

**BISMUTH(III) TRIFLATE: AN ECONOMICAL AND ENVIRONMENTALLY FRIENDLY CATALYST FOR THE NAZAROV REACTION**

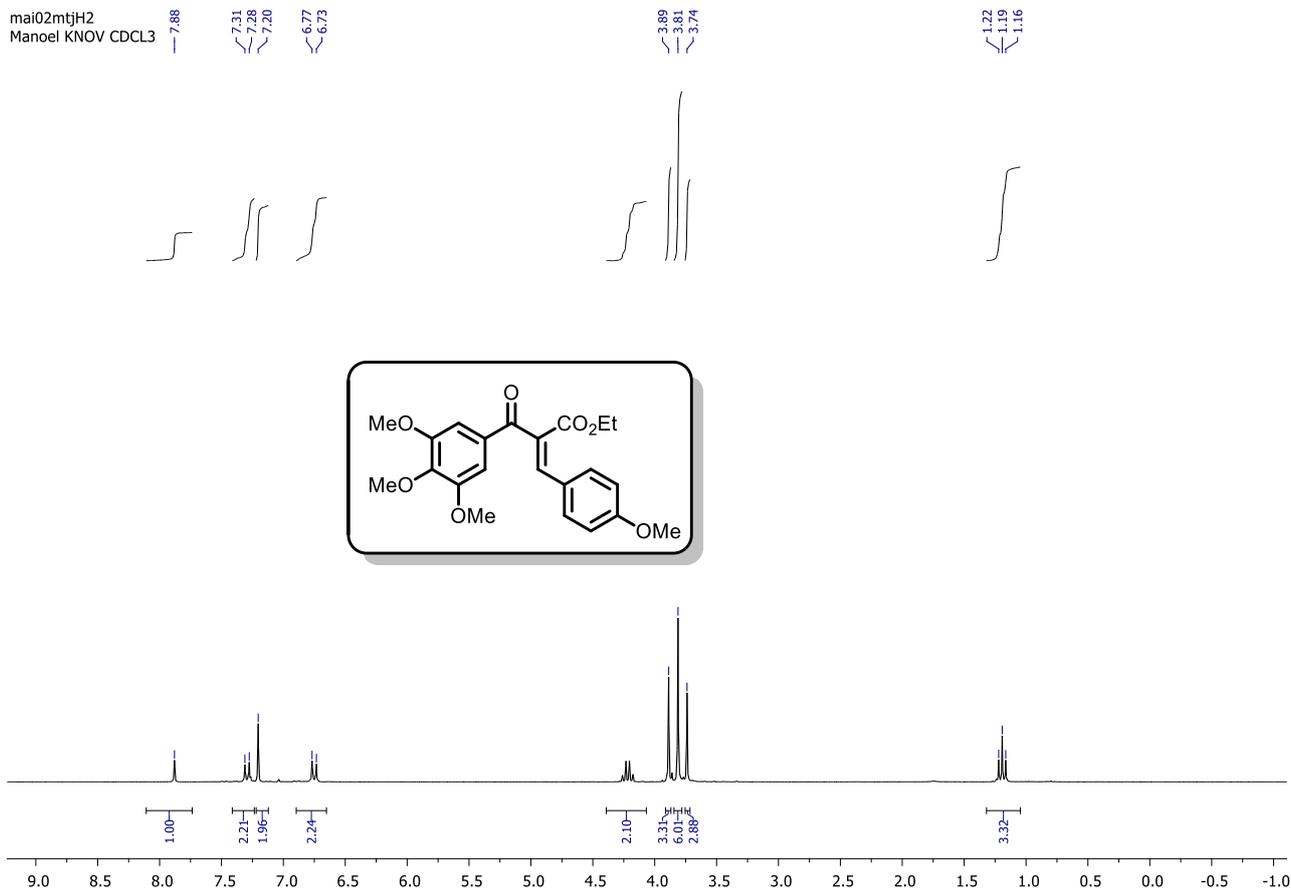
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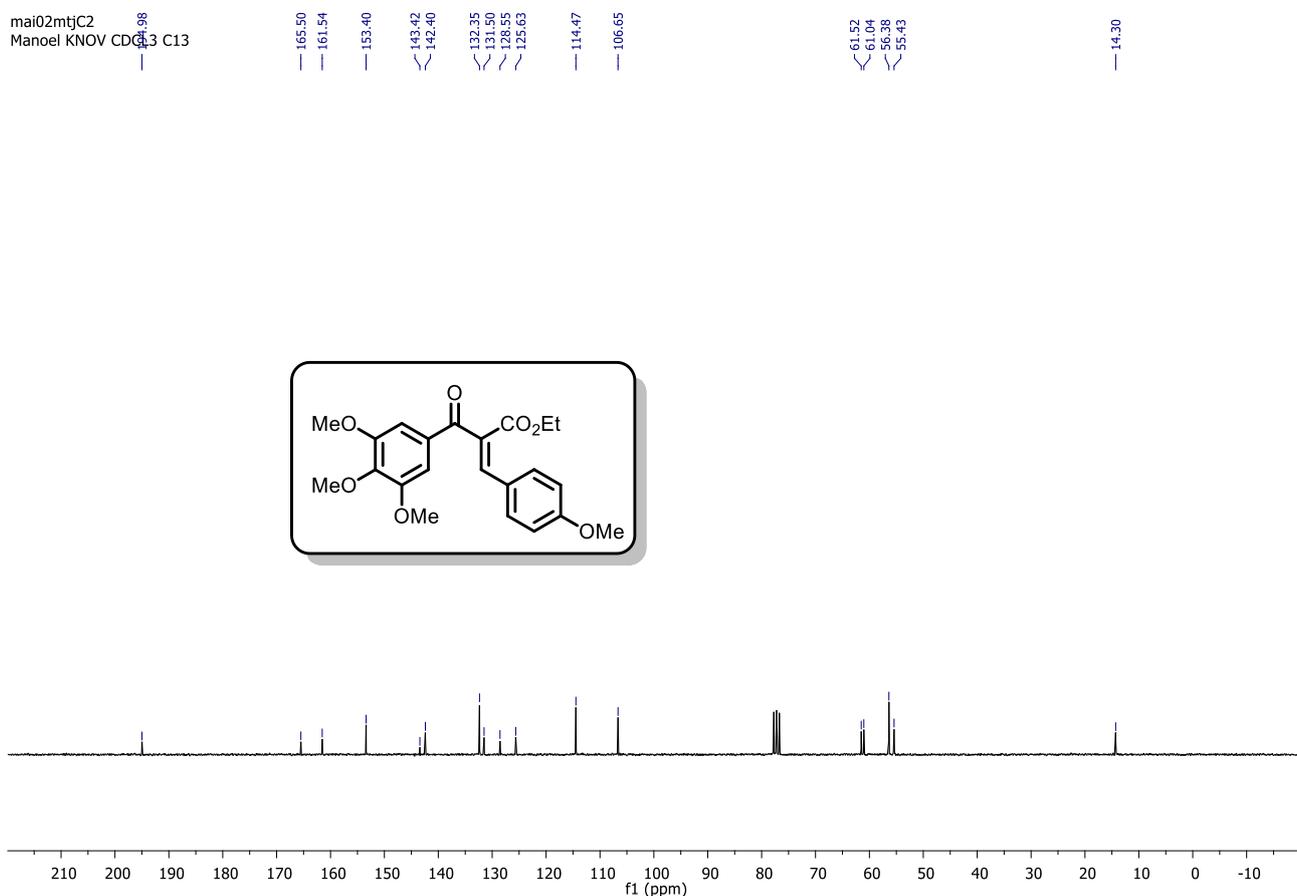
**SUPPORTING INFORMATION**

S3-S46      Copies of <sup>1</sup>H NMR and <sup>13</sup>C NMR spectra for all compounds

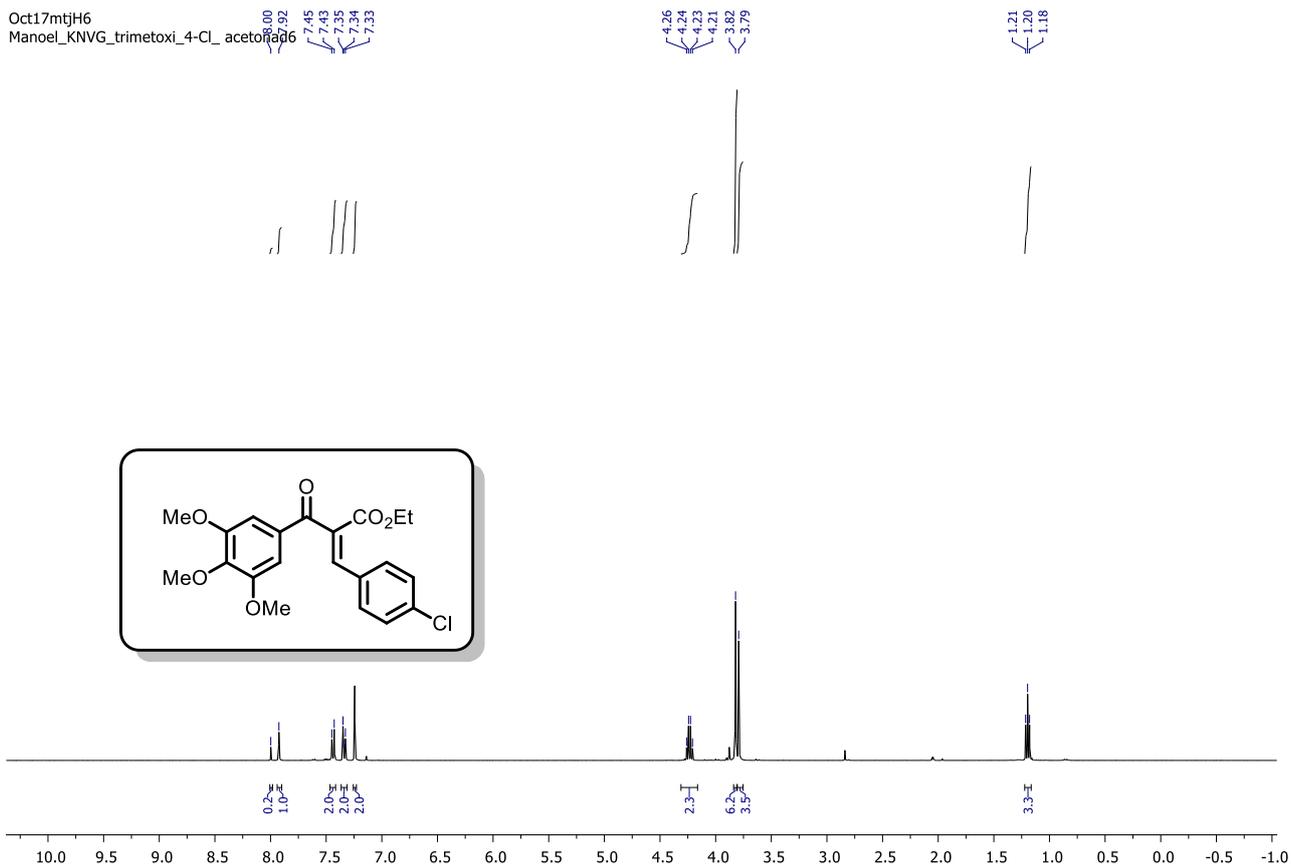
# **$^1\text{H}$ NMR and $^{13}\text{C}$ NMR spectra**



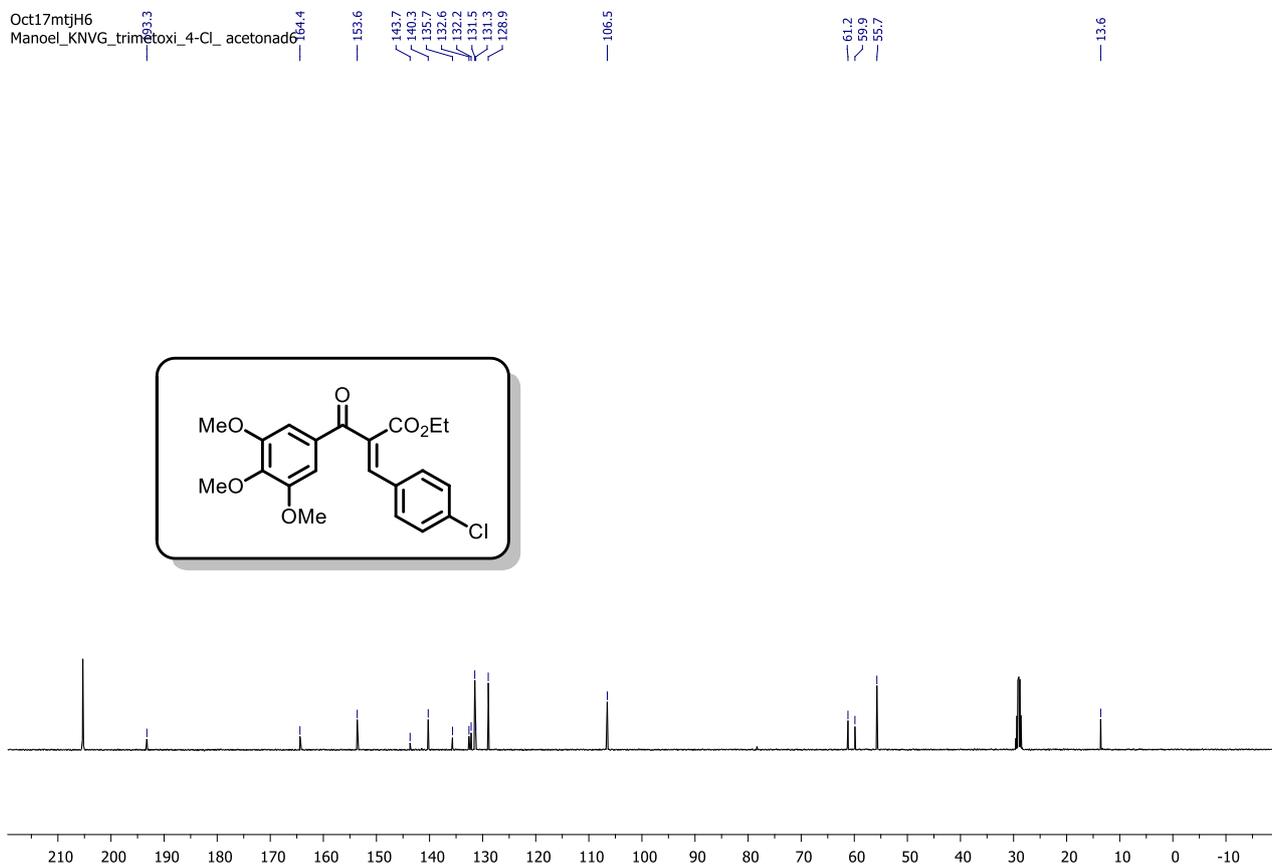
**Figure S1.**  $^1\text{H}$  NMR spectrum (250 MHz,  $\text{CDCl}_3$ ) of compound **9aa**.



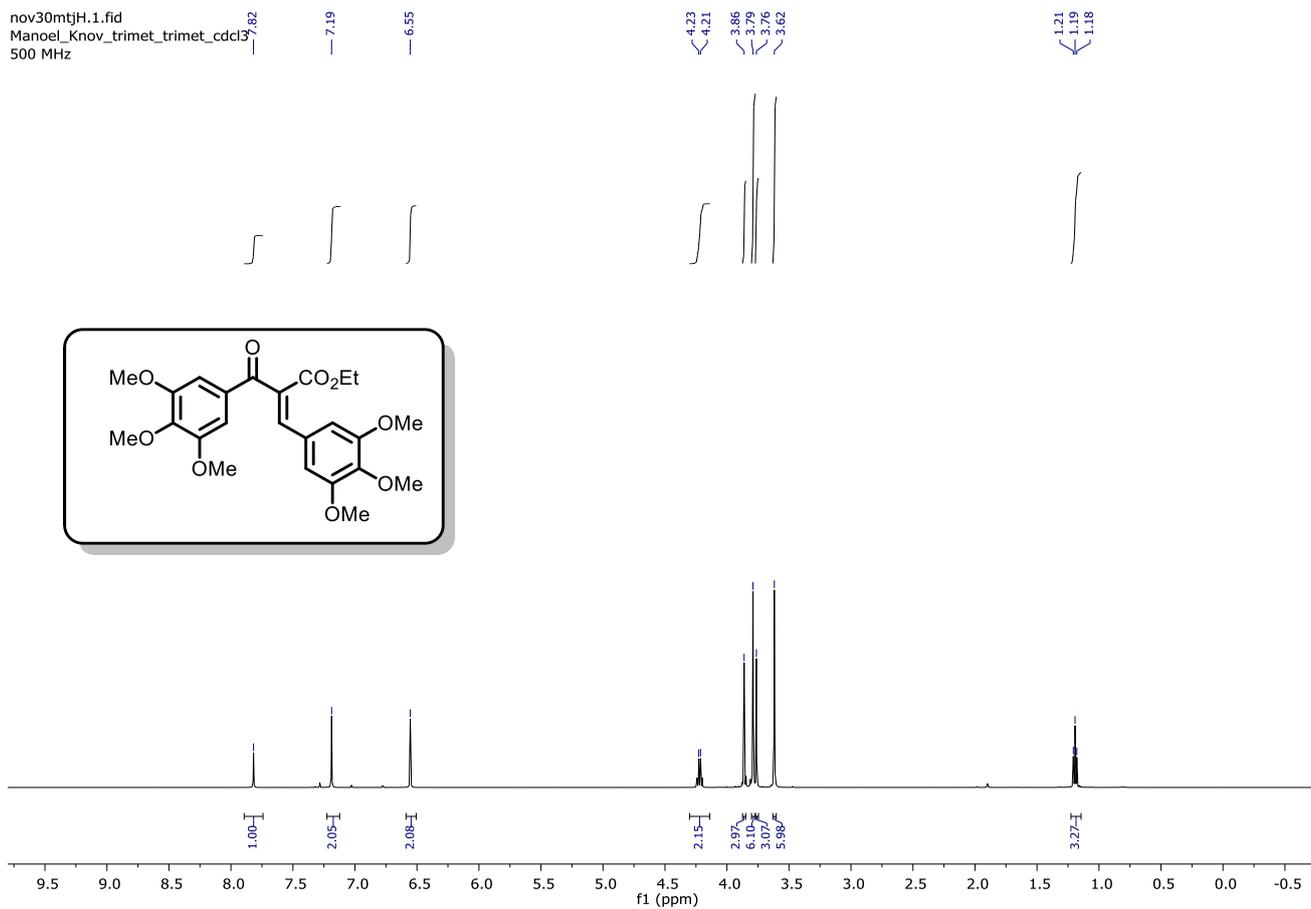
**Figure S2.**  $^{13}\text{C}$  NMR spectrum (63 MHz,  $\text{CDCl}_3$ ) of compound **9aa**.



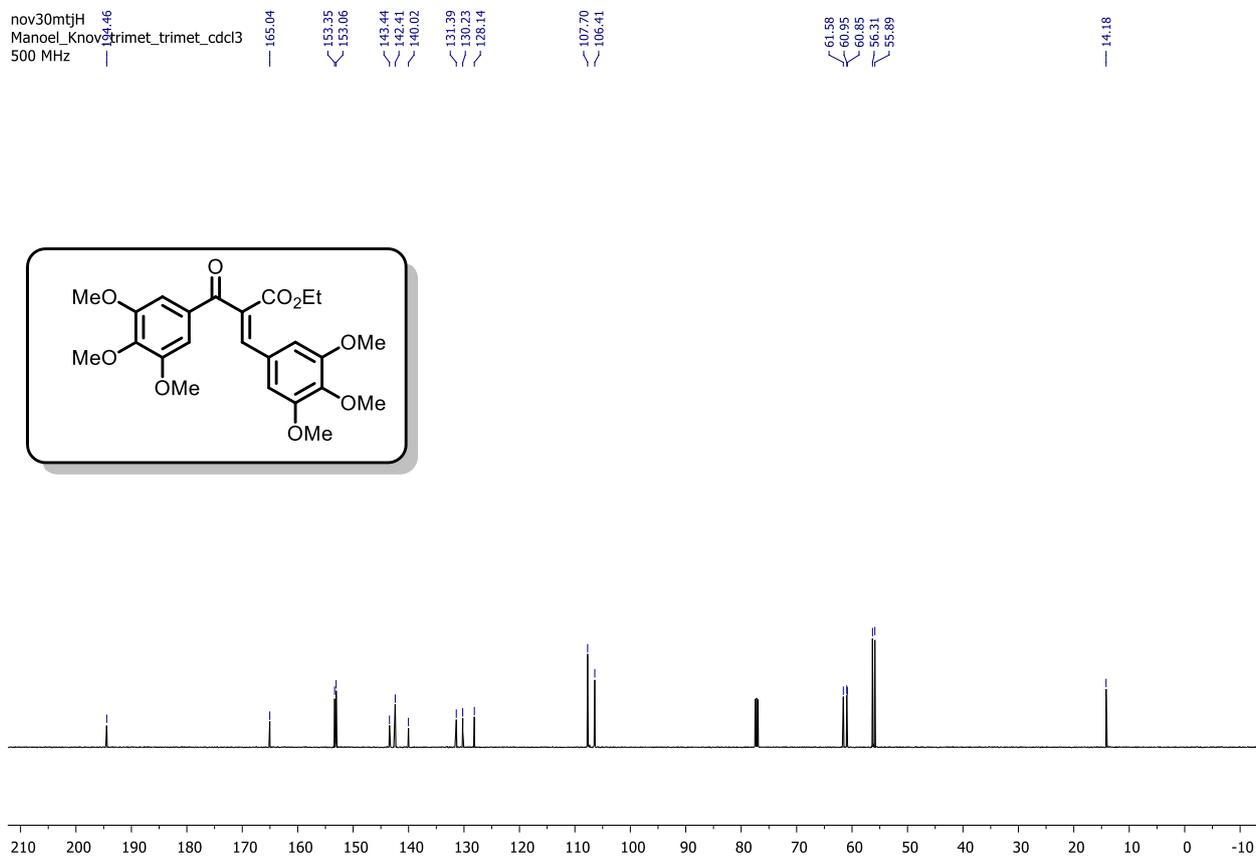
**Figure S3.**  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **9ab**.



**Figure S4.**  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound **9ab**.

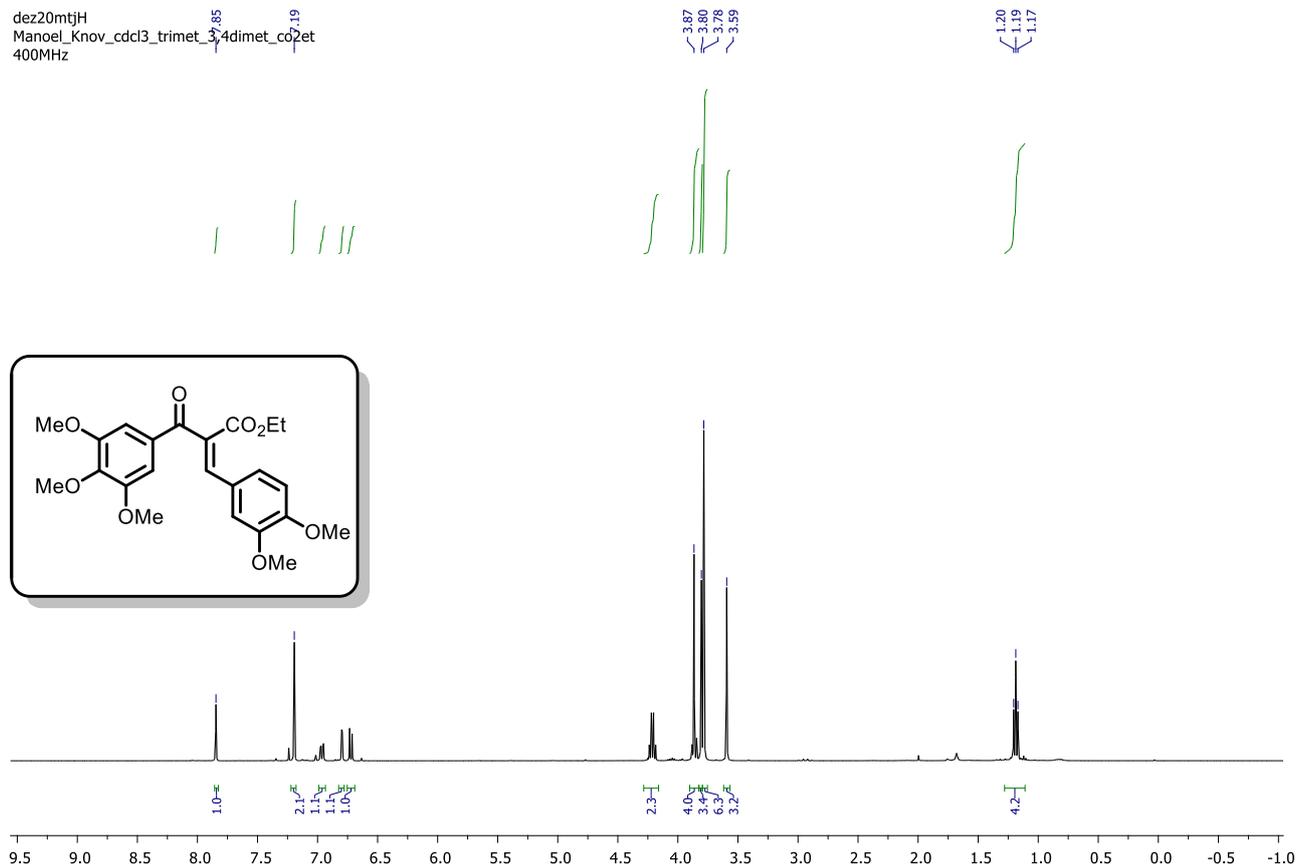


**Figure S5.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **9ac**.



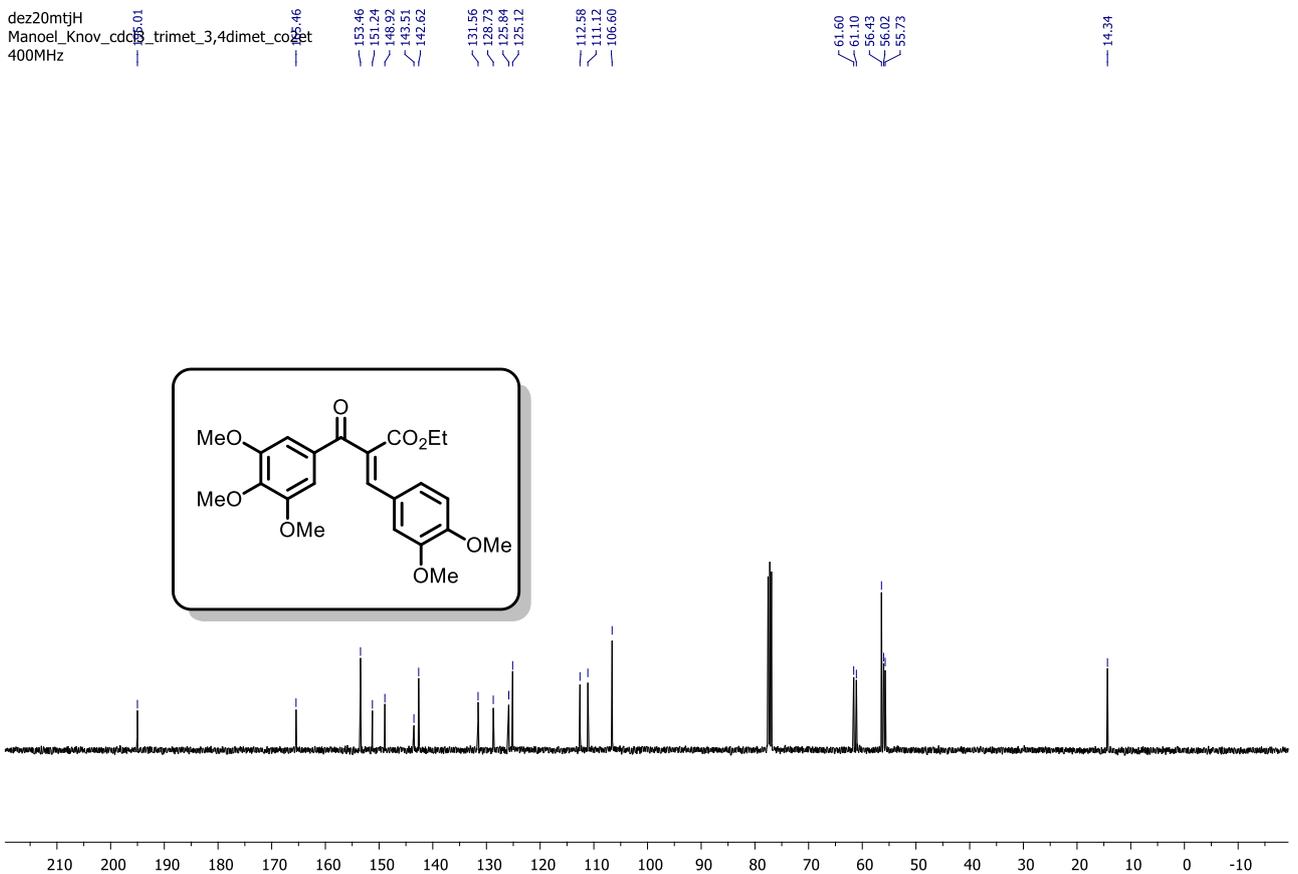
**Figure S6.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **9ac**.

dez20mtjH  
Manoel\_Knov\_cdcl3\_trimet\_3,4dimet\_co2et  
400MHz

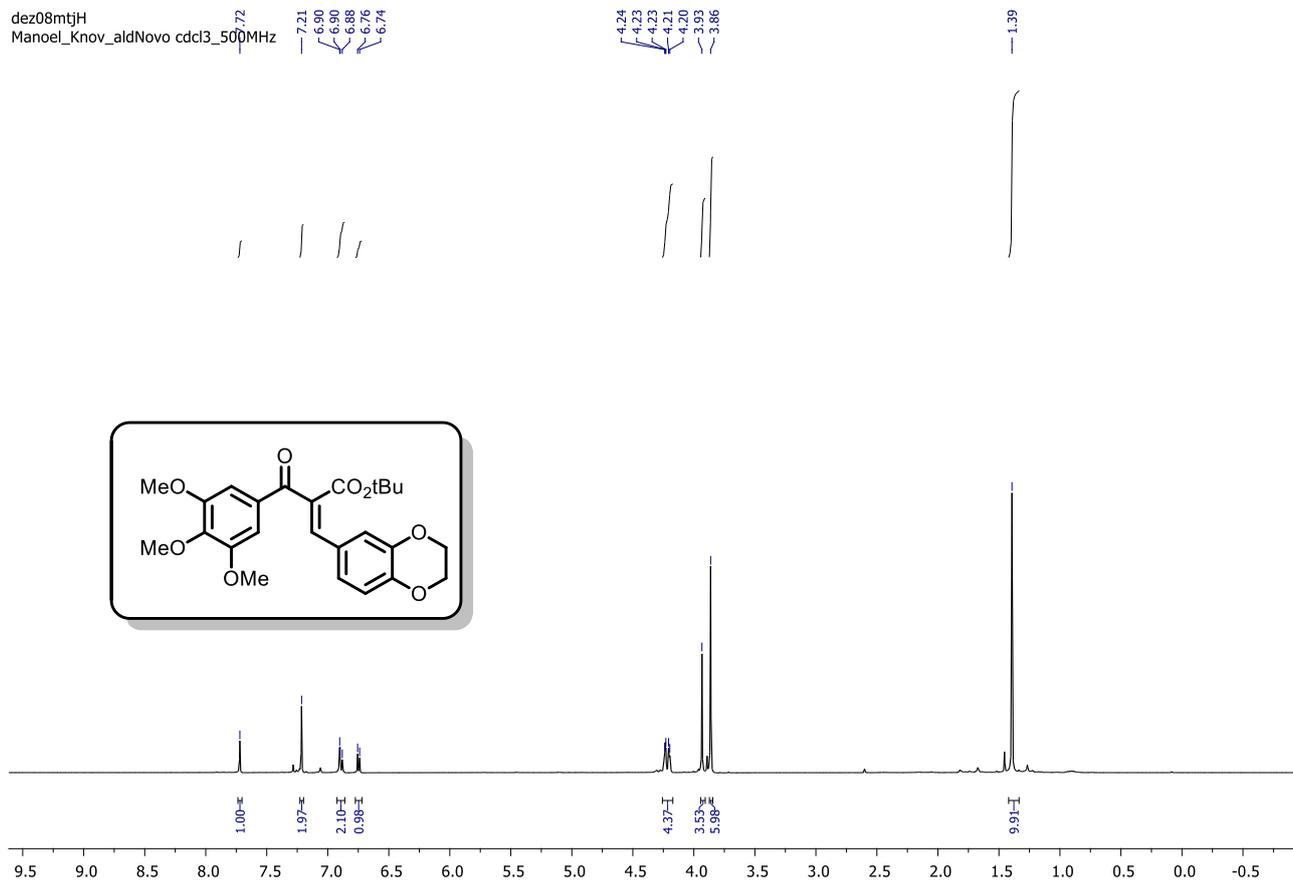


**Figure S7.** <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **9ad**.

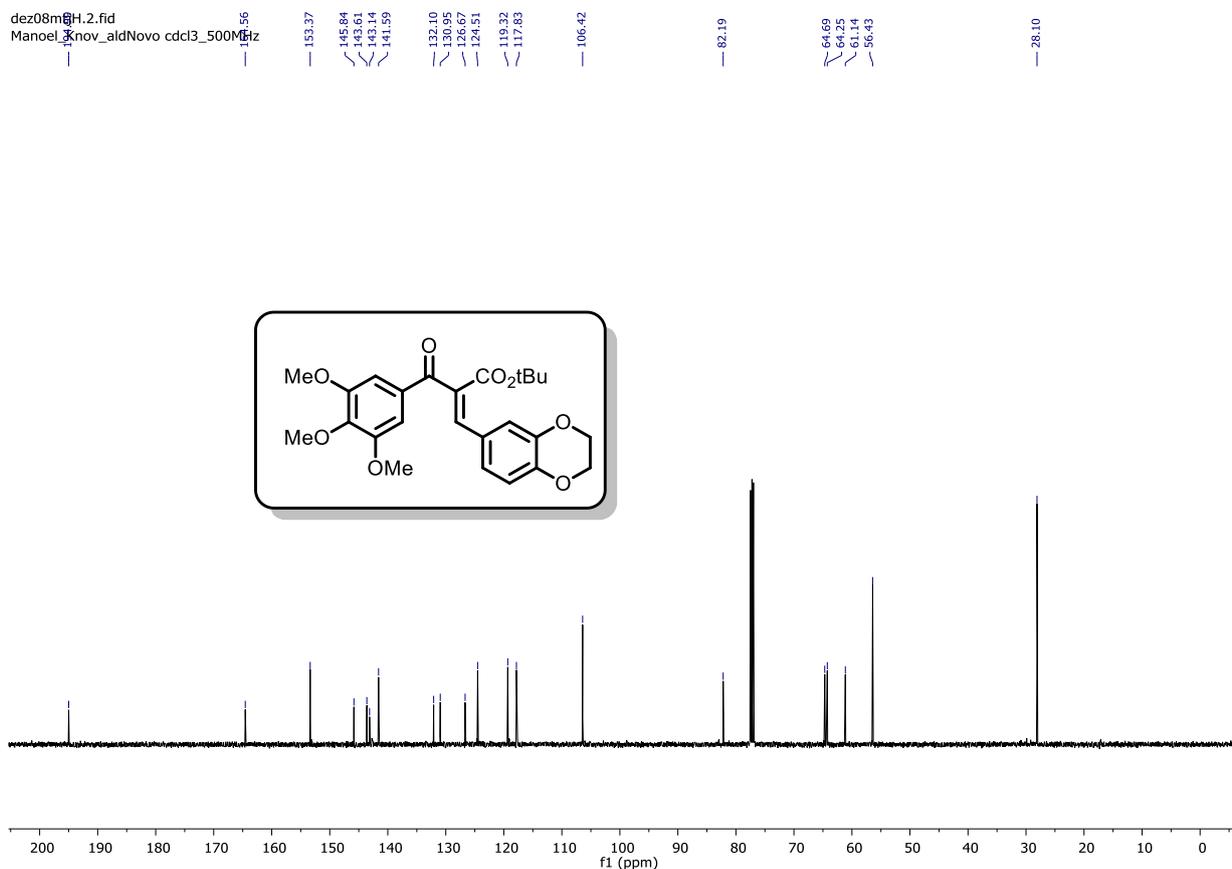
dez20mtjH  
Manoel\_Knov\_cdcl3\_trimet\_3,4dimet\_co2et  
400MHz



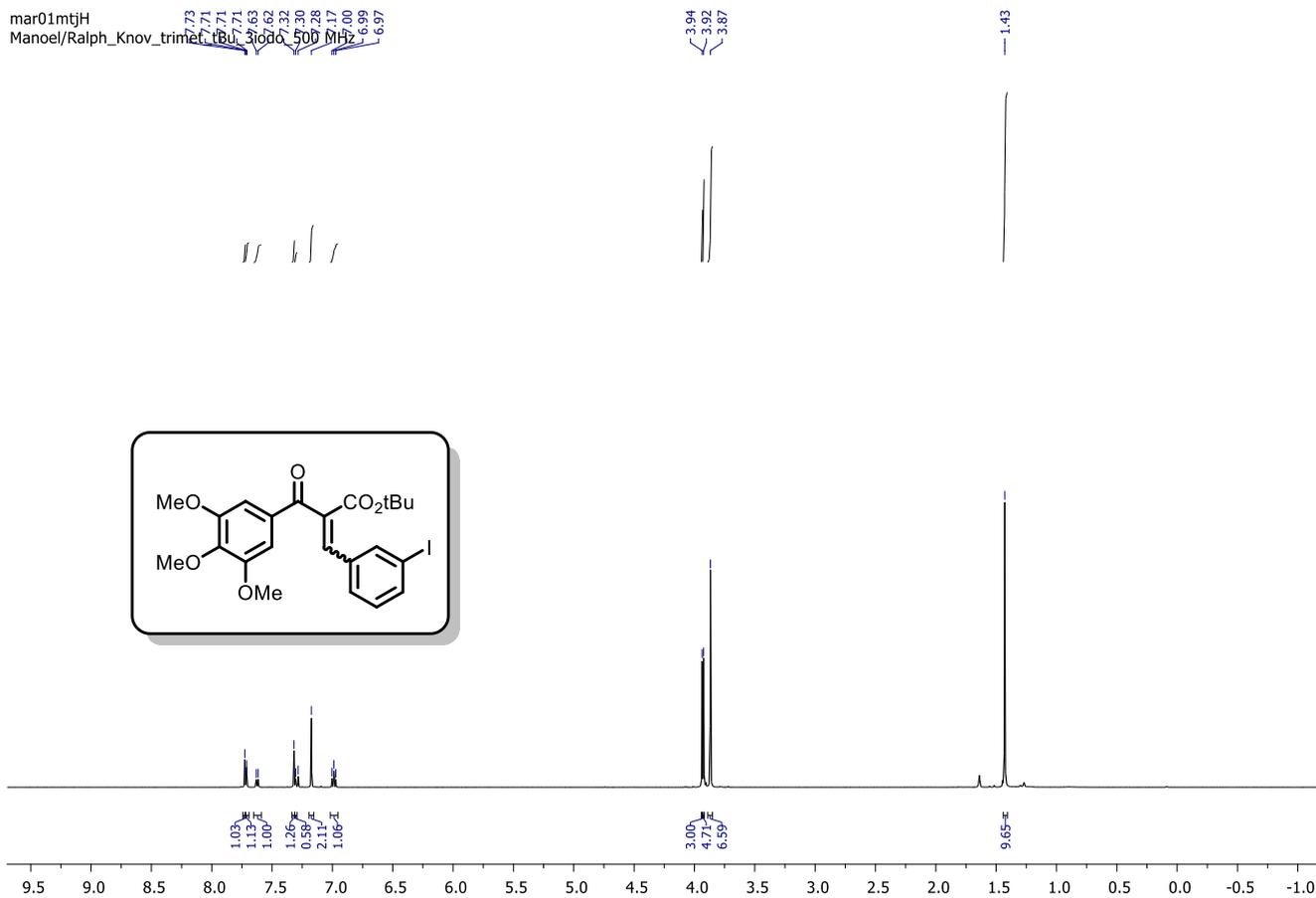
**Figure S8.** <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **9ad**.



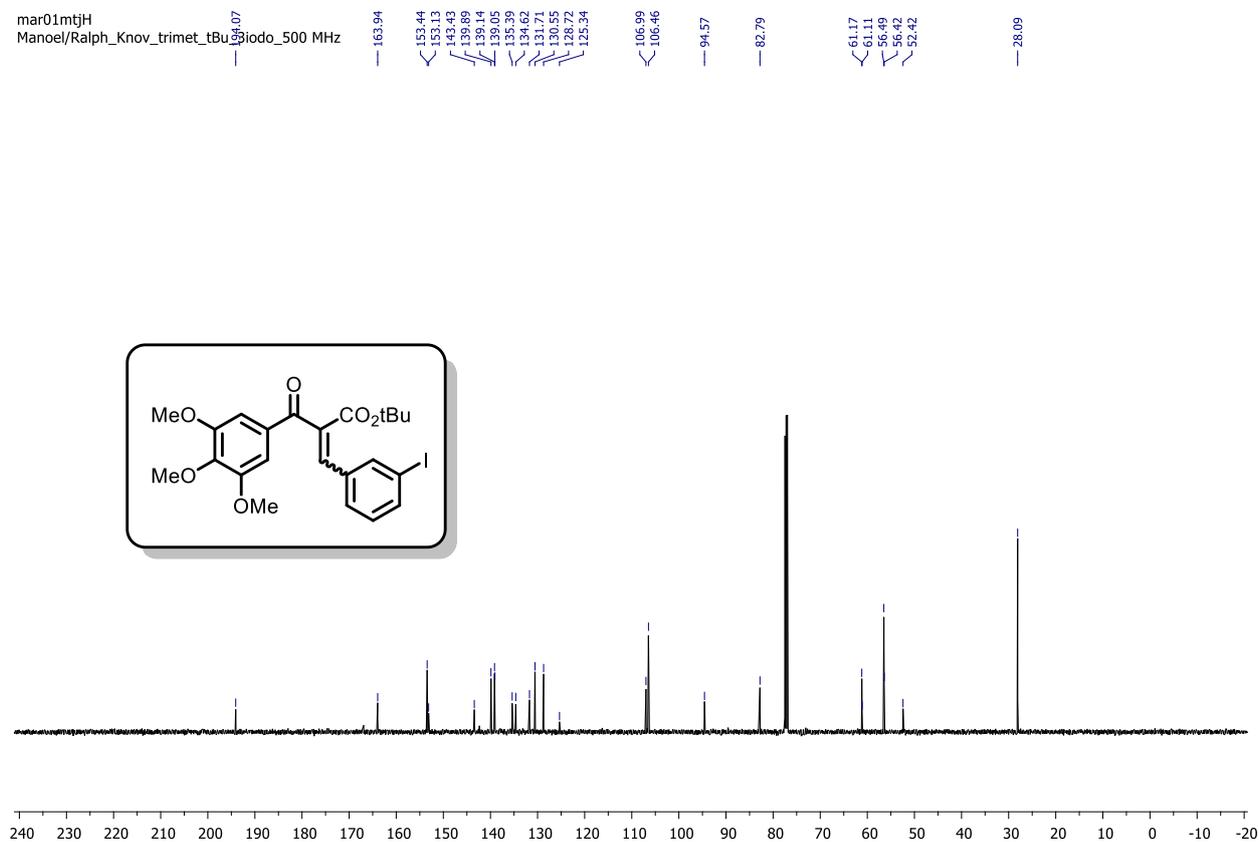
**Figure S9.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **9ae**.



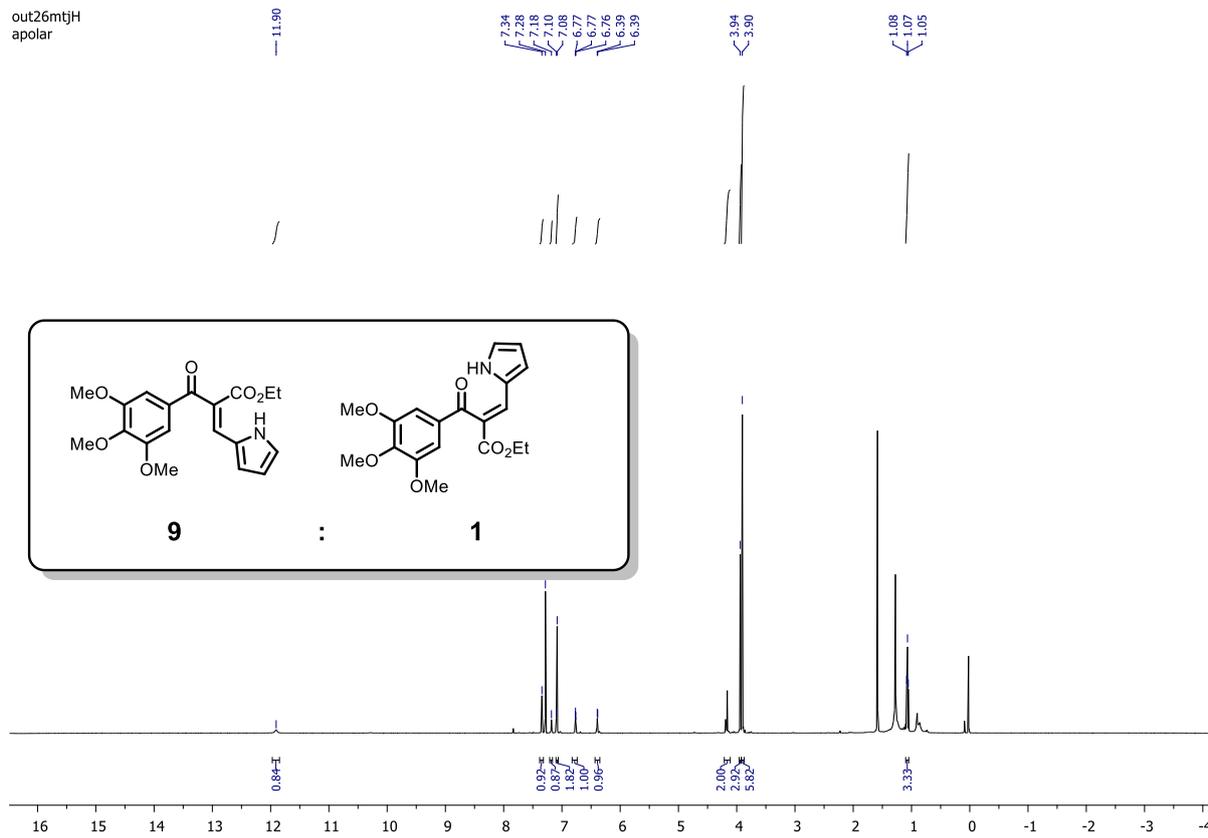
**Figure S10.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **9ae**.



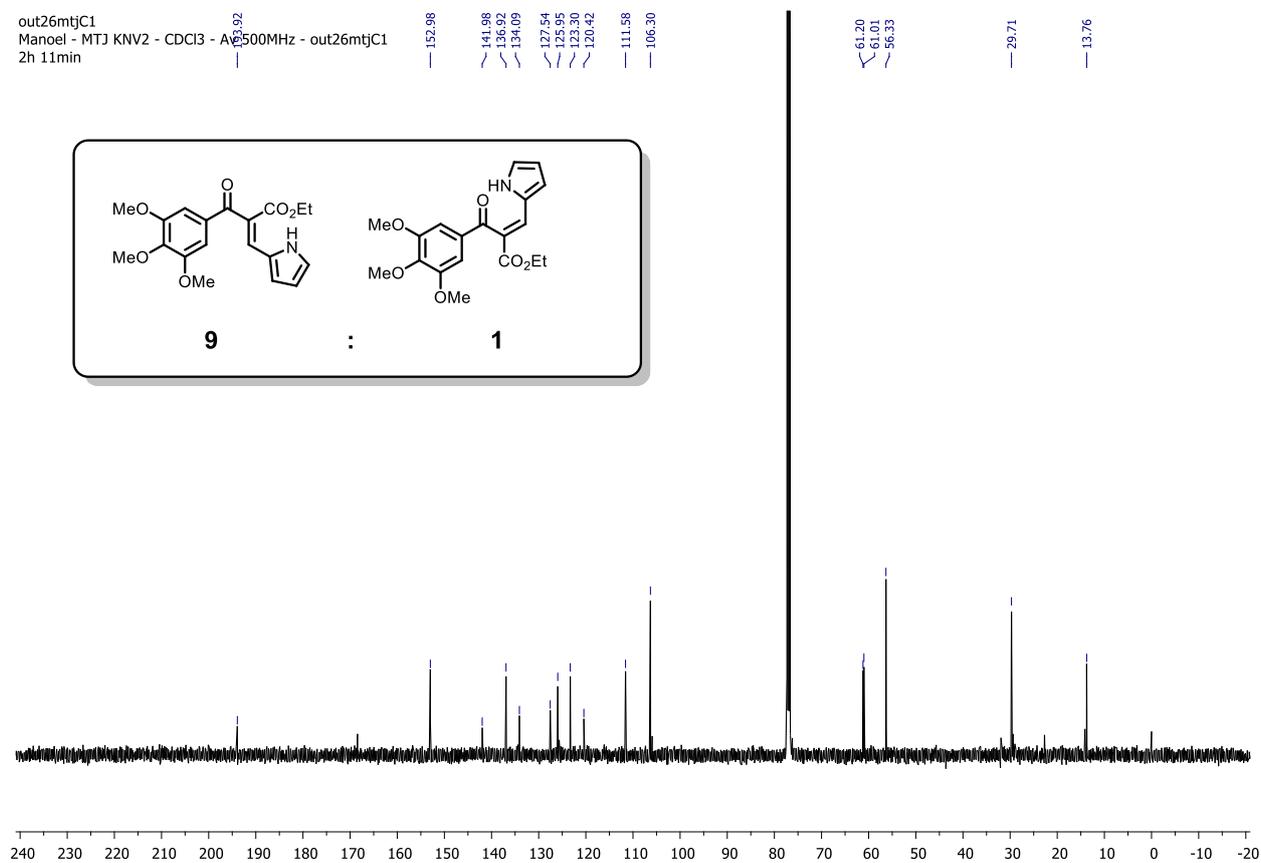
**Figure S11.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **9af**.



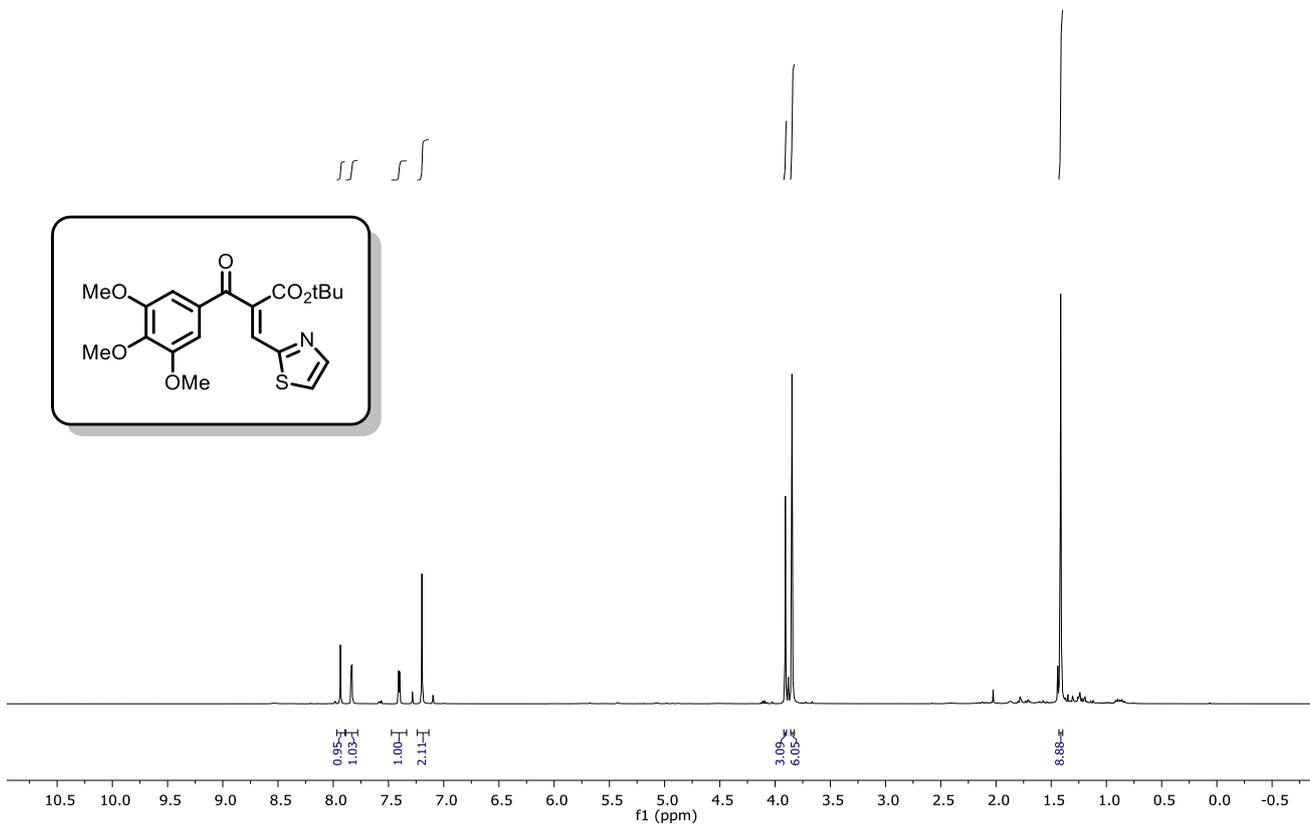
**Figure S12.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **9af**.



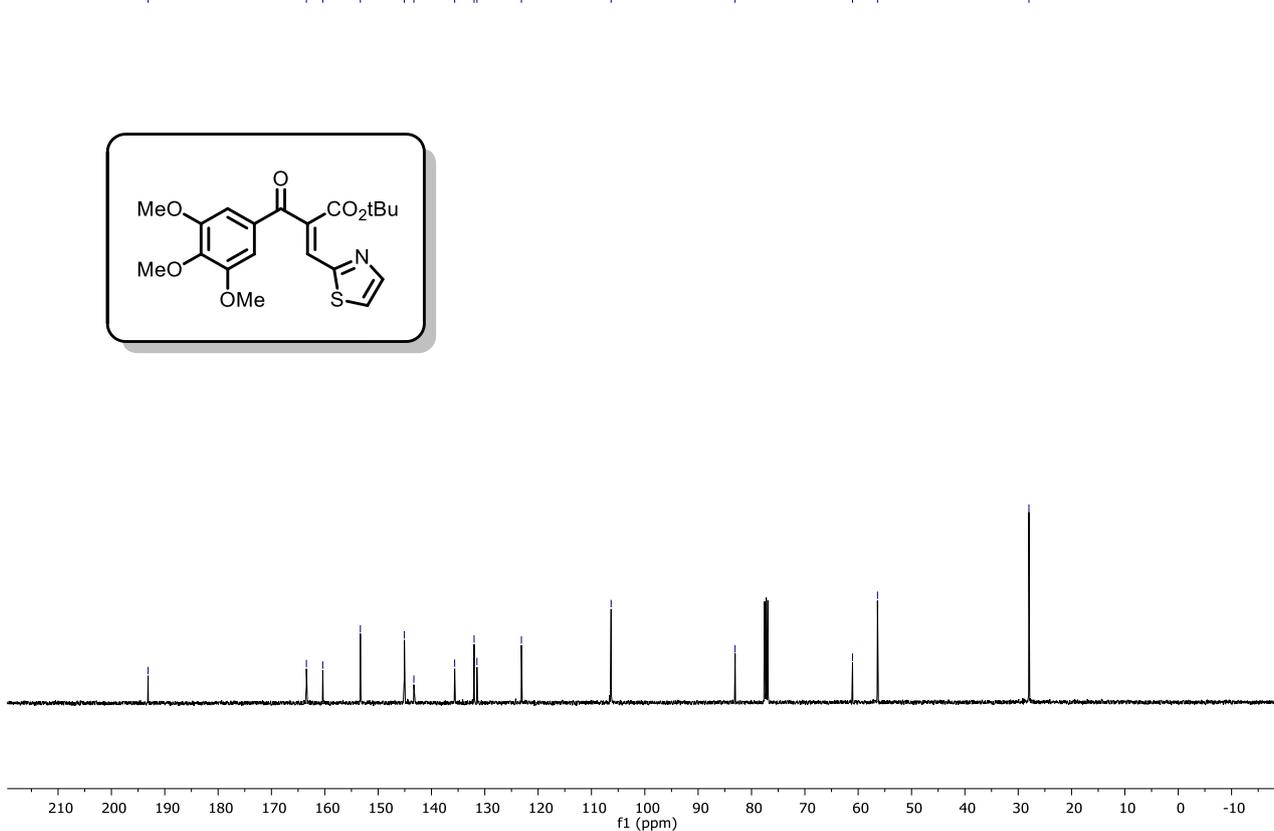
**Figure 13.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **9ag**.



**Figure S14.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **9ag**.



dez12mtjH3.2.fid  
Manoel\_Knov\_trimet\_tiazol\_cdcl3\_400MHz



out23mtjH2.1.fid

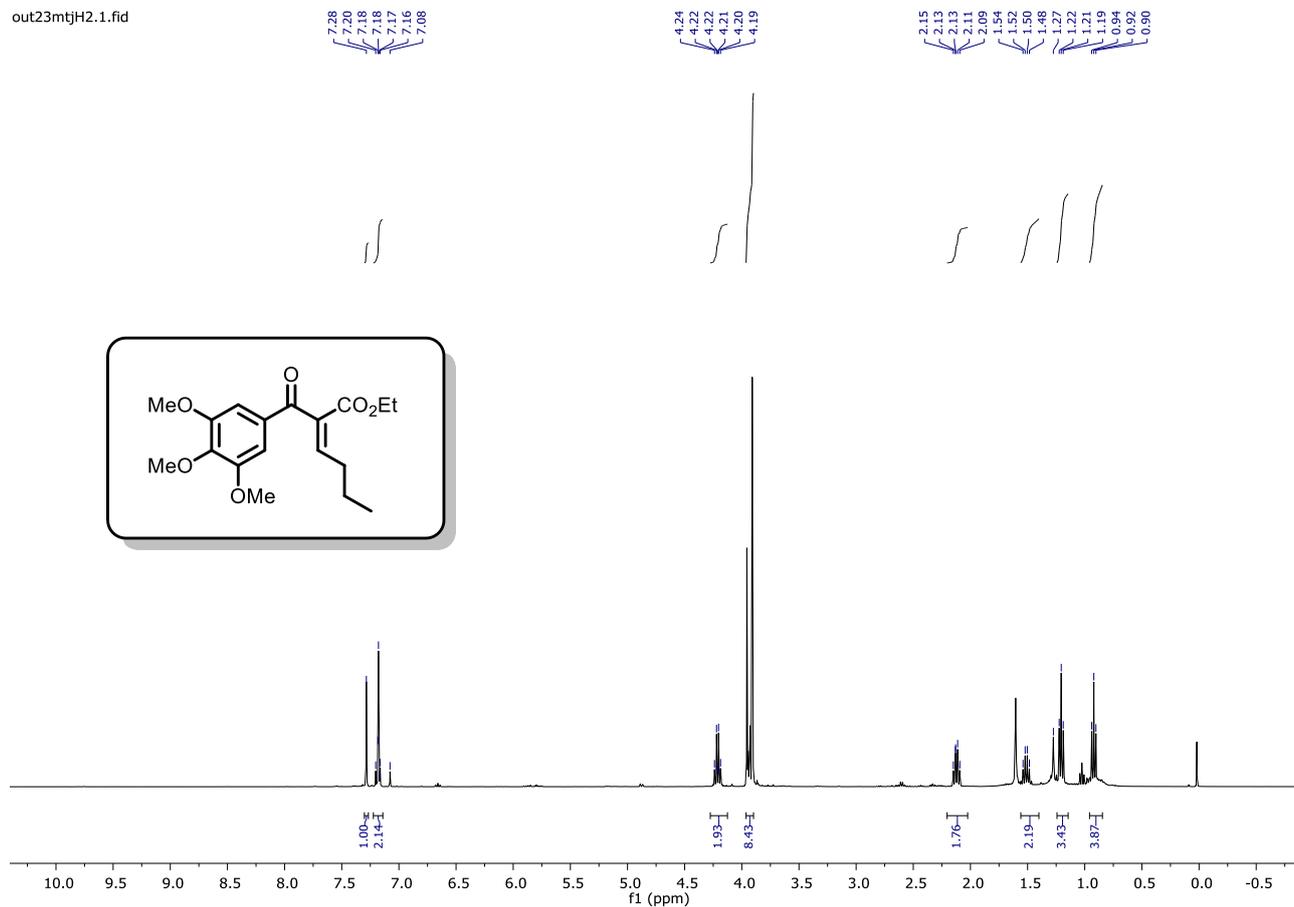


Figure S17. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **9ai**.

out24mtjC1.1.fid  
Manoel - MTJ KNV  
5 horas

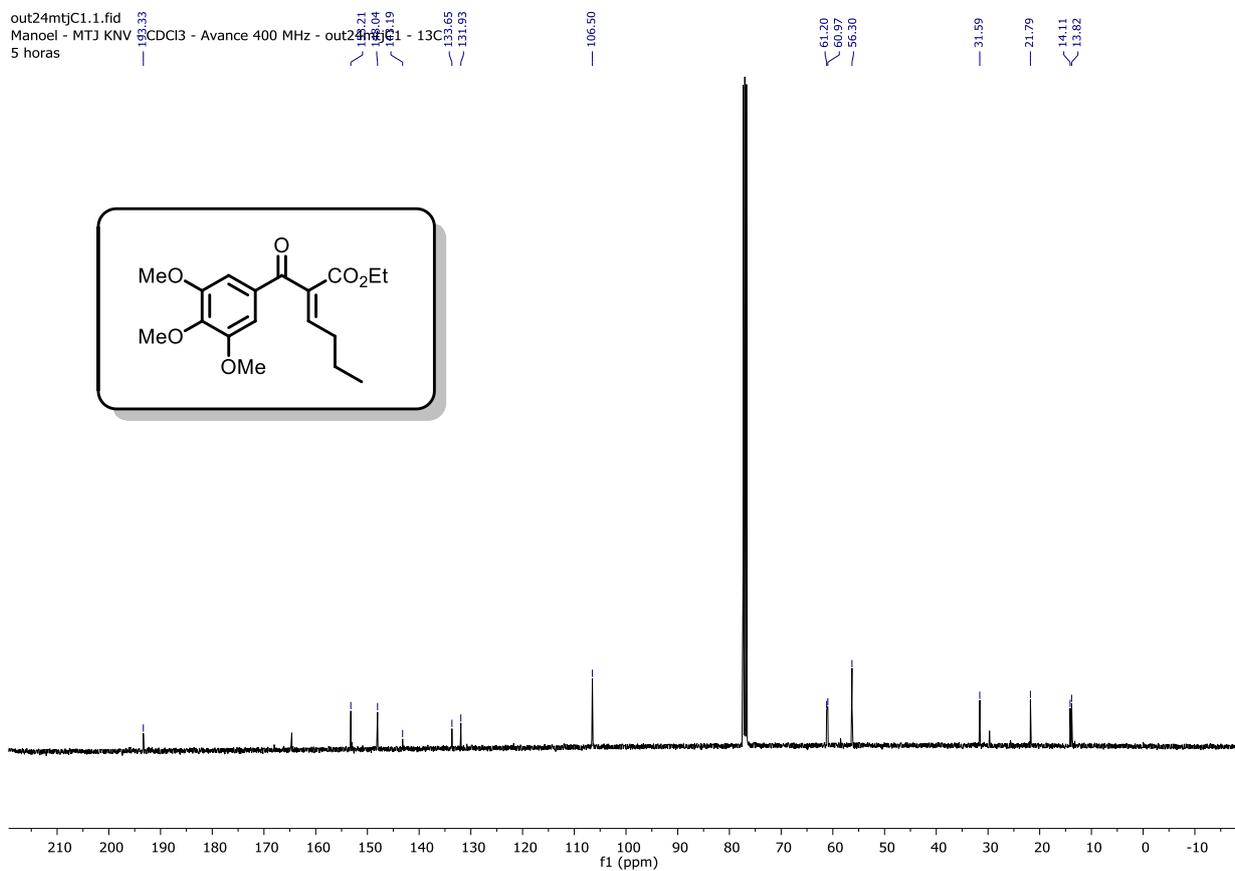


Figure S18. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **9ai**.

fev05mtjH  
Manoel\_Knov\_3,5-dimet\_trimet\_Co2et  
CDCl3

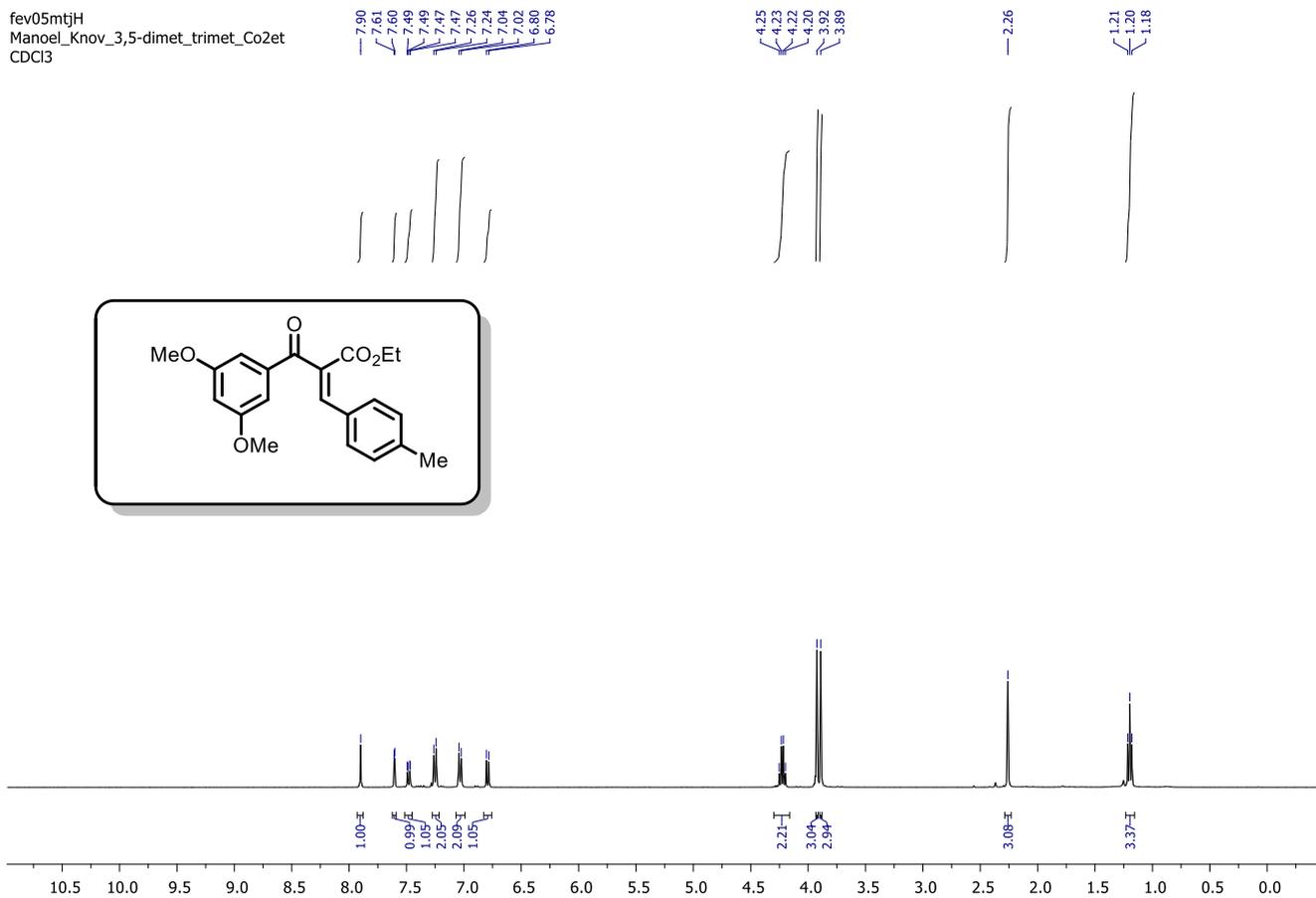


Figure S19. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 9bj.

fev05mtjH  
Manoel\_Knov\_3,5-dimet\_trimet\_Co2et  
CDCl3

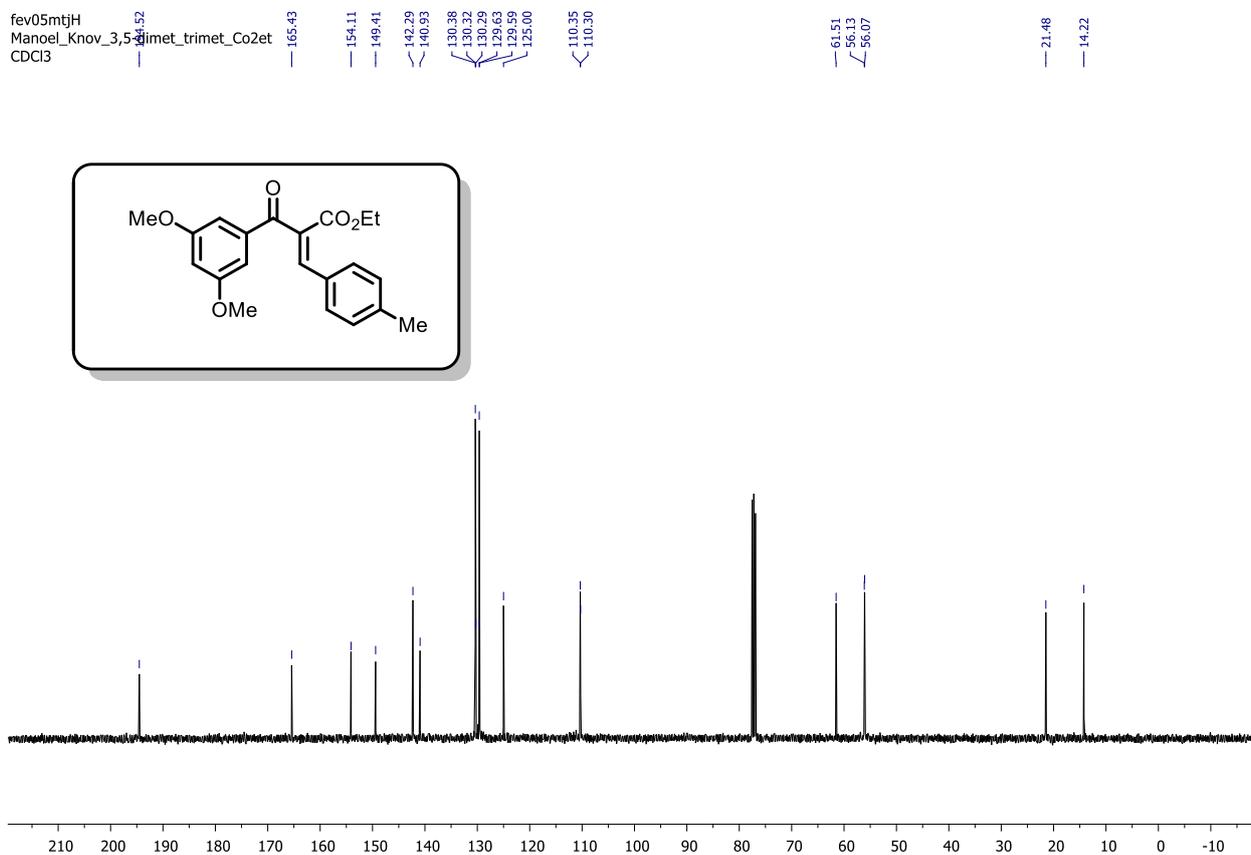
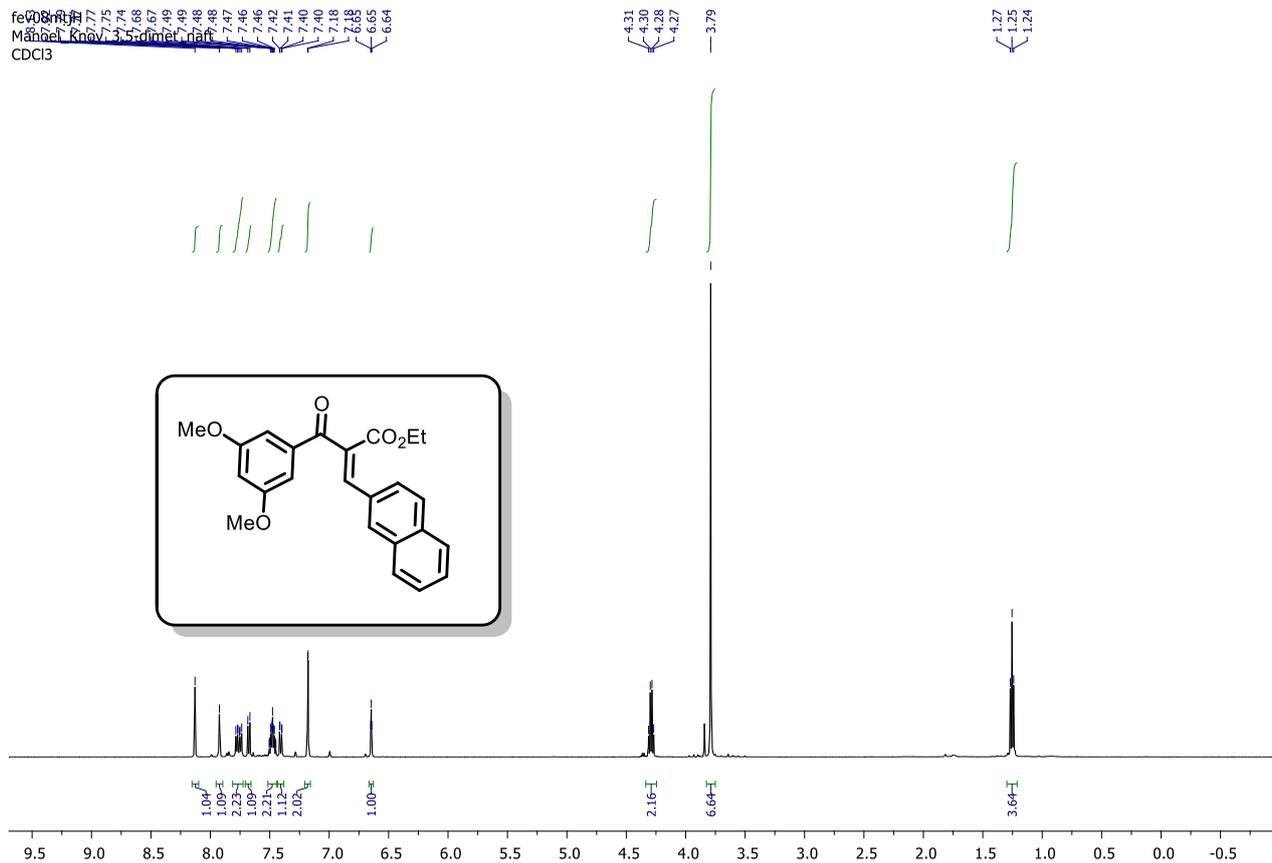
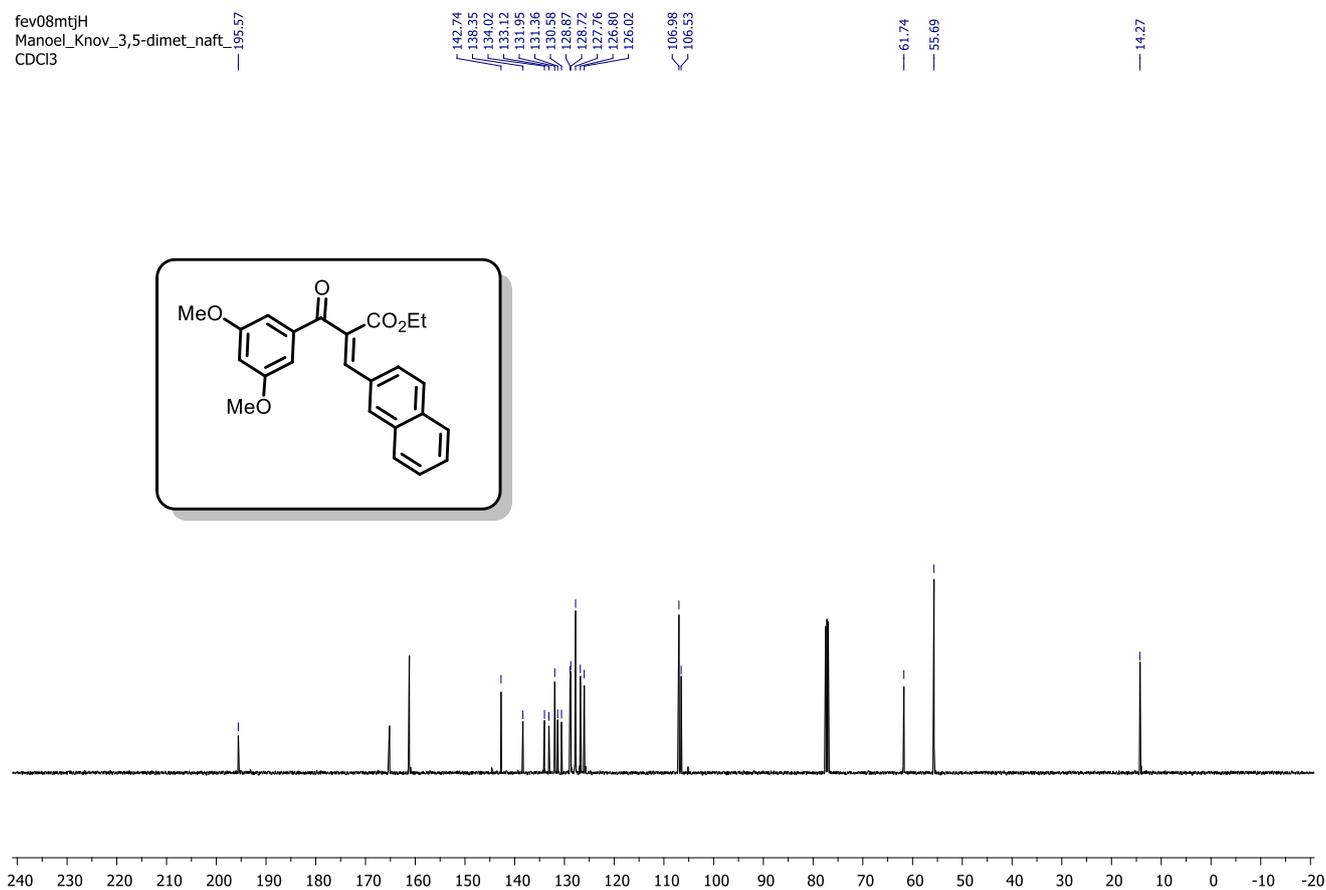


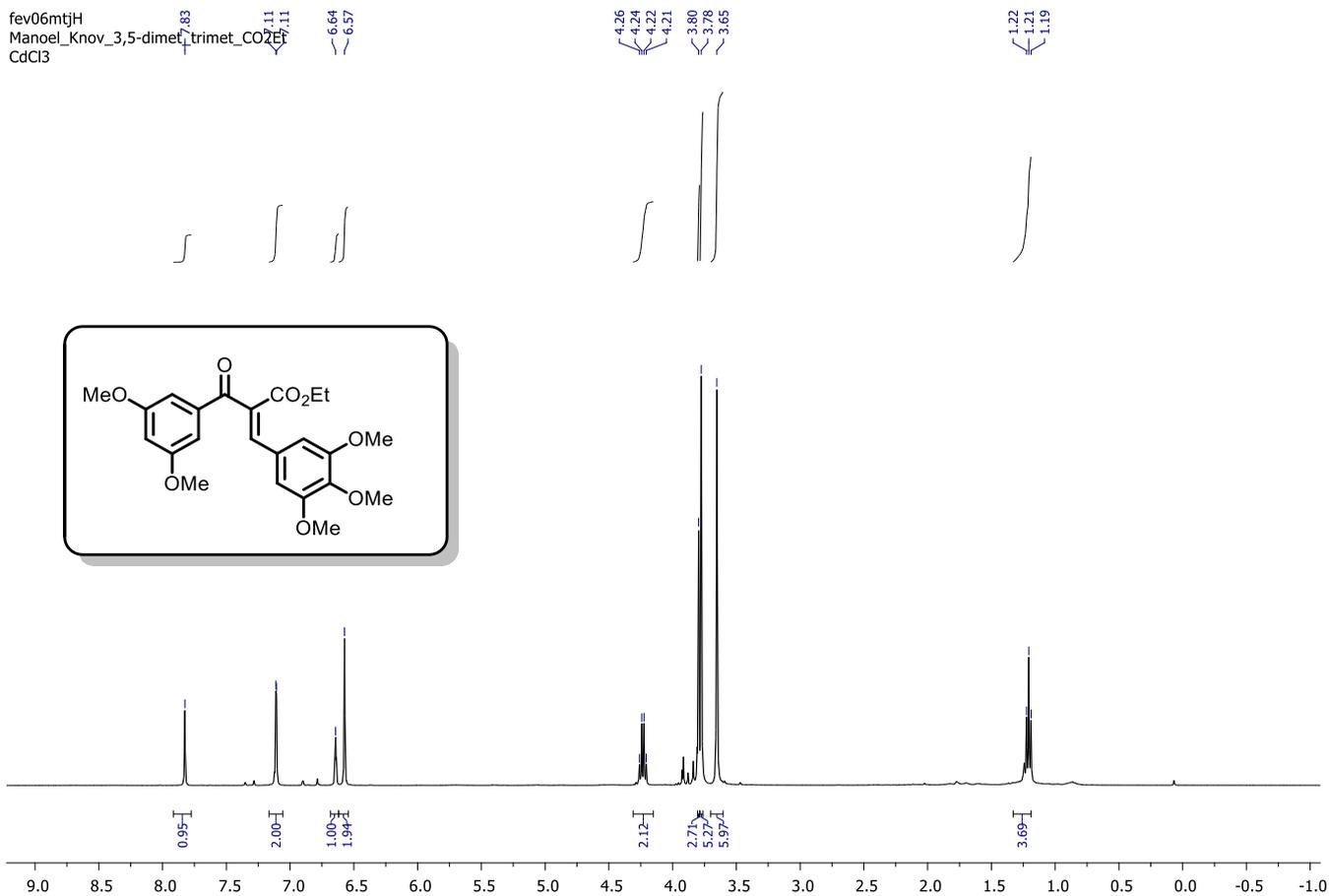
Figure S20. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound 9bj.



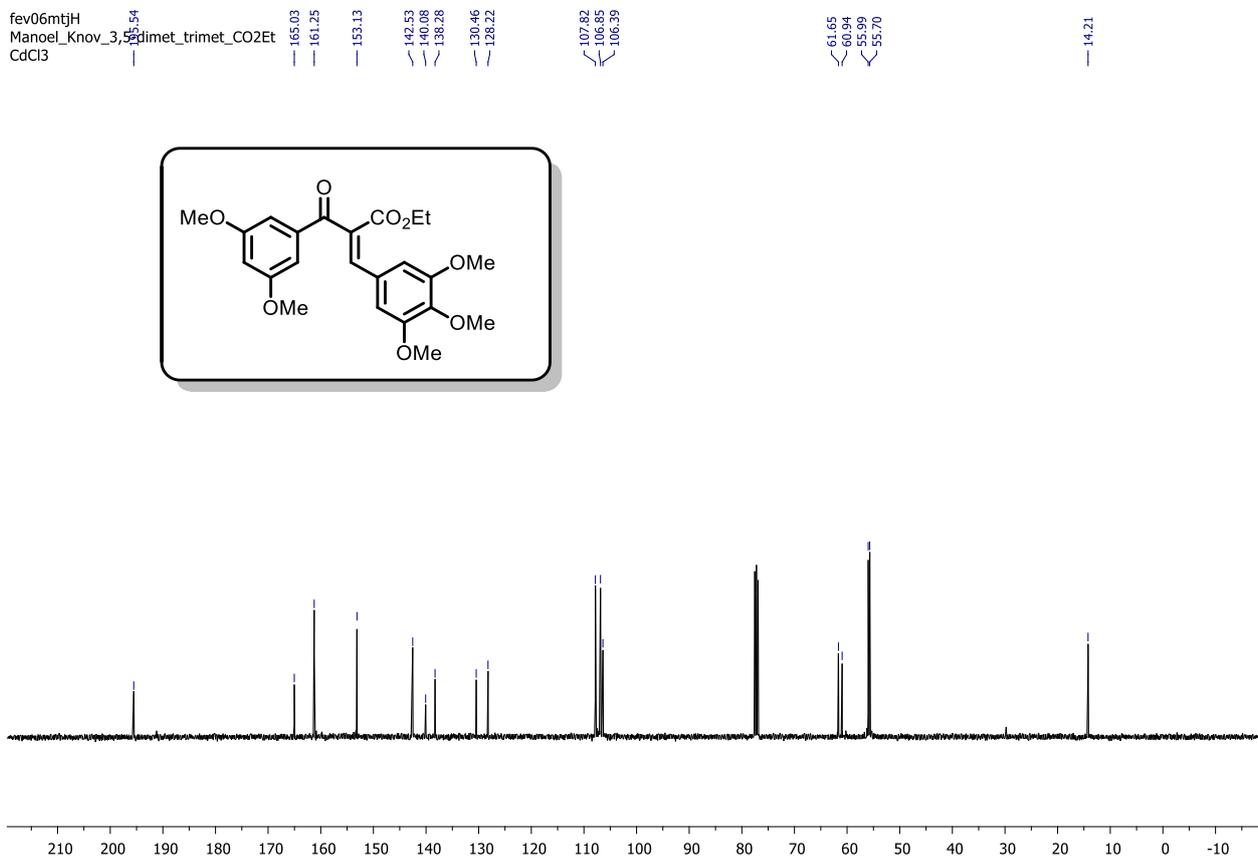
**Figure S21.** <sup>1</sup>H NMR spectrum (500 MHz, CDCl<sub>3</sub>) of compound **9bk**.



**Figure S22.** <sup>13</sup>C NMR spectrum (126 MHz, CDCl<sub>3</sub>) of compound **9bk**.



**Figure S23.**  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **9bc**.



**Figure S24.**  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound **9bc**.

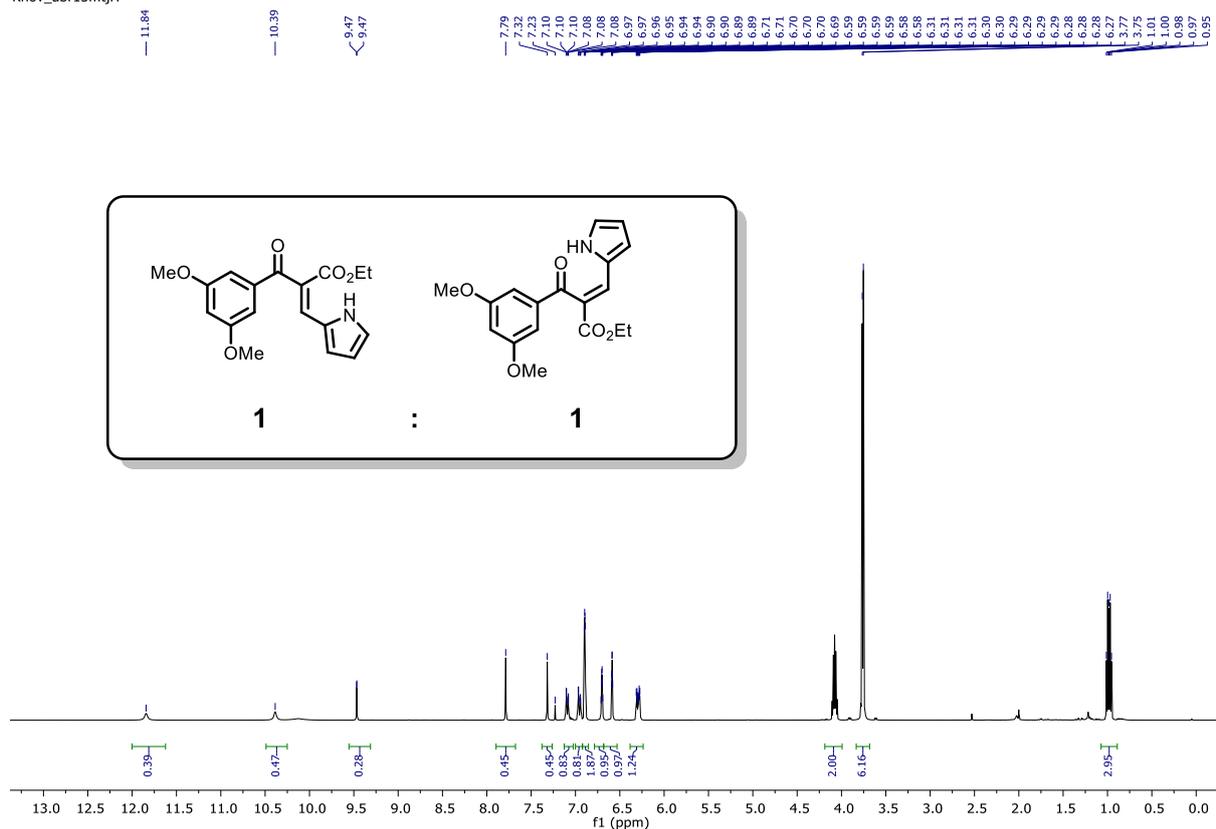


Figure S25. <sup>1</sup>H NMR spectrum (500 MHz, CDCl<sub>3</sub>) of compound **9bg**.

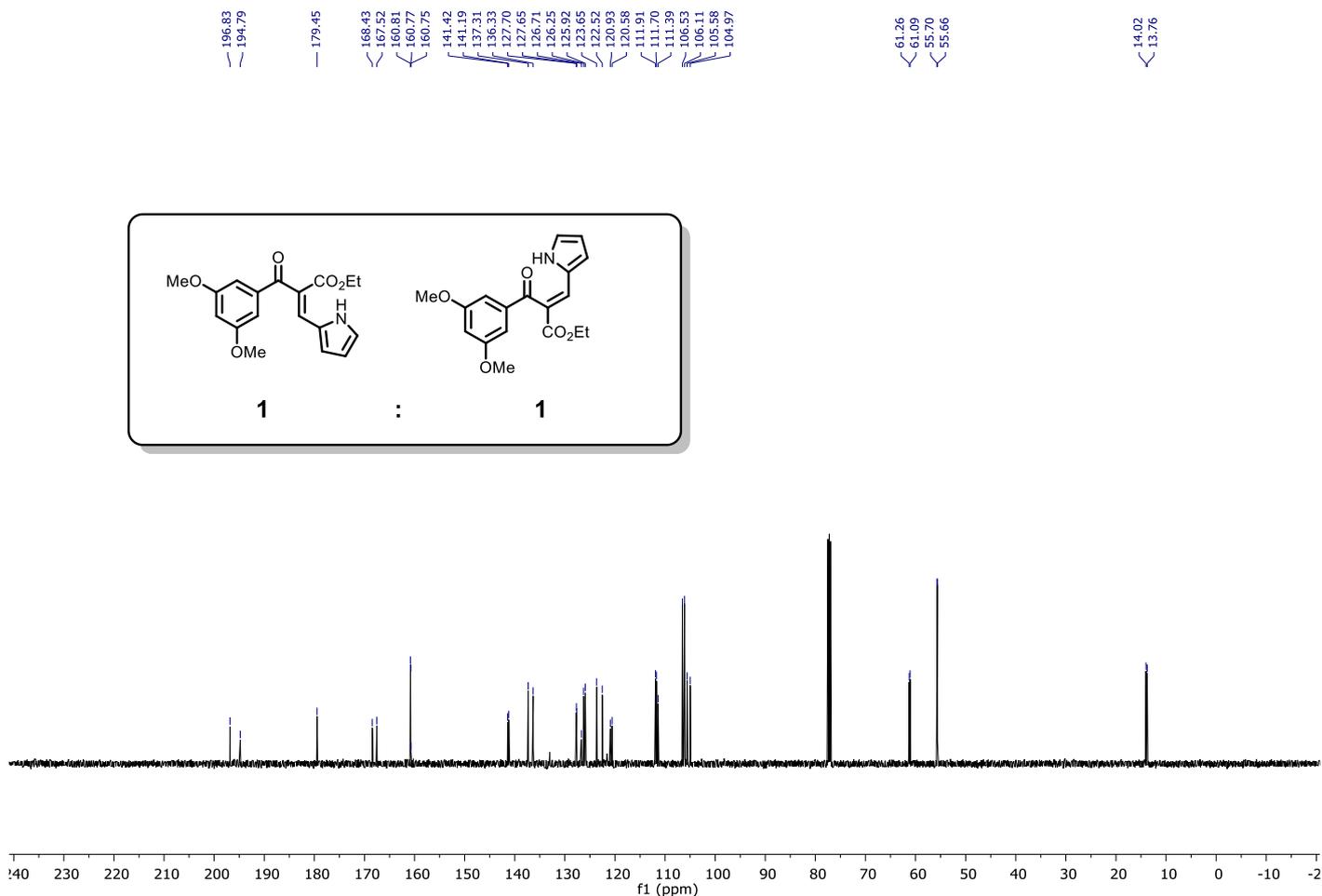
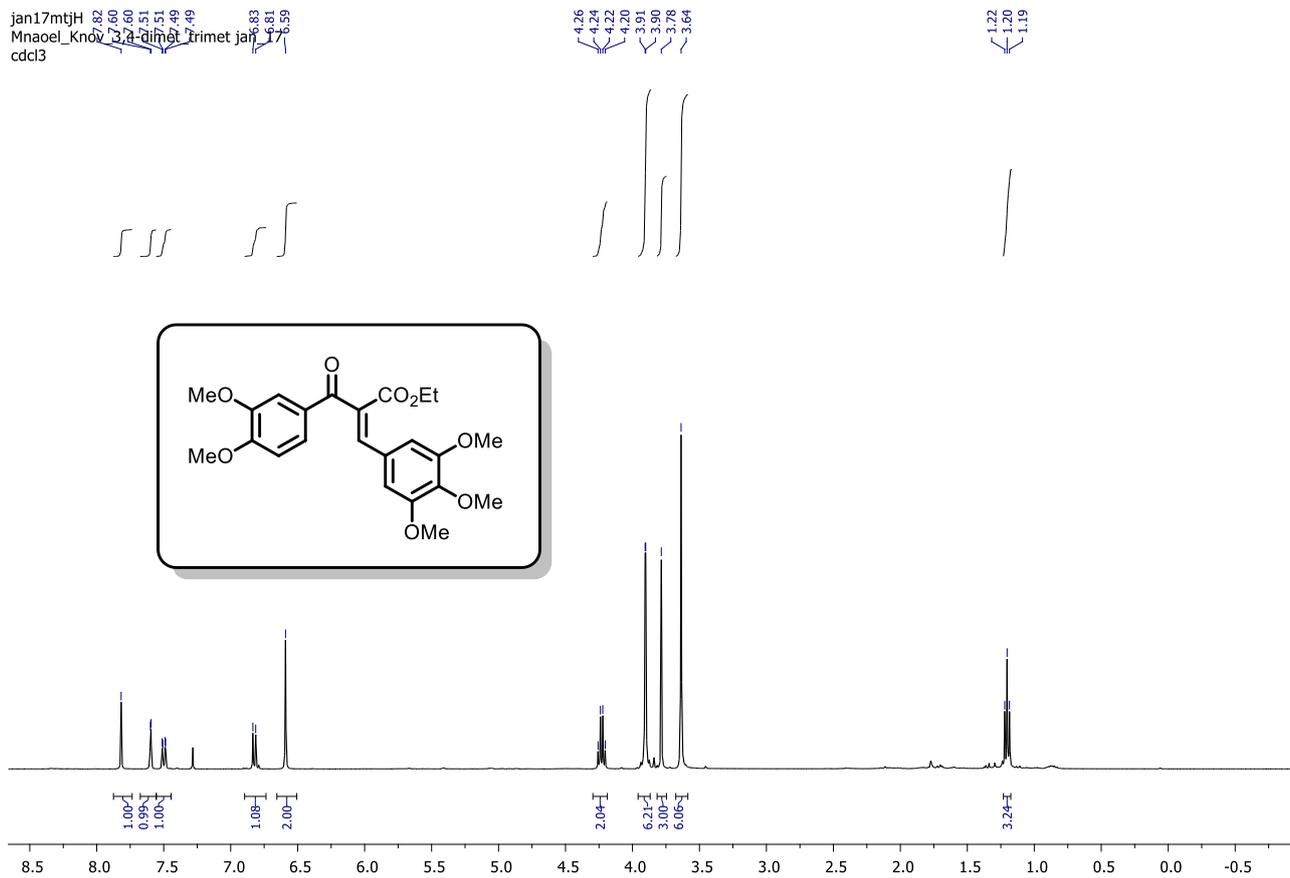
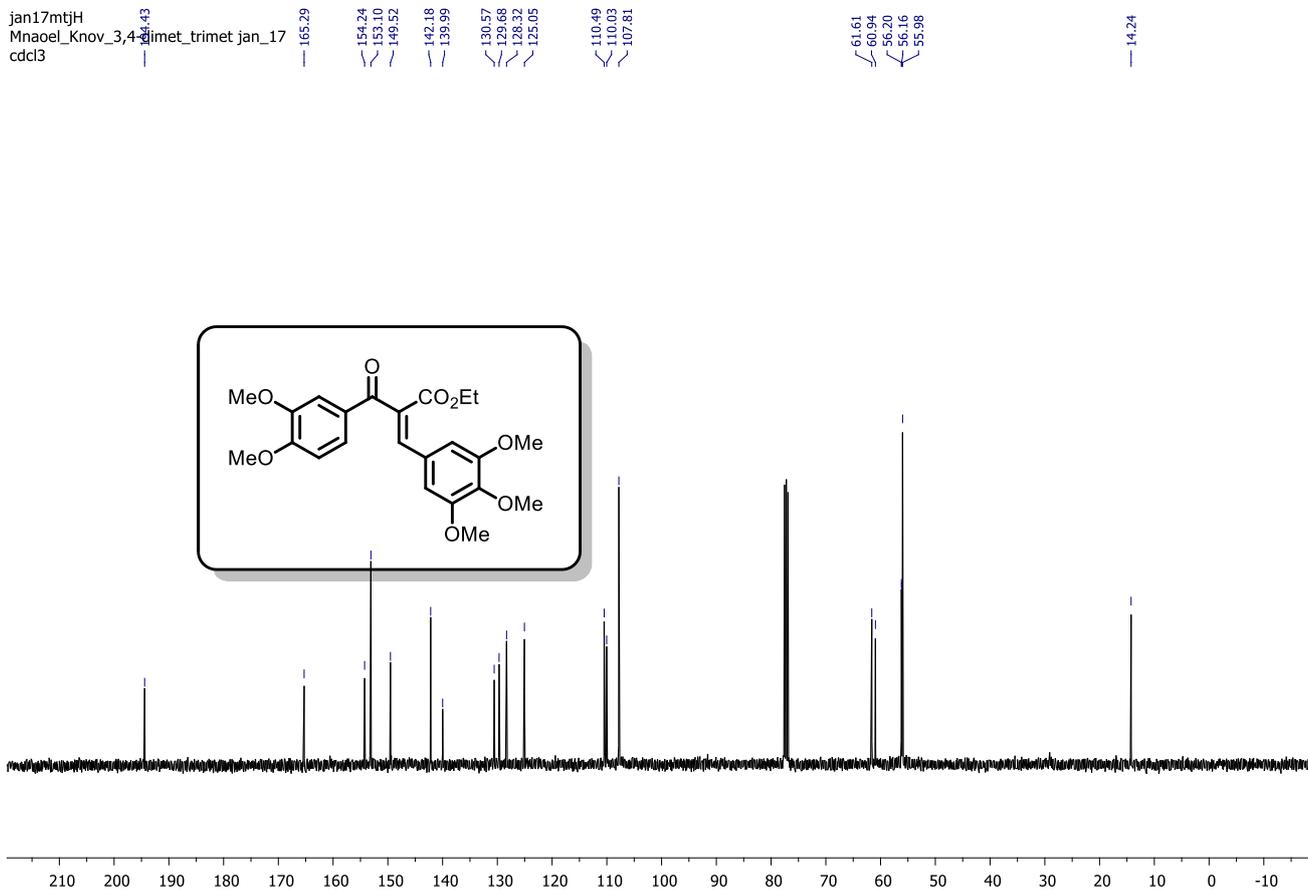


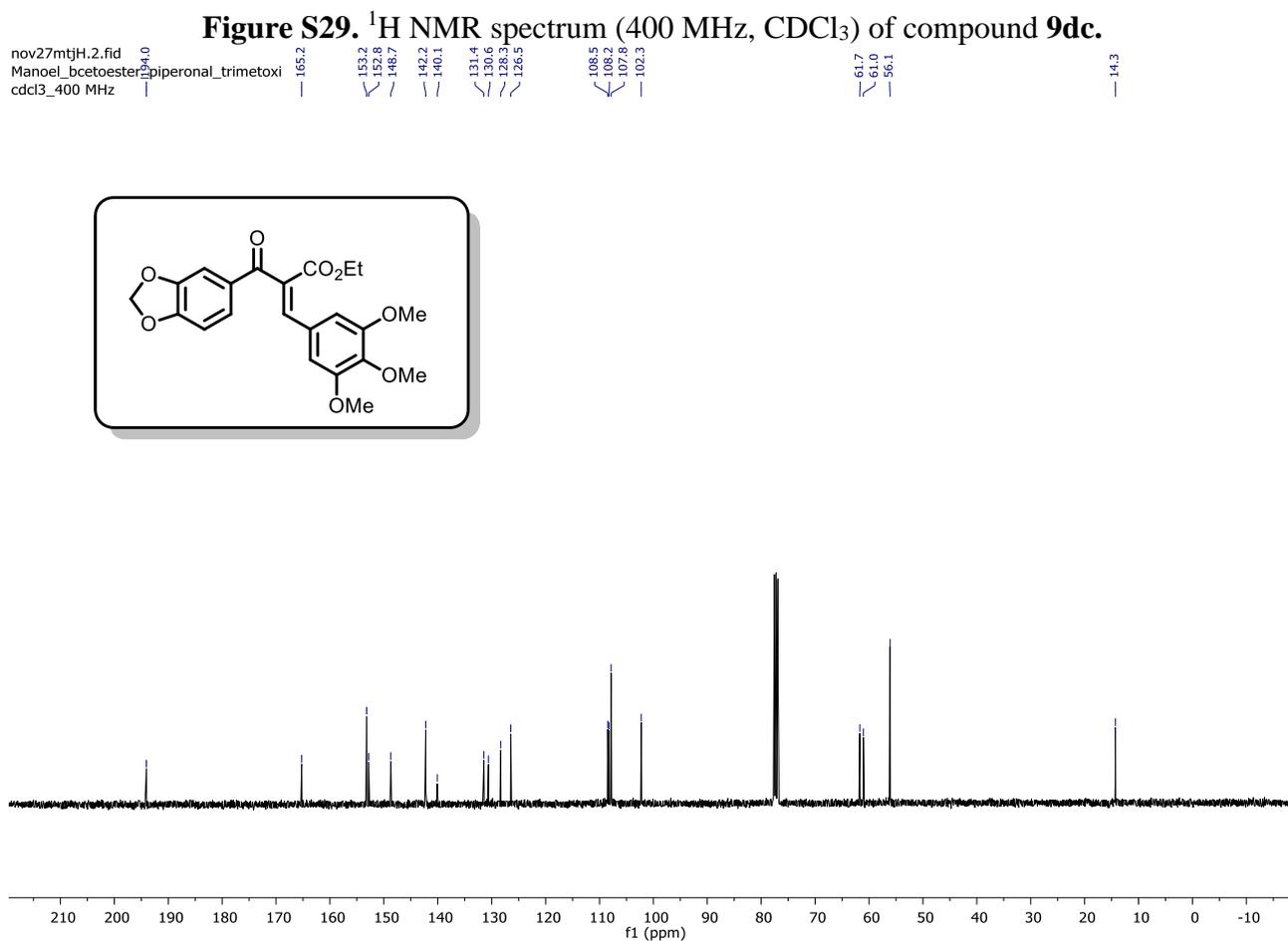
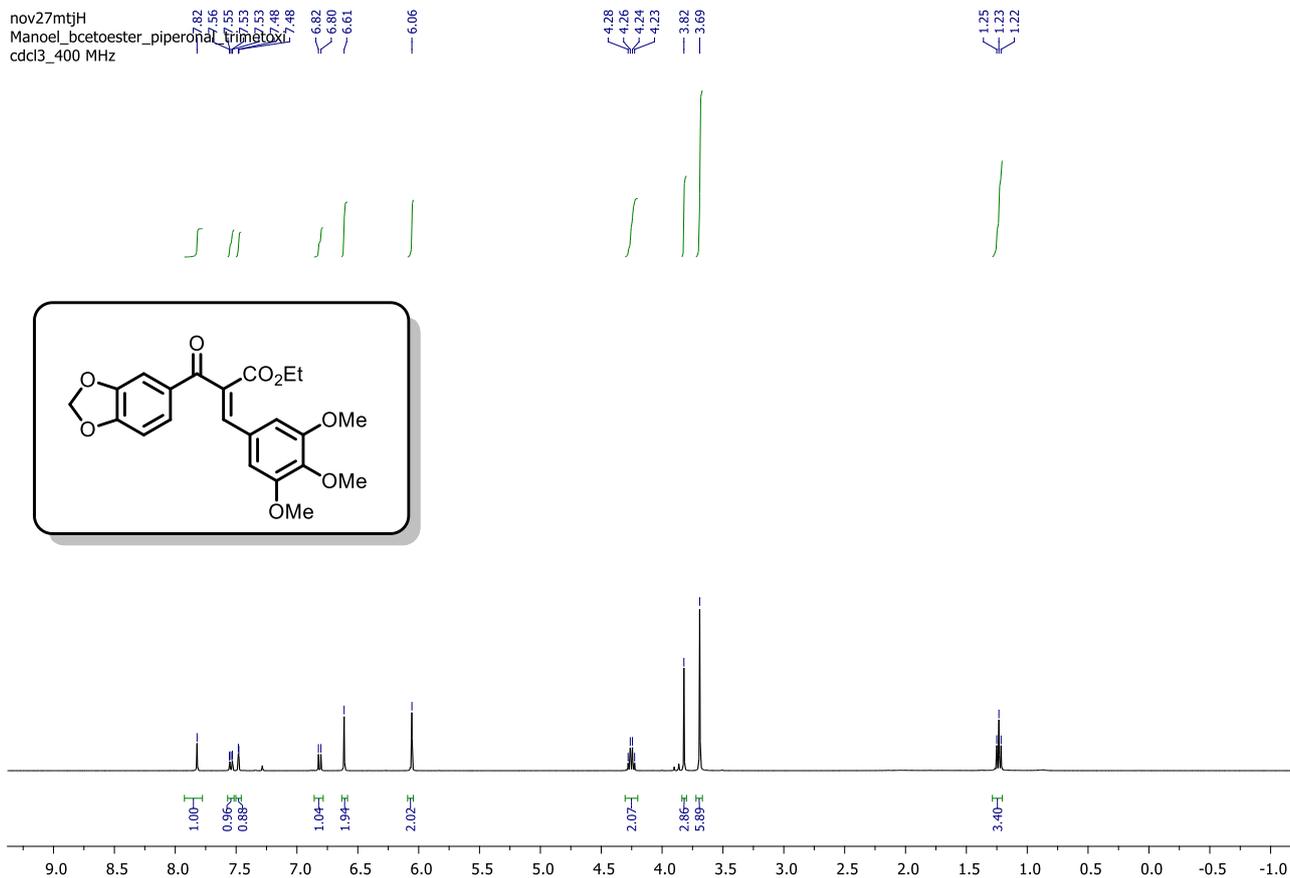
Figure S26. <sup>13</sup>C NMR spectrum (126 MHz, CDCl<sub>3</sub>) of compound **9bg**.

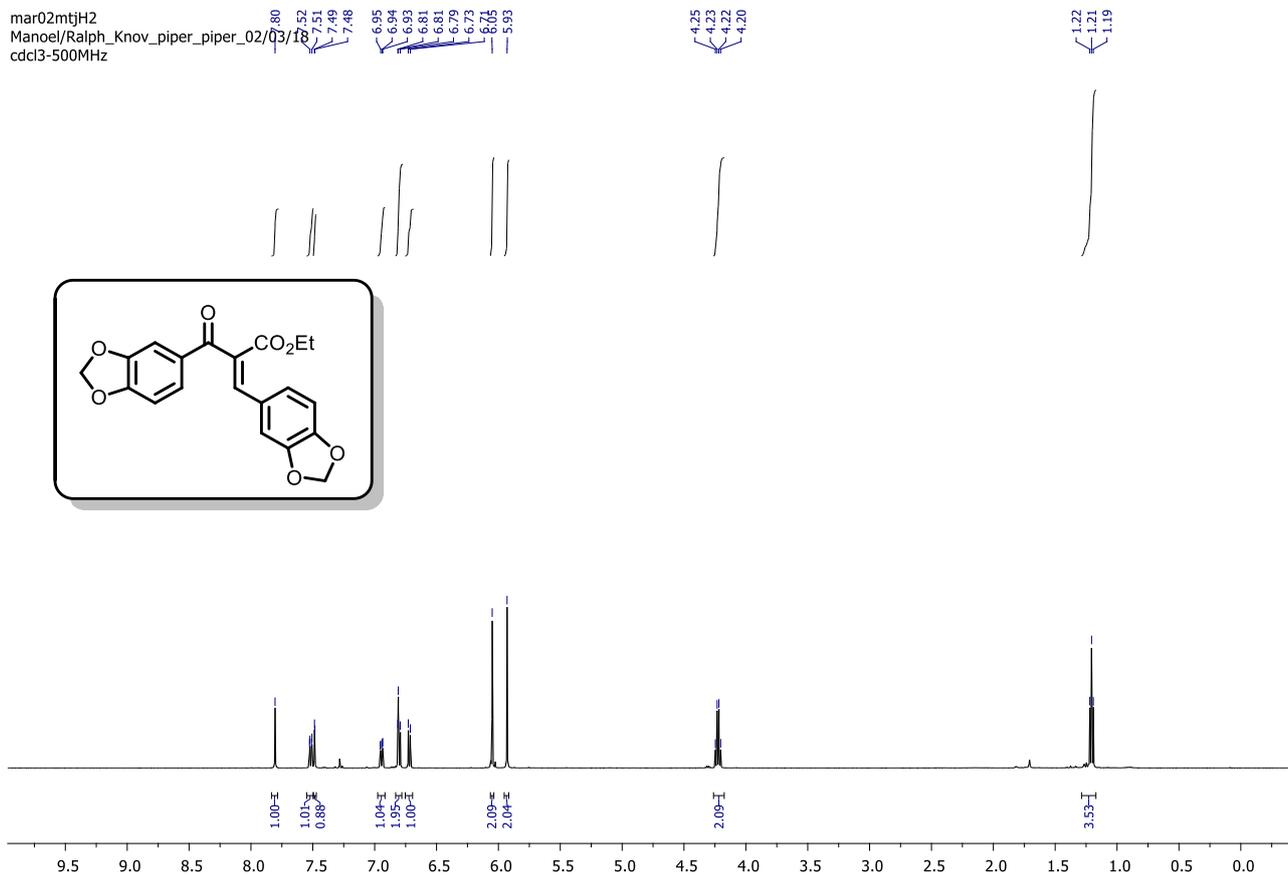


**Figure S27.**  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **9cc**.

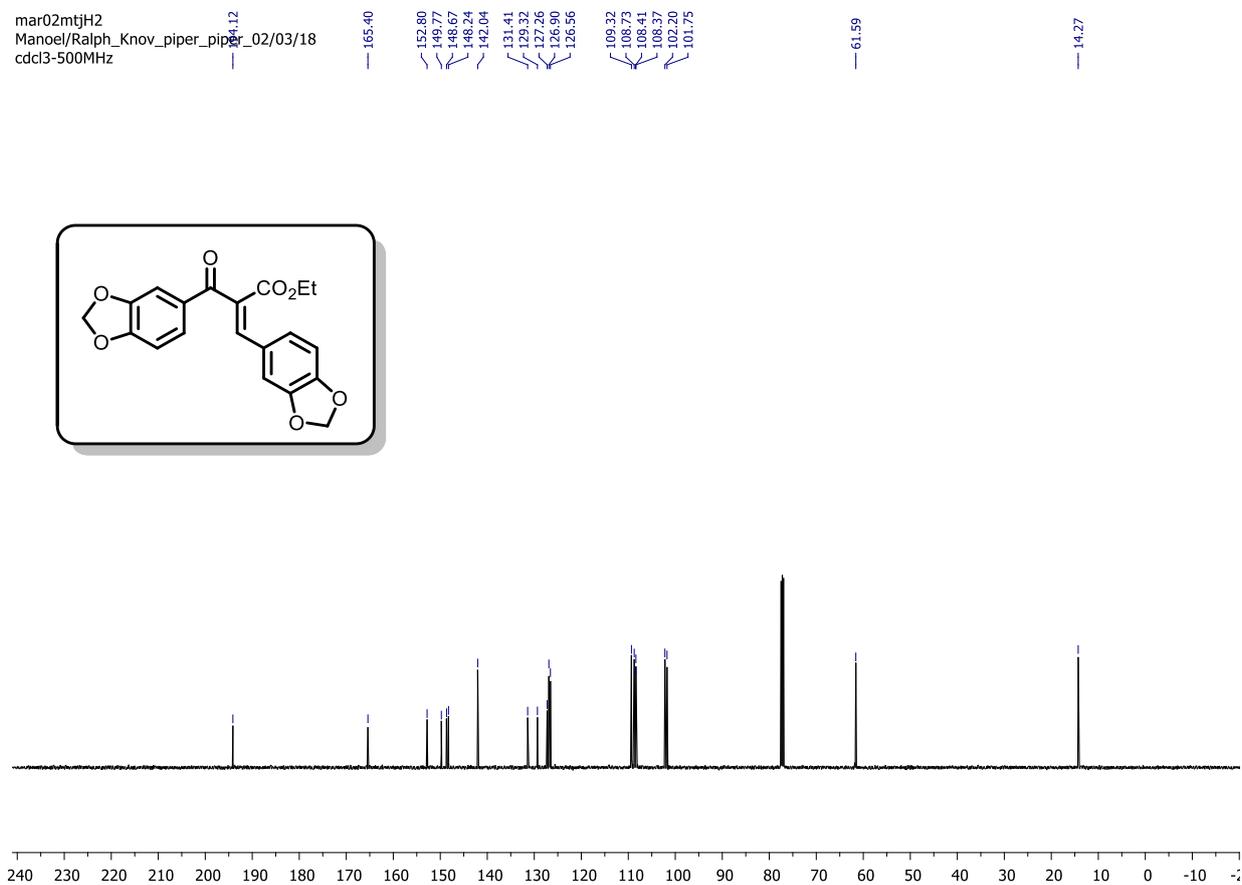


**Figure S28.**  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound **9cc**.

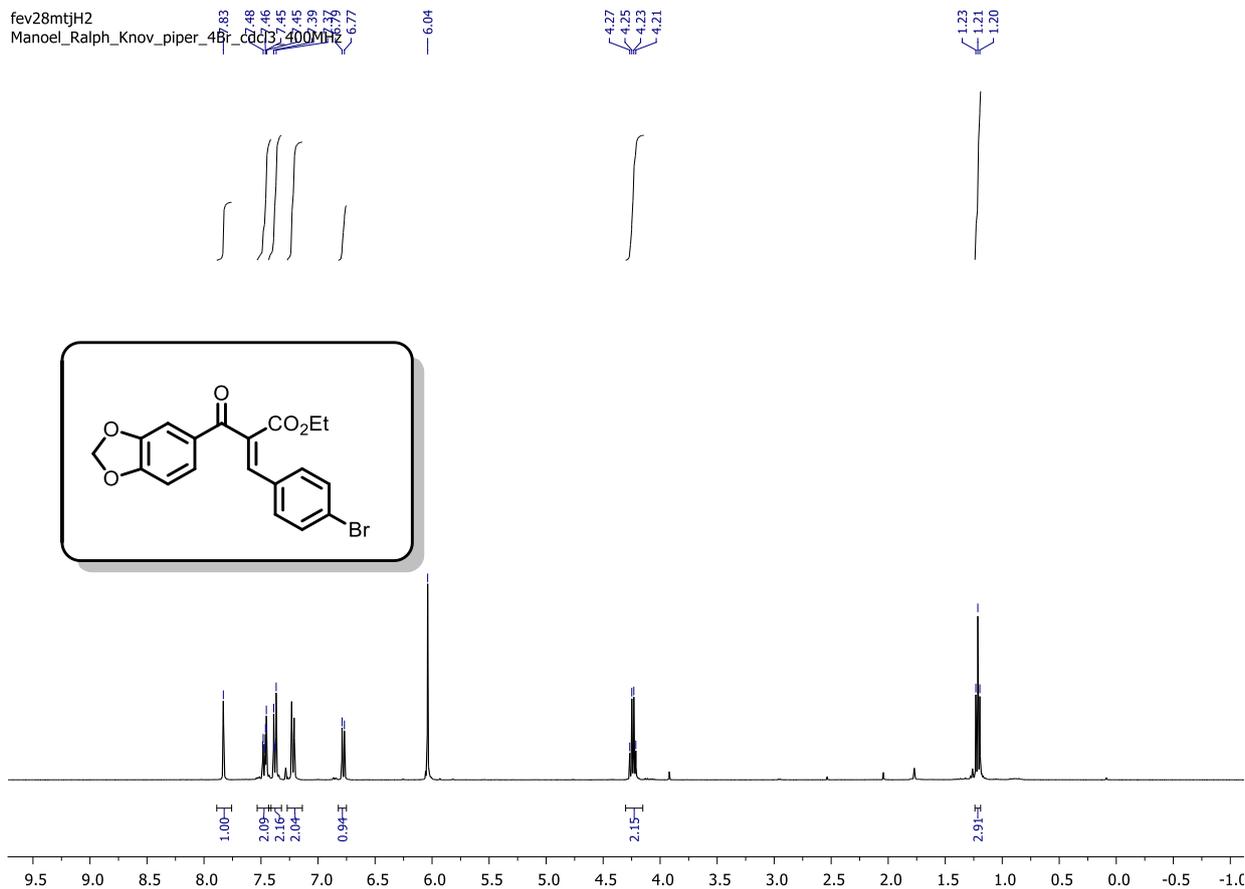




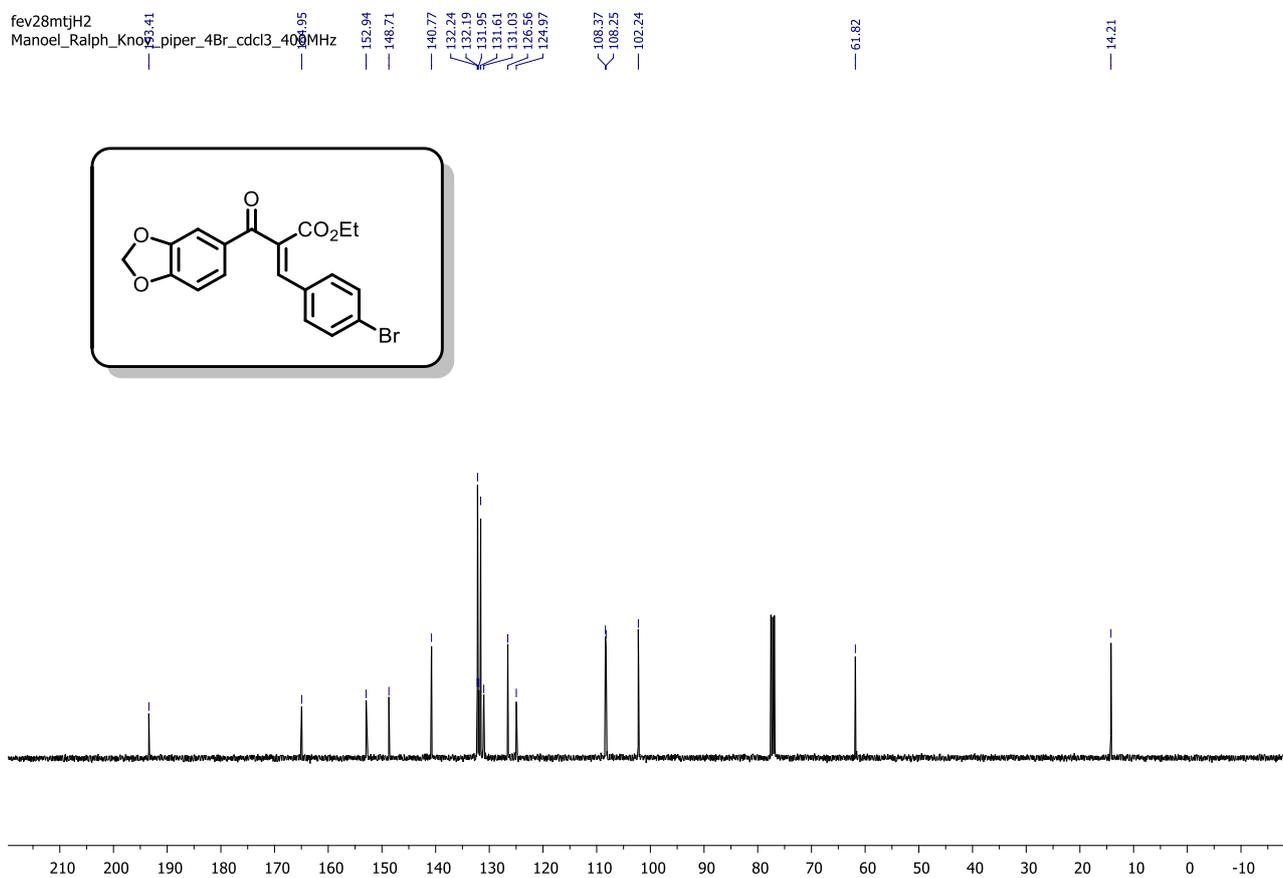
**Figure S31.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **9dl**.



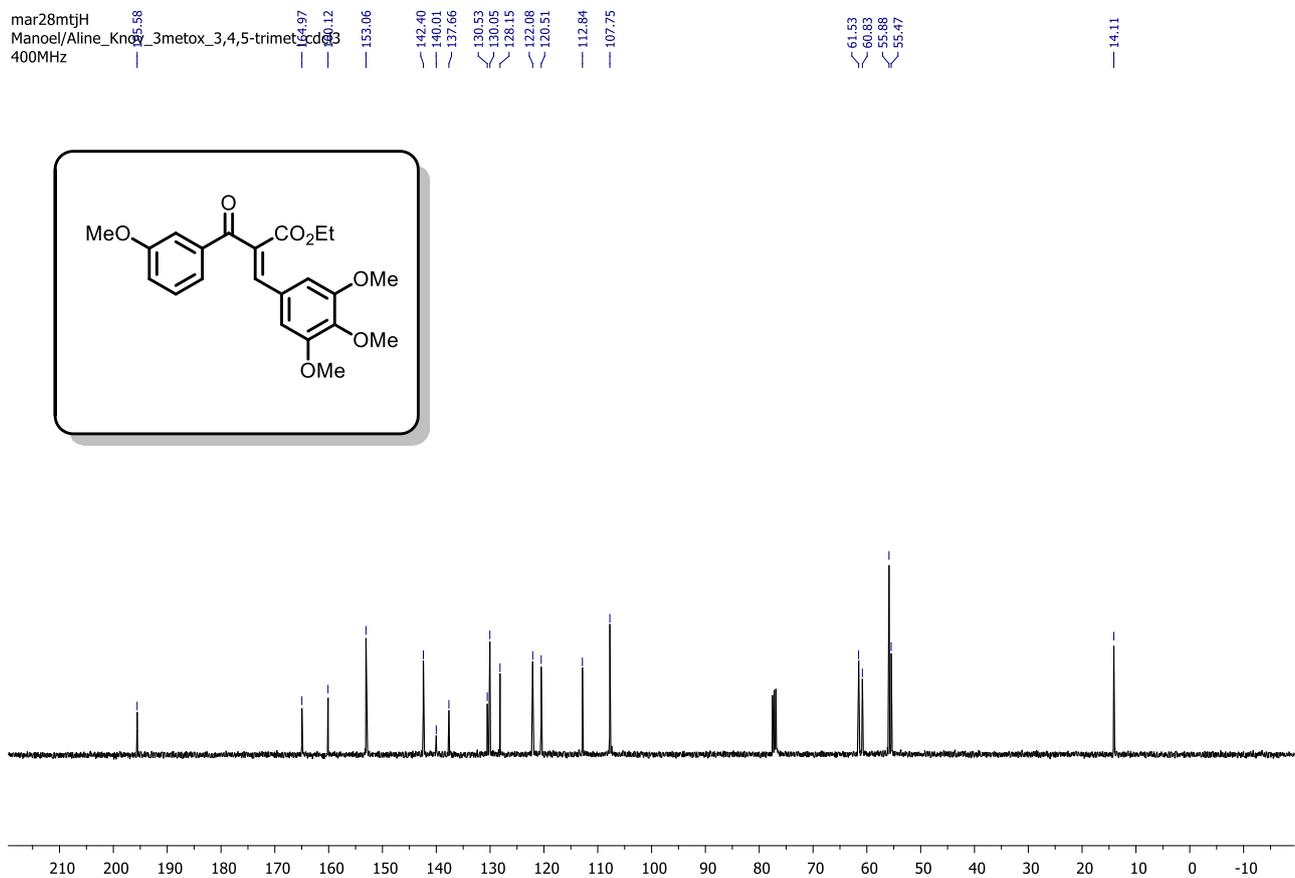
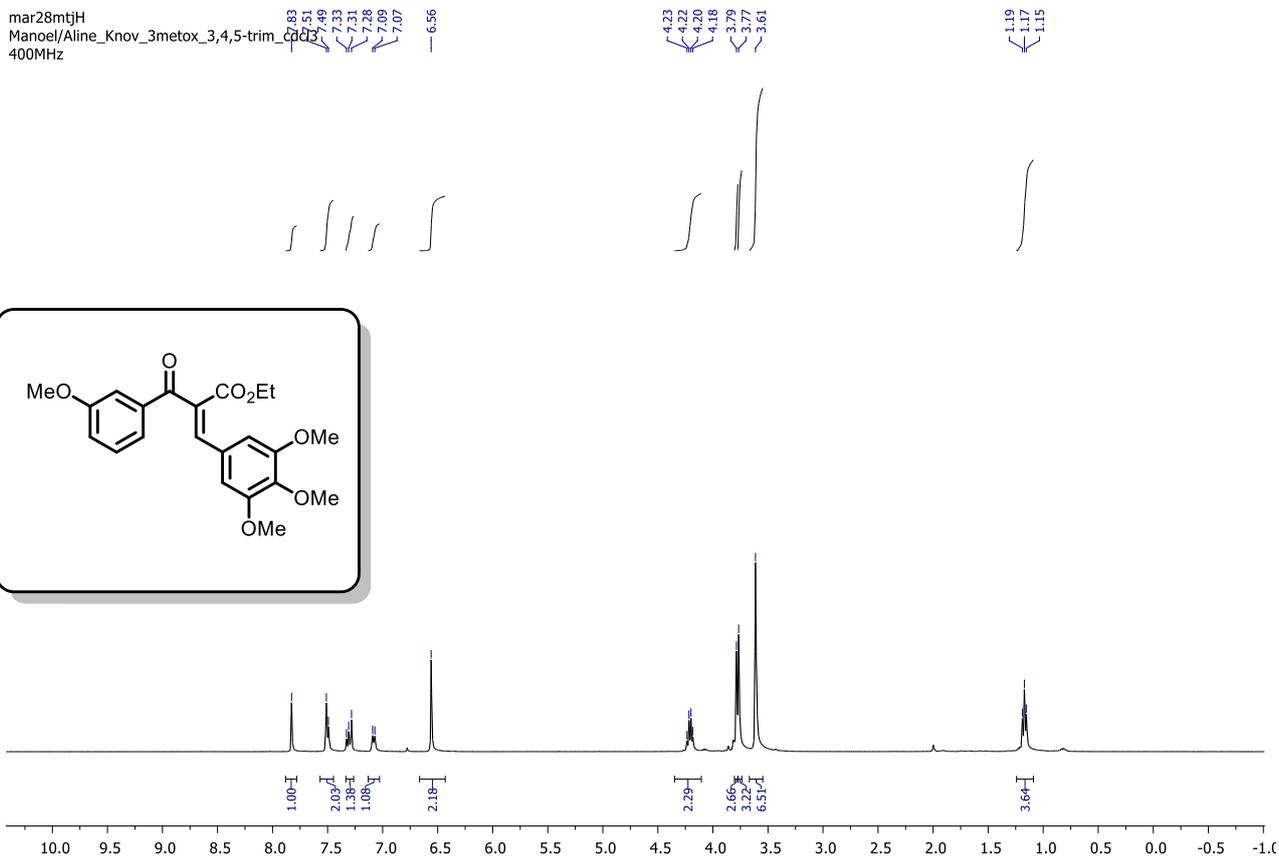
**Figure S32.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **9dl**.



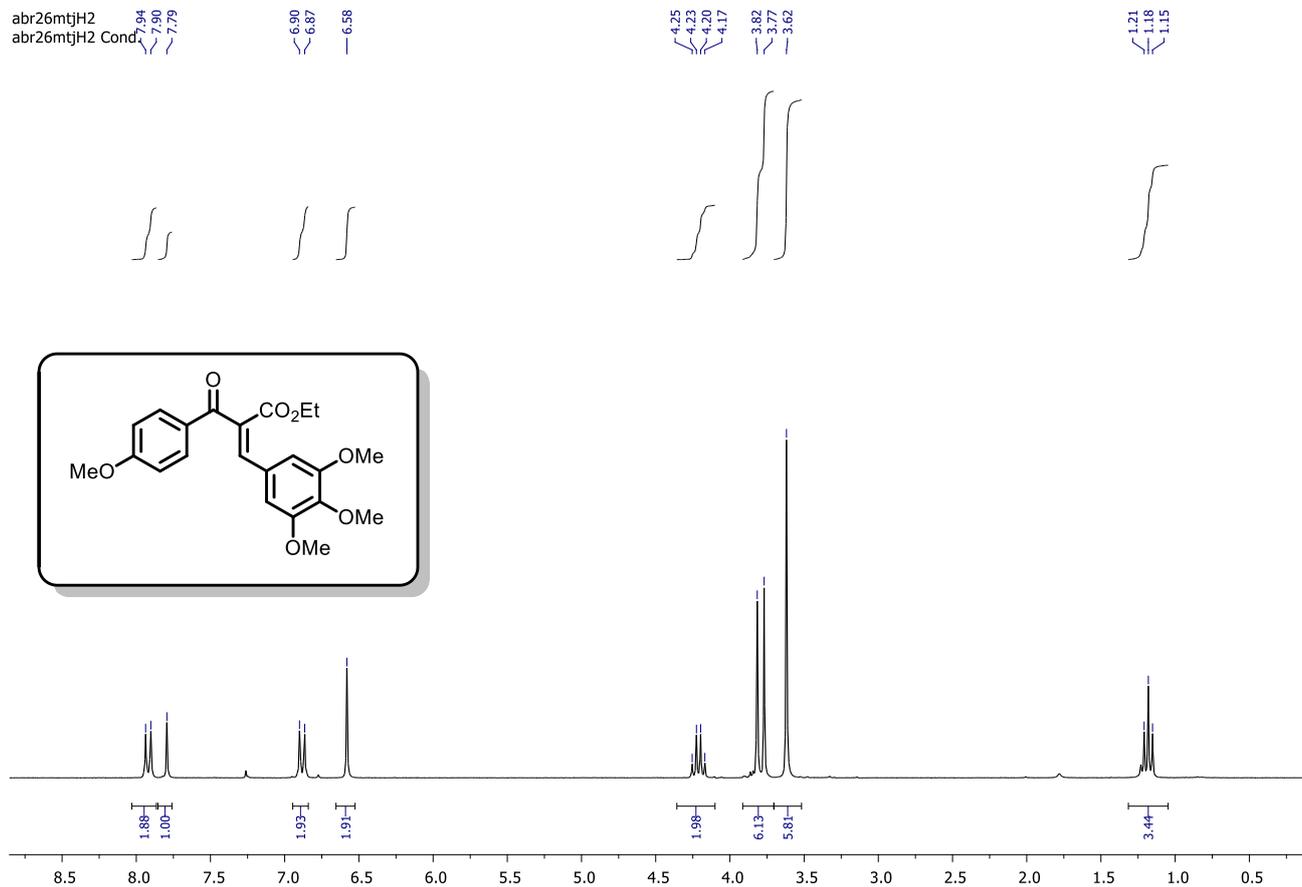
**Figure S33.**  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **9dm**.



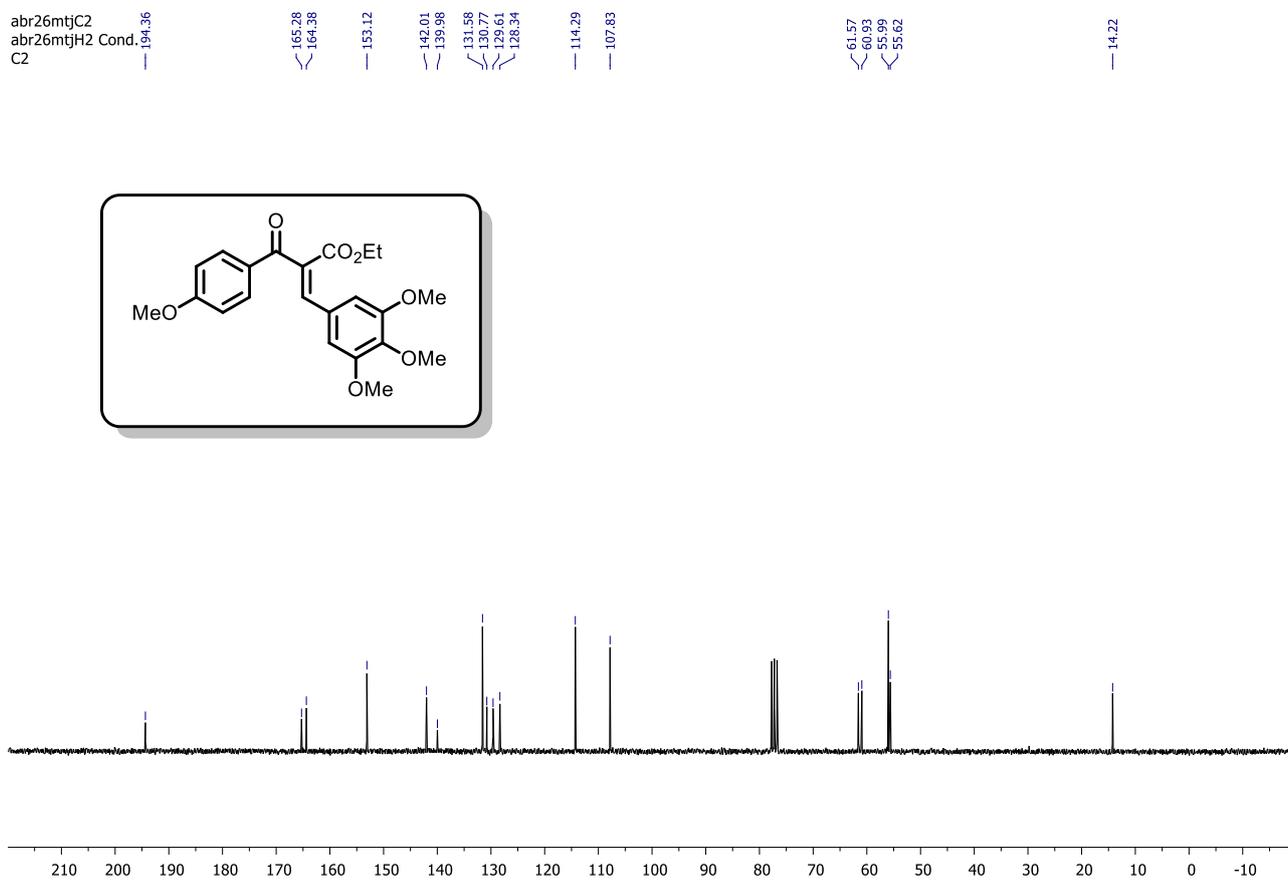
**Figure S34.**  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound **9dm**.



**Figure S36.**  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound **9c**.  
S20



**Figure S37.**  $^1\text{H}$  NMR spectrum (250 MHz,  $\text{CDCl}_3$ ) of compound **9fc**.



**Figure S38.**  $^{13}\text{C}$  NMR spectrum (63 MHz,  $\text{CDCl}_3$ ) of compound **9fc**.

out23mtjH  
Manoel\_KNOVG2\_CDCL3\_BenzTio\_trimet

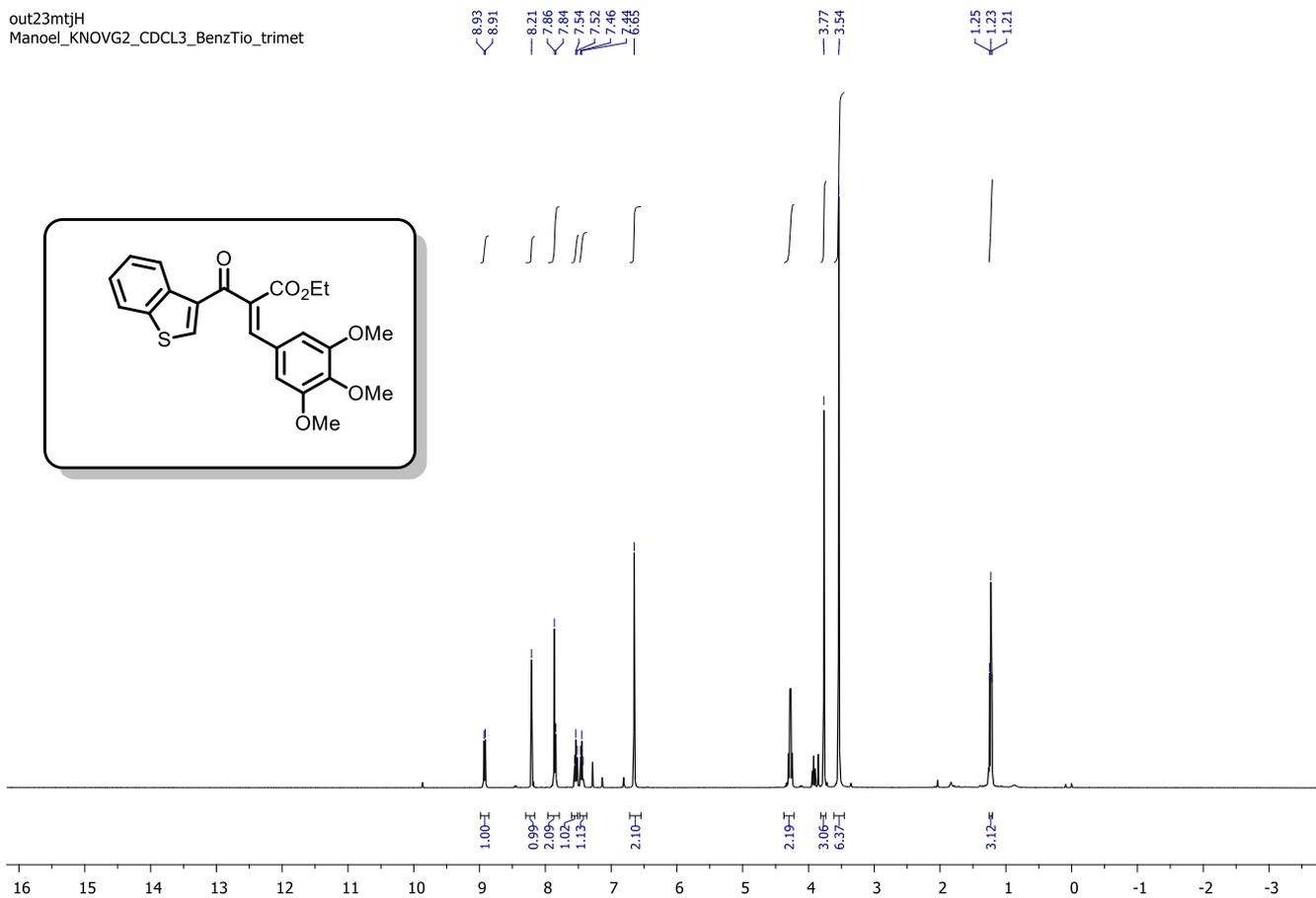


Figure S39. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **9gc**.

out23mtjH  
Manoel\_KNOVG2\_CDCL3\_BenzTio\_trime

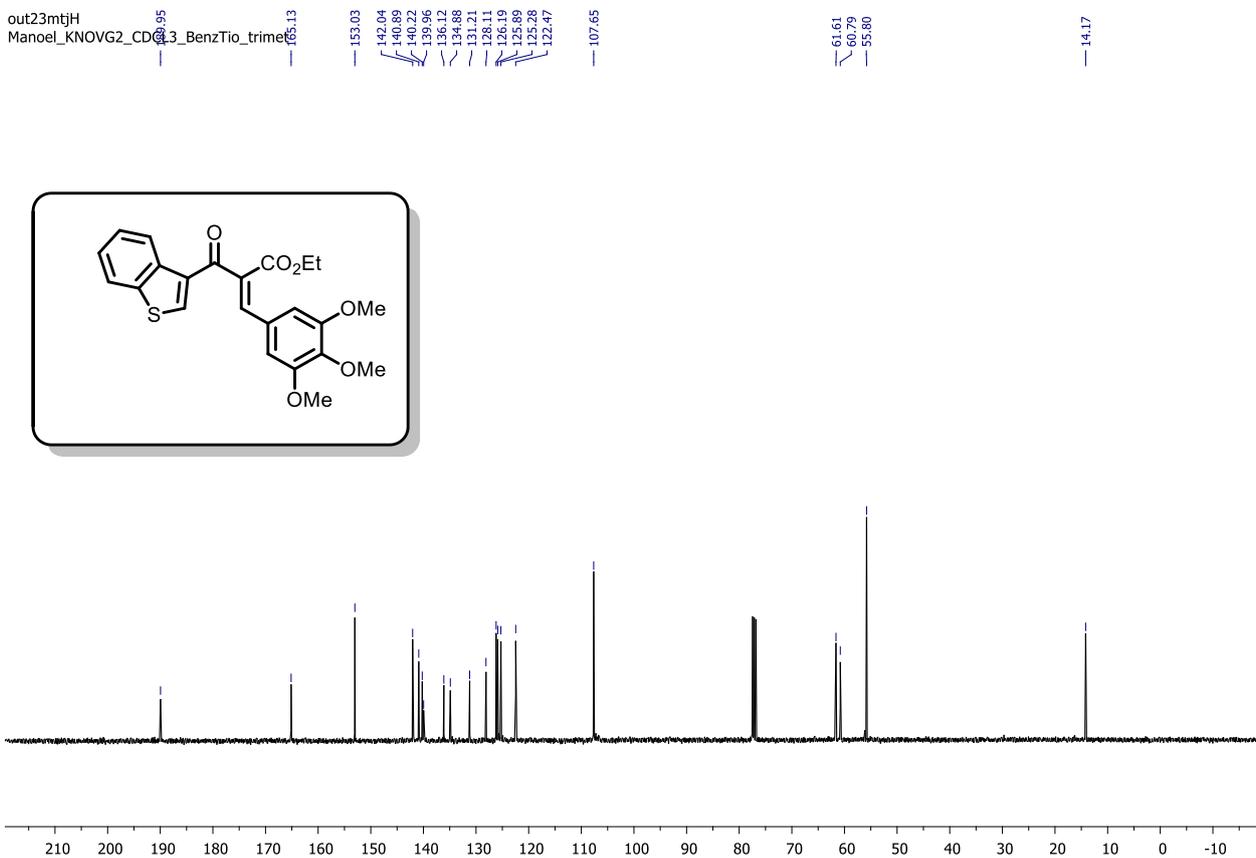


Figure S40. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **9gc**.

mai04mtjH  
Manoel Nazarov\_trimet\_pOme mai04mtjH

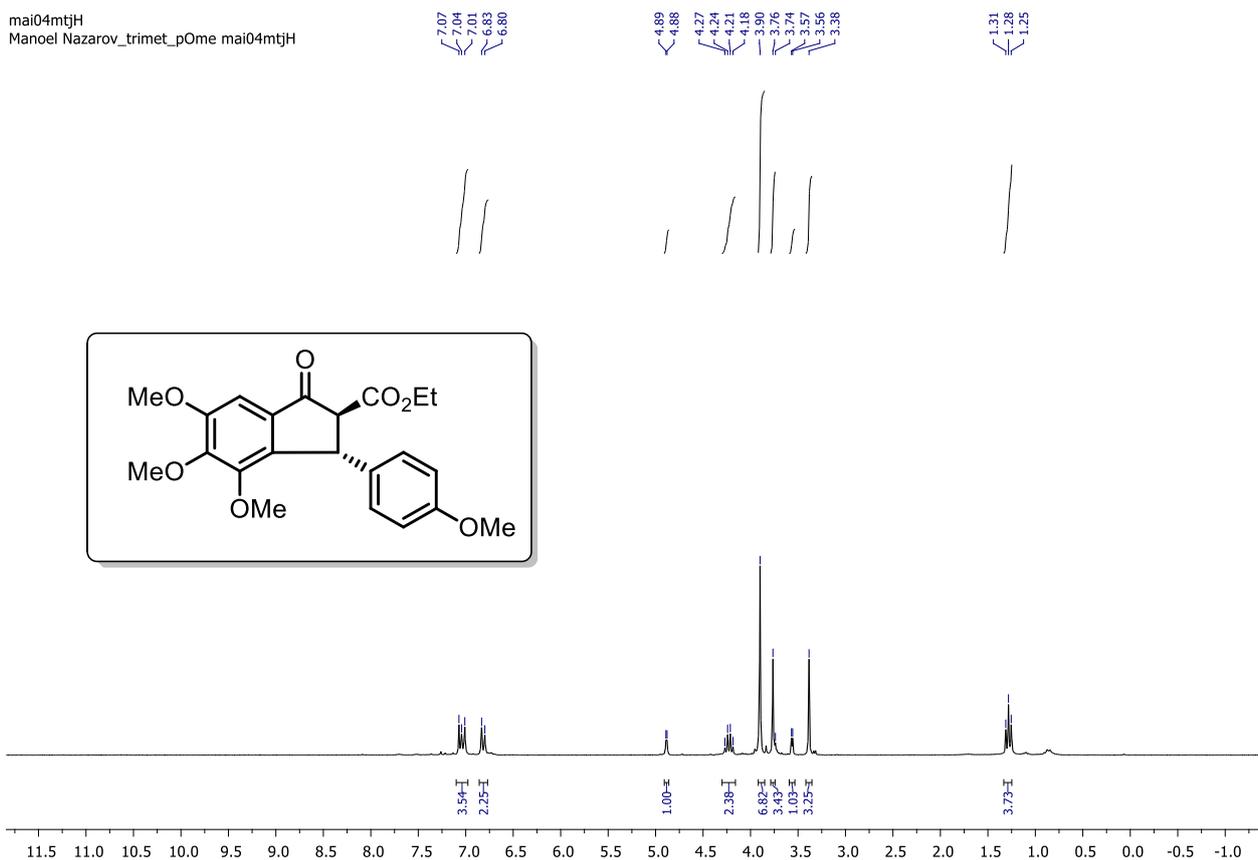


Figure S41. <sup>1</sup>H NMR spectrum (250 MHz, CDCl<sub>3</sub>) of compound 10aa.

mai04mtjC  
Manoel Nazarov\_trimet\_pOme mai04mtjC

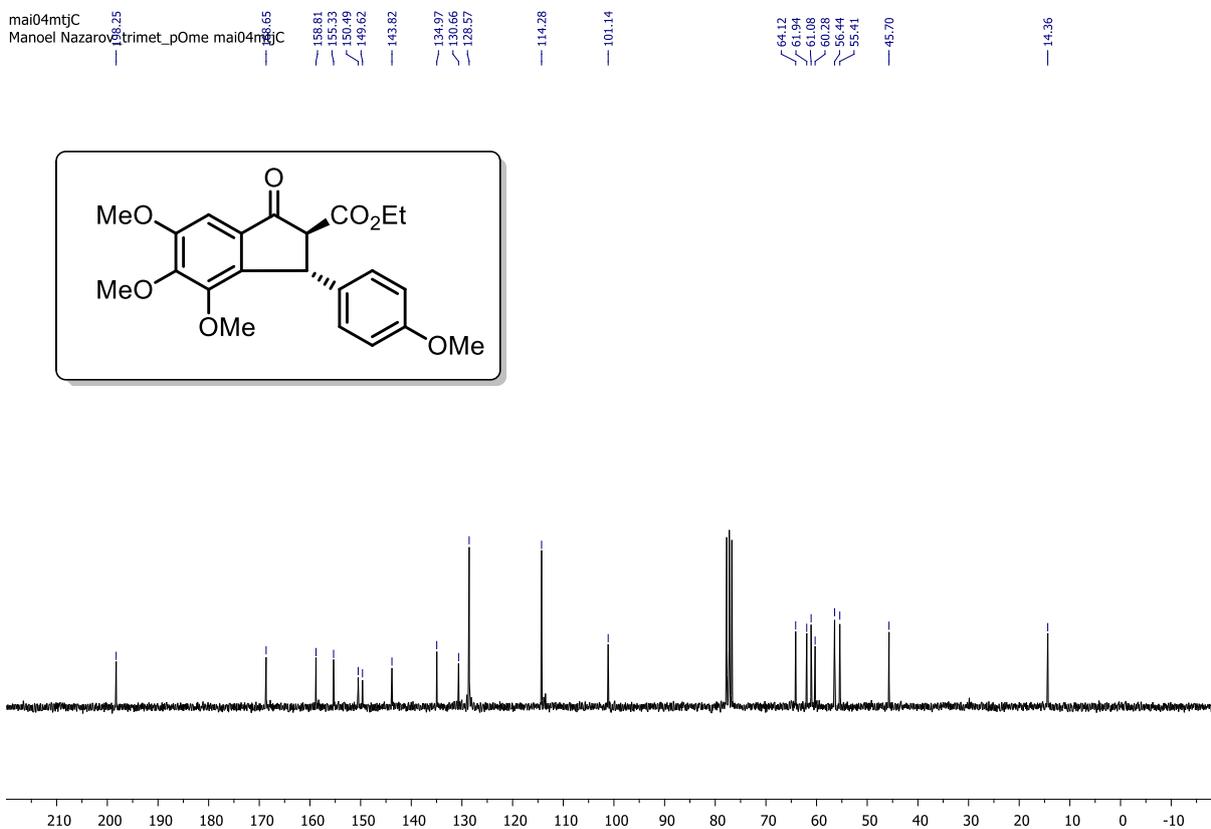


Figure S42. <sup>13</sup>C NMR spectrum (63 MHz, CDCl<sub>3</sub>) of compound 10aa.

dez19mtjH  
manoeI\_Naz\_trimet\_pClPh\_cddI  
400MHz

7.30  
7.28  
7.10  
7.09  
7.07

4.94  
4.93

3.93  
3.93

3.56  
3.56  
3.45

1.34  
1.32  
1.30

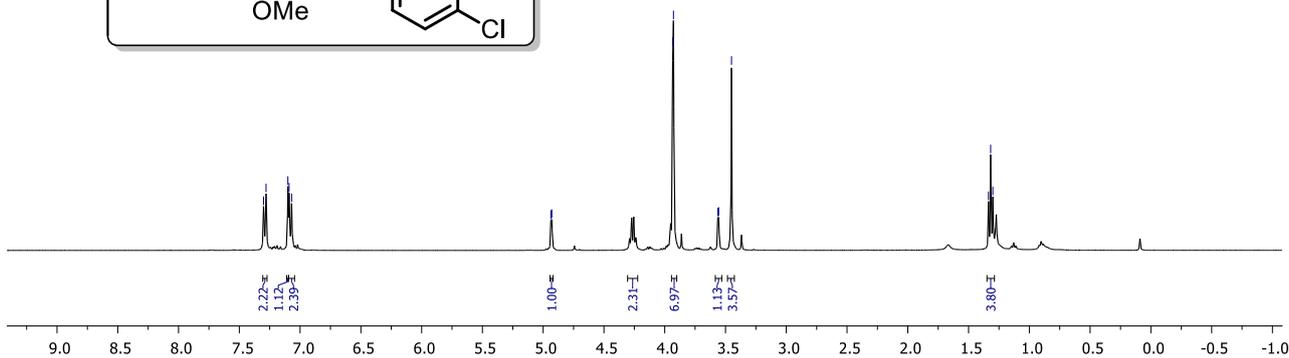
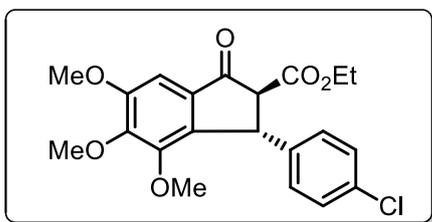


Figure S43. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 10ab.

dez19mtjH  
manoeI\_Naz\_trimet\_pClPh\_cddI  
400MHz

177.47

168.19

155.42

150.19

149.57

142.67

141.31

132.88

130.51

128.92

128.76

101.03

63.61

61.96

60.96

60.13

56.31

45.51

14.20

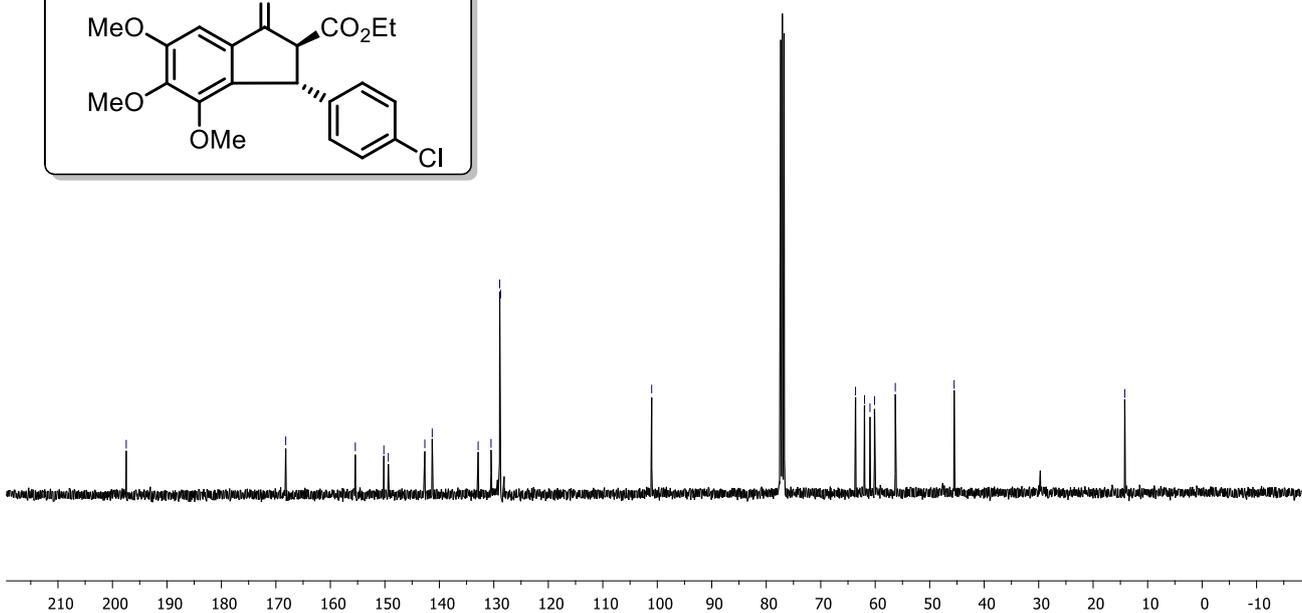
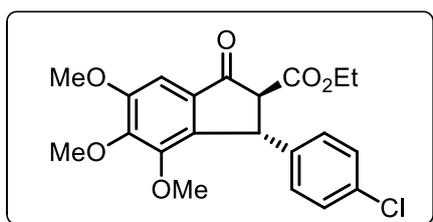


Figure S44. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound 10ab.

dez14mtjH.1.fid  
Manoel\_Naz60oC(2h)\_Trimet\_Trimet\_Co2Et  
CDCL3 500MHz

7.09  
6.32  
4.89  
4.88  
4.28  
4.28  
4.28  
4.28  
4.27  
4.26  
4.25  
4.25  
4.24  
4.24  
4.23  
3.93  
3.82  
3.82  
3.78  
3.62  
3.45

1.33  
1.31  
1.30

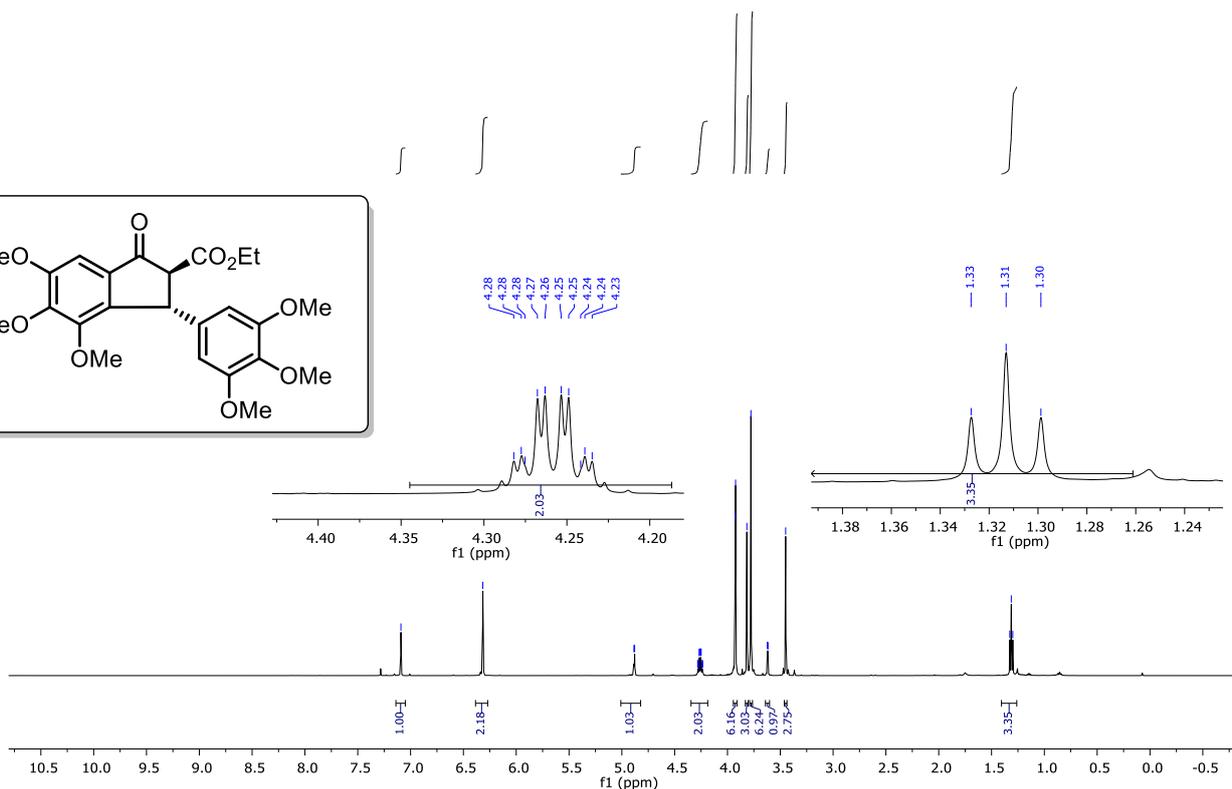
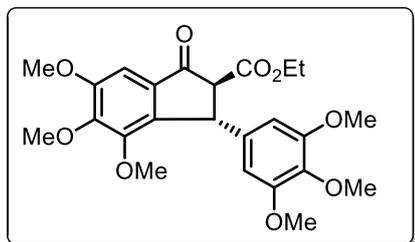


Figure S45. <sup>1</sup>H NMR spectrum (500 MHz, CDCl<sub>3</sub>) of compound 10ac.

dez14mtjH.2.fid  
Manoel\_Naz60oC(2h)\_Trimet\_Trimet\_Co2Et  
CDCL3 500MHz

163.51  
155.43  
153.59  
150.50  
149.57  
143.19  
138.61  
137.23  
130.64  
104.56  
101.18  
63.83  
62.06  
61.10  
61.04  
60.35  
56.43  
56.33  
46.57  
14.37

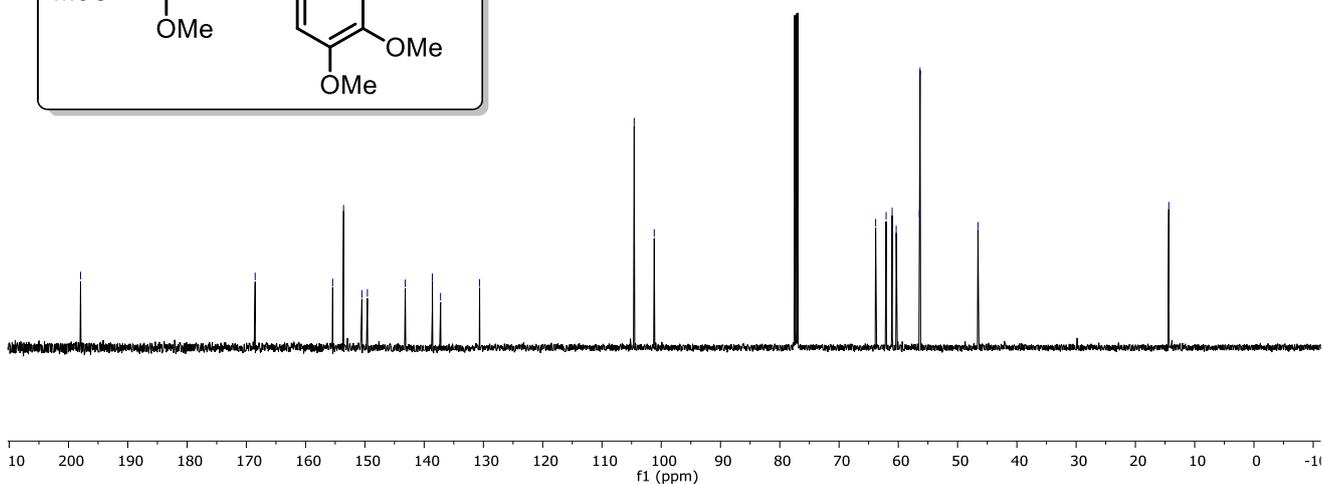
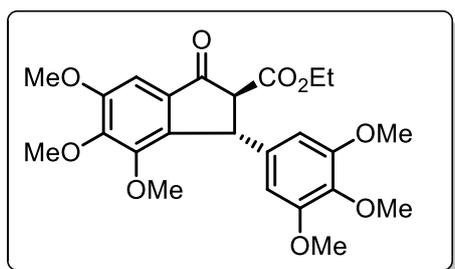


Figure S46. <sup>13</sup>C NMR spectrum (126 MHz, CDCl<sub>3</sub>) of compound 10ac.

dez22mtjH  
Manoel\_Naz\_trimet\_3,4-dimetox\_Et  
CDCL3\_400MHz

7.05  
6.77  
6.74  
6.63  
6.63  
6.60

4.24  
4.22  
4.20  
4.19  
3.88  
3.82  
3.78  
3.57  
3.56  
3.38

1.29  
1.27  
1.25

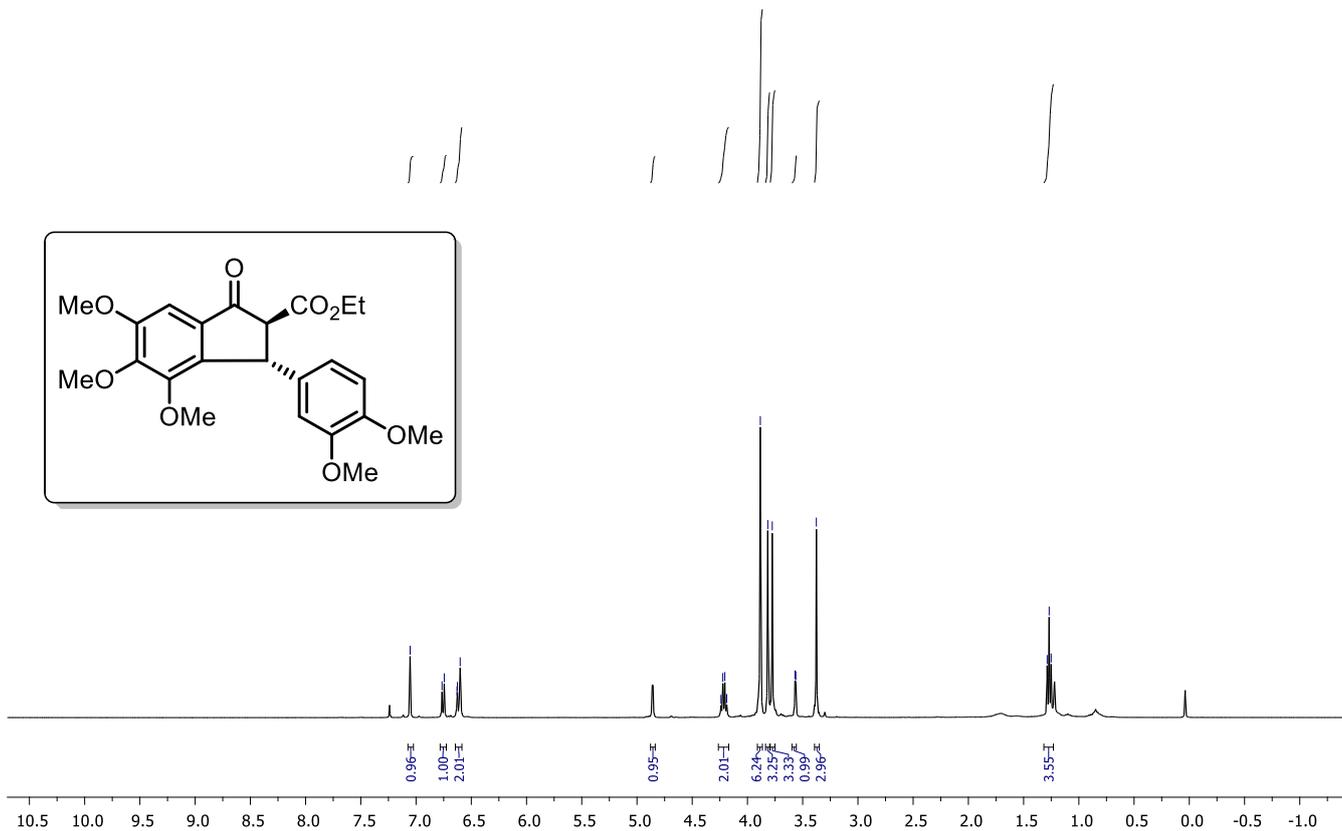


Figure S47.  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound 10ad.

dez22mtjH  
Manoel\_Naz\_trimet\_3,4-dimetox\_Et  
CDCL3\_400MHz

168.63

155.37

150.52

149.63

149.31

148.27

143.61

135.48

130.65

119.62

111.51

110.83

101.17

64.08

62.02

61.11

60.36

56.45

56.07

46.06

14.39

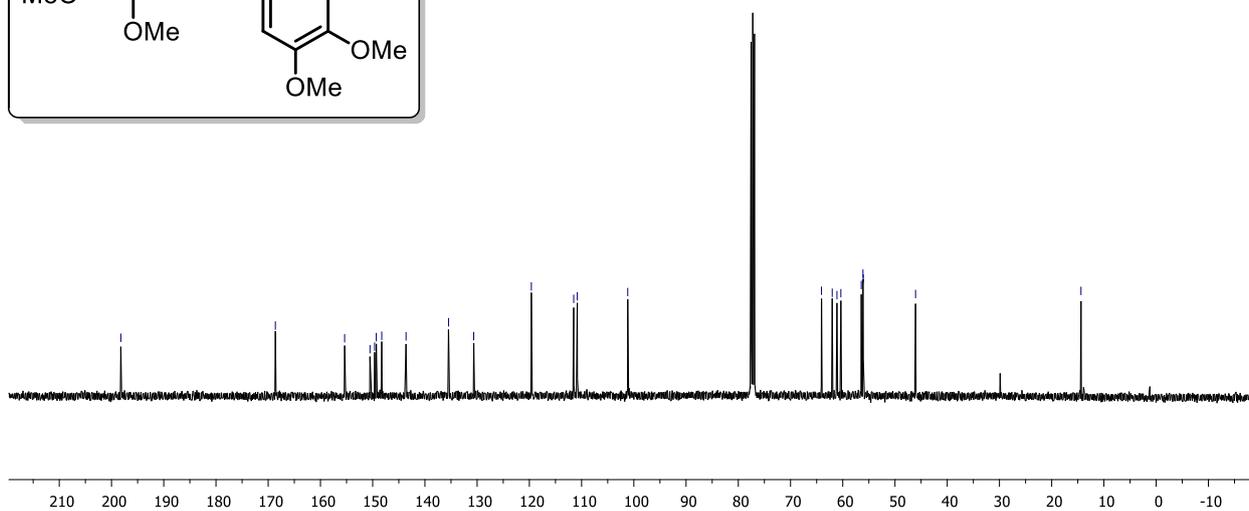
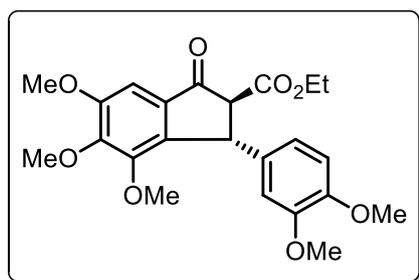


Figure S48.  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound 10ad.

mar26mtjH2  
Manoel\_Naz\_pirrol\_cdcl3\_400MHz

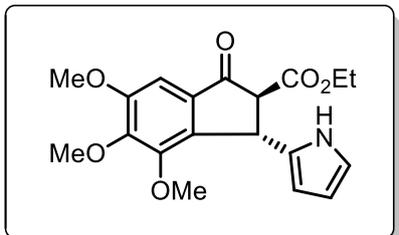
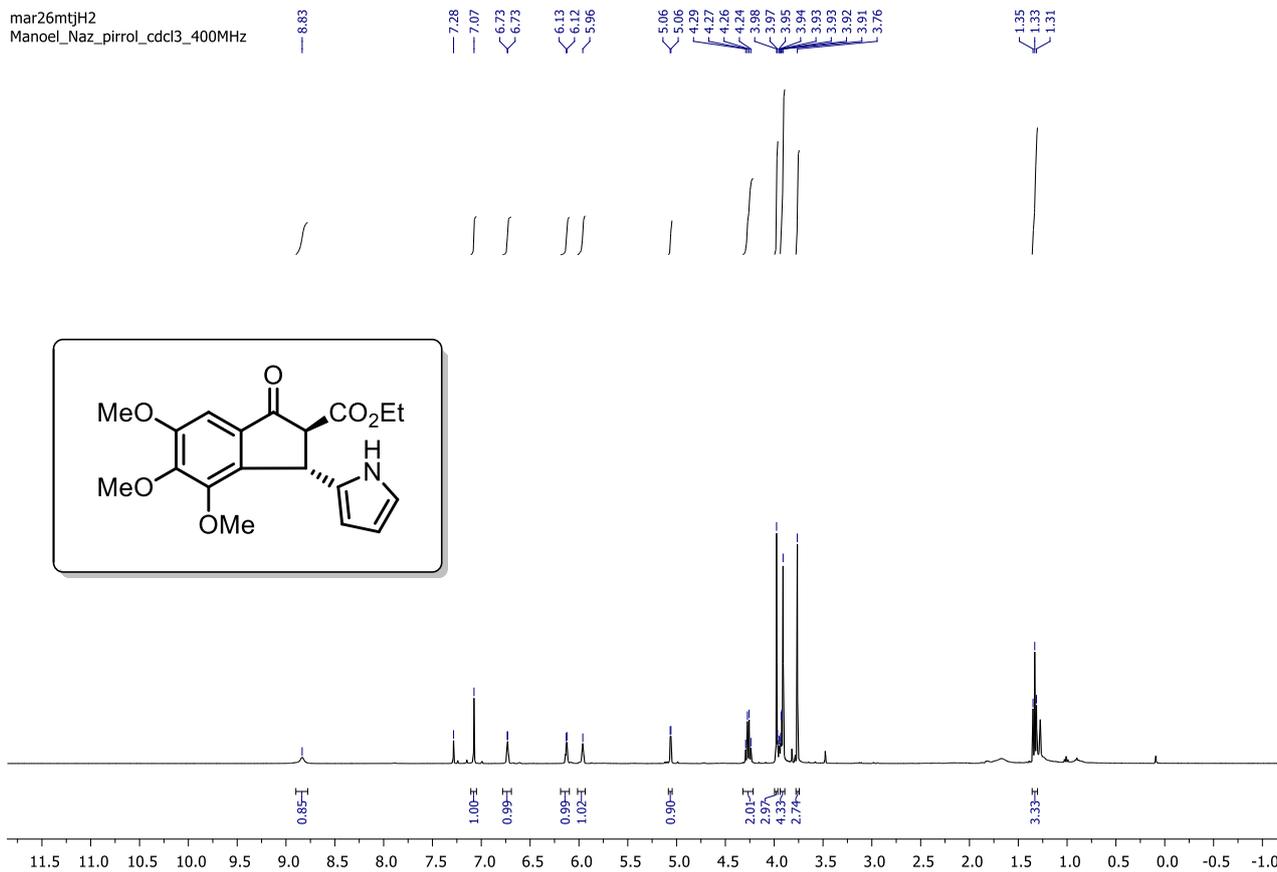


Figure S49. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **10ag**.

mar27mtjC1  
Manoel - PIR-TRM-NAZ - CDCl3 - Avance 400 MHz  
5 horas

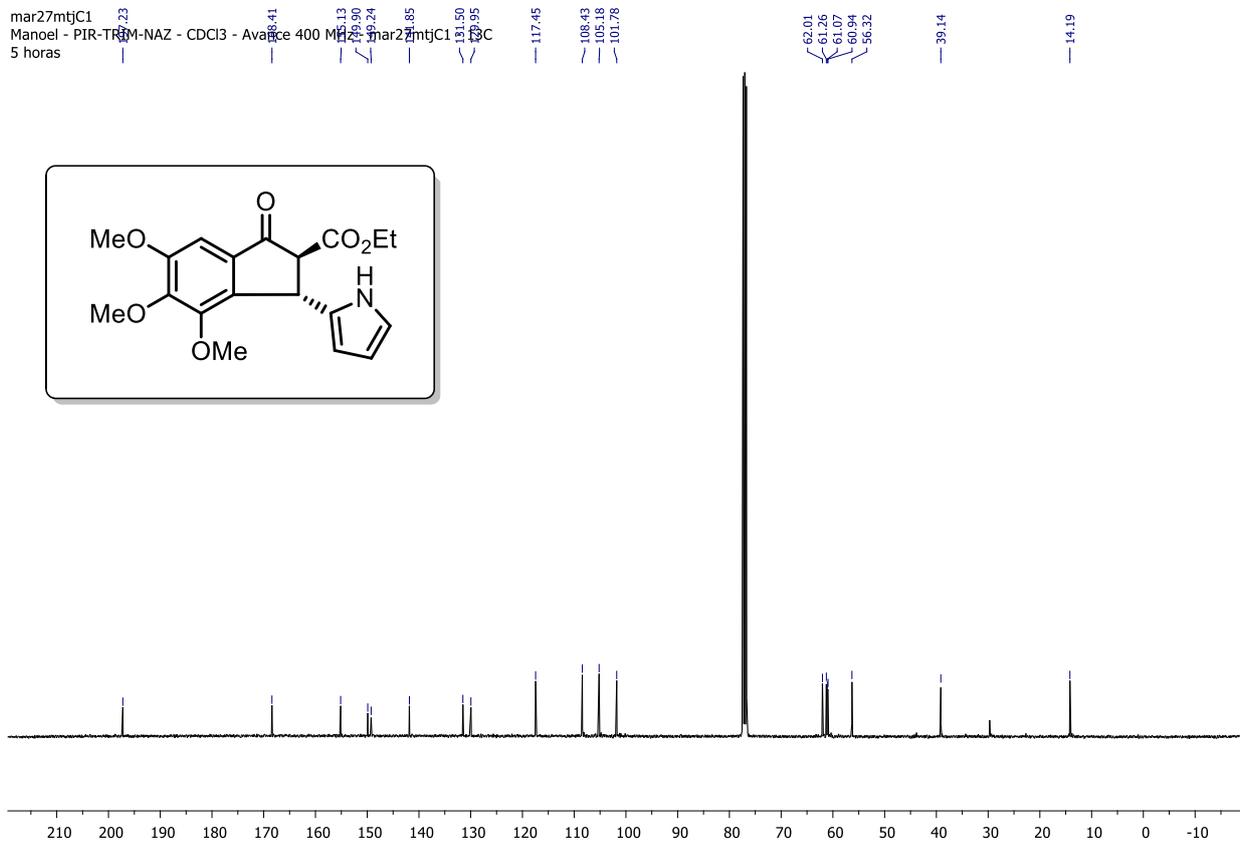
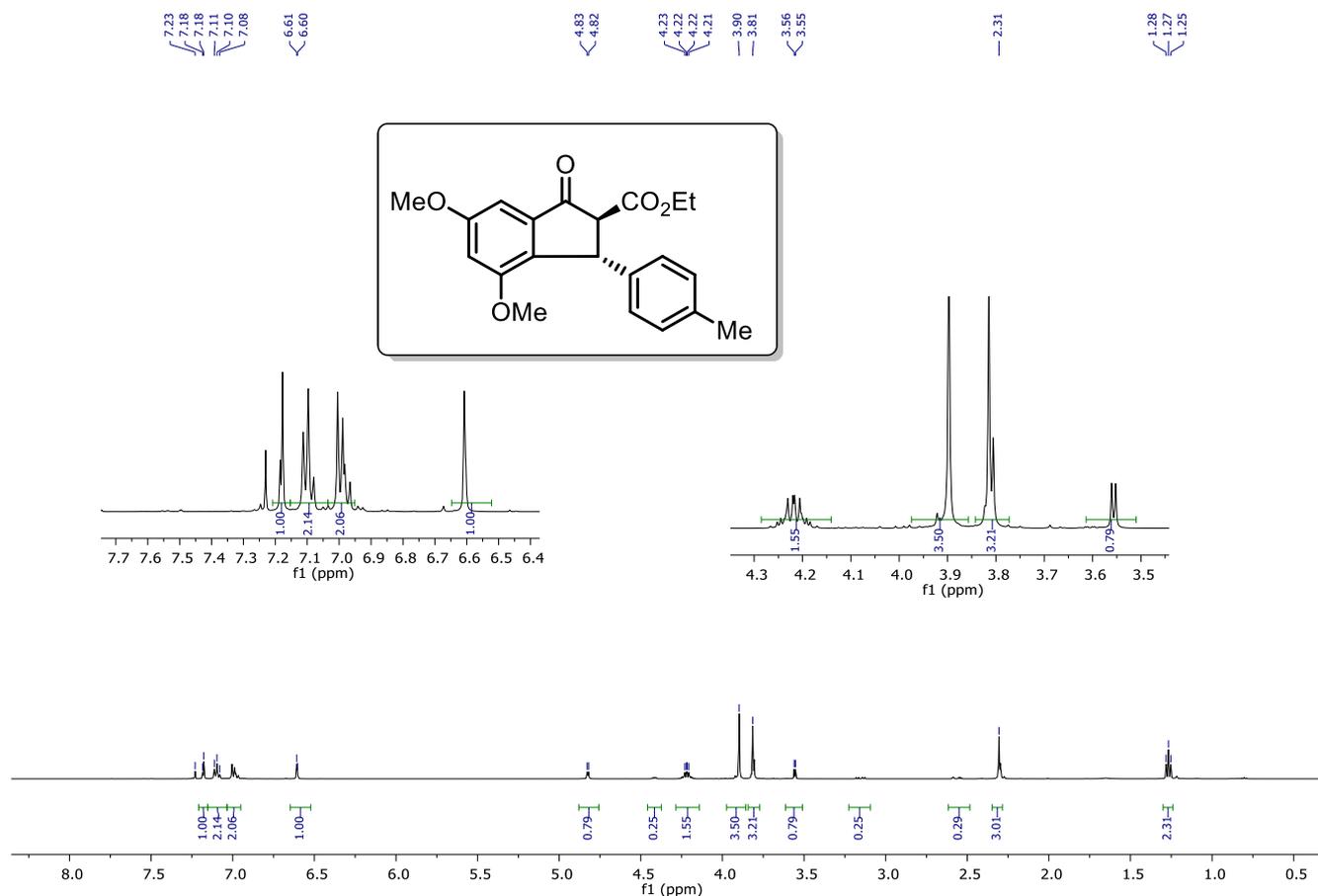
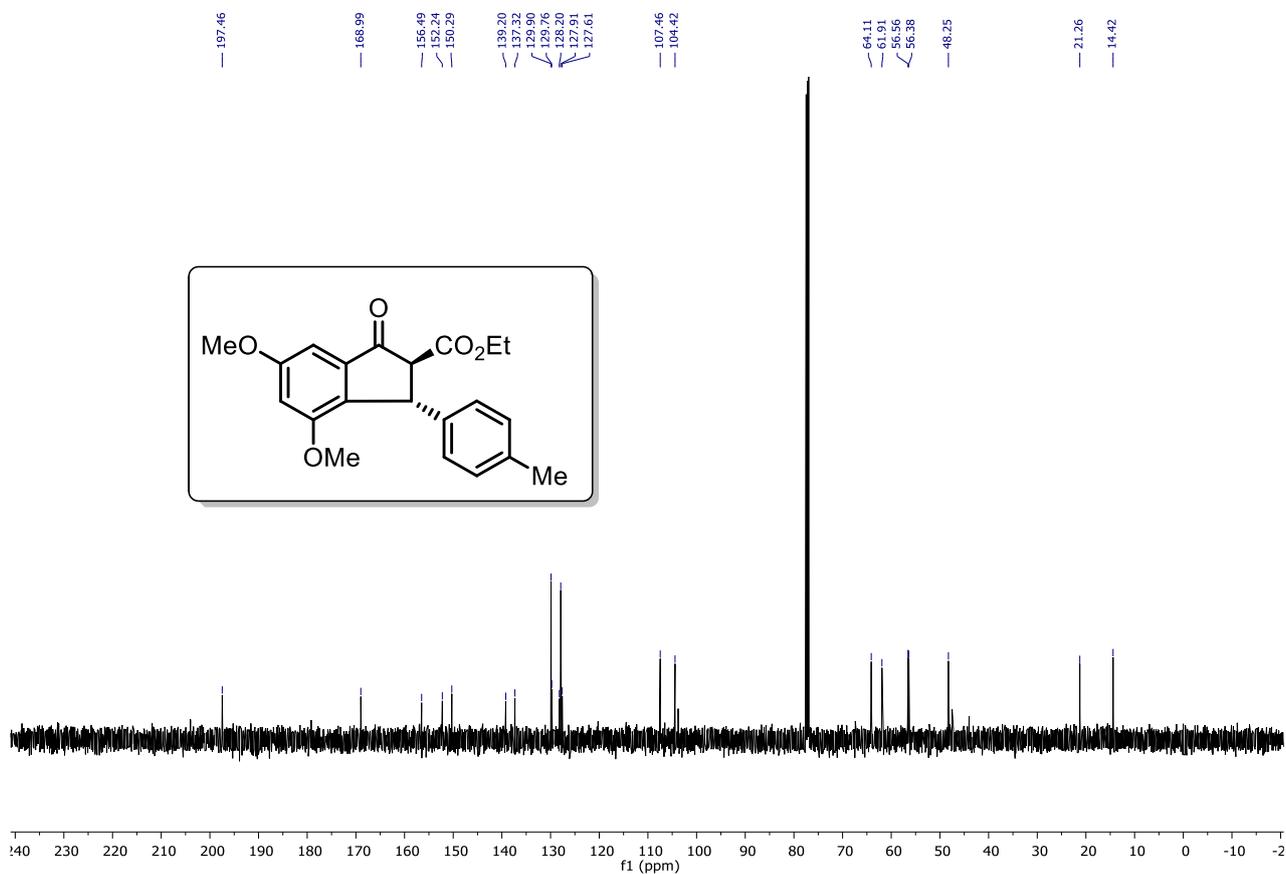


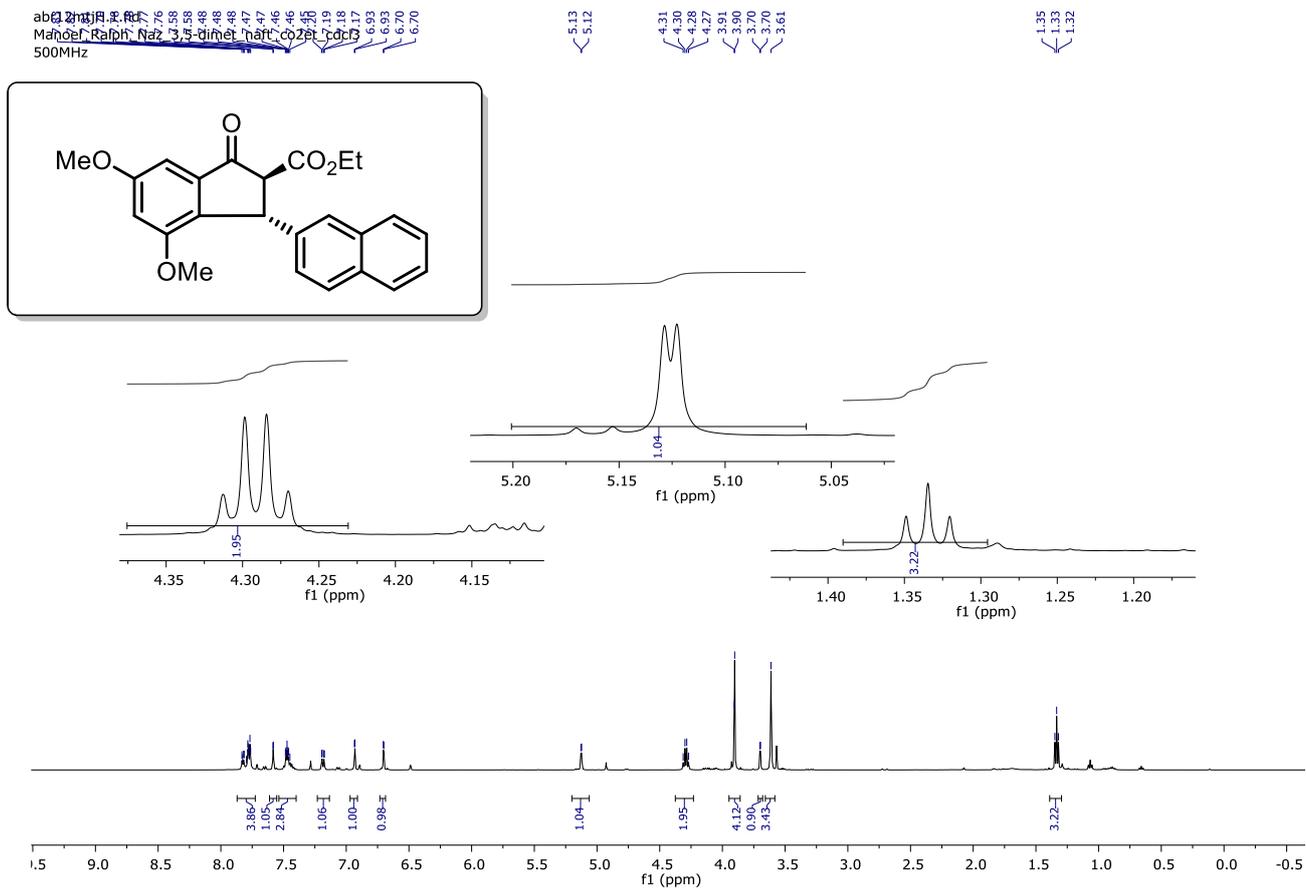
Figure S50. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **10ag**.



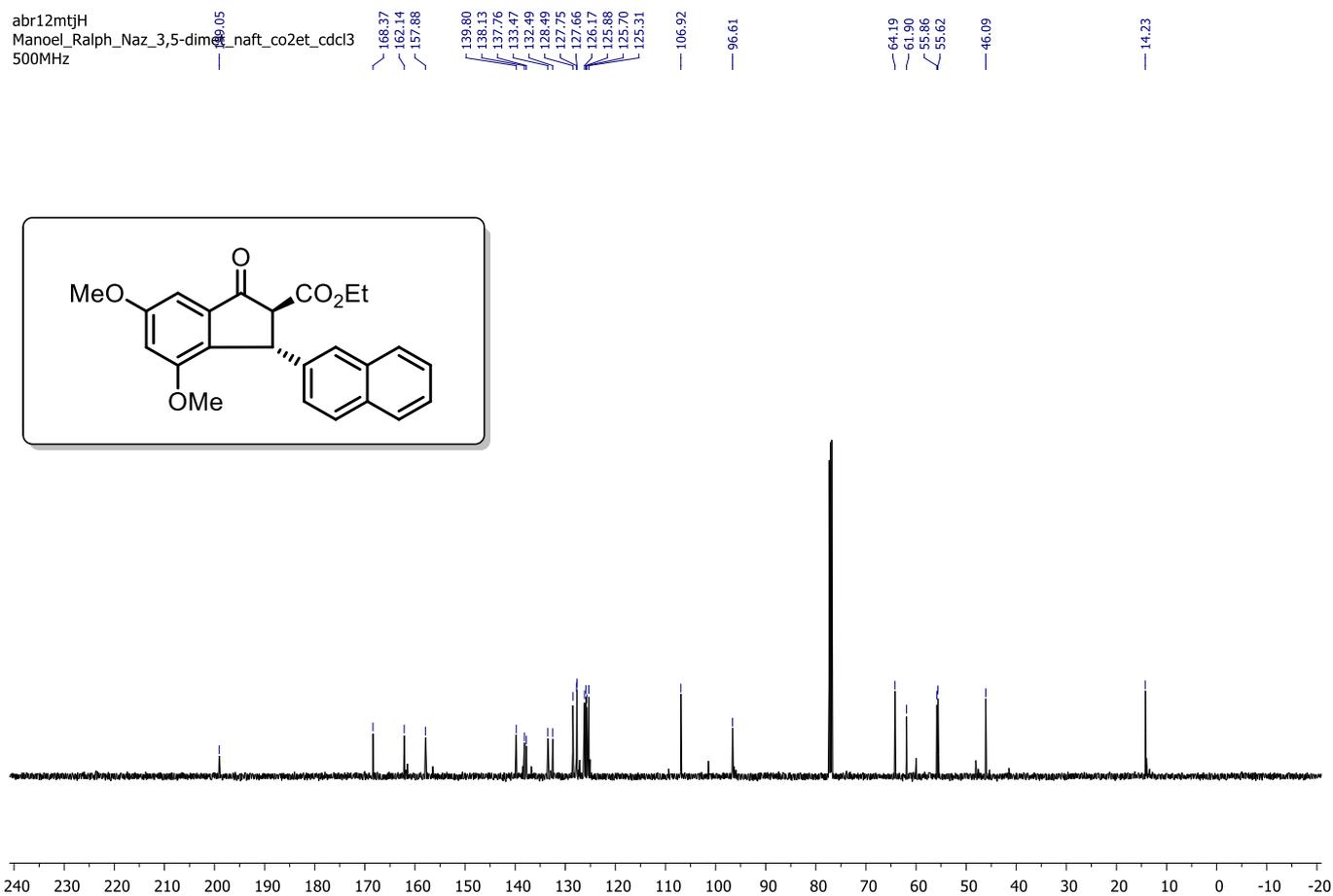
**Figure S51.** <sup>1</sup>H NMR spectrum (500 MHz, CDCl<sub>3</sub>) of compound 10bj.



**Figure S52.** <sup>13</sup>C NMR spectrum (126 MHz, CDCl<sub>3</sub>) of compound 10bj.



**Figure S53.** <sup>1</sup>H NMR spectrum (500 MHz, CDCl<sub>3</sub>) of compound **10bk**.



**Figure S54.** <sup>13</sup>C NMR spectrum (126 MHz, CDCl<sub>3</sub>) of compound **10bk**.

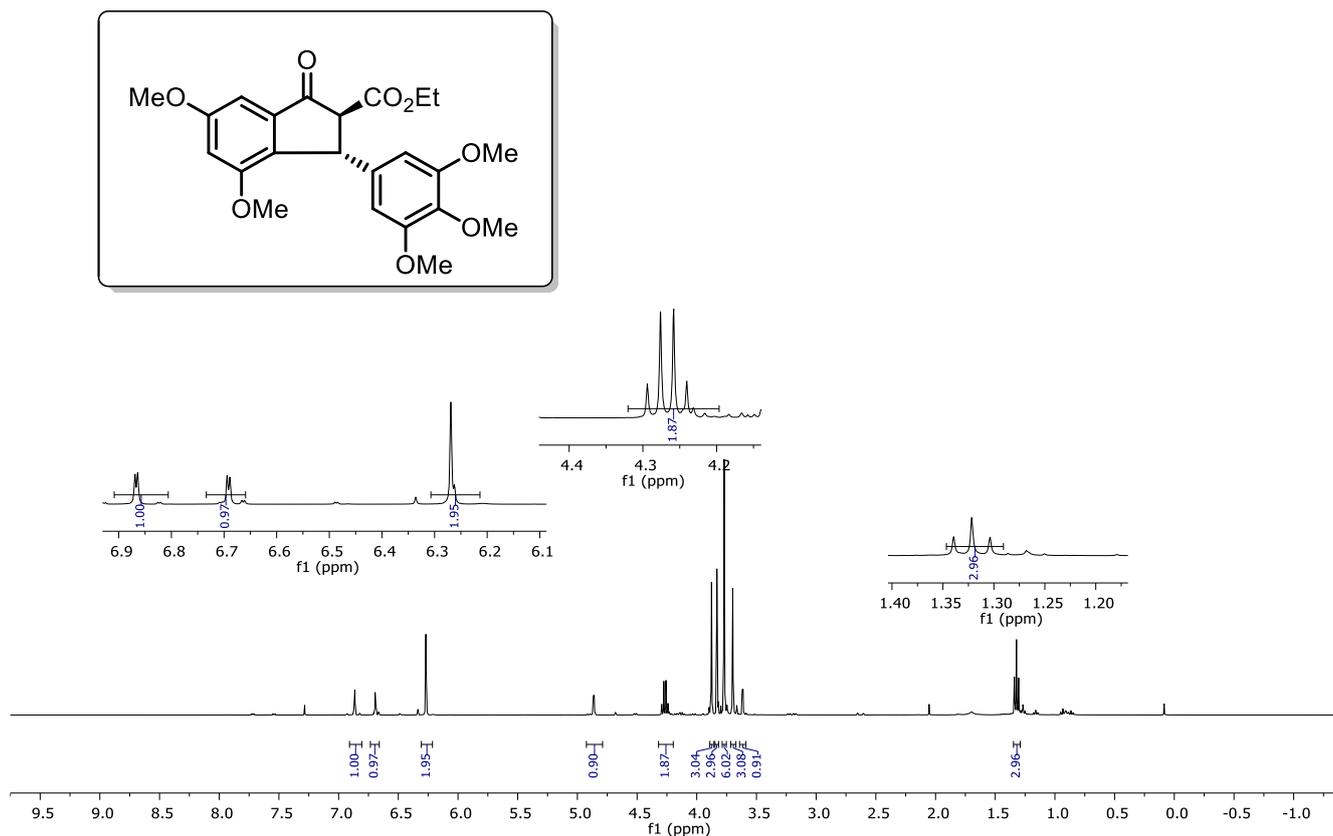


Figure S55. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 10bc.

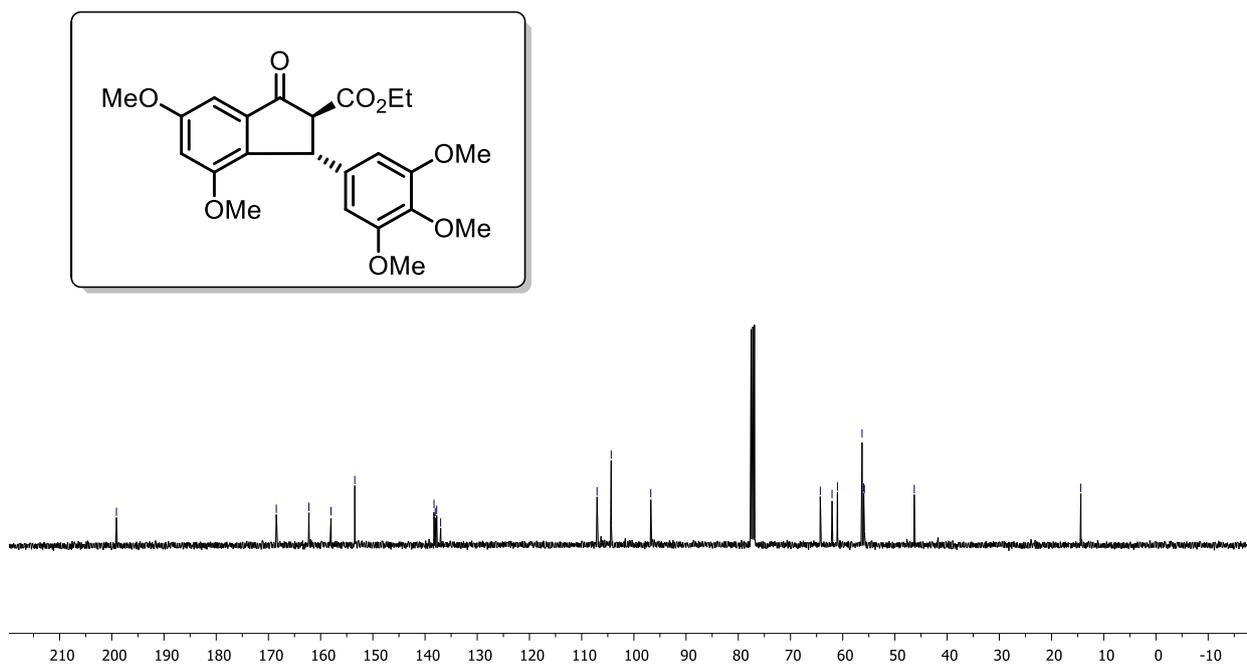
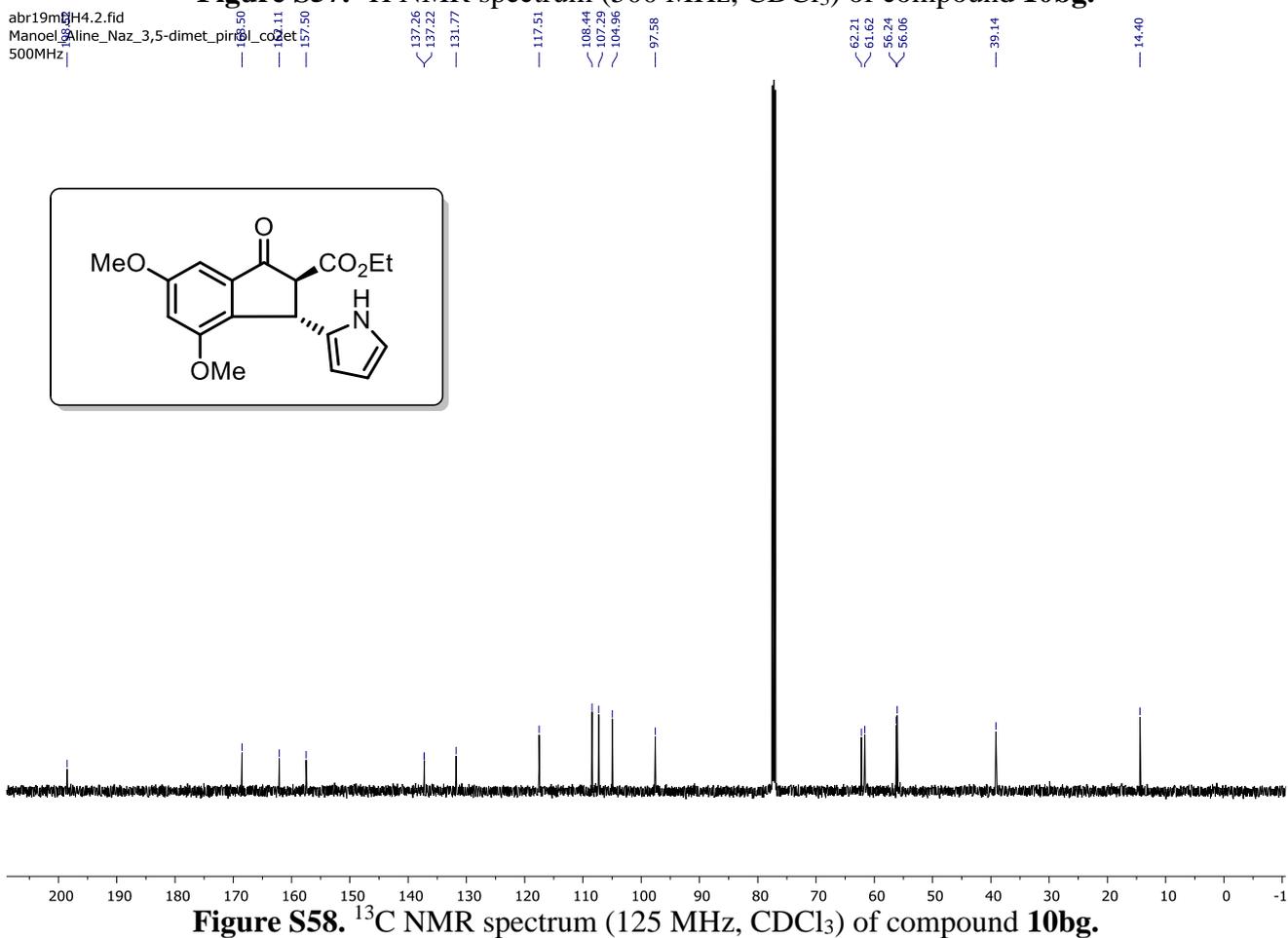
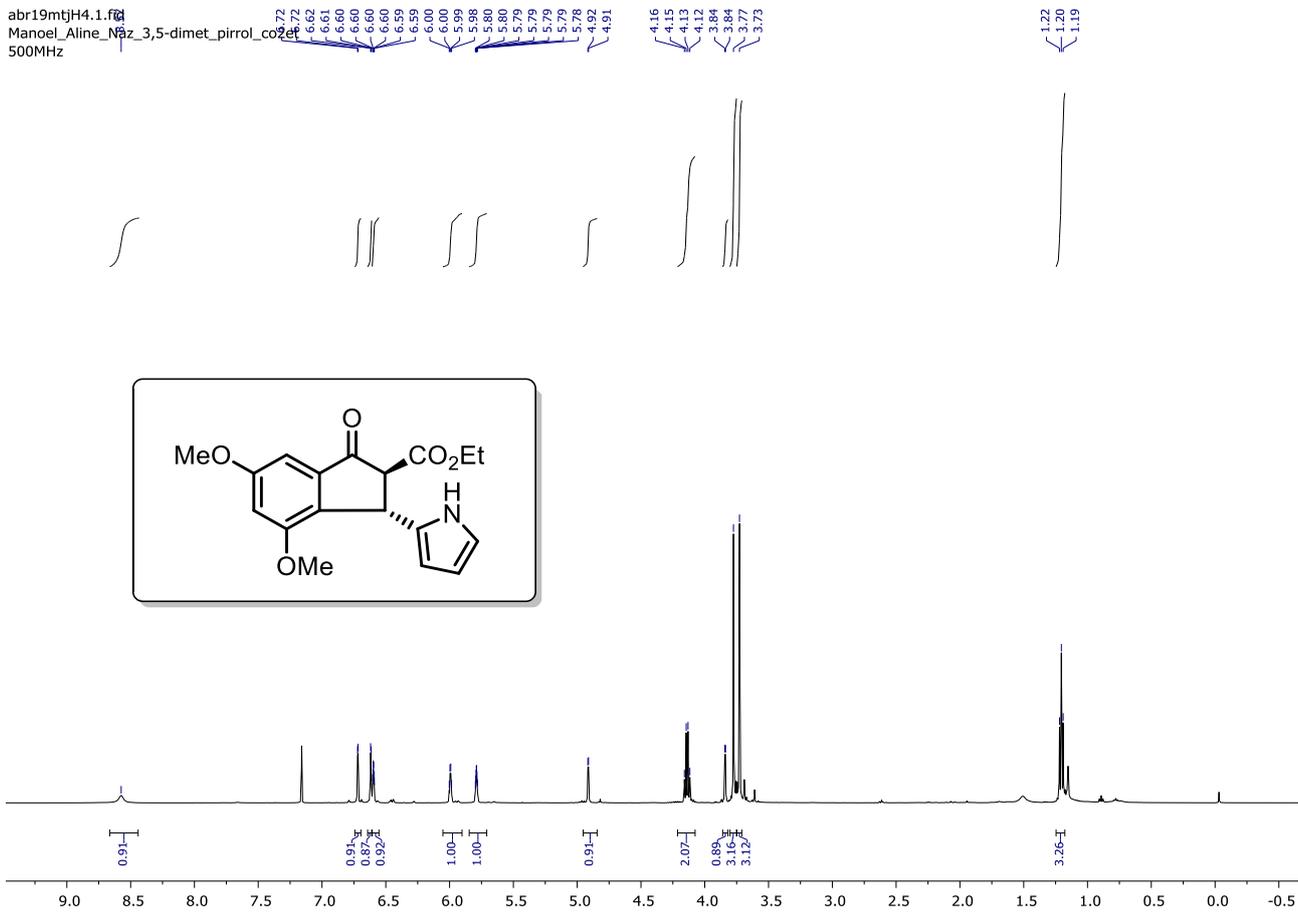
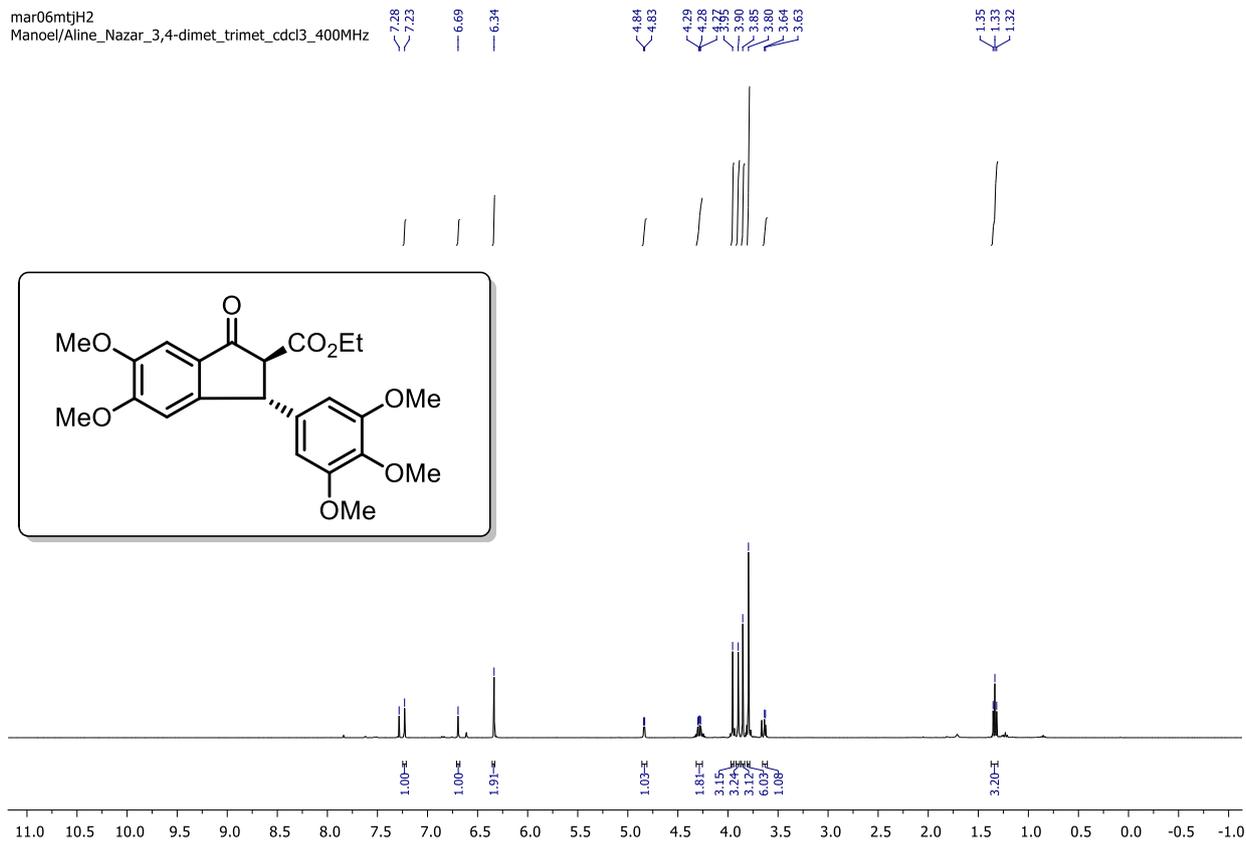
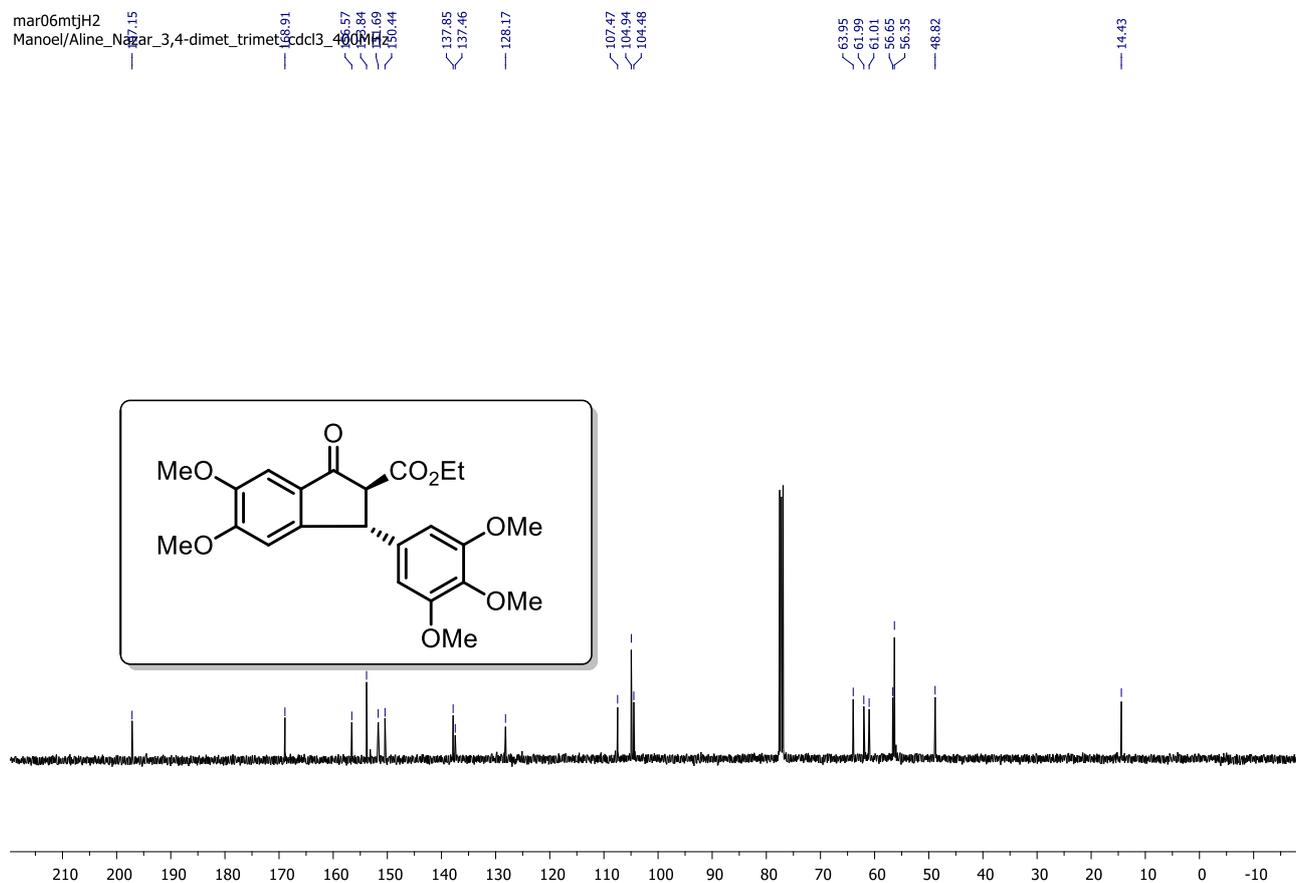


Figure S56. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound 10bc.





**Figure S59.**  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **10cc**.



**Figure S60.**  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound **10cc**.

abr19mtjH2.1.fid  
Manoel/Aline\_NAZ\_ccVO2ET\_

7.384  
7.3899  
7.3864  
7.4738  
7.4702  
7.4617  
7.3881  
7.3898  
7.3845  
7.3806  
7.2370  
7.2328  
7.2335  
7.2197  
6.7981  
6.7819

6.0543

4.2689  
4.2516  
4.2404  
4.2263

1.2372  
1.2230  
1.2088

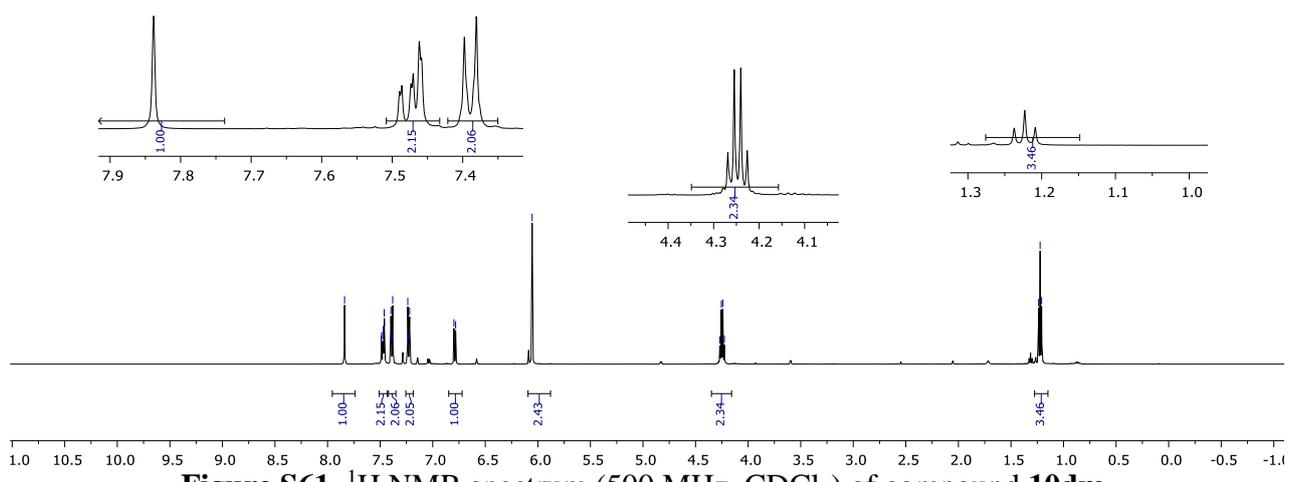
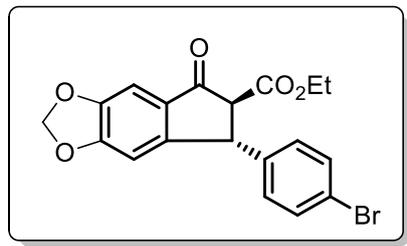


Figure S61. <sup>1</sup>H NMR spectrum (500 MHz, CDCl<sub>3</sub>) of compound 10dm.

abr19mtjH2.2.fid  
Manoel/Aline\_NAZ\_ccVO2ET\_PipBr\_500MHz

164.91  
152.90  
148.66  
140.74  
132.30  
132.15  
131.89  
131.57  
130.97  
129.66  
126.83  
124.94  
108.34  
108.21  
102.20

61.79

14.18

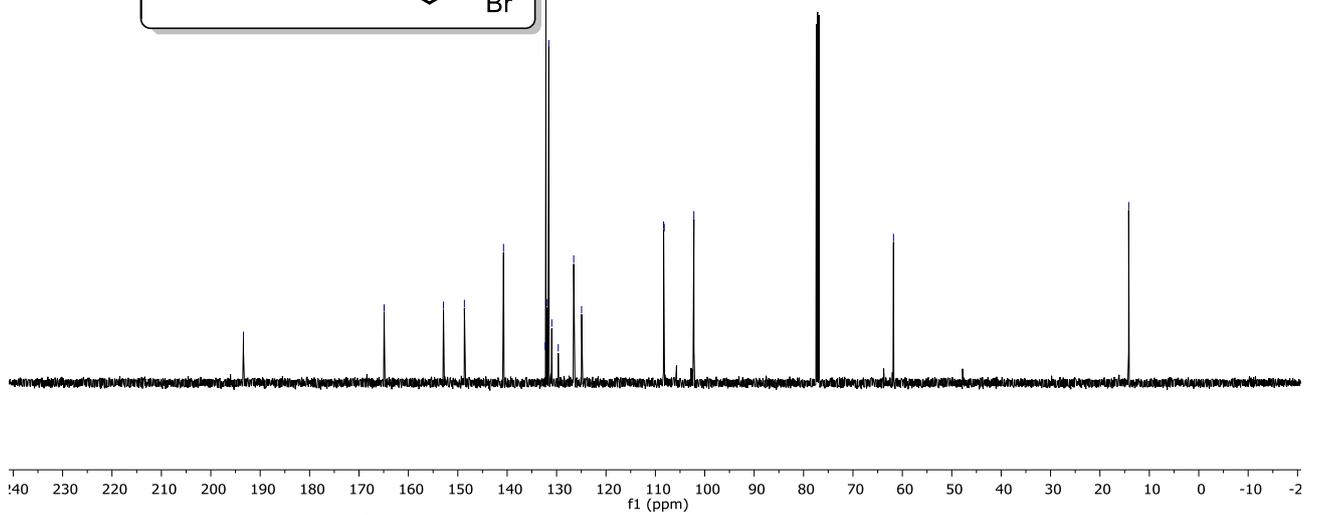
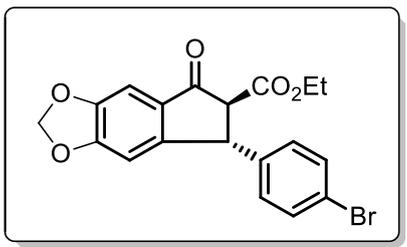


Figure S62. <sup>13</sup>C NMR spectrum (125 MHz, CDCl<sub>3</sub>) of compound 10dm.

nov14mtjH  
Manoel\_Naz2\_descarb\_trimet\_4OMe-CDCL3  
400MHz

7.10  
7.05  
7.03  
7.03  
6.84  
6.82  
4.57  
4.56  
4.55  
4.54  
3.93  
3.92  
3.79  
3.38  
3.22  
3.20  
3.17  
3.15  
2.62  
2.57  
2.57

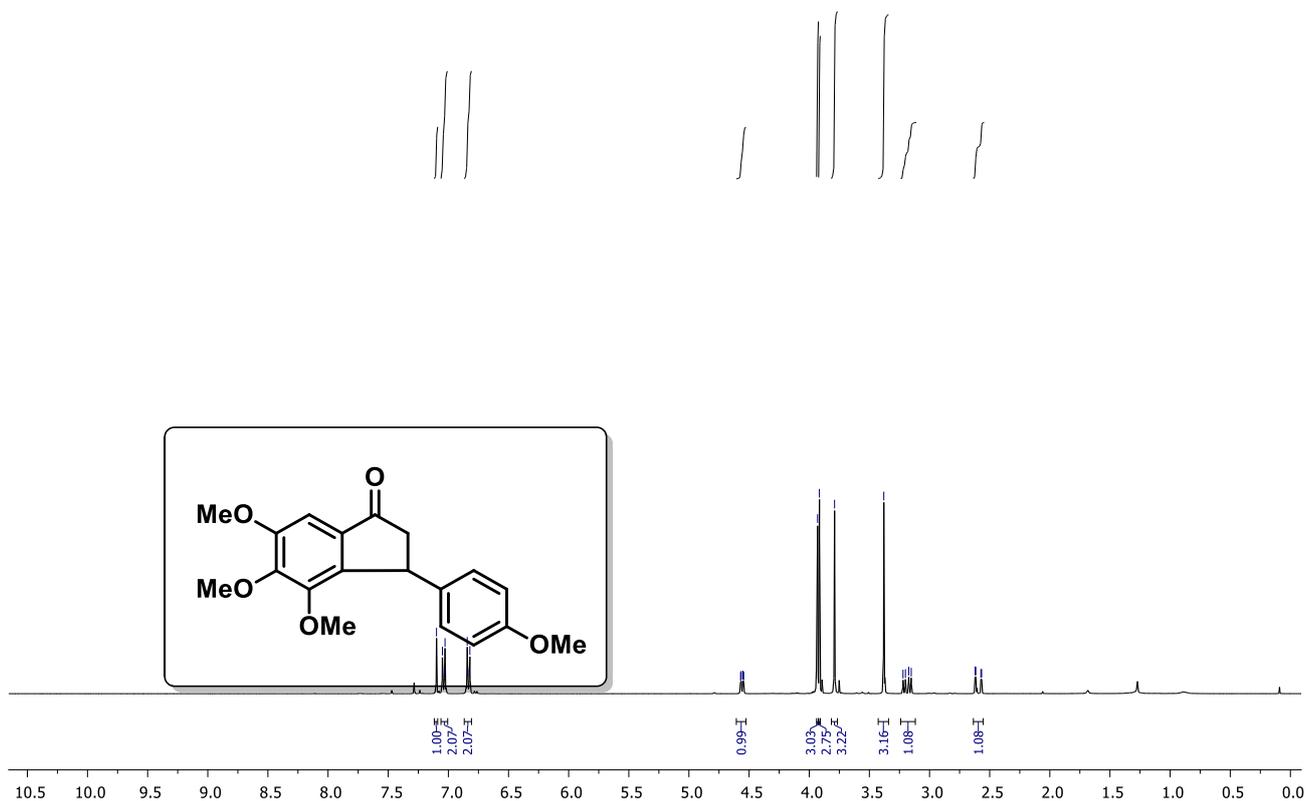


Figure S63.  $^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound 11aa.

nov14mtjH  
Manoel\_Naz2\_descarb\_trimet\_4OMe-CDCL3  
400MHz

158.47  
155.04  
150.59  
149.01  
145.05  
136.61  
132.23  
128.40  
114.16  
100.45  
61.06  
60.28  
56.42  
55.43  
47.52  
41.03

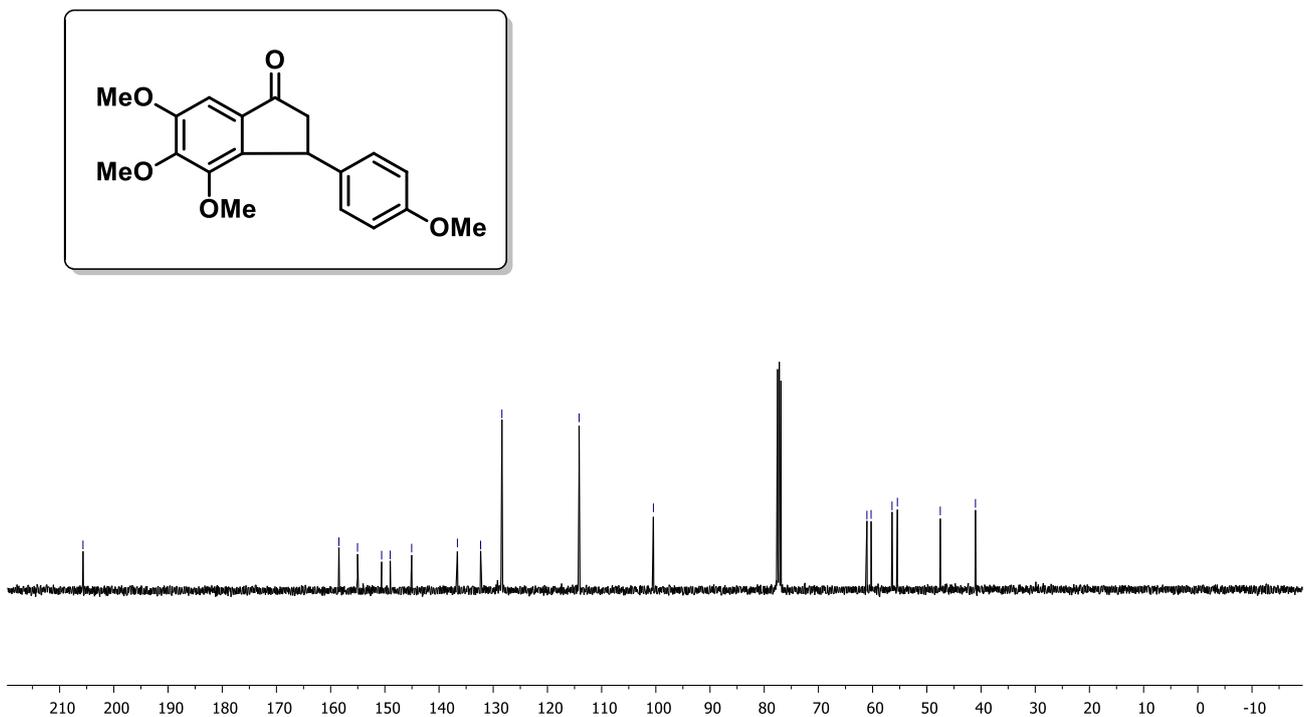


Figure S64.  $^{13}\text{C}$  NMR spectrum (101 MHz,  $\text{CDCl}_3$ ) of compound 11aa.

out08mtjH2  
Manoel\_proddescarb\_4Cl-trimetoxi\_cdcl3  
400 MHz

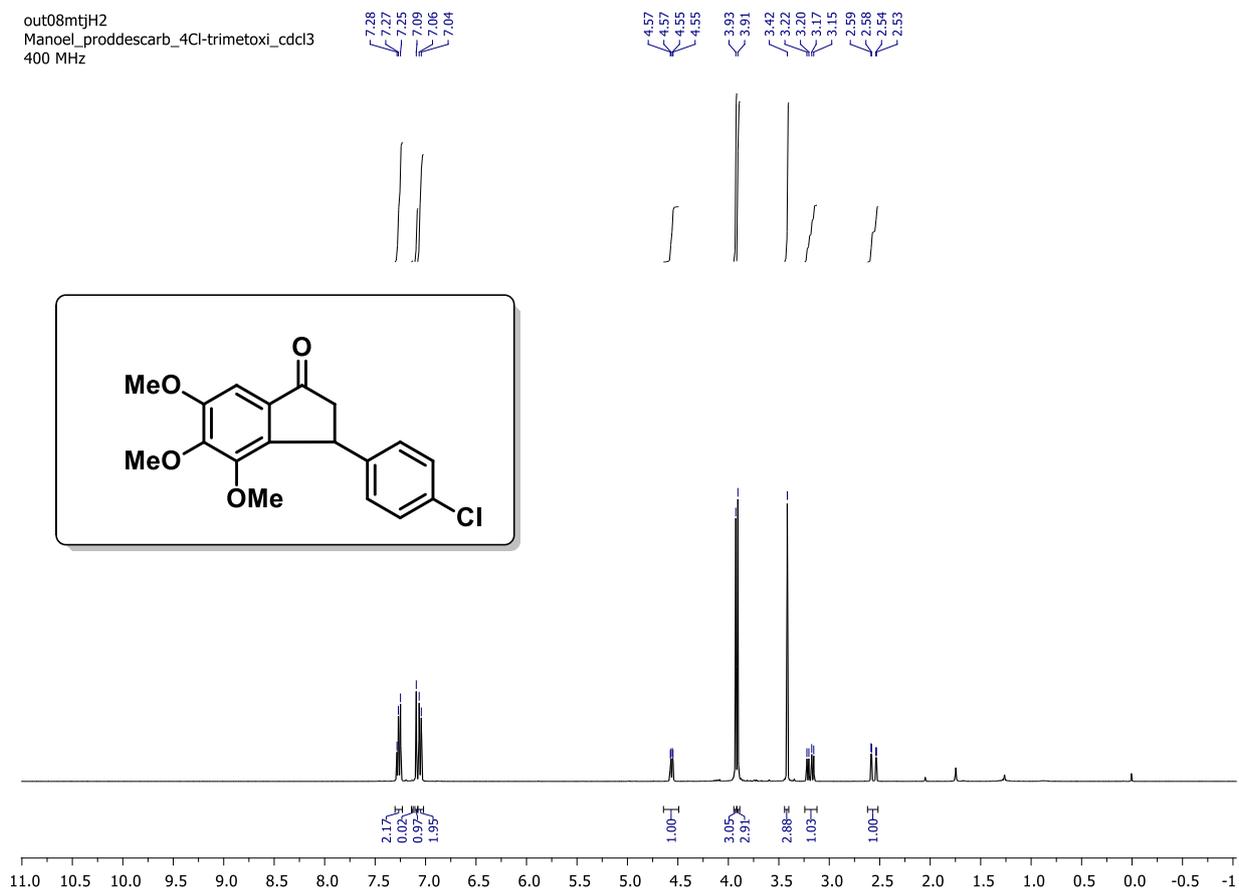


Figure S65. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 11ab.

out08mtjH2  
Manoel\_proddescarb\_4Cl-trimetoxi\_cdcl3  
400 MHz

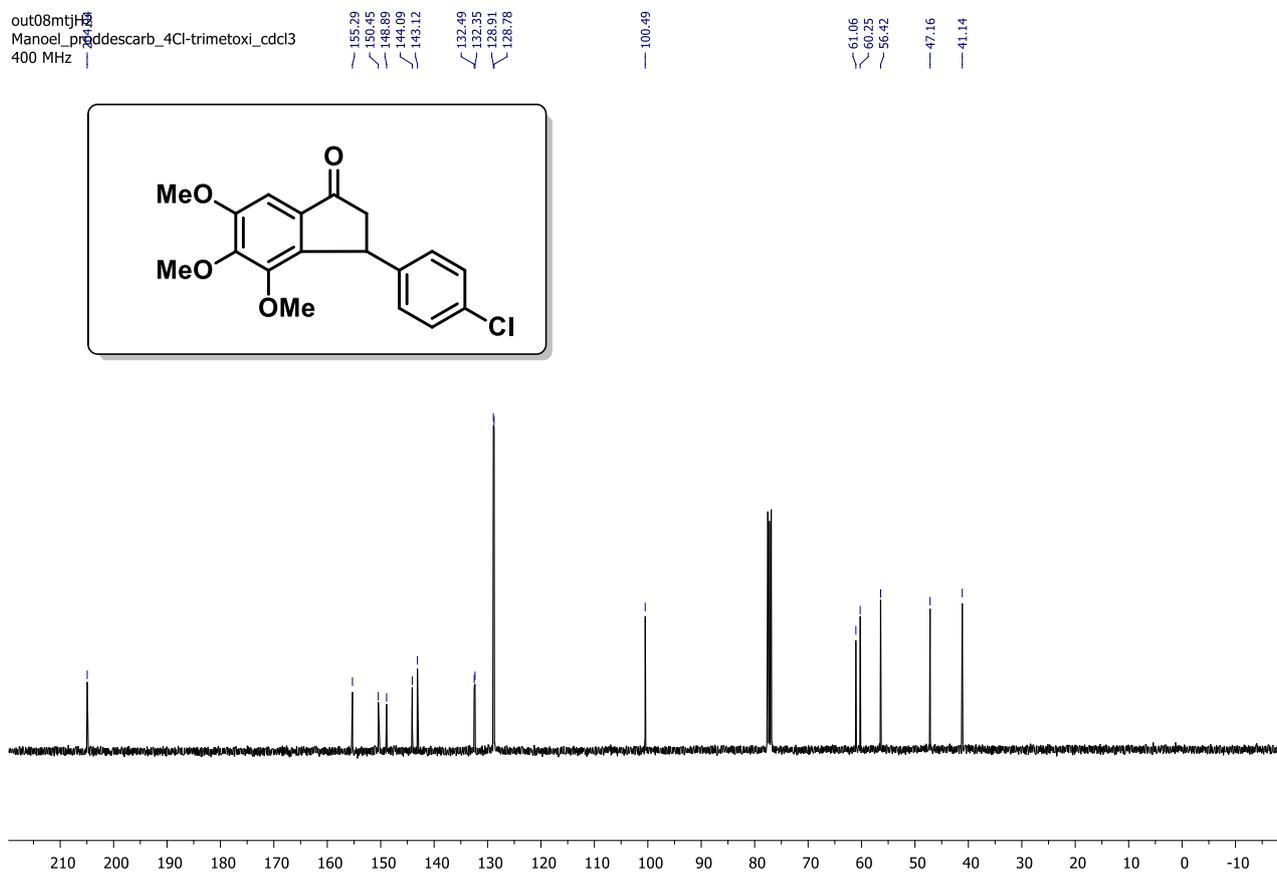
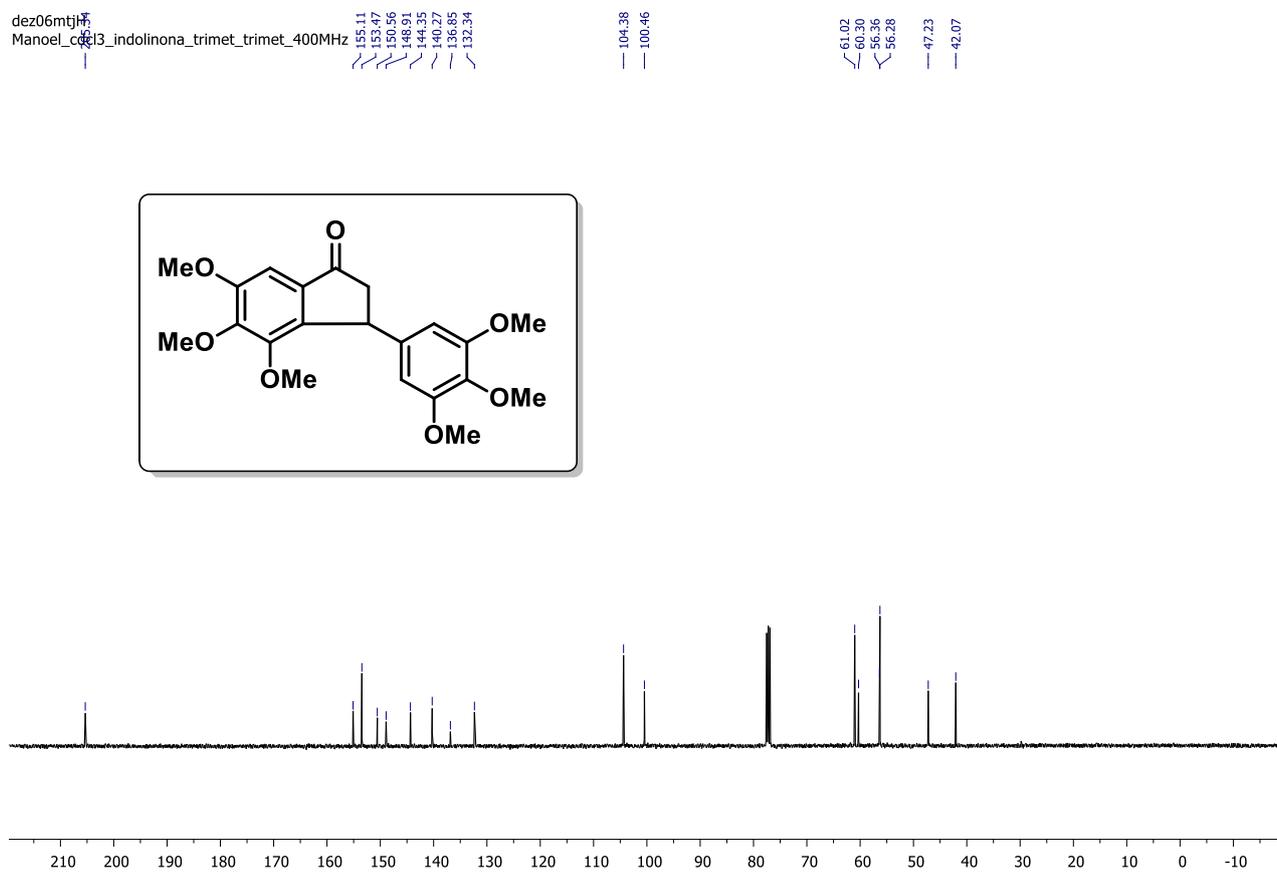
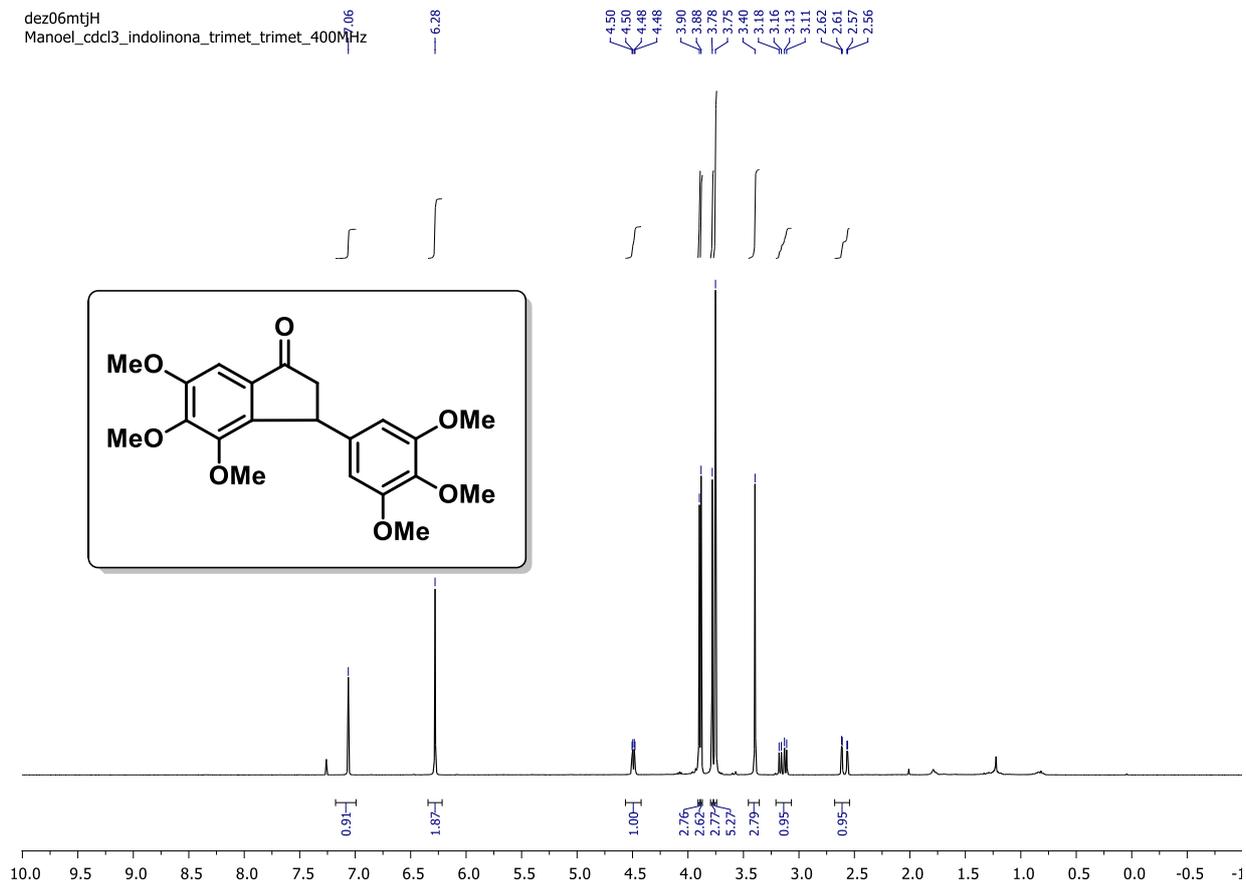


Figure S66. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound 11ab.



mar02mtjH  
Manoel/Aline\_Nazav\_trimet\_3,4dimet\_cdcl3\_500MHz

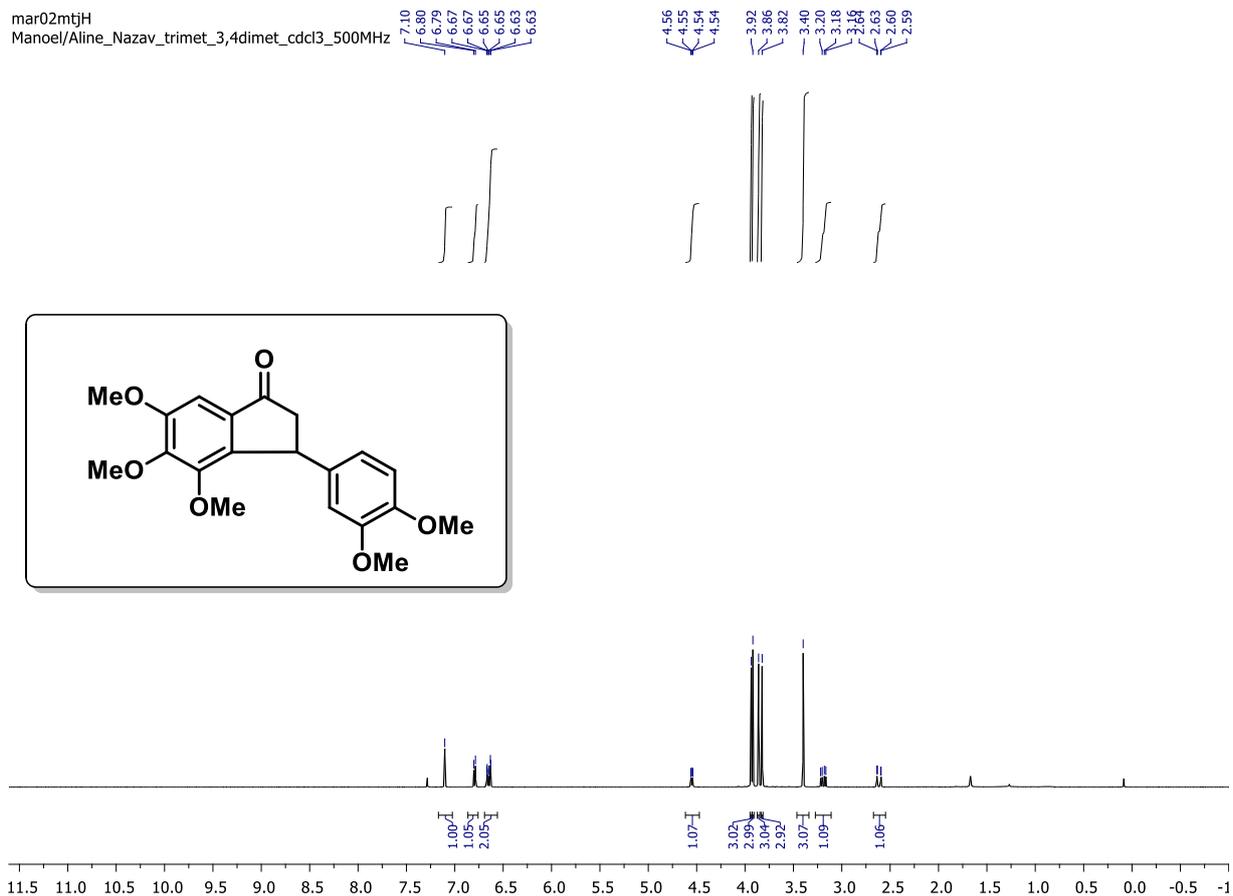


Figure S69.  $^1\text{H NMR}$  spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound 11ad.

mar02mtjC  
Manoel/Aline

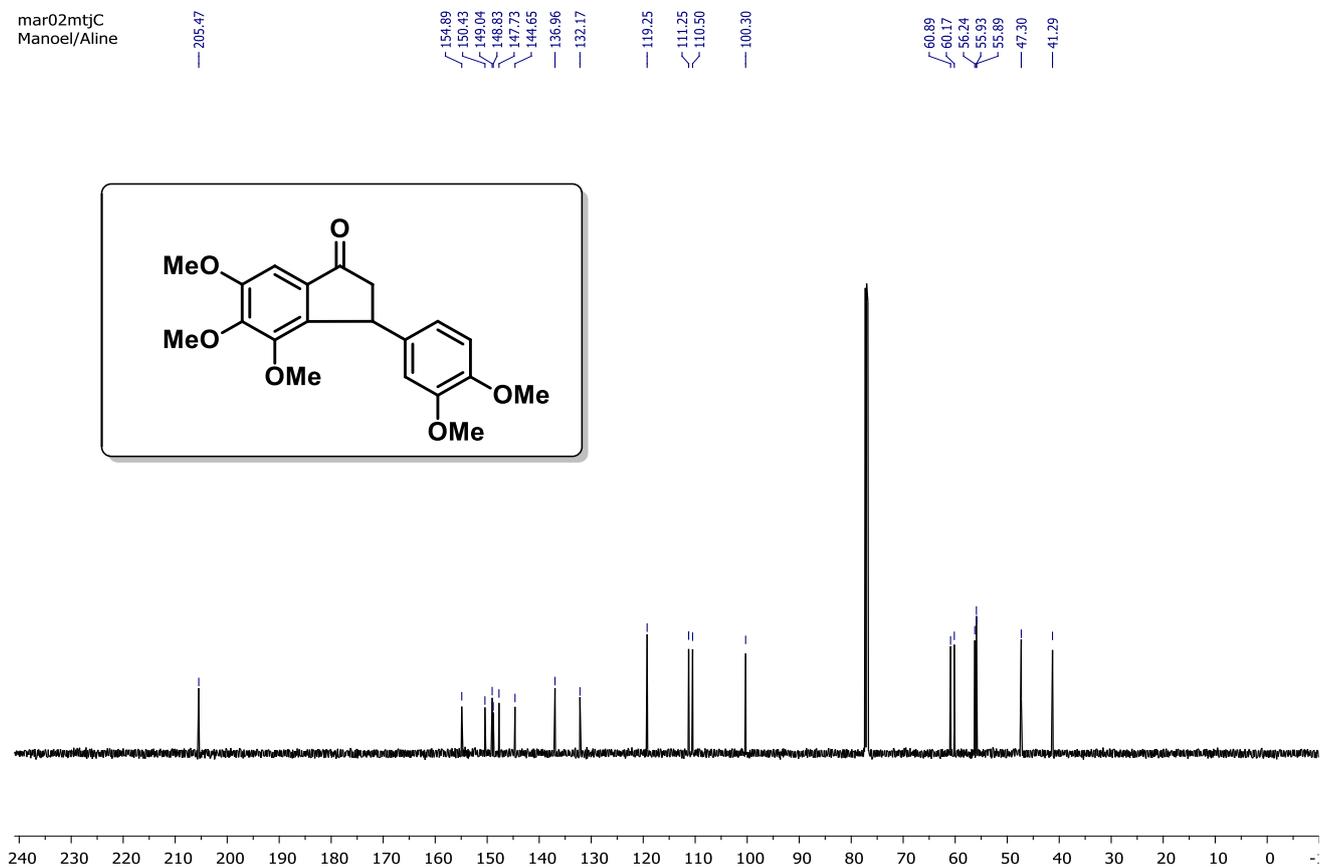


Figure S70.  $^{13}\text{C NMR}$  spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound 11ad.

mar14mtjH  
Manoel/Ralph\_Naz\_desc\_3,5-dimet\_ptoluil\_cdc  
400MHz

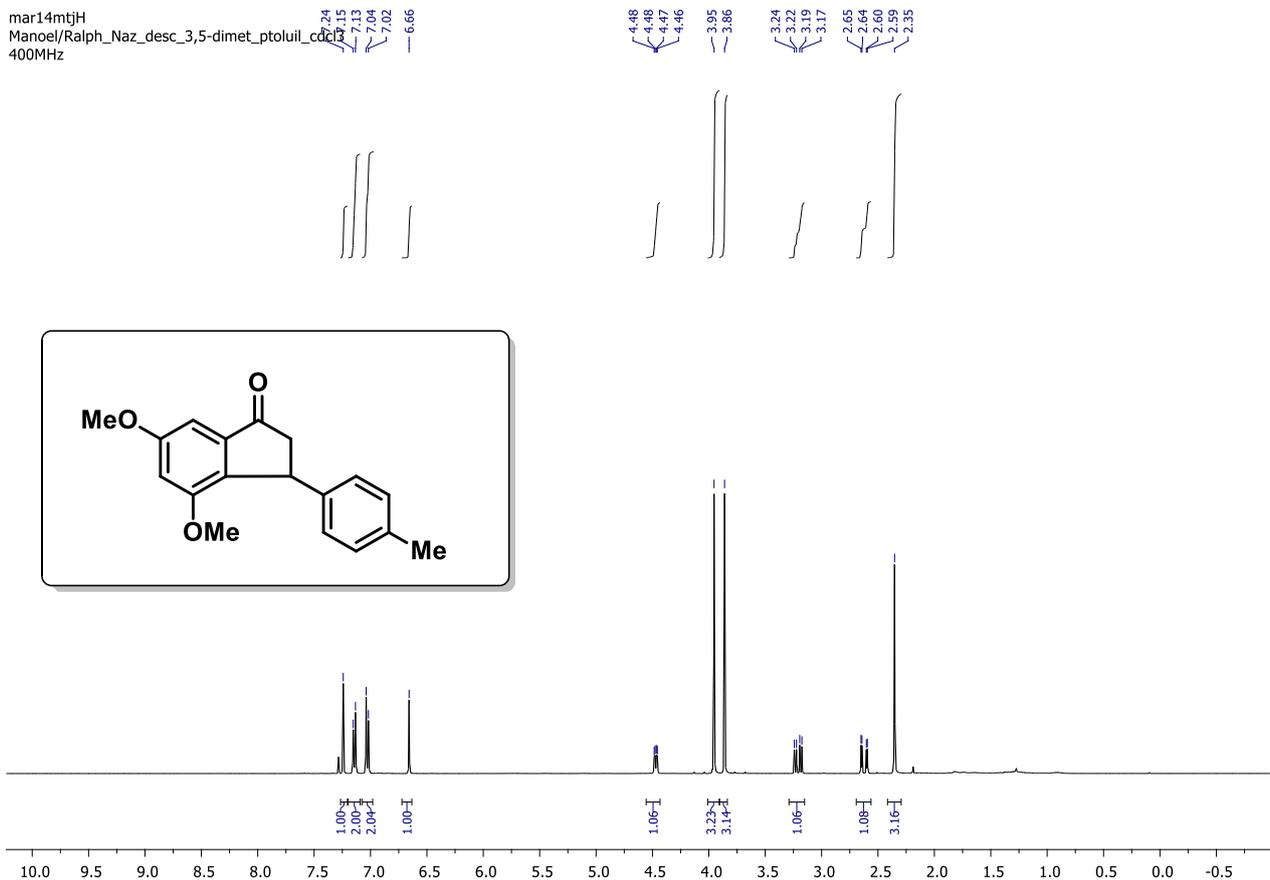


Figure S71. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **11bj**.

mar14mtjH  
Manoel/Ralph\_Naz\_desc\_3,4-dimet\_ptoluil\_cdc  
400MHz

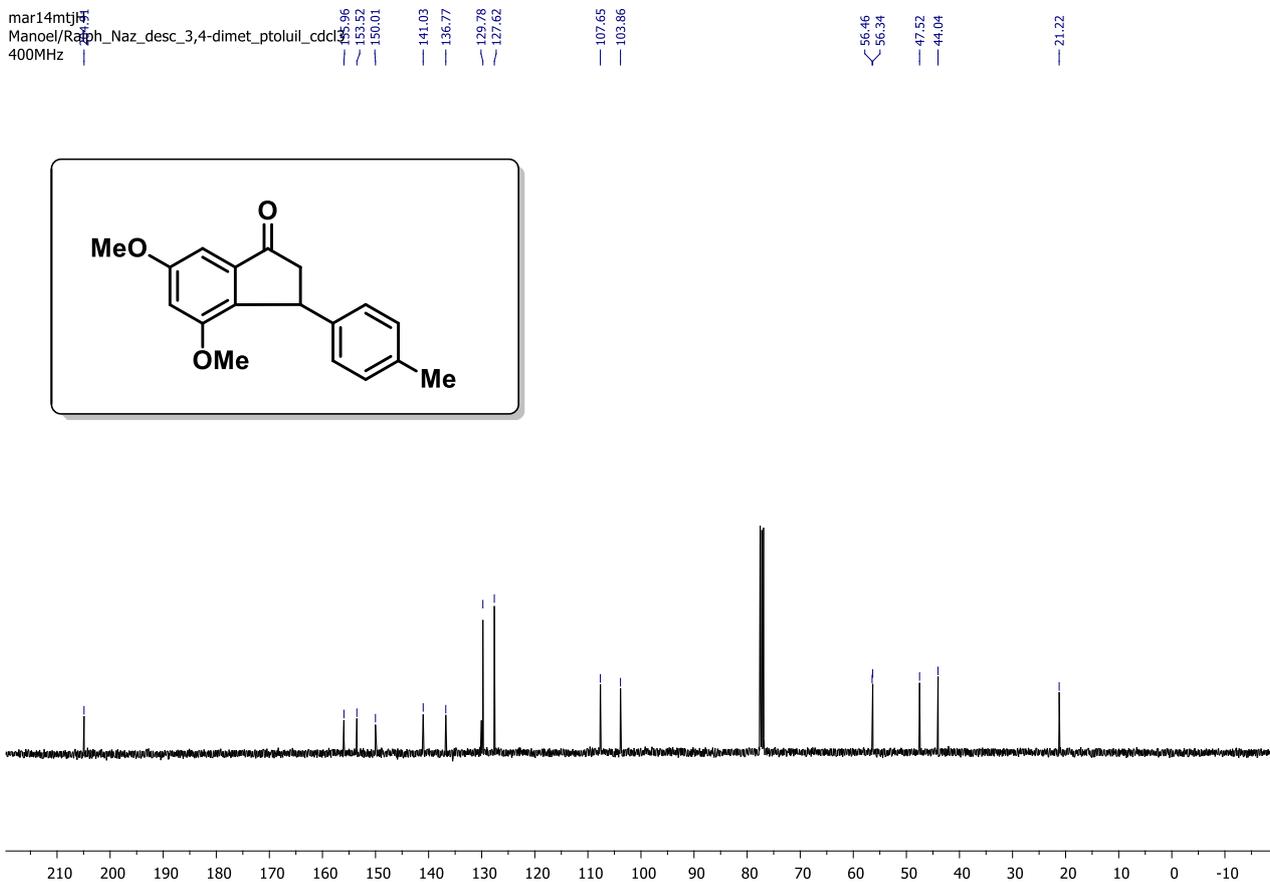
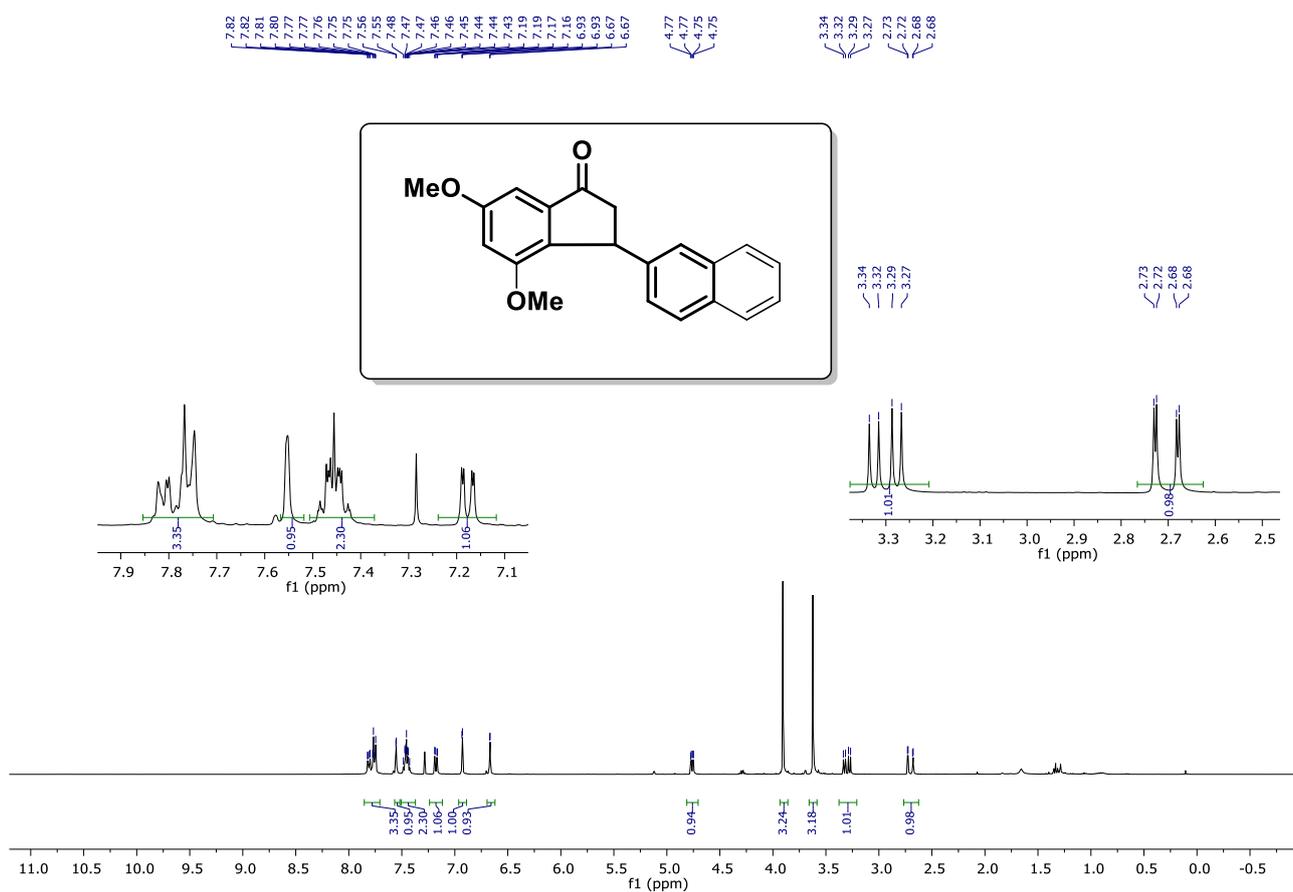
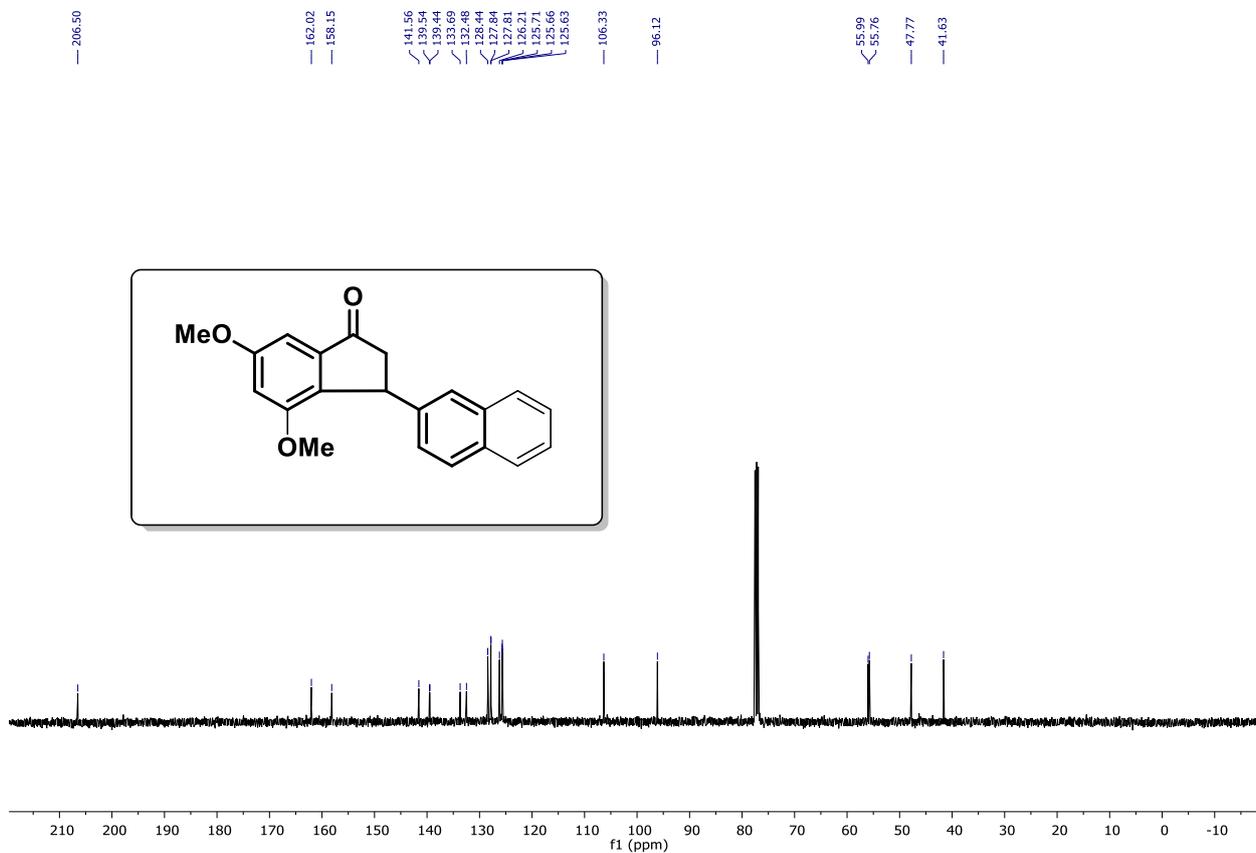


Figure S72. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **11bj**.



**Figure S73.** <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **11bk**.



**Figure S74.** <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **11bk**.

mar20mtjH  
Manoel/RAlph\_Naz\_desc\_3,5dimet\_trimet\_cdc13\_400MHz

4.53  
4.53  
4.51  
4.51  
3.88  
3.83  
3.78  
3.71  
3.24  
3.22  
3.19  
3.17  
2.66  
2.66  
2.61  
2.61

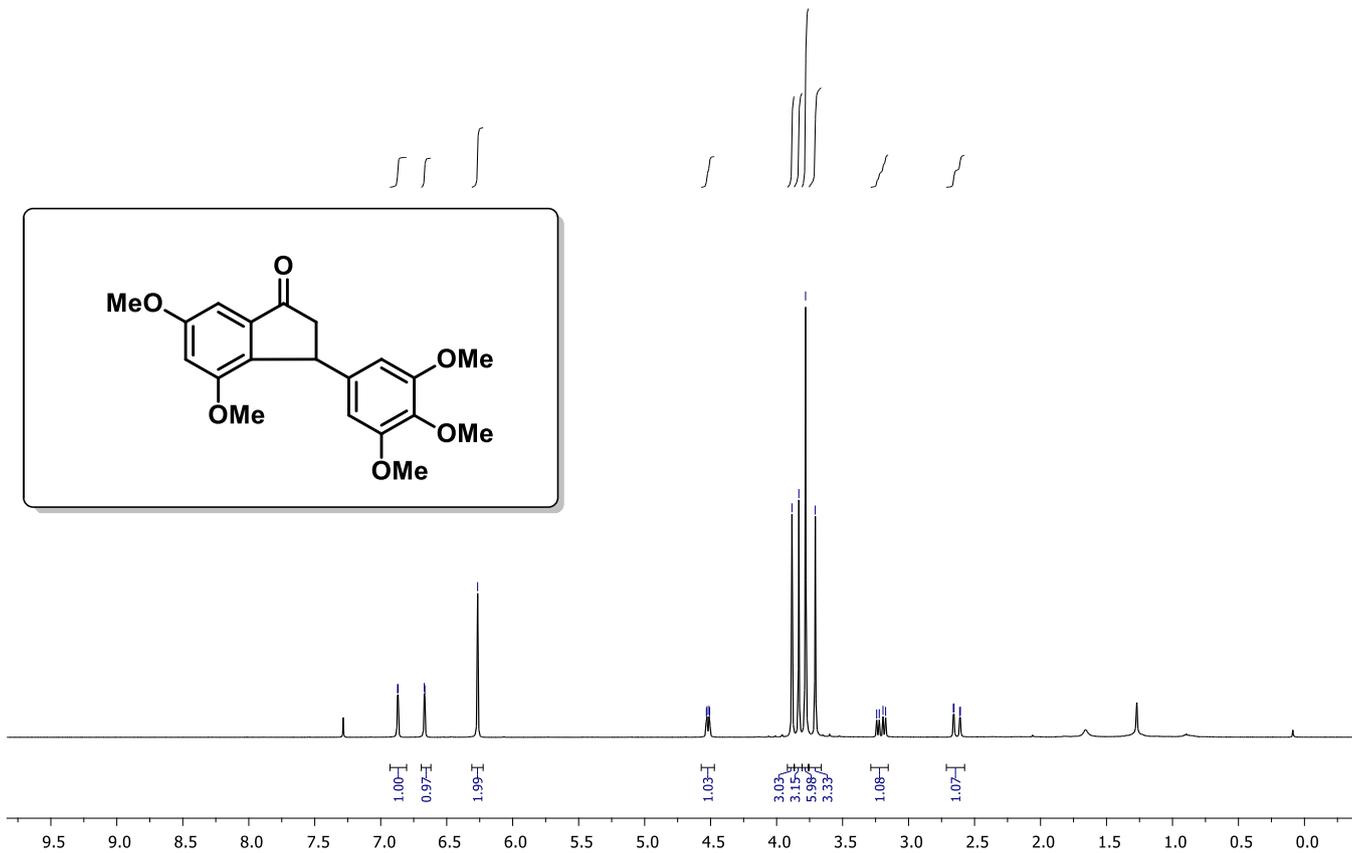


Figure S75. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 11bc.

mar20mtjH  
Manoel/RAlph\_Naz\_desc\_3,5dimet\_trimet\_cdc13\_100MHz

161.97  
158.11  
153.36  
139.89  
139.30  
139.26  
136.69  
106.31  
104.27  
96.12  
61.01  
56.28  
55.96  
55.82  
47.73  
41.76

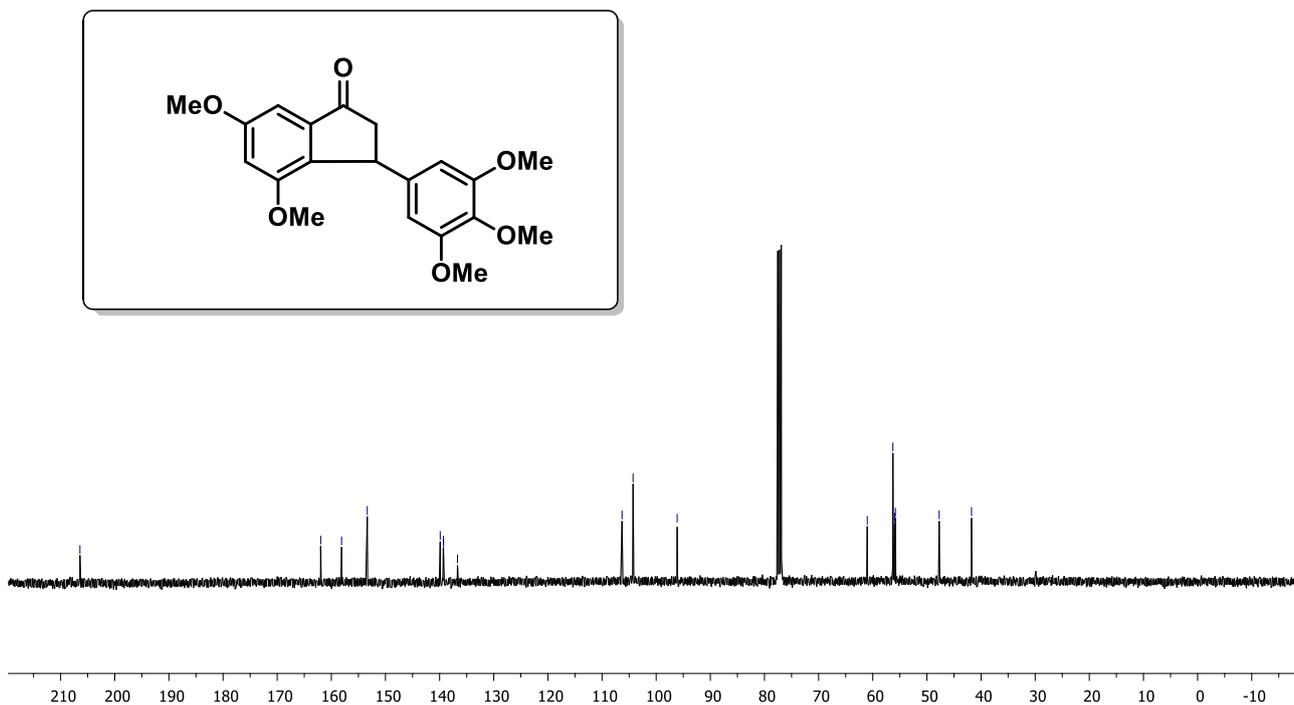


Figure S76. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound 11bc.

nov30mtjH2  
Manoel\_indolinona\_piper\_trimet\_cdcl3  
500 MHz

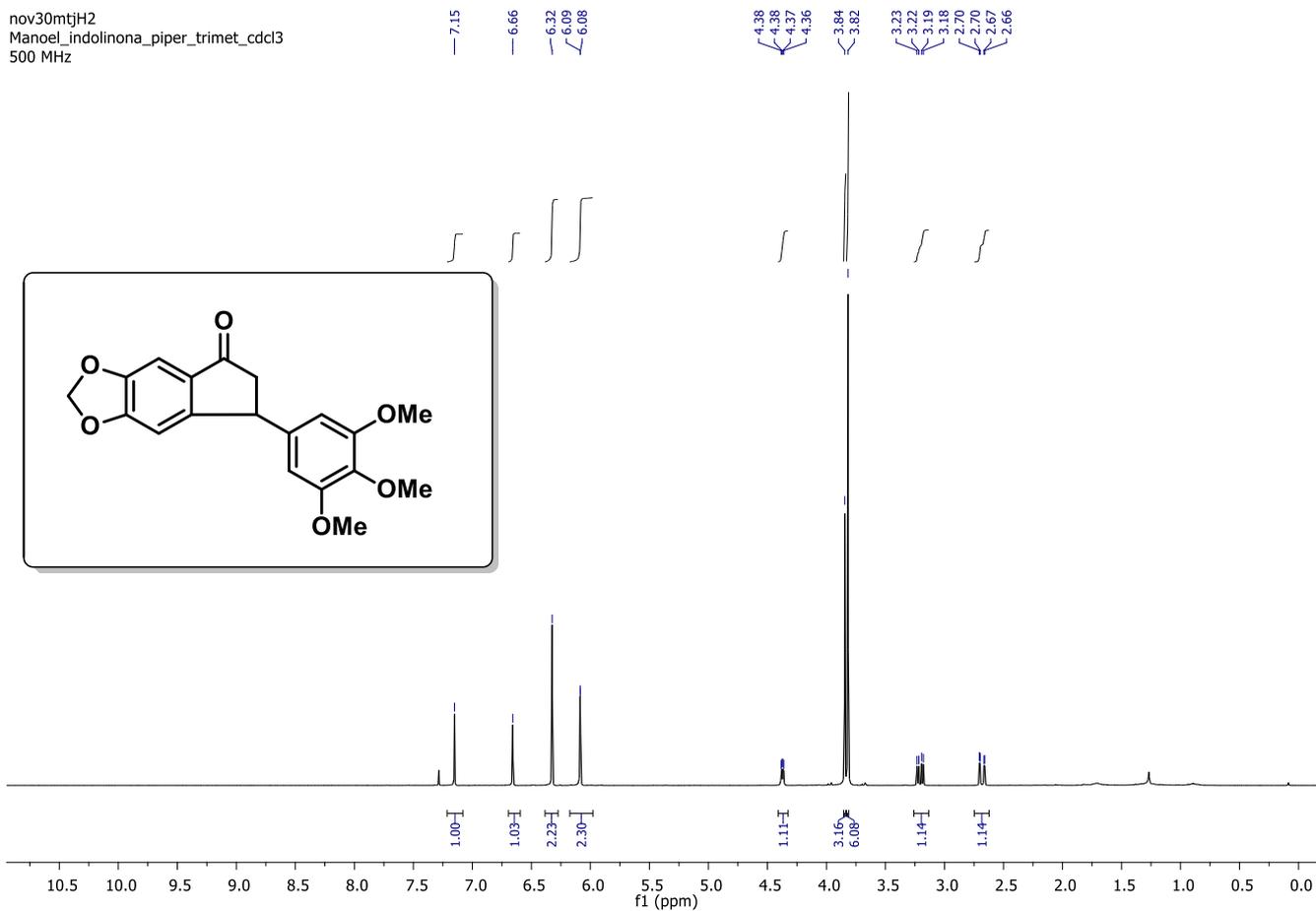


Figure S77.  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **11dc**.

nov30mtjH2  
Manoel\_indolinona\_piper\_trimet\_cdcl3  
500 MHz

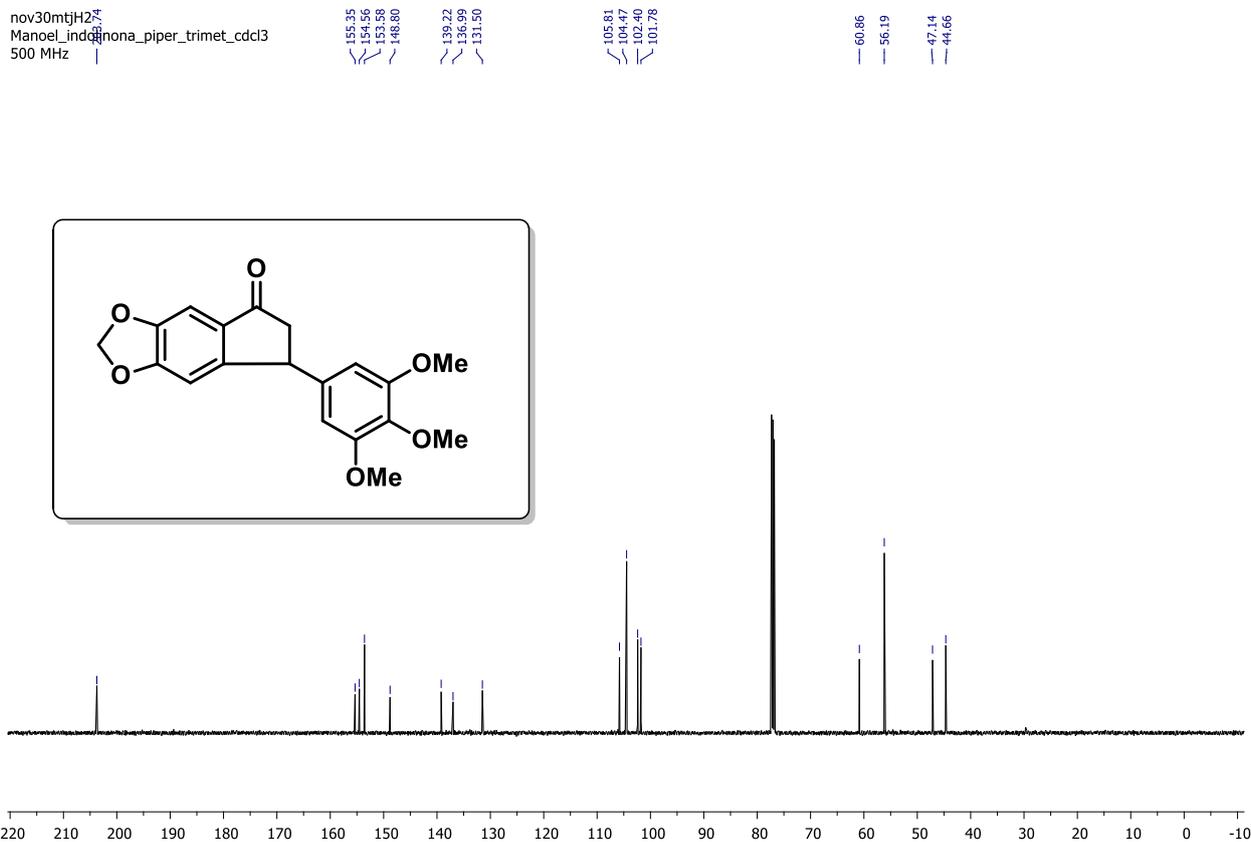
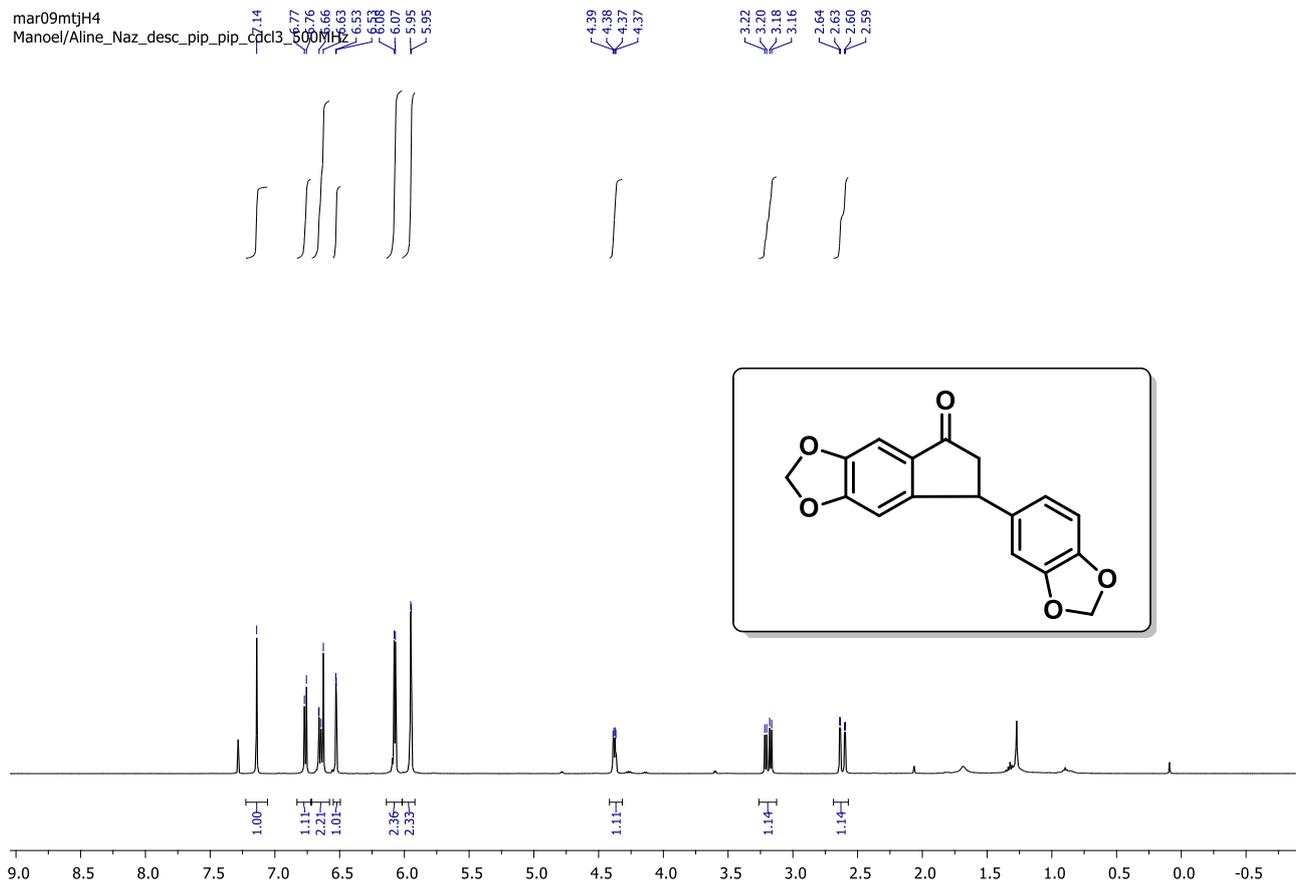
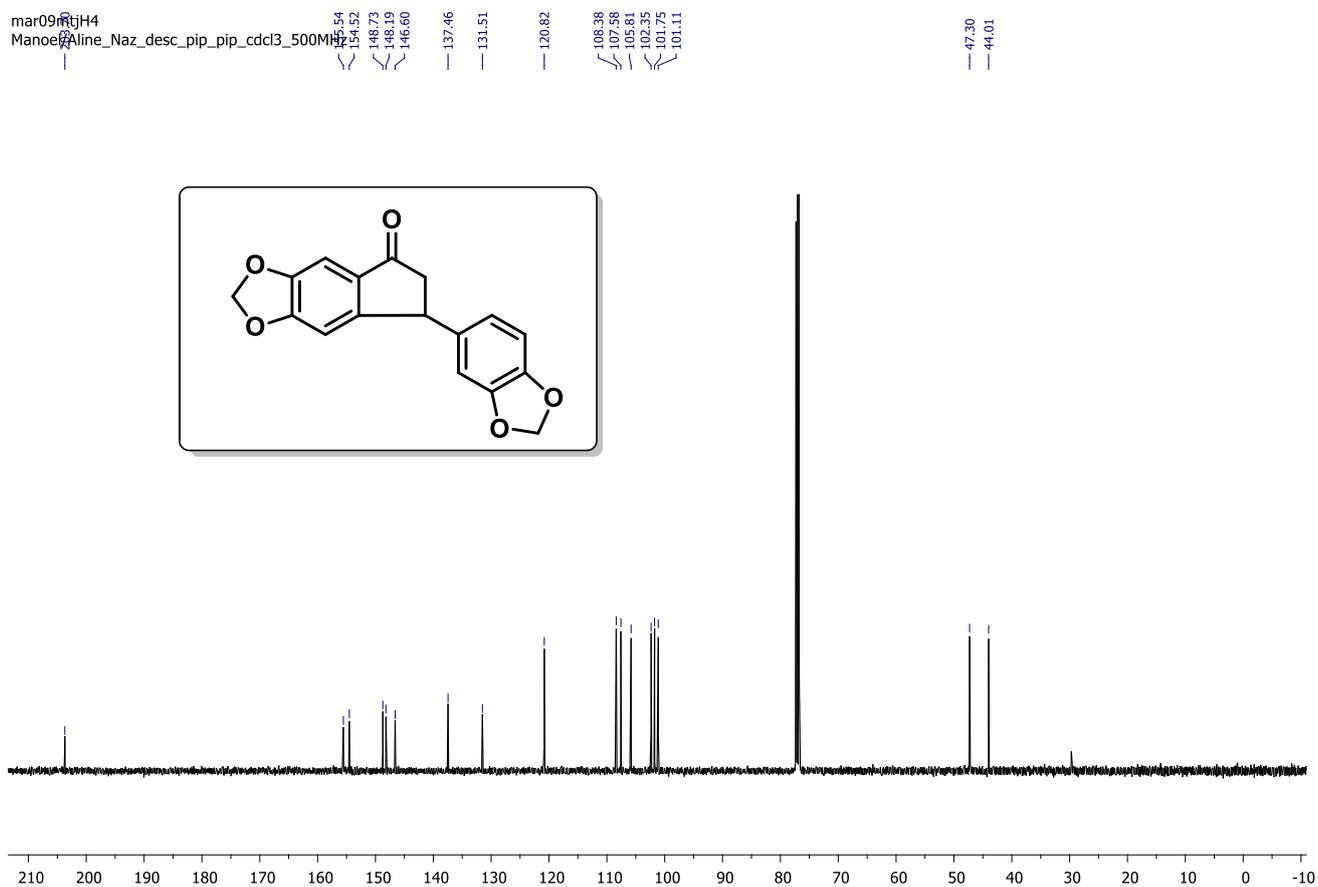


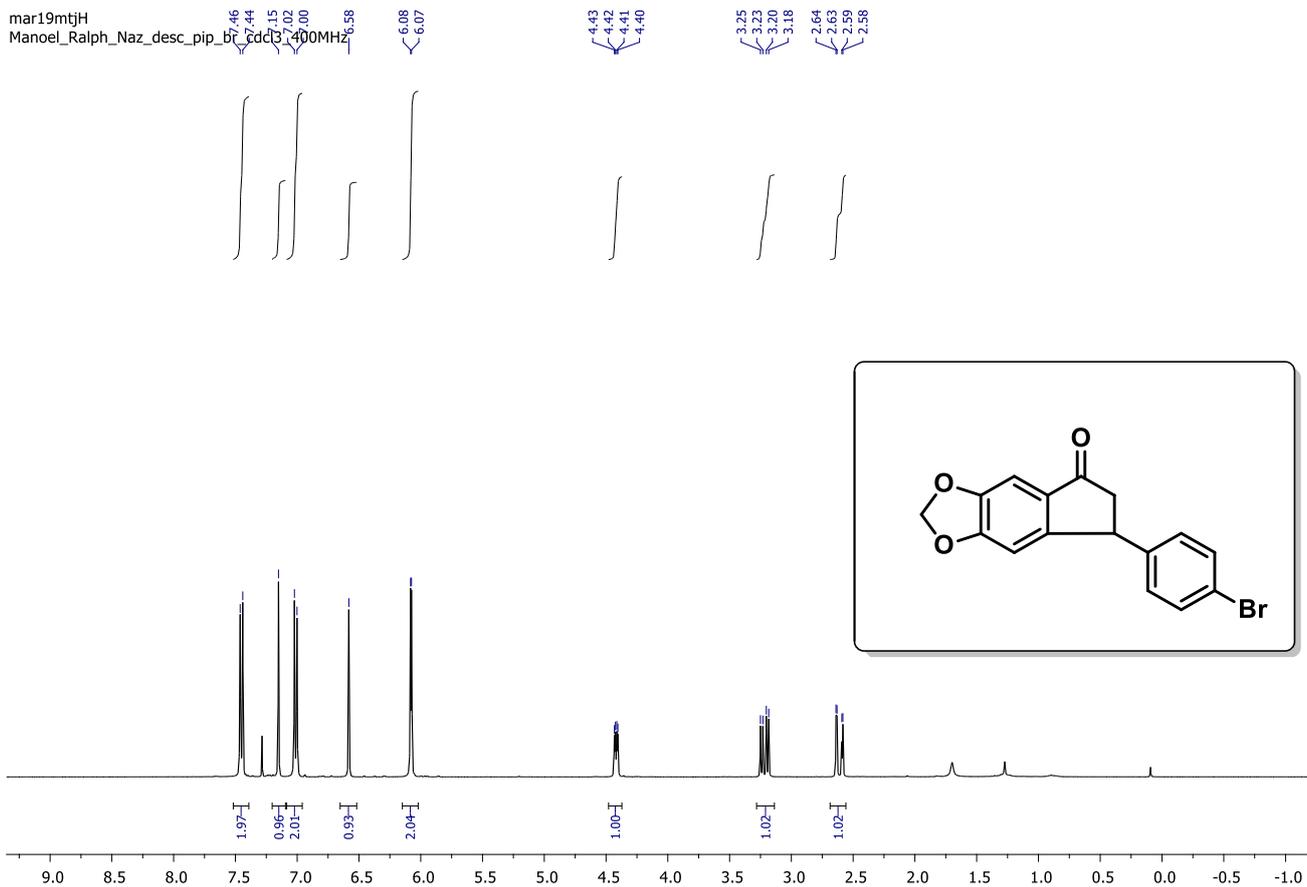
Figure S78.  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **11dc**.



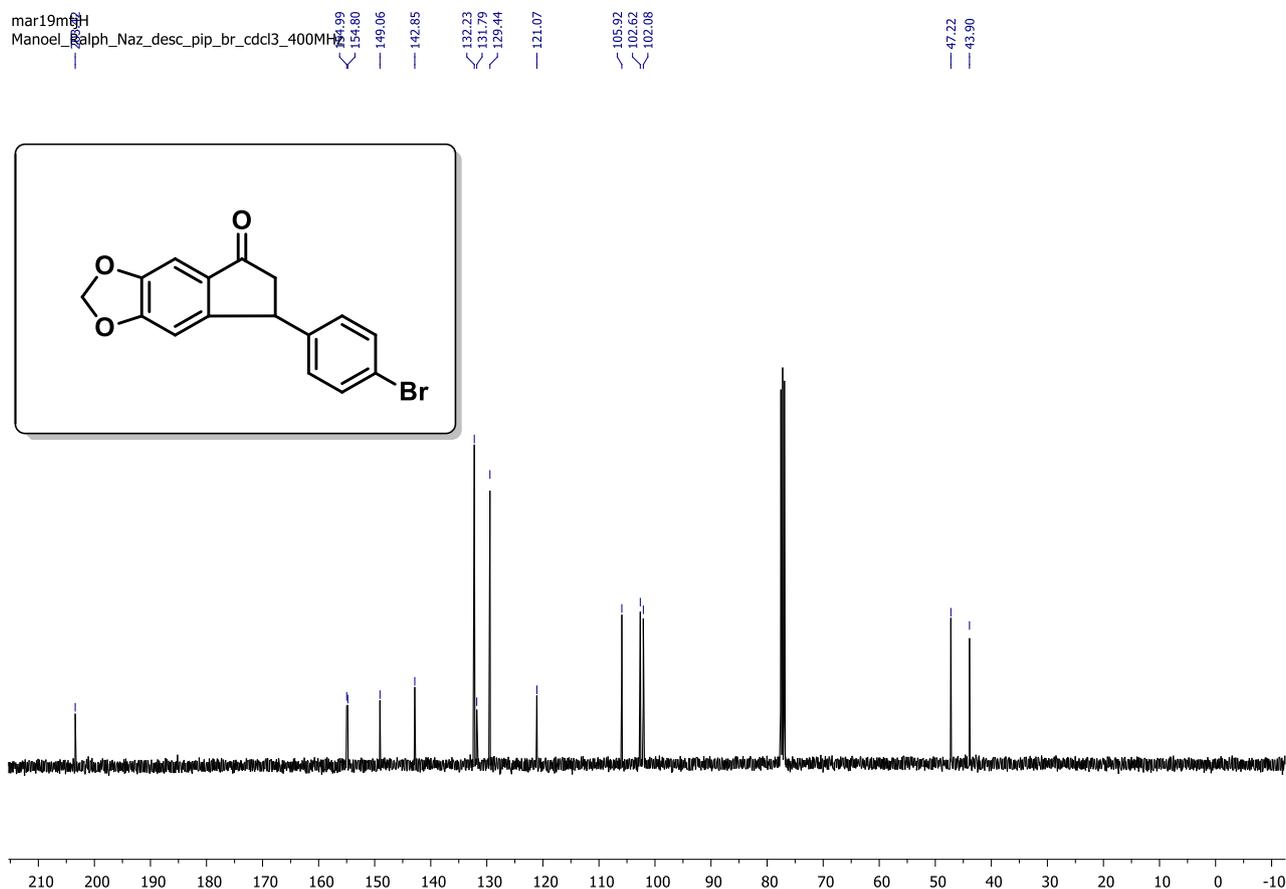
**Figure S79.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **11dl**.



**Figure S80.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **11dl**.



**Figure S81.**  $^1\text{H}$  NMR spectrum (500 MHz,  $\text{CDCl}_3$ ) of compound **11dm**.



**Figure S82.**  $^{13}\text{C}$  NMR spectrum (126 MHz,  $\text{CDCl}_3$ ) of compound **11dm**.

mar13mtjH2  
Manoel/Aline\_Ralph\_ind\_desc\_3,4-dimet\_trimet\_cdcCl3\_400MHz

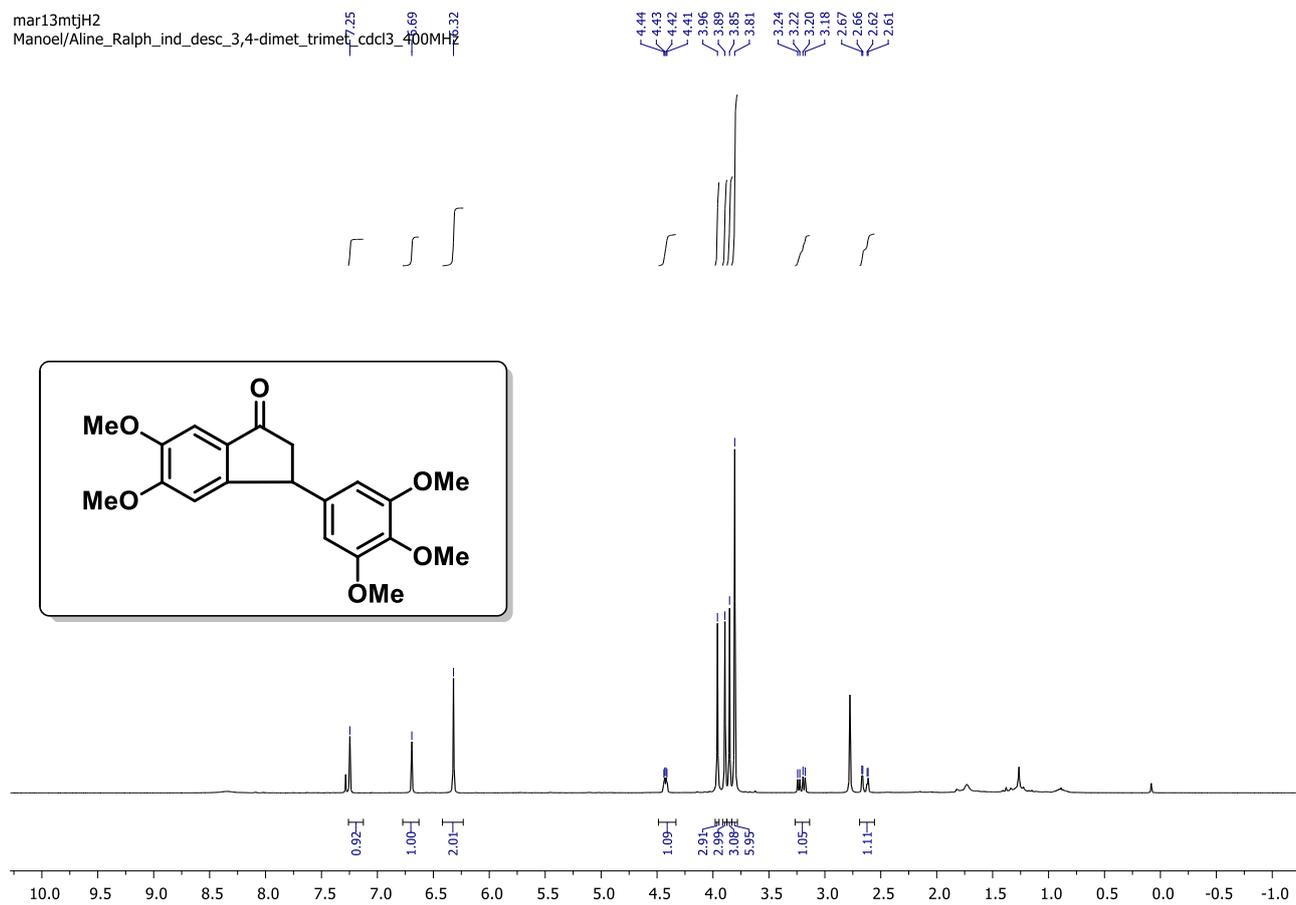


Figure S83. <sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **11cc**.

mar13mtjH2  
Manoel/Aline\_Ralph\_ind\_desc\_3,4-dimet\_trimet\_cdcCl3\_100MHz

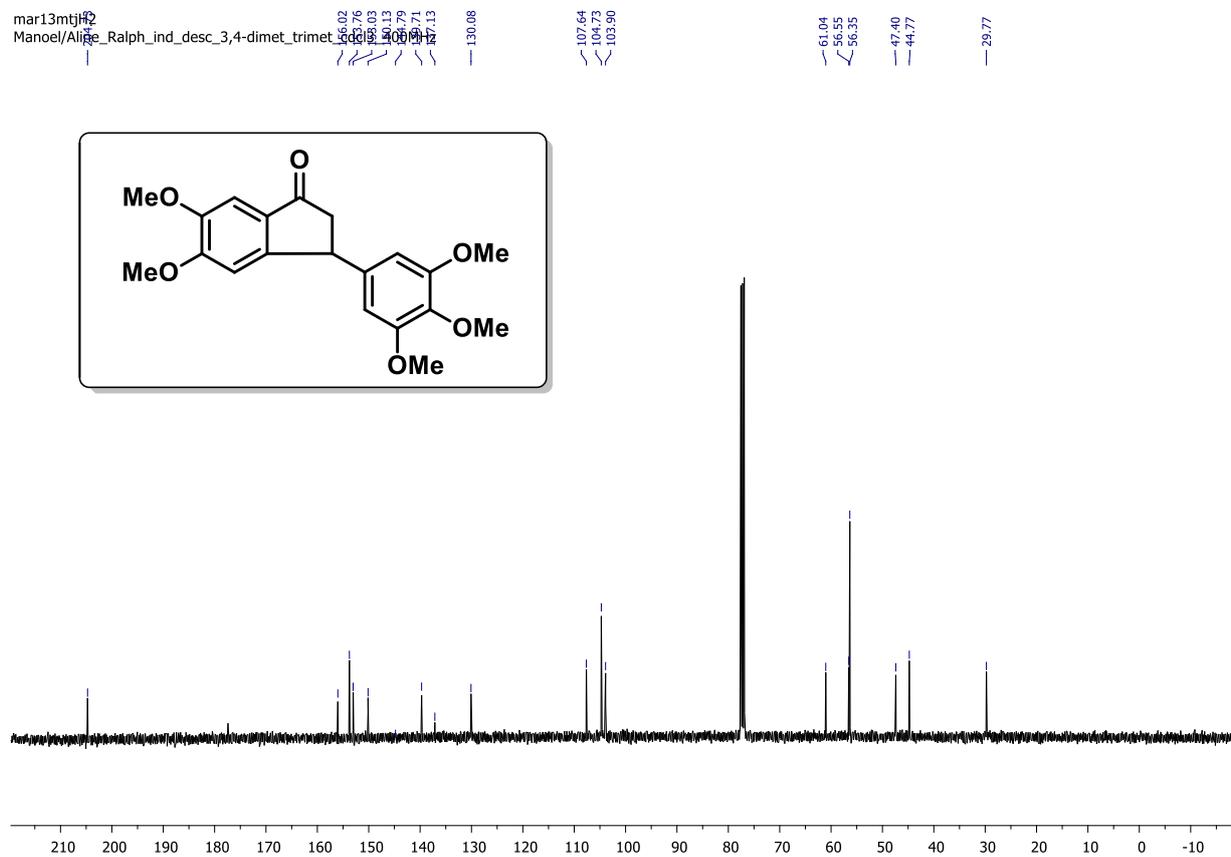


Figure S84. <sup>13</sup>C NMR spectrum (101 MHz, CDCl<sub>3</sub>) of compound **11cc**.

