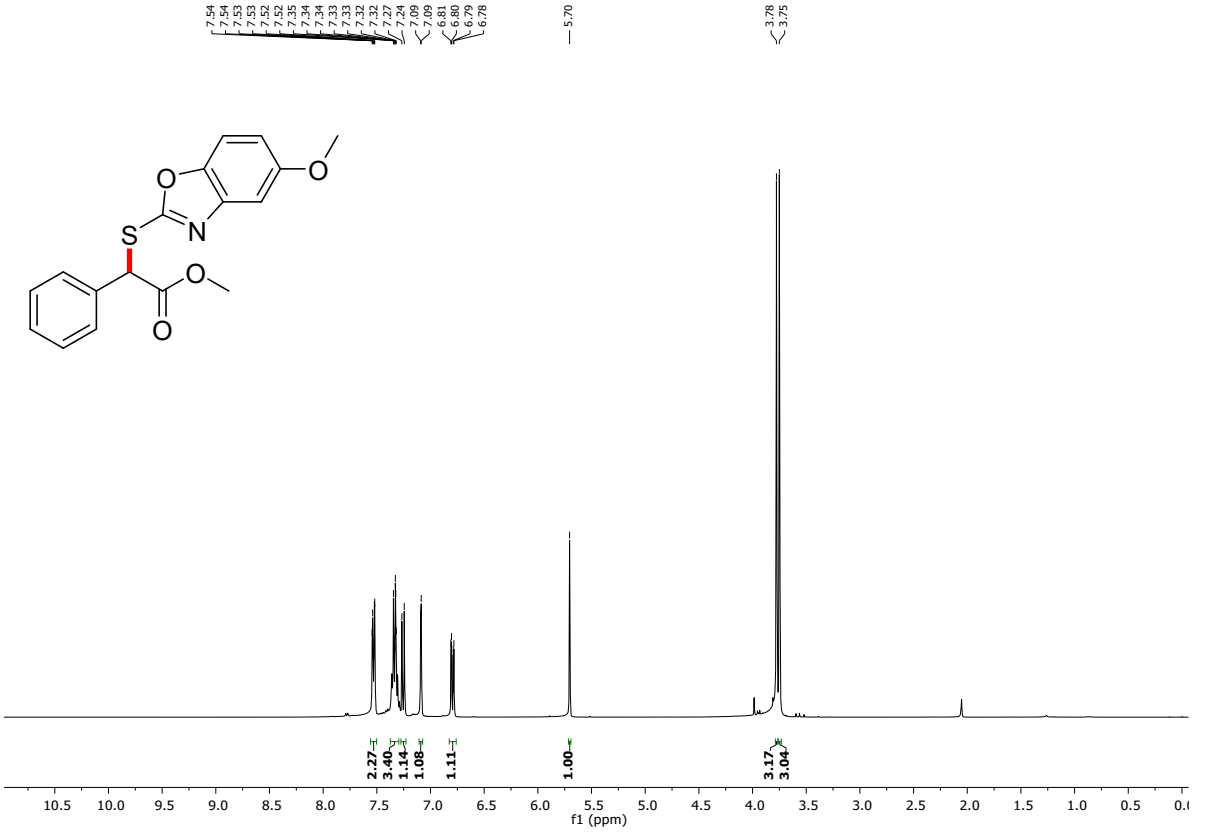


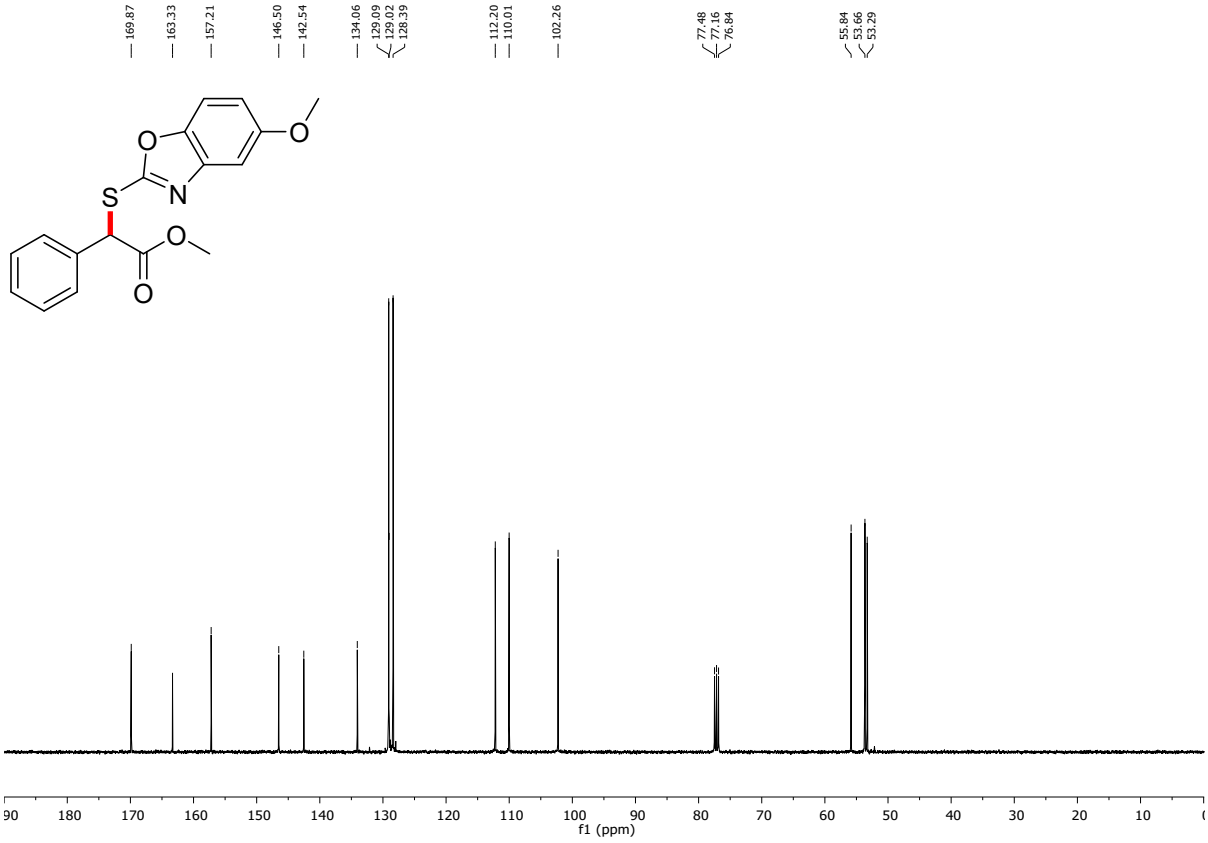
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4e**:



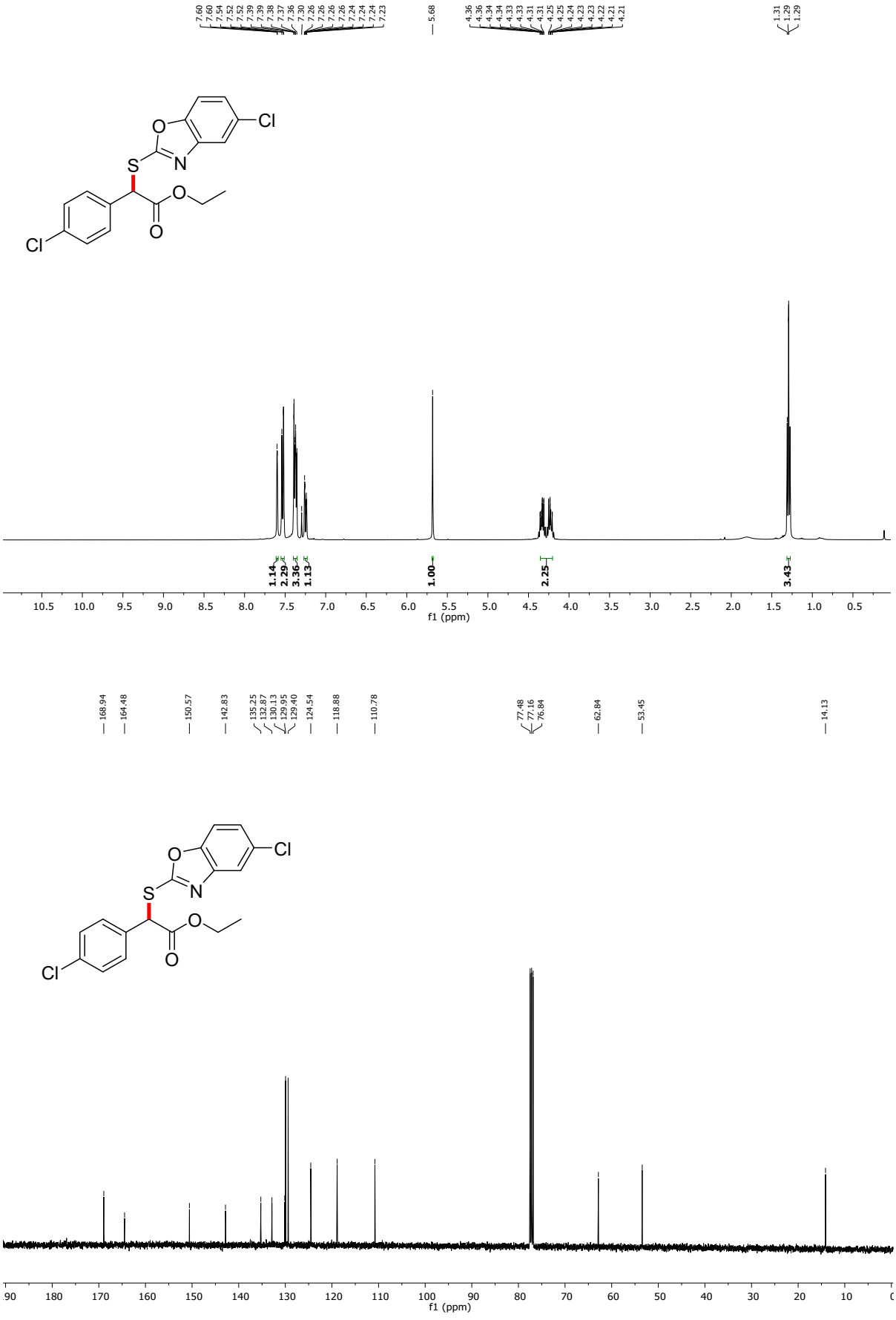


^{1}H (400 MHz, $CDCl_3$) and ^{13}C {^{1}H} NMR (101 MHz, $CDCl_3$) Spectra of **4f**:

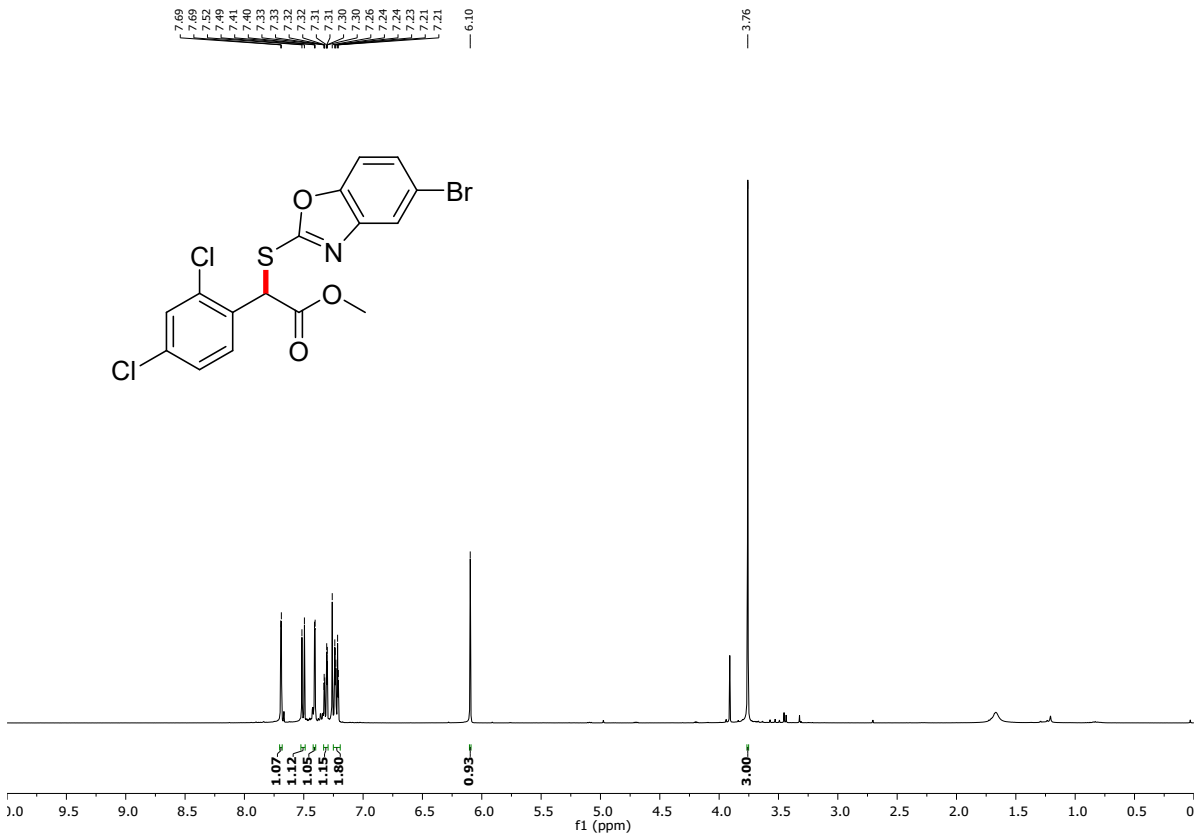


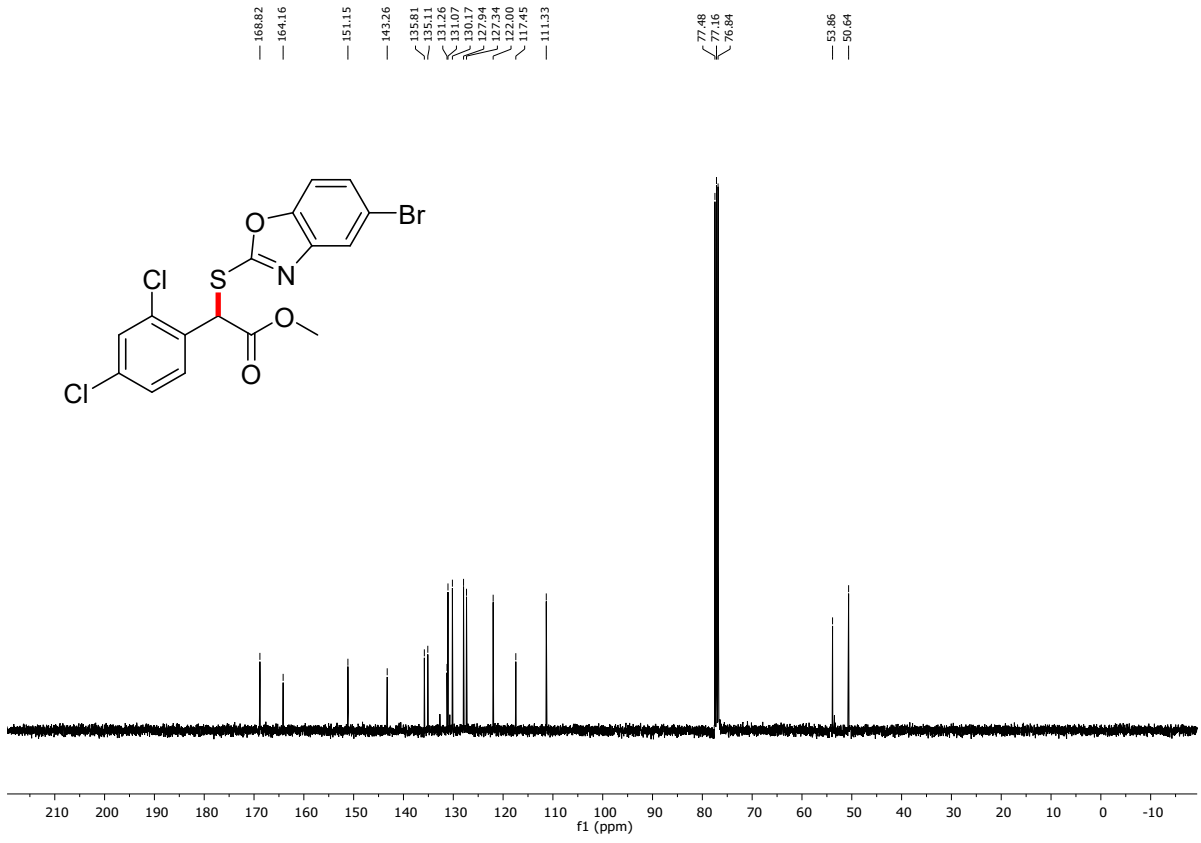


^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4g**:

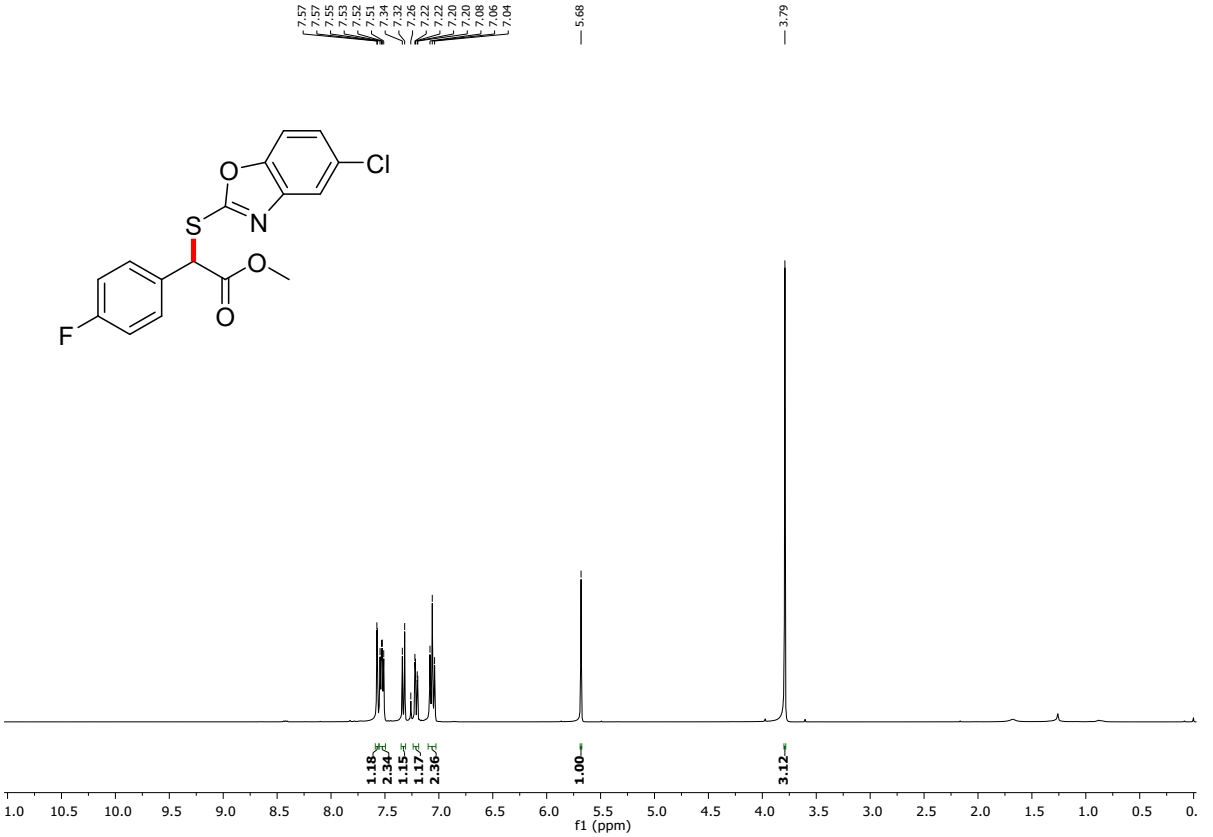


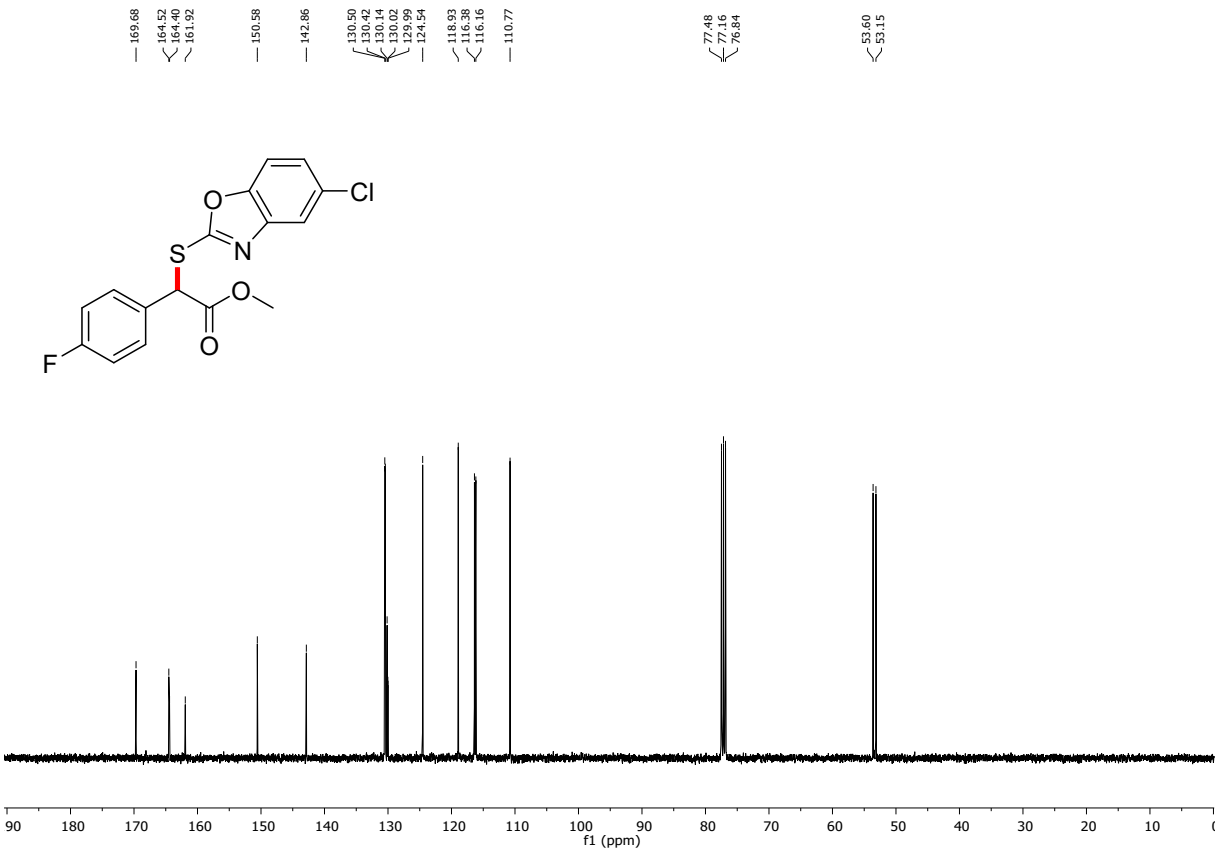
^{1}H (400 MHz, $CDCl_3$) and ^{13}C {^{1}H} NMR (101 MHz, $CDCl_3$) Spectra of **4h**:



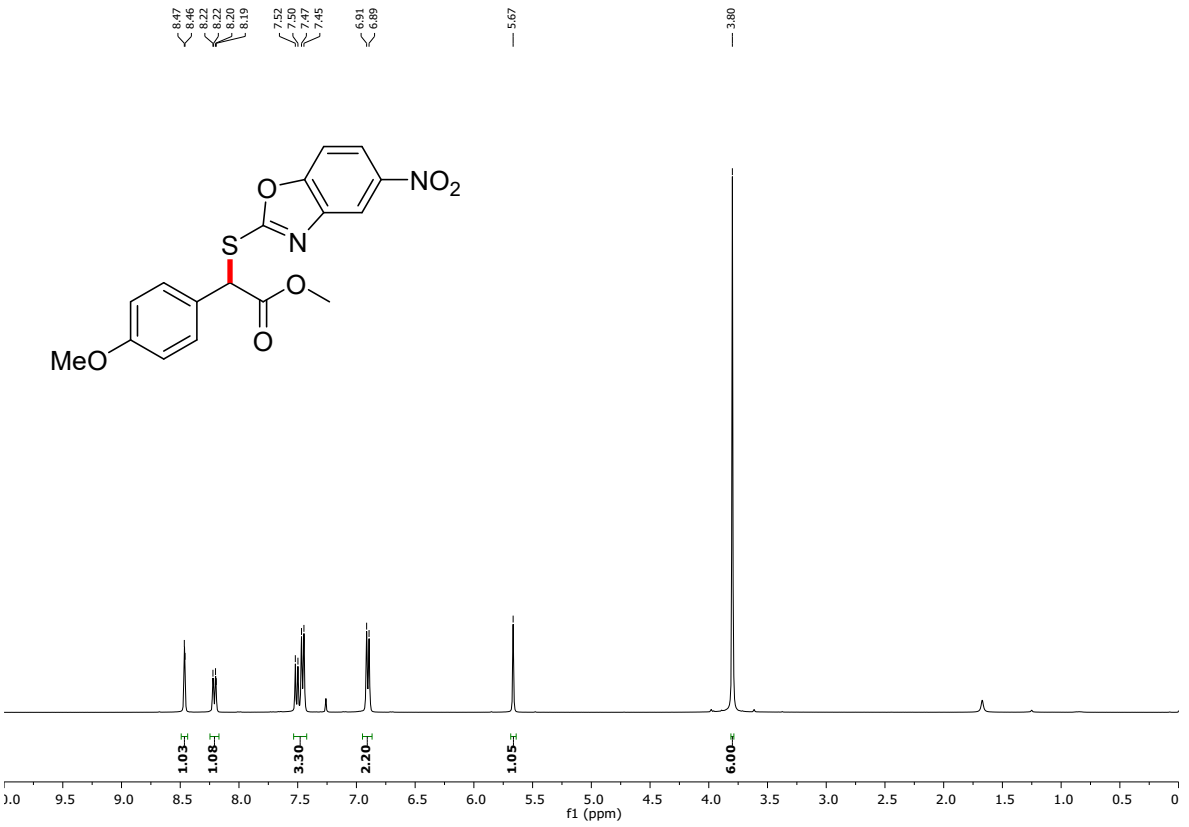


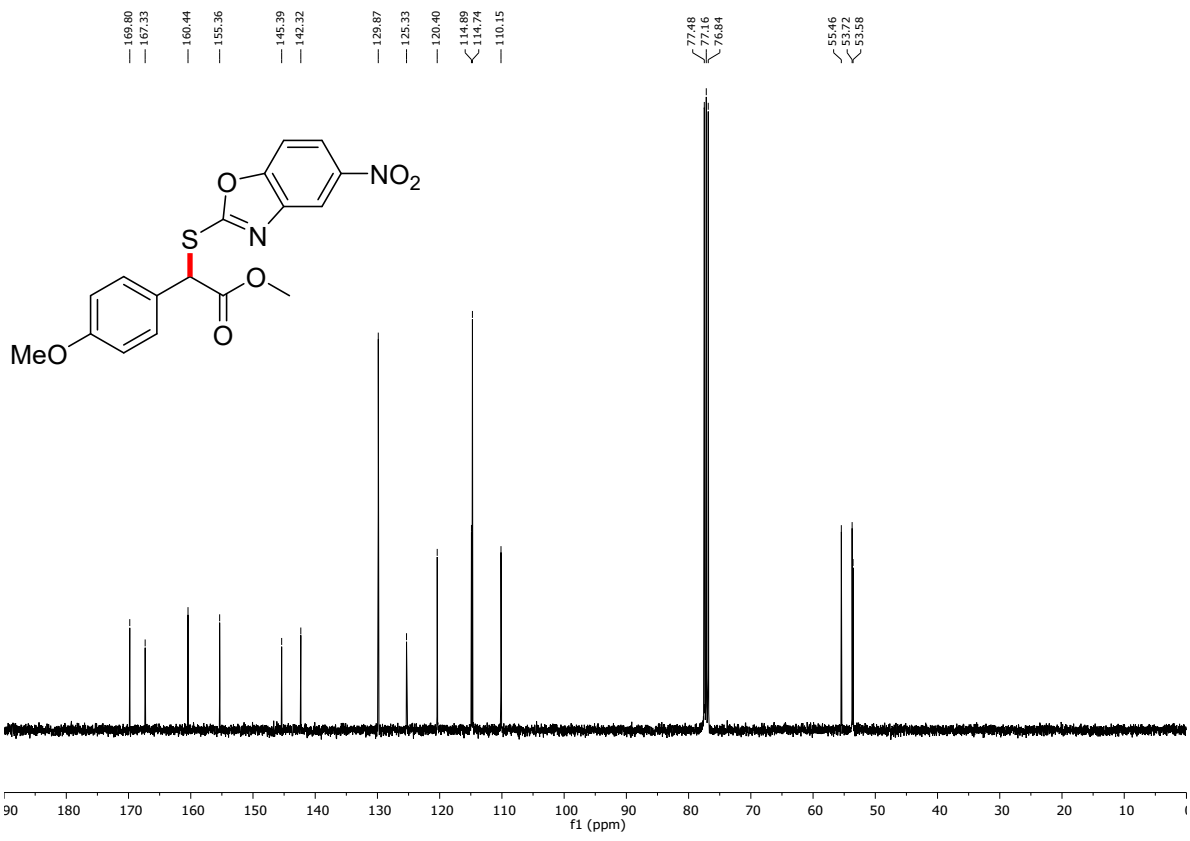
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4i**:


7.57
7.57
7.55
7.53
7.52
7.51
7.34
7.32
7.26
7.22
7.20
7.08
7.06
7.04
5.68
3.79
Cl
O
S
N
O
O
F
1.18
2.34
1.15
1.17
2.36
1.00
3.12
f1 (ppm)

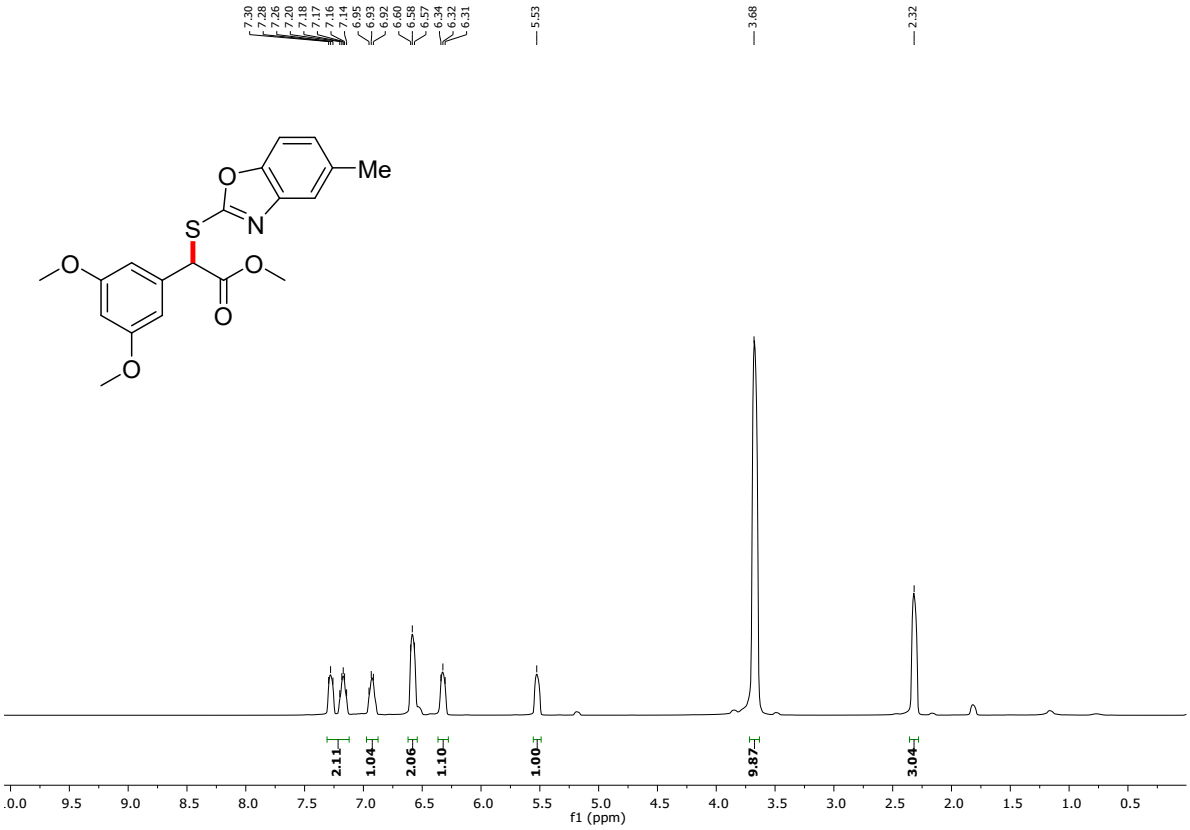

169.68
164.52
164.40
161.92
150.58
142.86
130.50
130.42
130.14
130.02
129.99
124.54
118.93
116.38
116.16
110.77
77.48
77.16
76.84
53.60
53.15
Cl
O
S
N
O
O
F
f1 (ppm)

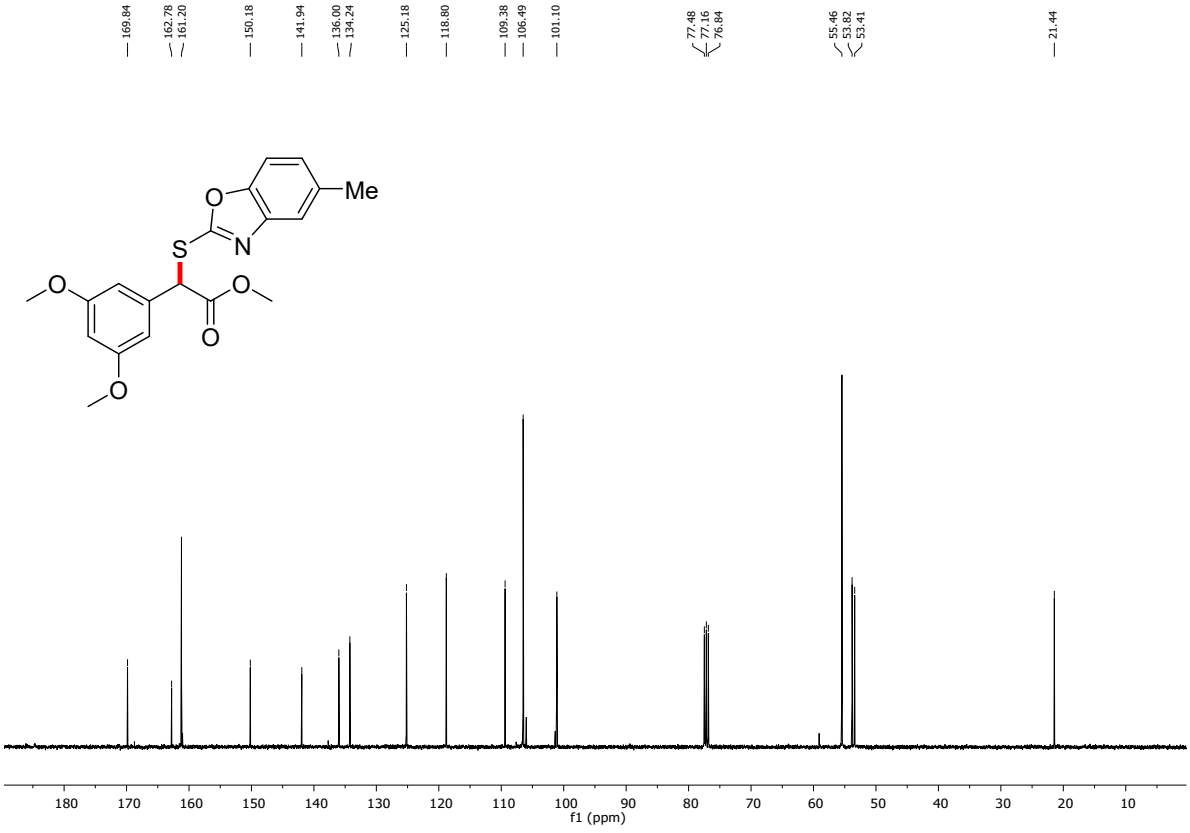
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4j**:



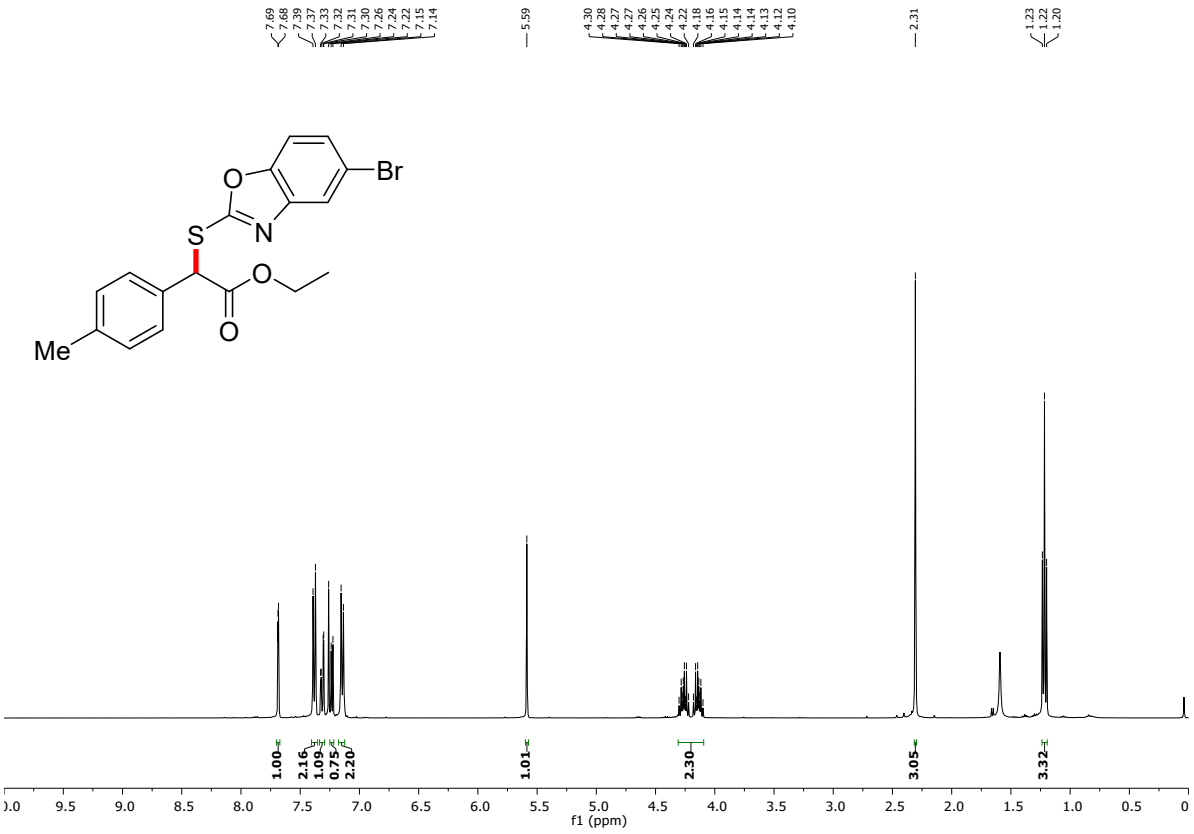


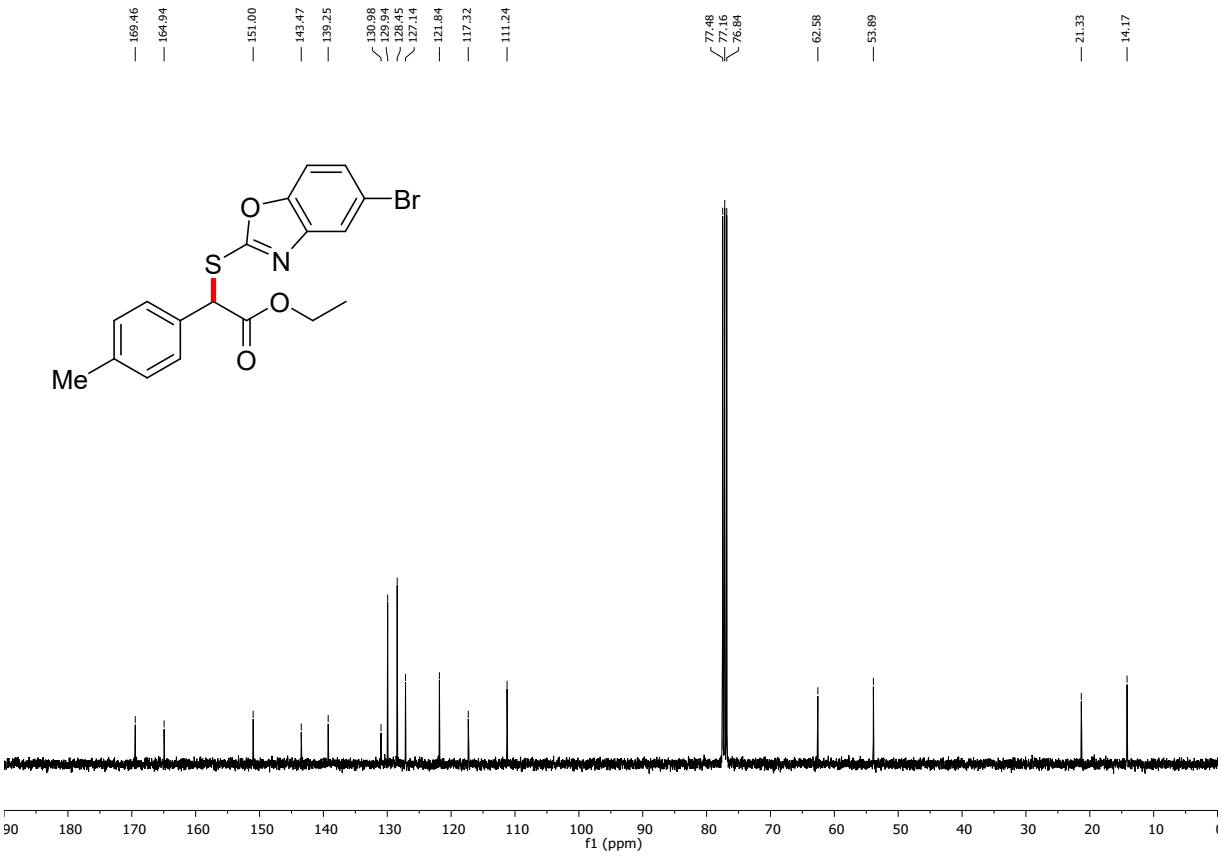
^{1}H (400 MHz, $CDCl_3$) and ^{13}C {^{1}H} NMR (101 MHz, $CDCl_3$) Spectra of **4k**:



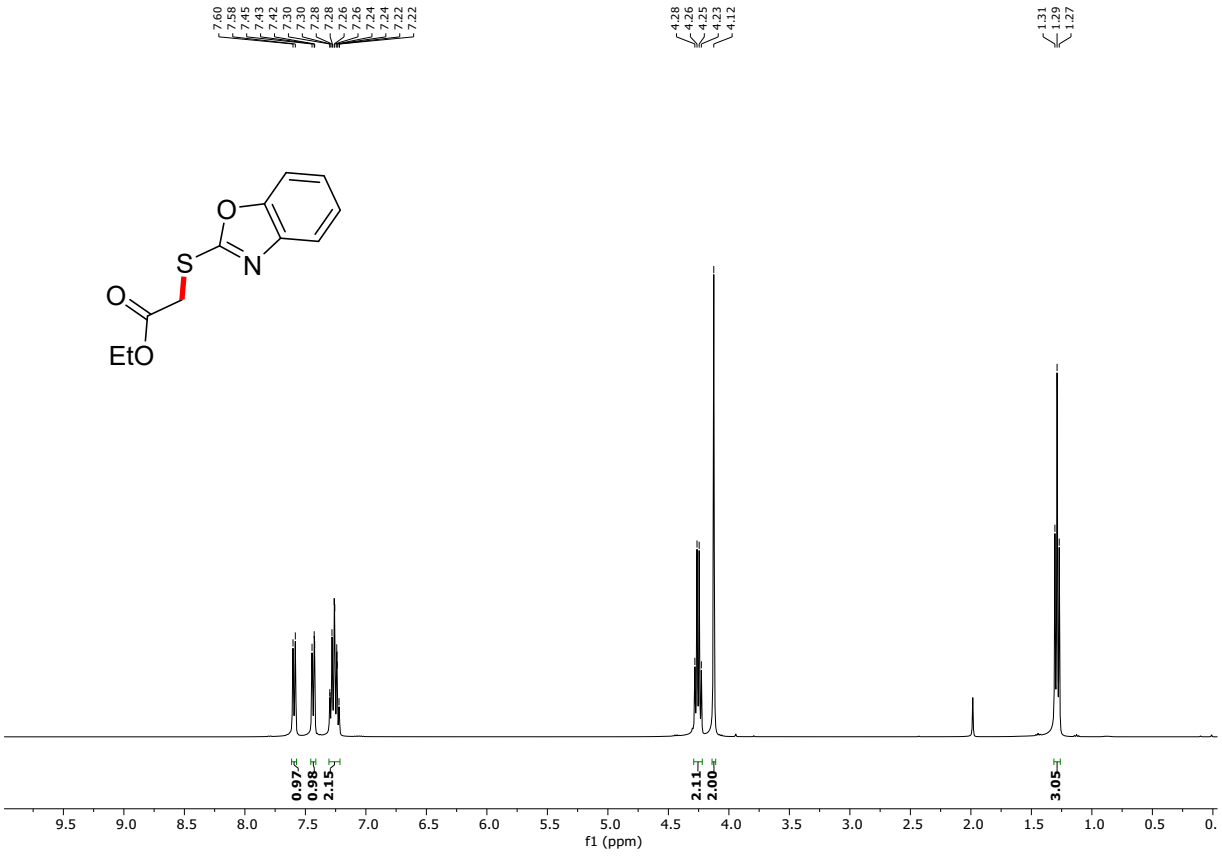


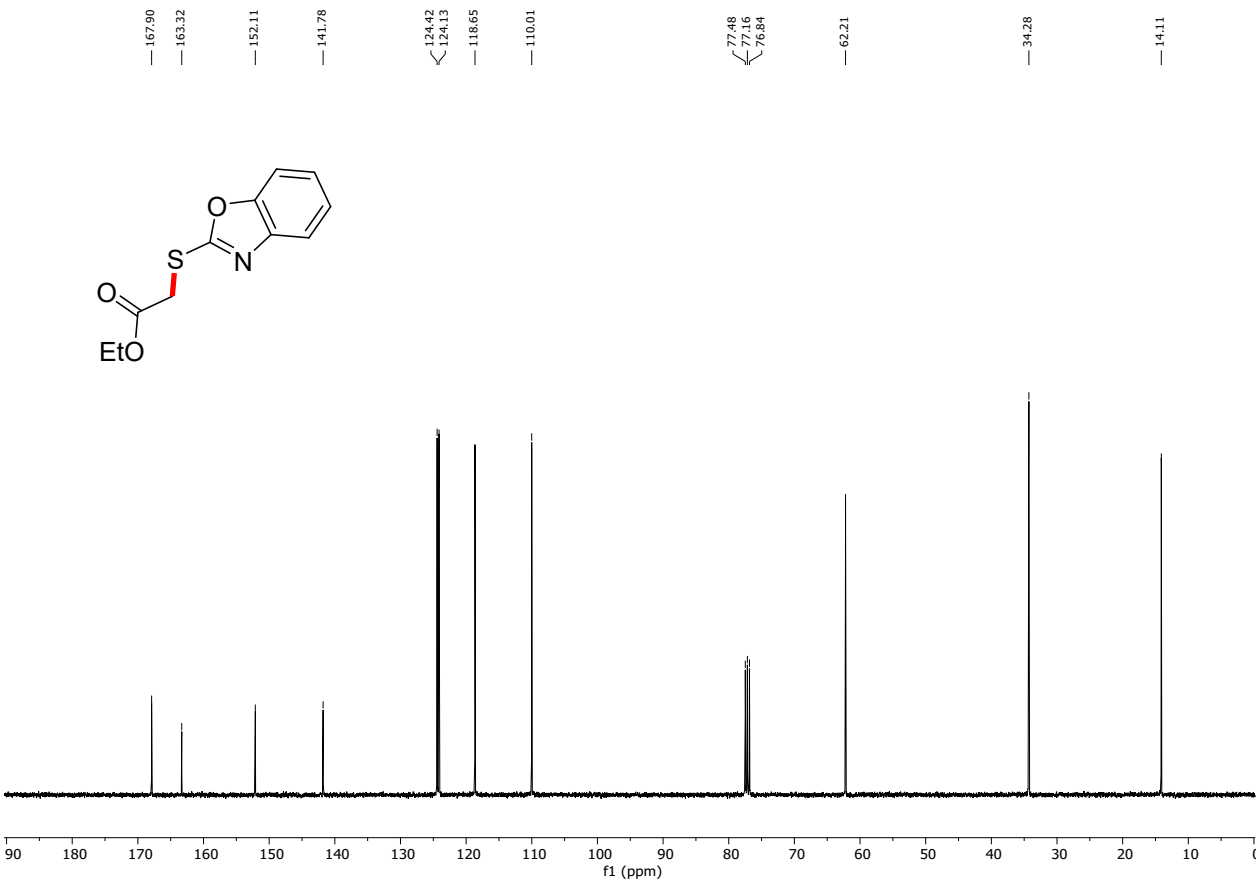
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **4l**:



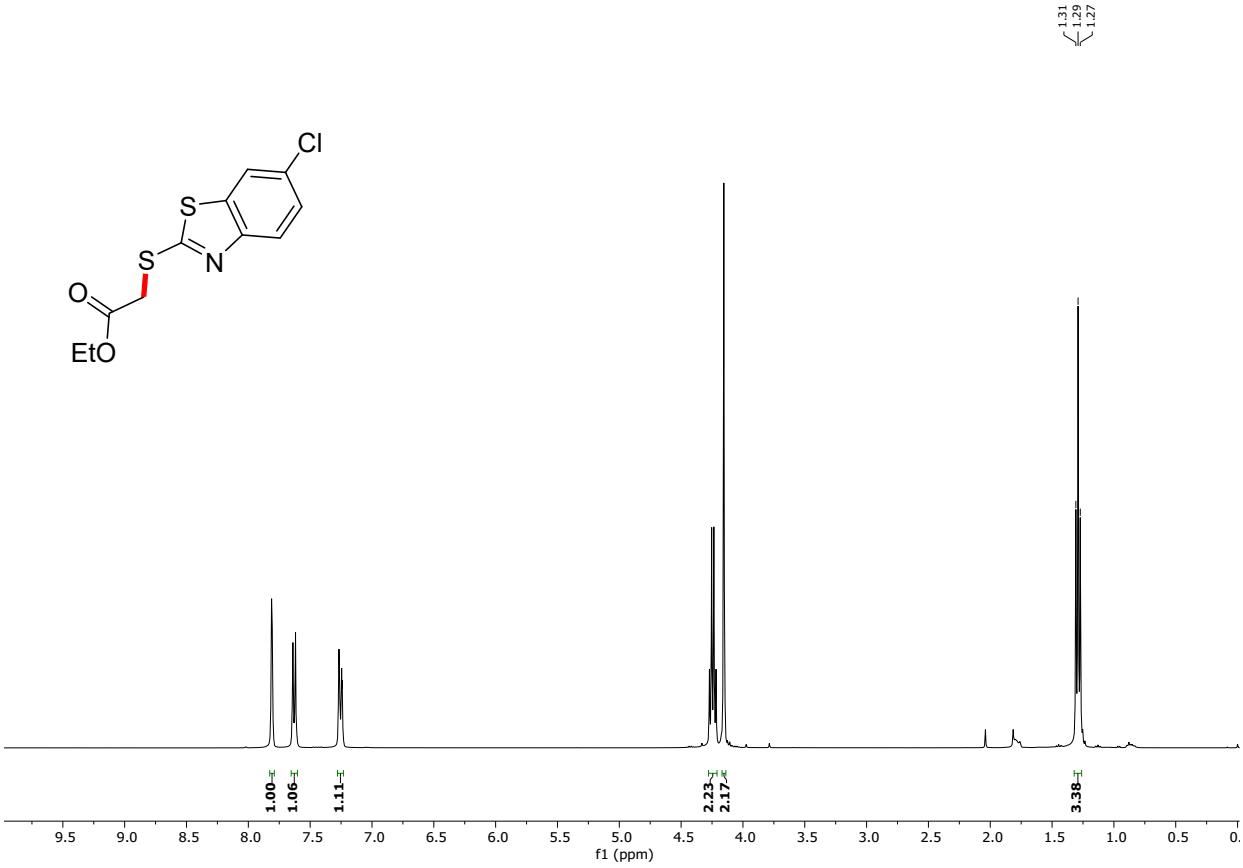


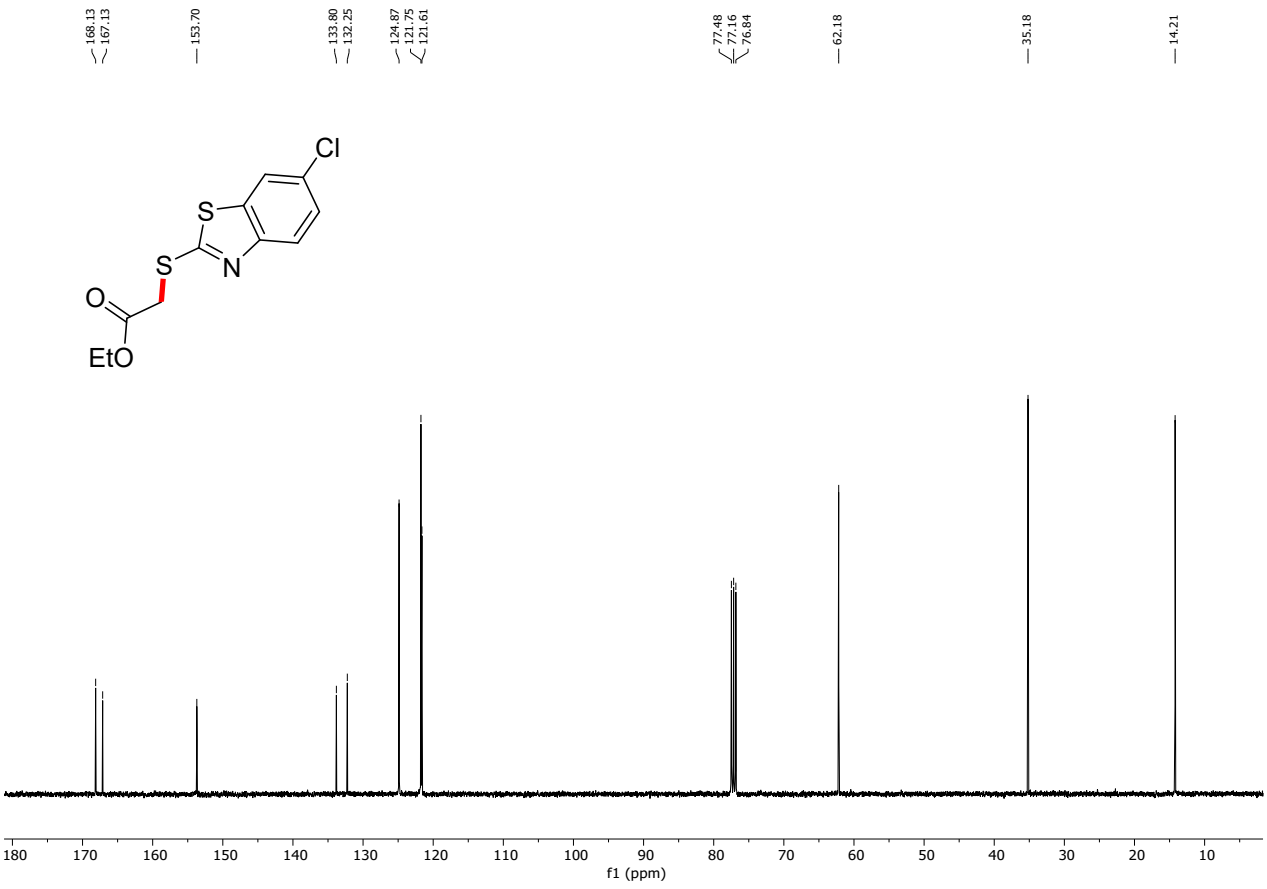
^{1}H (400 MHz, $CDCl_3$) and ^{13}C {^{1}H} NMR (101 MHz, $CDCl_3$) Spectra of **5a**:



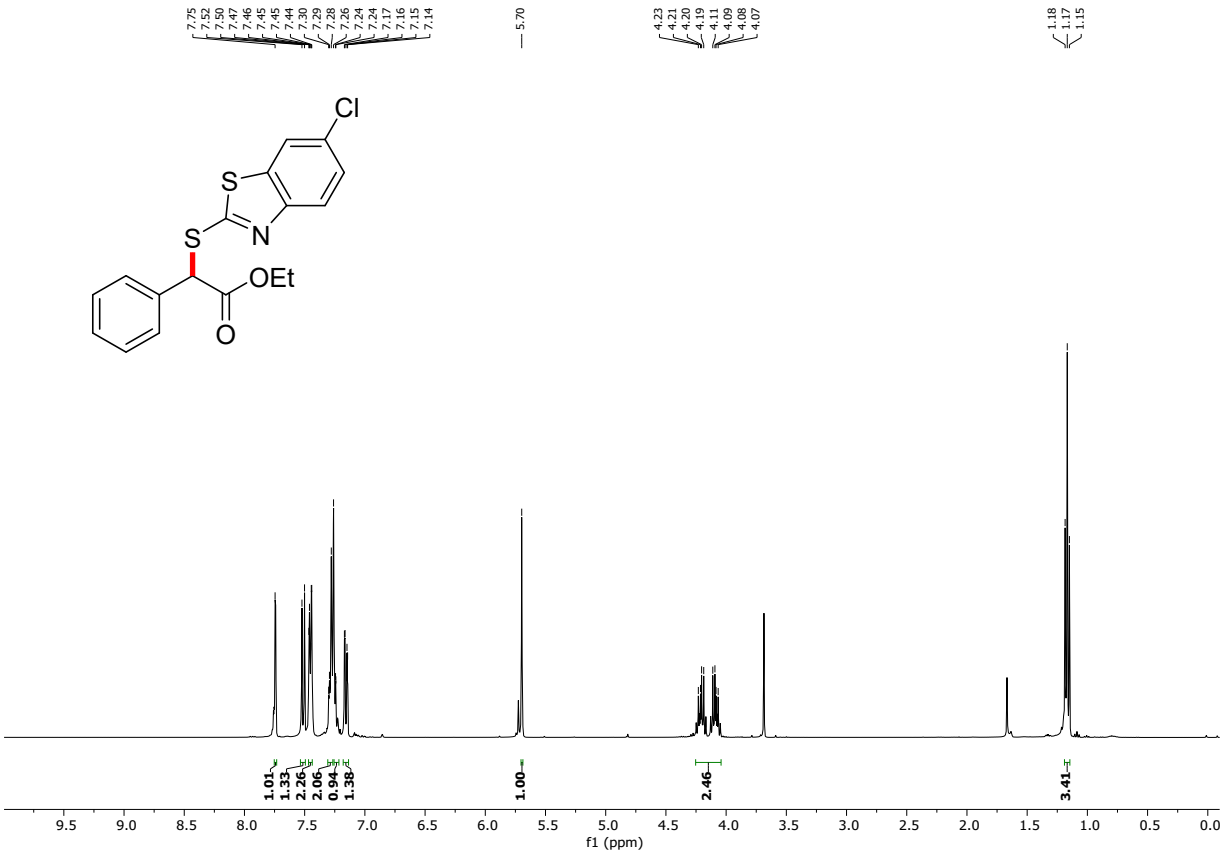


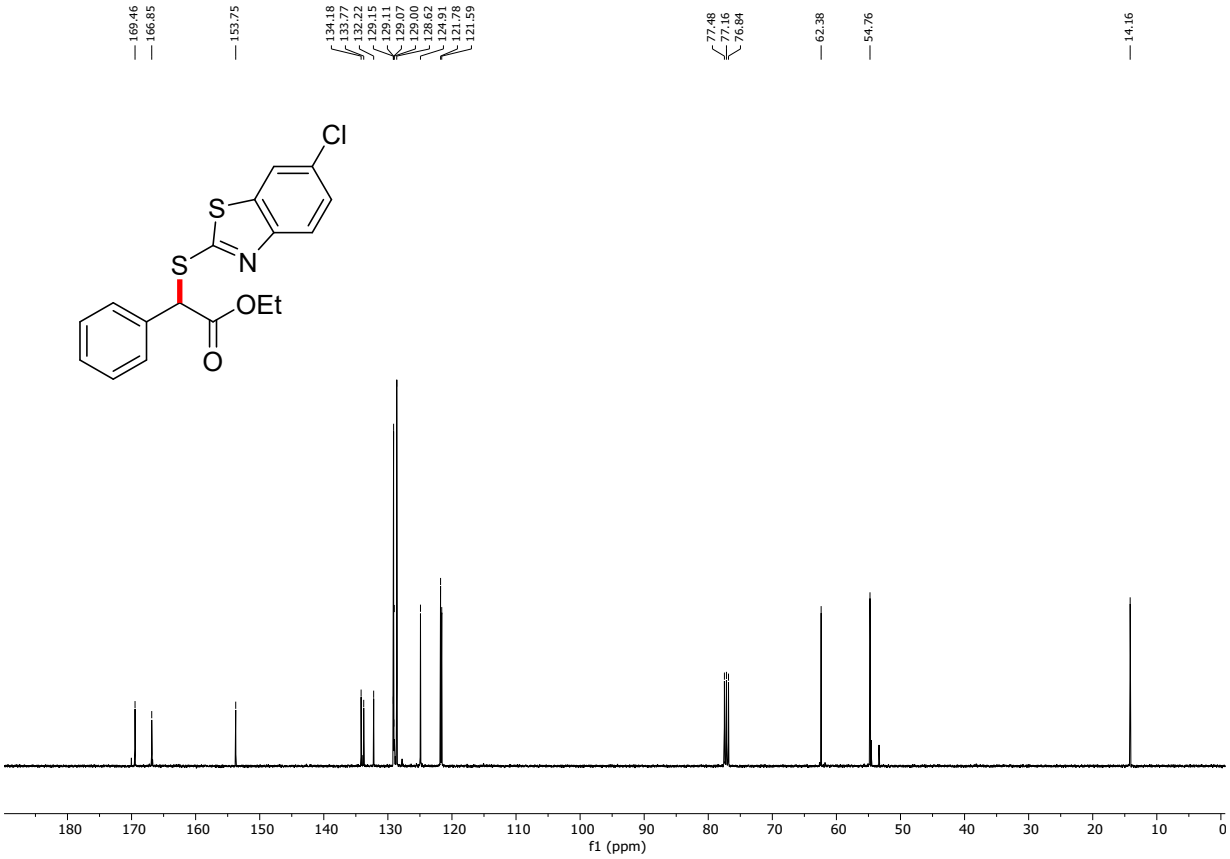
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **5b**:


Cl
S
S
N
O
EtO
1.31
1.29
1.27
1.00
1.06
1.11
2.23
2.17
3.38
f1 (ppm)

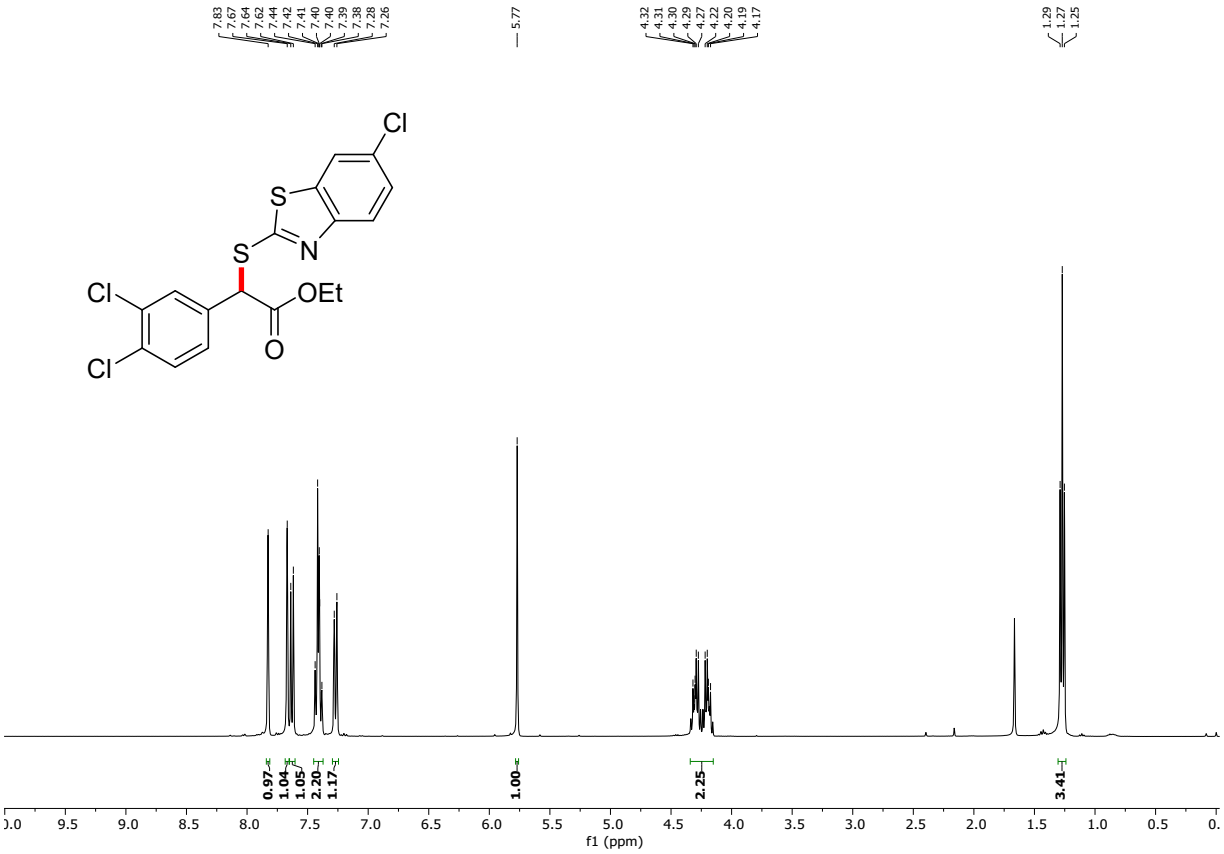

168.13
167.13
153.70
133.80
132.25
124.87
121.75
121.61
77.48
77.16
76.84
62.18
35.18
14.21
Cl
S
S
N
O
EtO
f1 (ppm)

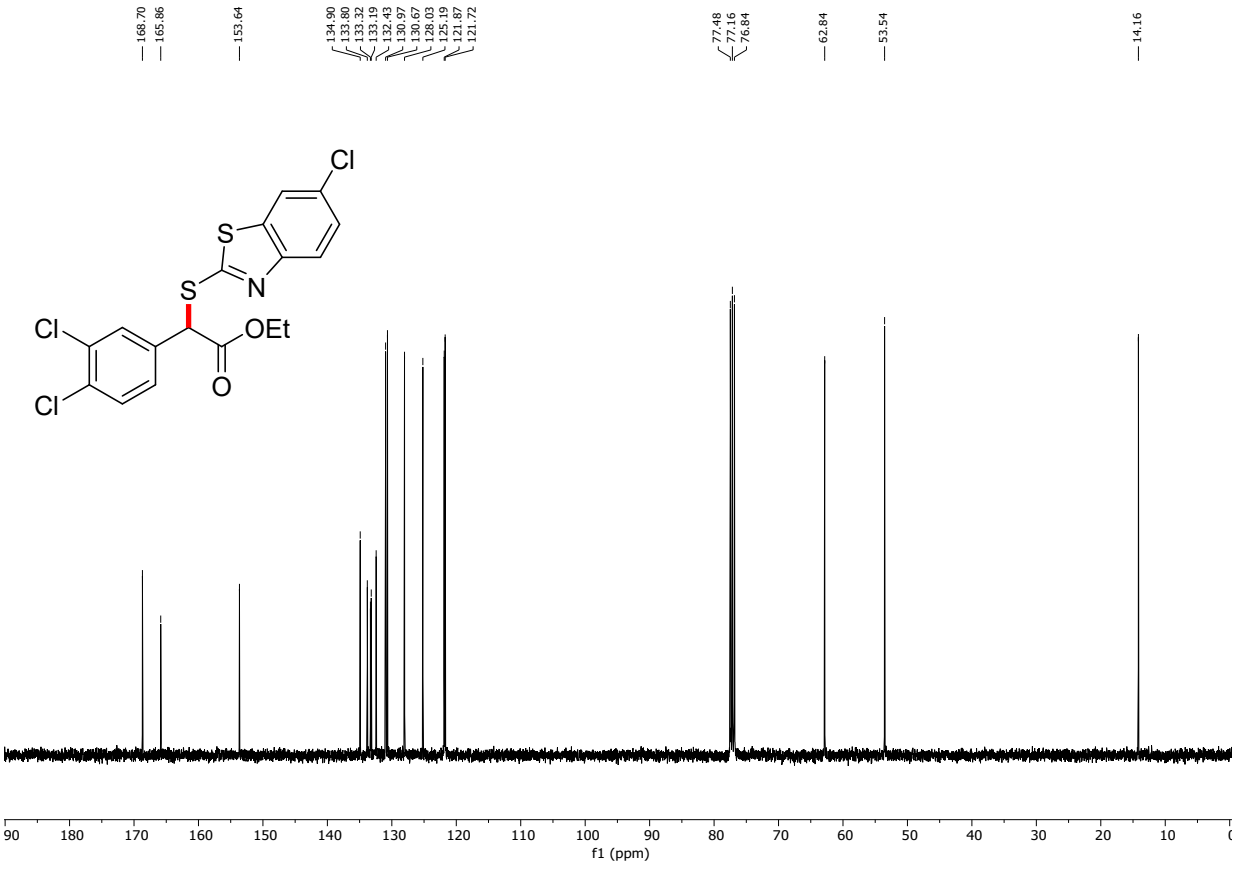
^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **5c**:





^{1}H (400 MHz, $CDCl_3$) and ^{13}C $\{^{1}H\}$ NMR (101 MHz, $CDCl_3$) Spectra of **5d**:


7.83
7.67
7.64
7.62
7.44
7.42
7.41
7.40
7.40
7.39
7.38
7.28
7.26
5.77
4.32
4.31
4.30
4.29
4.27
4.22
4.20
4.19
4.17
1.29
1.27
1.25
Cl
S
S
N
Cl
OEt
Cl
O
0.97
1.04
1.05
2.20
1.17
1.00
2.25
3.41
f1 (ppm)


168.70
165.86
153.64
134.90
133.80
133.32
133.19
132.43
130.97
130.67
128.03
125.19
121.87
121.72
77.48
77.16
76.84
62.84
53.54
14.16
Cl
S
S
N
Cl
OEt
Cl
O
f1 (ppm)

Notes and references

1. W. A. J. Starmans, Synthesis and application of functionalized azetidines. Nijmegen: Katholieke Universities, Nijmegen. 2007.