

Supporting Information

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# Supporting Information

## Green Synthesis of Five-Membered Heterene *N*-Oxides: A Designed Approach to the Synthesis of Substituted Chromeno[3,4-*c*]pyrrole-2-oxides

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## Experimental Section

### General remarks:

All reactions were monitored by thin-layer chromatography (TLC) on Merck silica gel 60 F254 plates. The temperatures were monitored using a mercury laboratory thermometer. Column chromatography purification was carried out on silica gel (63-200 mesh ASTM). Melting points were measured on an Electrothermal 9100 apparatus. IR spectra were recorded as KBr pellets on a Nicolet FTIR 100 spectrophotometer.  $^1\text{H}$  NMR (500, 400 and 300 MHz),  $^{13}\text{C}\{^1\text{H}\}$  NMR (75 MHz) spectra were obtained using Bruker DRX-500 Avance and Bruker DRX-300 Avance spectrometers. All NMR spectra were recorded at r.t in  $\text{DMSO-}d_6$  and  $\text{CDCl}_3$ . Chemical shifts are reported in parts per million ( $\delta$ ) downfield from an internal TMS reference. Coupling constants ( $J$  values) are reported in hertz (Hz), and standard abbreviations were used to indicate spin multiplicities. Elemental analyses for C, H, and N were performed using a Heraeus CHN-O-Rapid analyzer. Mass spectra were recorded on a Finnigan-MATT 8430 mass spectrometer operating at an ionization potential of 70 eV.

### General procedure for the preparation of compounds **2** and **3**.<sup>20</sup>

To a magnetically stirred solution of 3-(bromoacetyl)coumarin (10 mmol) in  $\text{CH}_2\text{Cl}_2$  (20 mL) was added  $\text{Ph}_3\text{P}$  (10 mmol) slowly. The reaction mixture was stirred at ambient temperature, and turned yellow gradually. After stirring for 3 h, the volatiles were removed *in vacuo* to obtain **2** as yellow oil product. Without further purification, a EtOH solution (30 mL) of **3** was prepared. The solution was treated dropwise with potassium carbonate (15 mmol) in 15 ml of  $\text{H}_2\text{O}$ , stirred for 5 h at room temperature, diluted with 20 mL of  $\text{H}_2\text{O}$ , and extracted with  $4 \times 20$  mL of EtOAc. Finally, a yellow crystalline solid was prepared with a yield of 90%.

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[20]. Pardin, C.; Pelletier, J. N.; Lubell, W. D.; Keillor, J. W. *J. Org. Chem.* **2008**, *73*, 5766-5775.

**General procedure for the preparation of 3-[(2E)-3-aryl-2-propenoyl]coumarin (coumarin-chalcone) 4.**

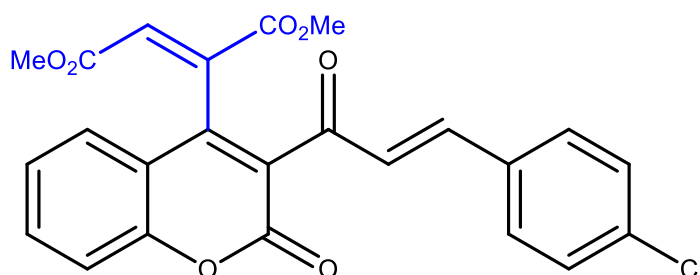
The coumarin derivative  $\alpha,\beta$ -unsaturated coumarins **4** was synthesized from the treatment of aryl aldehydes (5 mmol) with 3-[(triphenylphosphoranylidene)acetyl]coumarin **3** (5 mmol) in 10 mL EtOH overnight at room temperature. At this point, a precipitate formed, which was filtered and washed with cold ethanol to give a yellow solid (85% yield).

**General procedure for preparation of dialkyl 2-(2-oxo-3-((E)-3-aryl-2H-chromen-4-yl)fumarate 5.**

To a magnetically stirred solution of triphenylphosphine (1 mmol) and dialkyl 2-(2-oxo-3-((E)-3-aryl-2H-chromen-4-yl)fumarate (coumarin-chalcone) (1 mmol) in  $\text{CH}_2\text{Cl}_2$  was added dialkyl acetylenedicarboxylates (1 mmol) slowly. After completion (3 h), monitored by TLC, the solvent was removed under reduced pressure and 5 mL of ethanol was added to the residue. At this point, a precipitate formed, which was filtered and washed with ethanol to give a cream solid (88% yield).

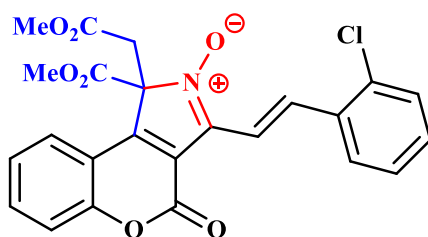
**Characteristic data for compound 5b**

**Dimethyl (2E)-2-{3-[(2E)-3-(4-chlorophenyl)-2-propenoyl]-2-oxo-2H-chromen-4-yl}-2-butenedioate (5b).**



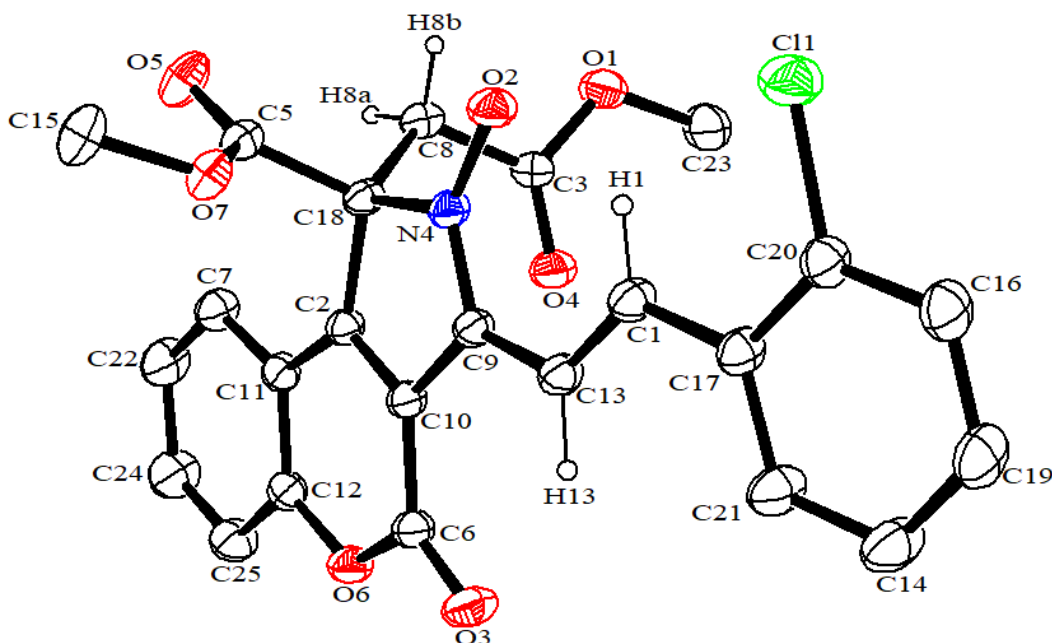
Light cream solid, m.p = 160-162 °C (dec.), 0.4 g, yield: 88%. IR (KBr) ( $\nu_{\text{max}}$ ,  $\text{cm}^{-1}$ ): 1724 and 1720 ( $\text{CO}_2\text{Me}$ ), 1710 (COO of lactone ring), 1665 (C=O), 1604, 1587 and 1564 (Ar), 1267 and 1209 (C-O), 1182 (C-Cl), 771 and 758 (C-H)  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500.13 MHz,  $\text{DMSO}-d_6$ ): 3.48 (3H, s, OMe), 3.66 (3H, s, OMe), 7.01 (1H, s, CH of alken), 7.18 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene), 7.39 (1H,





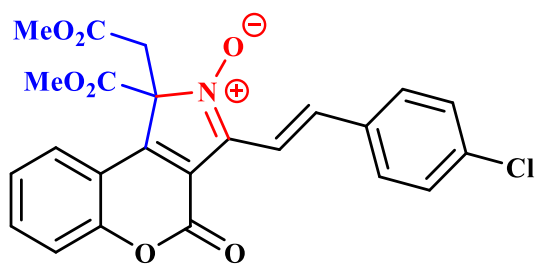
Light yellow solid, m.p = 275-277 °C (dec.), 0.21 g, yield: 90%. IR (KBr) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1732 ( $\text{CO}_2\text{Me}$  and  $\text{COO}$  of lactone ring), 1602, 1553 and 1493 (Ar), 1587 ( $-\text{C}=\text{N}-\text{O}$ ), 1257 and 1225 ( $\text{C}-\text{O}$ ), 1060 ( $\text{C}-\text{Cl}$ ), 1016 ( $\text{N}-\text{O}$ ), 755 ( $\text{C}-\text{H}$ )  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (300.13 MHz,  $\text{CDCl}_3$ ): 3.50 (3H, s, OMe), 3.78 (3H, s, OMe), 3.93 (2H, ABq,  $^2J_{\text{HH}} = 17.5$  Hz,  $\text{CH}_2$ ), 7.27-7.32 (2H, m, 2CH of Ar), 7.35 (1H, td,  $^3J_{\text{HH}} = 8.0$  Hz,  $^4J_{\text{HH}} = 1.2$  Hz,  $\text{CH}^8$  of coumarin), 7.40 (1H, dd,  $^3J_{\text{HH}} = 7.3$  Hz,  $^4J_{\text{HH}} = 1.9$  Hz,  $\text{CH}^6$  of coumarin), 7.45 (1H, d,  $^3J_{\text{HH}} = 7.2$  Hz, CH of Ar), 7.60 (1H, td,  $^3J_{\text{HH}} = 8.4$  Hz,  $^4J_{\text{HH}} = 1.6$  Hz,  $\text{CH}^7$  of coumarin), 7.62 (1H, d,  $^3J_{\text{HH}} = 7.9$  Hz, CH of Ar), 7.73 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene), 7.88 (1H, dd,  $^3J_{\text{HH}} = 7.4$  Hz,  $^4J_{\text{HH}} = 2.2$  Hz,  $\text{CH}^9$  of coumarin), 9.42 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene).  $^{13}\text{C}$  NMR (75.46 MHz,  $\text{CDCl}_3$ ): 38.02 ( $\text{CH}_2$ ), 52.24 (OMe), 54.92 (OMe), 83.38 ( $\text{C}^1$ ), 114.53 (CH of alken), 114.69 ( $\text{C}^{3a}$ ), 117.93 ( $\text{CH}^6$  of coumarin), 122.96 ( $\text{C}^{9a}$ ), 125.50 ( $\text{CH}^9$  of coumarin), 126.96 (2CH of Ar), 127.03 ( $\text{CH}^8$  of coumarin), 130.03 (CH of Ar), 130.26 (CH of Ar), 132.35 ( $\text{C}_{\text{ipso}}-\text{Ar}$ ), 134.67 ( $\text{CH}^7$  of coumarin), 134.72 ( $\text{C}_{\text{ipso}}-\text{Cl}$ ), 134.85 ( $\text{C}^3$ ), 140.84 (CH of alkene), 145.38 ( $\text{C}^{9b}$ ), 154.15 ( $\text{C}^{5a}$ ), 155.15 ( $\text{CO}_2$ ), 164.79 ( $\text{CO}_2$ ), 167.23 ( $\text{CO}_2$ ). MS (EI, 70 eV)  $m/z$  (%): 468 ( $\text{M}^{+1}$ , 18), 467 ( $\text{M}^+$ , 38), 408 (18), 392 (19), 372 (30), 382 (30), 314 (28), 211 (45), 138 (63), 74 (15), 58 (87). Anal. calcd. for  $\text{C}_{24}\text{H}_{18}\text{ClNO}_7$  (467.85): C, 61.61; H, 3.88; N, 2.99. Found: C, 61.60; H, 3.89; N, 3.01%. Crystal data for **6a**  $\text{C}_{24}\text{H}_{18}\text{ClNO}_7$  (CCDC 2092630):  $M_w = 467.84$ , monoclinic, P 1 21/c 1,  $a = 14.797(3)$  Å,  $b = 18.665(4)$  Å,  $c = 8.1097(16)$  Å,  $\alpha = 90.0$ ,  $\beta = 101.66(3)$ ,  $\gamma = 90.0$ ,  $V = 2193.6(8)$  Å<sup>3</sup>,  $Z = 4$ ,  $D_c = 1.417$   $\text{mg}/\text{m}^3$ ,  $F(000) = 968$ , crystal dimension  $0.30 \times 0.20 \times 0.15$  mm, radiation, Mo  $\text{K}\alpha$  ( $\lambda = 0.71073$  Å),  $1.8 \leq 2\theta \leq 26.4$ , intensity data were collected at 209 K with a Bruker APEX area-detector diffractometer, and employing  $\omega/2\theta$  scanning technique, in the range of  $-18 \leq h \leq 18$ ,  $-23 \leq k \leq 23$ ,  $-10 \leq l \leq 9$ ; the structure was solved by a direct method, all non-hydrogen atoms were positioned and

anisotropic thermal parameters refined from 4441 observed reflections with  $R(\text{into}) = 0.0449$  by a full-matrix least-squares technique converged to  $R1 = 0.0552$ , and  $wR2 = 0.1246 [I > 2\sigma(I)]$ .



ORTEP diagram of **6a**.

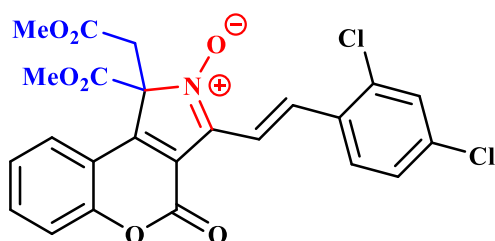
**Methyl**                      **3-[(*E*)-2-(4-chlorophenyl)vinyl]-1-(2-methoxy-2-oxoethyl)-4-oxo-1,4-dihydrochromeno[3,4-*c*]pyrrole-1-carboxylate 2-oxide (**6b**).**



Light yellow solid, m.p = 268-270 °C (dec.), 0.21 g, yield: 90%. IR (KBr) ( $\nu_{\text{max}}$ ,  $\text{cm}^{-1}$ ): 1732 ( $\text{CO}_2\text{Me}$  and COO of lactone ring), 1602, 1553 and 1496 (Ar), 1588 ( $-\text{C}=\text{N}-\text{O}$ ), 1236 and 1212 (C-O), 1034 (C-Cl), 1008 (N-O), 758 (C-H)  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (300.13 MHz,  $\text{DMSO}-d_6$ ): 3.43 (3H, s, OMe), 3.71 (3H, s, OMe), 3.93 (2H, ABq,  $^2J_{\text{HH}} = 17.3$  Hz,  $\text{CH}_2$ ), 7.44 (1H, t,  $^3J_{\text{HH}} = 7.1$  Hz,  $\text{CH}^8$  of coumarin), 7.50 (2H, d,  $^3J_{\text{HH}} = 8.5$  Hz, 2CH of Ar), 7.56 (1H, d,  $^3J_{\text{HH}} = 16.3$  Hz, CH of alkene), 7.59 (1H, d,  $^3J_{\text{HH}} = 7.8$  Hz,  $\text{CH}^6$  of coumarin), 7.67 (2H, d,  $^3J_{\text{HH}} = 8.7$  Hz, 2CH of Ar), 7.71 (1H, t,  $^3J_{\text{HH}} = 7.3$  Hz,  $\text{CH}^7$  of coumarin), 7.82 (1H, d,  $^3J_{\text{HH}} = 7.9$  Hz,  $\text{CH}^9$  of coumarin), 8.86 (1H, d,  $^3J_{\text{HH}} = 16.3$  Hz, CH of

alkene).  $^{13}\text{C}$  NMR (75.46 MHz, DMSO- $d_6$ ): 37.53 (CH<sub>2</sub>), 52.13 (OMe), 54.99 (OMe), 83.30 (C<sup>1</sup>), 113.29 (C<sup>3a</sup>), 114.11 (CH of alkene), 117.56 (CH<sup>6</sup> of coumarin), 121.82 (C<sup>9b</sup>), 123.90 (CH<sup>8</sup> of coumarin), 125.87 (CH<sup>9</sup> of coumarin), 129.06 (2CH of Ar), 129.30 (2CH of Ar), 132.87 (C<sub>ipso</sub>-Cl), 134.15 (CH<sup>7</sup> of coumarin), 135.00 (C<sup>3</sup>), 135.77 (C<sub>ipso</sub>-Ar), 138.88 (CH of alkene), 145.50 (C<sup>9b</sup>), 153.53 (C<sup>5a</sup>), 154.91 (CO<sub>2</sub>), 164.08 (CO<sub>2</sub>), 167.48 (CO<sub>2</sub>). MS (EI, 70 eV)  $m/z$  (%): 468 (M<sup>+1</sup>, 18), 467 (M<sup>+</sup>, 38), 408 (18), 392 (19), 372 (30), 382 (30), 314 (28), 211 (45), 138 (63), 74 (15), 58 (87). Anal. calcd. for C<sub>24</sub>H<sub>18</sub>ClNO<sub>7</sub> (467.85): C, 61.61; H, 3.88; N, 2.99. Found: C, 61.60; H, 3.87; N, 3.01%.

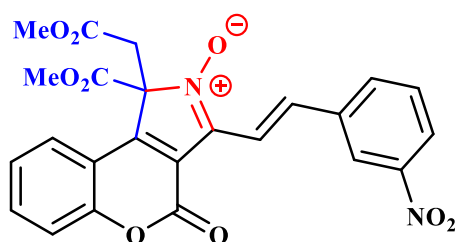
**Methyl 3-[(E)-2-(2,4-dichlorophenyl)vinyl]-1-(2-methoxy-2-oxoethyl)-4-oxo-1,4-dihydrochromeno[3,4-c]pyrrole-1-carboxylate 2-oxide (6c).**



Light yellow solid, m.p = 295-296 °C (dec.), 0.24 g, yield: 95%. IR (KBr) ( $\nu_{\text{max}}$ , cm<sup>-1</sup>): 1736 (CO<sub>2</sub>Me and COO of lactone ring), 1600, 1549 and 1492 (Ar), 1595 (-C=N-O), 1252 and 1200 (C-O), 1051 and 1034 (C-Cl), 1024 (N-O), 778 and 756 (C-H) cm<sup>-1</sup>.  $^1\text{H}$  NMR (300.13 MHz, DMSO- $d_6$ ): 3.43 (3H, s, OMe), 3.72 (3H, s, OMe), 3.95 (2H, ABq,  $^2J_{\text{HH}} = 17.3$  Hz, CH<sub>2</sub>), 7.45 (1H, d,  $^3J_{\text{HH}} = 7.3$  Hz, CH<sup>8</sup> of coumarin), 7.52 (1H, d,  $^3J_{\text{HH}} = 8.5$  Hz,  $^2J_{\text{HH}} = 2.2$  Hz, CH<sup>6</sup> of coumarin), 7.58 (1H, d,  $^4J_{\text{HH}} = 8.1$  Hz, CH of Ar), 7.61 (1H, d,  $^3J_{\text{HH}} = 16.1$  Hz, CH of alkene), 7.71 (1H, s, Ar), 7.72 (1H, d,  $^3J_{\text{HH}} = 7.2$  Hz, CH<sup>7</sup> of coumarin), 7.82 (1H, d,  $^3J_{\text{HH}} = 8.1$  Hz, CH of Ar), 7.90 (1H, d,  $^3J_{\text{HH}} = 8.6$  Hz, CH<sup>9</sup> of coumarin), 9.21 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene).  $^{13}\text{C}$  NMR (75.46 MHz, DMSO- $d_6$ ): 37.59 (CH<sub>2</sub>), 52.11 (OMe), 55.03 (OMe), 83.58 (C<sup>1</sup>), 114.08 (C<sup>3a</sup>), 115.42 (CH of alkene), 117.55 (CH<sup>6</sup> of coumarin), 121.68 (C<sup>9a</sup>), 123.91 (CH<sup>8</sup> of coumarin), 125.87 (CH<sup>9</sup> of coumarin), 128.07 (CH of Ar), 128.31 (CH of Ar), 129.61 (CH of Ar), 130.92 (C<sub>ipso</sub>-Cl), 132.92 (CH<sup>7</sup> of coumarin, C<sub>ipso</sub>-Cl), 134.05

(*C<sub>ipso</sub>*-Ar), 134.58 (C<sup>3</sup>), 138.93 (C<sup>3</sup>), 145.53 (C<sup>9b</sup>), 153.56 (C<sup>5a</sup>), 154.85 (CO<sub>2</sub>), 163.90 (CO<sub>2</sub>), 167.41 (CO<sub>2</sub>). MS (EI, 70 eV) *m/z* (%): 503 (M<sup>+</sup>, 25), 502 (M<sup>+</sup>, 12), 501 (M<sup>-</sup>, 36), 479 (26), 442 (20), 407 (12), 370 (100), 298 (43), 242 (18), 176 (23), 139 (37), 109 (68). Anal. calcd. for C<sub>24</sub>H<sub>17</sub>Cl<sub>2</sub>NO<sub>7</sub> (502.30): C, 57.39; H, 3.41; N, 2.79. Found: C, 57.40; H, 3.42; N, 2.77%.

**Methyl 1-(2-methoxy-2-oxoethyl)-3-[(*E*)-2-(3-nitrophenyl)vinyl]-4-oxo-1,4-dihydrochromeno[3,4-*c*]pyrrole-1-carboxylate 2-oxide (6d).**

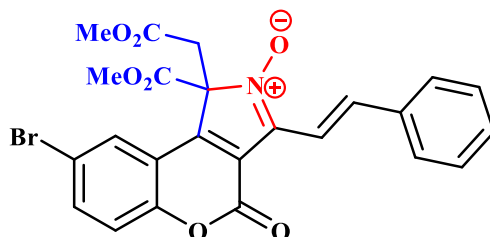


Light yellow solid, m.p = 281-282 °C (dec.), 0.23 g, yield: 96%. IR (KBr) ( $\nu_{\max}$ , cm<sup>-1</sup>): 1735 (CO<sub>2</sub>Me and COO of lactone ring), 1600, 1555 and 1486 (Ar), 1604 (-C=N-O), 1253 and 1218 (C-O), 1013 (N-O), 751 and 734 (C-H) cm<sup>-1</sup>. <sup>1</sup>H NMR (400.13 MHz, CDCl<sub>3</sub>): 3.52 (3H, s, OMe), 3.82 (3H, s, OMe), 3.96 (2H, <sup>3</sup>J<sub>HH</sub> = 15.5 Hz, CH<sub>2</sub>), 7.38 (1H, t, <sup>3</sup>J<sub>HH</sub> = 7.6 Hz, CH<sup>8</sup> of coumarin), 7.46 (1H, d, <sup>3</sup>J<sub>HH</sub> = 8.5 Hz, CH<sup>6</sup> of coumarin), 7.56 (1H, t, <sup>3</sup>J<sub>HH</sub> = 8.2 Hz, CH of Ar), 7.63 (1H, t, <sup>3</sup>J<sub>HH</sub> = 7.8 Hz, CH<sup>7</sup> of coumarin), 7.66 (1H, d, <sup>3</sup>J<sub>HH</sub> = 8.1 Hz, CH of Ar), 7.78 (1H, d, <sup>3</sup>J<sub>HH</sub> = 16.6 Hz, CH alkene), 7.97 (1H, d, <sup>3</sup>J<sub>HH</sub> = 7.8 Hz, CH<sup>9</sup> of coumarin), 8.15 (1H, d, <sup>3</sup>J<sub>HH</sub> = 8.0 Hz, CH of Ar), 8.42 (1H, s, CH of Ar), 9.04 (1H, d, <sup>3</sup>J<sub>HH</sub> = 16.2 Hz, CH of alkene). <sup>13</sup>C NMR (125.03 MHz, DMSO-*d*<sub>6</sub>): 38.09 (CH<sub>2</sub>), 52.58 (OMe), 55.47 (OMe), 84.03 (C<sup>1</sup>), 114.56 (C<sup>3a</sup>), 115.53 (CH of alkene), 118.01 (CH<sup>6</sup> of coumarin), 121.91 (CH of Ar), 122.18 (C<sup>9a</sup>), 124.29 (CH of Ar), 124.38 (CH<sup>8</sup> of coumarin), 126.31 (CH<sup>9</sup> of coumarin), 131.16 (CH of Ar), 133.36 (CH<sup>7</sup> of coumarin), 133.93 (CH of Ar), 135.14 (C<sup>3</sup>), 138.36 (CH of alken), 139.19 (*C<sub>ipso</sub>*-Ar), 145.94 (C<sup>9b</sup>), 148.77 (C-NO<sub>2</sub>), 154.01 (C<sup>5a</sup>), 155.33 (CO<sub>2</sub>), 164.40 (CO<sub>2</sub>), 167.87 (CO<sub>2</sub>). MS (EI, 70 eV) *m/z* (%): 478 (M<sup>+</sup>, 9), 461 (10), 419 (5), 403 (5), 388 (25), 327 (11), 297 (14), 270 (23), 228 (30), 211 (100), 150 (60), 105 (25), 77 (52), 59 (45). Anal. calcd. for C<sub>24</sub>H<sub>18</sub>N<sub>2</sub>O<sub>9</sub> (478.41): C, 60.25; H, 3.79; N, 5.86. Found: C, 60.29; H, 3.77; N, 5.84%.

Methyl

8-bromo-1-(2-methoxy-2-oxoethyl)-4-oxo-3-[(E)-2-phenylvinyl]-1,4-

dihydrochromeno[3,4-c]pyrrole-1-carboxylate 2-oxide (6e).

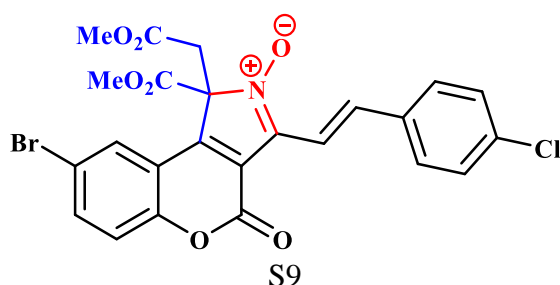


Light yellow solid, m.p = 275-278 °C (dec.), 0.22 g, yield: 86%. IR (KBr) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1735 ( $\text{CO}_2\text{Me}$  and COO of lactone ring), 1600, 1555 and 1486 (Ar), 1604 ( $-\text{C}=\text{N}-\text{O}$ ), 1253 and 1218 (C-O), 1013 (N-O), 751 and 734 (C-H)  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400.13 MHz,  $\text{CDCl}_3$ ): 3.56 (3H, s, OMe), 3.83 (3H, s, OMe), 3.91 (2H, ABq,  $^2J_{\text{HH}} = 17.4$  Hz,  $\text{CH}_2$ ), 7.37 (2H, t,  $^3J_{\text{HH}} = 8.6$  Hz, 2CH of Ph), 7.41 (1H, t,  $^3J_{\text{HH}} = 7.2$  Hz, CH of Ph), 7.42 (1H, d,  $^3J_{\text{HH}} = 8.4$  Hz,  $\text{CH}^6$  of coumarin), 7.68 (2H, d,  $^3J_{\text{HH}} = 8.7$  Hz, 2CH of Ph), 7.69 (2H, m,  $\text{CH}^7$  of coumarin and CH of alkene), 7.74 (1H, d,  $^4J_{\text{HH}} = 1.5$  Hz,  $\text{CH}^9$  of coumarin), 9.05 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene).  $^{13}\text{C}$  NMR (75.46 MHz,  $\text{DMSO}-d_6$ ): 33.14 ( $\text{CH}_2$ ), 52.09 (OMe), 54.99 (OMe), 83.35 ( $\text{C}^1$ ), 112.52 ( $\text{C}^{3a}$ ), 115.92 (CH of alkene), 117.65 ( $\text{CH}^6$  of coumarin), 119.67 (C-Br), 123.00 ( $\text{C}^{9a}$ ), 125.78 (CH of Ph), 127.35 (2CH of Ph), 129.23 (2CH of Ph), 129.80 ( $\text{CH}^9$  of Ph), 135.09 ( $\text{C}^3$ ), 136.02 ( $\text{CH}^7$  of coumarin), 137.30 ( $\text{C}_{\text{ipso}}\text{-Ph}$ ), 138.78 (CH of alkene), 143.63 ( $\text{C}^{9b}$ ), 152.52 ( $\text{C}^{5a}$ ), 154.49 ( $\text{CO}_2$ ), 164.00 ( $\text{CO}_2$ ), 167.54 ( $\text{CO}_2$ ). MS (EI, 70 eV)  $m/z$  (%): 513 ( $\text{M}^+$ , 3), 512 ( $\text{M}^+$ , 1), 511 ( $\text{M}^-$ , 3), 479 (5), 435 (3), 415 (40), 370 (14), 298 (9), 265 (10), 238 (100), 213 (21), 192 (35), 140 (91), 112 (31), 77 (17), 56 (12). Anal. calcd. for  $\text{C}_{24}\text{H}_{18}\text{BrNO}_7$  (512.31): C, 56.27; H, 3.54; N, 2.73. Found: C, 56.24; H, 3.55; N, 2.75%.

Methyl

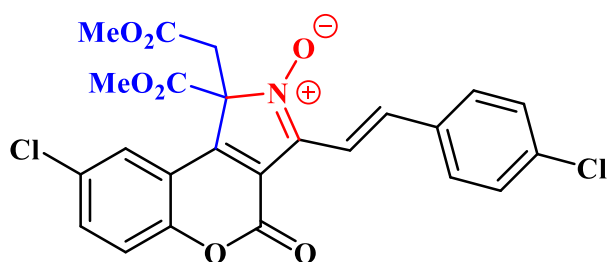
8-bromo-3-[(E)-2-(4-chlorophenyl)vinyl]-1-(2-methoxy-2-oxoethyl)-4-oxo-1,4-

dihydrochromeno[3,4-c]pyrrole-1-carboxylate 2-oxide (6f).



Light yellow solid, m.p = 285-287 °C (dec.), 0.23 g, yield: 84%. IR (3Br) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1742 ( $\text{CO}_2\text{Me}$  and  $\text{COO}$  of lactone ring), 1609, 1544 and 1486 (Ar), 1604 ( $-\text{C}=\text{N}-\text{O}$ ), 1253 and 1214 ( $\text{C}-\text{O}$ ), 1015 ( $\text{N}-\text{O}$ ), 815 ( $\text{C}-\text{H}$ )  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (400.13 MHz,  $\text{CDCl}_3$ ): 3.56 (3H, s, OMe), 3.83 (3H, s, OMe), 3.90 (2H, ABq,  $^2J_{\text{HH}} = 17.4$  Hz,  $\text{CH}_2$ ), 7.30 (1H, d,  $^3J_{\text{HH}} = 16.3$  Hz, CH of alkene), 7.36 (1H, d,  $^3J_{\text{HH}} = 7.3$  Hz,  $\text{CH}^6$  of coumarin), 7.38 (2H, d,  $^3J_{\text{HH}} = 7.3$  Hz, 2CH of Ar), 7.60 (2H, d,  $^3J_{\text{HH}} = 7.4$  Hz, 2CH of Ar), 7.71 (1H, d,  $^3J_{\text{HH}} = 7.3$  Hz,  $\text{CH}^7$  of coumarin), 7.74 (1H, s,  $\text{CH}^9$  of coumarin), 9.00 (1H, d,  $^3J_{\text{HH}} = 16.3$  Hz, CH of alkene).  $^{13}\text{C}$  NMR (75.46 MHz,  $\text{DMSO}-d_6$ ): 37.68 ( $\text{CH}_2$ ), 52.09 (OMe), 55.01 (OMe), 83.46 ( $\text{C}^1$ ), 113.18 ( $\text{C}^{3a}$ ), 115.90 (CH of alken), 117.67 ( $\text{CH}^6$  of coumarin), 119.67 ( $\text{C}-\text{Br}$ ), 122.90 ( $\text{C}^{9a}$ ), 125.81 ( $\text{CH}^9$  of coumarin), 129.03 (2CH of Ar), 129.26 (2CH of Ar), 134.16 ( $\text{CH}^7$  of coumarin), 134.96 ( $\text{CH}^7$  of coumarin), 135.15 ( $\text{C}_{\text{ipso}}-\text{Cl}$ ), 135.77 ( $\text{C}_{\text{ipso}}-\text{Ar}$ ), 138.66 (CH of alkene), 143.63 ( $\text{C}^{9b}$ ), 152.53 ( $\text{C}^{5a}$ ), 154.47 ( $\text{CO}_2$ ), 163.93 ( $\text{CO}_2$ ), 167.53 ( $\text{CO}_2$ ). MS (EI, 70 eV)  $m/z$  (%): 547 ( $\text{M}^+$ , 3), 546 ( $\text{M}^+$ , 1), 545 ( $\text{M}^-$ , 2), 479 (23), 415 (26), 370 (100), 298 (50), 238 (70), 208 (32), 176 (30), 140 (73), 109 (67), 84 (84), 51 (33). Anal. calcd. for  $\text{C}_{24}\text{H}_{17}\text{BrClINO}_7$  (546.75): C, 52.72; H, 3.13, N, 2.56. Found: C, 52.70; H, 3.14; N, 2.57%.

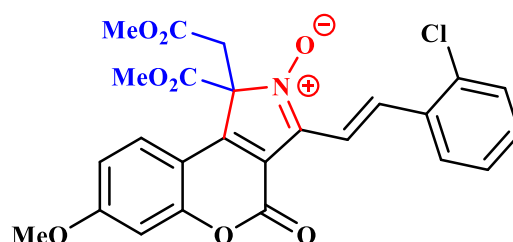
**Methyl 8-chloro-3-[(E)-2-(4-chlorophenyl)vinyl]-1-(2-methoxy-2-oxoethyl)-4-oxo-1,4-dihydrochromeno[3,4-c]pyrrole-1-carboxylate 2-oxide (6g).**



Light yellow solid, m.p = 305-307 °C (dec.), 0.23 g, yield: 91%. IR (KBr) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1744 ( $\text{CO}_2\text{Me}$  and  $\text{COO}$  of lactone ring), 1600, 1549 and 1484 (Ar), 1604 ( $-\text{C}=\text{N}-\text{O}$ ), 1251 and 1209 ( $\text{C}-\text{O}$ ), 1089 ( $\text{C}-\text{Cl}$ ) 1014 ( $\text{N}-\text{O}$ ), 818 ( $\text{C}-\text{H}$ )  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (300.13 MHz,  $\text{DMSO}-d_6$ ): 3.44 (3H, s, OMe), 3.72 (3H, s, OMe), 3.94 (1H,  $^3J_{\text{HH}} = 17.2$  Hz,  $\text{CH}_2$ ), 7.31 (1H, d,  $^3J_{\text{HH}} = 17.2$  Hz, CH of alkene), 7.48 (2H, d,  $^3J_{\text{HH}} = 8.4$  Hz, 2CH of Ar), 7.57 (1H, d,  $^3J_{\text{HH}} = 8.9$  Hz,  $\text{CH}^6$  of coumarin), 7.64 (2H, d,  $^3J_{\text{HH}} = 8.4$

Hz, 2CH of Ar), 7.73 (1H, d,  $^3J_{\text{HH}} = 8.3$  Hz, CH<sup>7</sup> of coumarin), 7.83 (1H, s, CH<sup>9</sup> of coumarin), 8.83 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene). <sup>13</sup>C NMR (75.46 MHz, DMSO-*d*<sub>6</sub>): 38.04 (CH<sub>2</sub>), 52.58 (OMe), 55.49 (OMe), 83.91 (C<sup>1</sup>), 113.60 (C<sup>3a</sup>), 115.88 (CH of alkene), 119.93 (CH<sup>6</sup> of coumarin), 123.46 (C<sup>9a</sup>), 128.51 (C<sub>ipso</sub>-Cl), 129.51 (2CH of Ar), 129.74 (2CH of Ar), 130.21 (CH<sup>9</sup> of coumarin), 132.79 (C<sub>ipso</sub>-Cl), 134.64 (CH<sup>7</sup> of coumarin), 135.40 (C<sup>3</sup>), 136.26 (C<sub>ipso</sub>-Ar), 139.14 (CH of alkene), 144.26 (C<sup>9b</sup>), 152.58 (C<sup>5a</sup>), 154.99 (CO<sub>2</sub>), 164.38 (CO<sub>2</sub>), 168.04 (CO<sub>2</sub>). MS (EI, 70 eV) *m/z* (%): 503 (M<sup>+1</sup>, 25), 502 (M<sup>+</sup>, 12), 501 (M<sup>-1</sup>, 36), 479 (26), 442 (20), 407 (12), 370 (100), 298 (43), 242 (18), 176 (23), 139 (37), 109 (68). Anal. calcd. for C<sub>24</sub>H<sub>17</sub>Cl<sub>2</sub>NO<sub>7</sub> (502.30): C, 57.39; H, 3.41; N, 2.79. Found: C, 57.36; H, 3.42; N, 2.81%.

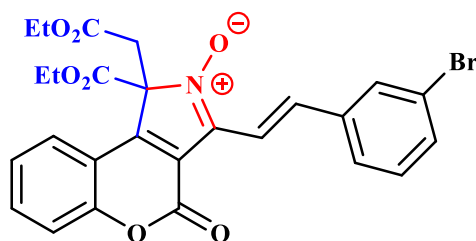
**Methyl 3-[(*E*)-2-(2-chlorophenyl)vinyl]-7-methoxy-1-(2-methoxy-2-oxoethyl)-4-oxo-1,4-dihydrochromeno[3,4-*c*]pyrrole-1-carboxylate 2-oxide (6h).**



Light yellow solid, m.p = 296-298 °C (dec.), 0.22 g, yield: 88%. IR (KBr) ( $\nu_{\text{max}}$ , cm<sup>-1</sup>): 1741 (CO<sub>2</sub>Me and COO of lactone ring), 1612, 1518 and 1489 (Ar), 1590 (-C=N-O), 1280, 1252 and 1195 (C-O), 1123 (C-Cl) 1028 (N-O), 765 (C-H) cm<sup>-1</sup>. <sup>1</sup>H NMR (300.13 MHz, DMSO-*d*<sub>6</sub>): 3.44 (3H, s, OMe), 3.73 (3H, s, OMe), 3.89 (3H, s, OMe), 3.92 (2H, ABq,  $^2J_{\text{HH}} = 17.3$  Hz, CH<sub>2</sub>), 7.04 (1H, dd,  $^3J_{\text{HH}} = 8.8$  Hz,  $^4J_{\text{HH}} = 2.1$  Hz, CH<sup>8</sup> of coumarin), 7.21 (1H, d,  $^3J_{\text{HH}} = 2.4$  Hz, CH<sup>6</sup> of coumarin), 7.41 (1H, td,  $^3J_{\text{HH}} = 7.3$  Hz,  $^4J_{\text{HH}} = 1.7$  Hz, CH of Ar), 7.45 (1H, td,  $^3J_{\text{HH}} = 7.3$  Hz,  $^4J_{\text{HH}} = 1.8$  Hz, CH of Ar), 7.54 (1H, dd,  $^3J_{\text{HH}} = 7.4$  Hz,  $^4J_{\text{HH}} = 1.9$  Hz, CH of Ar), 7.58 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene), 7.74 (1H, d,  $^3J_{\text{HH}} = 8.8$  Hz, CH<sup>9</sup> of coumarin), 7.87 (1H, dd,  $^3J_{\text{HH}} = 7.5$  Hz,  $^4J_{\text{HH}} = 2.1$  Hz, CH of Ar), 9.27 (1H, d,  $^3J_{\text{HH}} = 16.2$  Hz, CH of alkene). <sup>13</sup>C NMR (75.46 MHz, DMSO-*d*<sub>6</sub>): 37.26 (CH<sub>2</sub>), 54.05 (OMe), 54.88 (OMe), 55.00 (OMe), 83.33 (C<sup>1</sup>), 101.84 (C<sup>9a</sup>), 107.70 (CH<sup>6</sup> of coumarin), 114.19 (C<sup>3a</sup>), 114.88

(CH of alkene), 117.93 (CH<sup>8</sup> of coumarin), 124.85 (CH<sup>9</sup> of coumarin), 126.89 (CH of Ar), 128.01 (CH of Ar), 130.22 (CH of Ar), 131.01 (CH of Ar), 132.11 (C<sub>ipso</sub>-Ar), 133.88 (C<sup>3</sup>, C<sub>ipso</sub>-Cl), 138.94 (CH of alkene), 146.31 (C<sup>9b</sup>), 155.09 (C<sup>5a</sup>), 155.78 (CO<sub>2</sub>), 163.20 (C<sub>ipso</sub>-OMe), 164.18 (CO<sub>2</sub>), 167.42 (CO<sub>2</sub>). MS (EI, 70 eV) *m/z* (%): 498 (M<sup>+1</sup>, 13), 497 (M<sup>+</sup>, 46), 480 (13), 462 (100), 438 (11), 422 (14), 362 (33), 344 (26), 328 (20), 139 (66), 59 (44). Anal. calcd. for C<sub>25</sub>H<sub>20</sub>ClNO<sub>8</sub> (497.88): C, 60.31; H, 4.05; N, 2.81. Found: C, 60.32; H, 4.06; N, 2.79%.

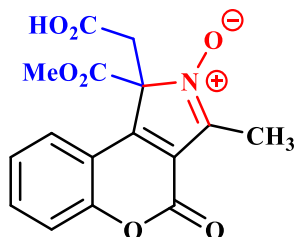
**Ethyl (1R)-3-[(E)-2-(3-bromophenyl)vinyl]-1-(2-ethoxy-2-oxoethyl)-4-oxo-1,4-dihydrochromeno[3,4-c]pyrrole-1-carboxylate 2-oxide (6i).**



Light yellow solid, m.p = 288-290 °C (dec.), 0.25 g, yield: 92%. IR (KBr) ( $\nu_{\max}$ , cm<sup>-1</sup>): 1736 (CO<sub>2</sub>Me and COO of lactone ring), 1601, 1592 and 1474 (Ar), 1560 (-C=N-O), 1240 and 1200 (C-O), 1161 (C-Br) 1024 (N-O), 778 and 756 (C-H) cm<sup>-1</sup>. <sup>1</sup>H NMR (300.13 MHz, DMSO-*d*<sub>6</sub>): 0.86 (3H, t, Me), 1.03 (3H, t, Me), 3.82 (2H, q, <sup>3</sup>J<sub>HH</sub> = 7.1 Hz, CH<sub>2</sub>), 3.85 (2H, ABq, <sup>2</sup>J<sub>HH</sub> = 17.0 Hz, CH<sub>2</sub>), 4.17 (2H, q, <sup>3</sup>J<sub>HH</sub> = 7.1 Hz, CH<sub>2</sub>), 7.38 (1H, t, <sup>3</sup>J<sub>HH</sub> = 7.8 Hz, CH<sup>8</sup> of coumarin), 7.44 (1H, d, <sup>3</sup>J<sub>HH</sub> = 7.6 Hz, CH<sup>6</sup> coumarin), 7.53 (1H, d, <sup>3</sup>J<sub>HH</sub> = 16.3 Hz, CH of alkene), 7.56 (1H, s, CH of Ar), 7.63-7.70 (3H, m, Ar) 7.71 (1H, t, <sup>3</sup>J<sub>HH</sub> = 7.8 Hz, CH<sup>7</sup> of coumarin), 7.82 (1H, d, <sup>3</sup>J<sub>HH</sub> = 7.9 Hz, CH<sup>9</sup> of coumarin), 8.81 (1H, d, <sup>3</sup>J<sub>HH</sub> = 16.3 Hz, CH of alkene). <sup>13</sup>C NMR (75.46 MHz, DMSO-*d*<sub>6</sub>): 13.54 (2 Me), 37.93 (CH<sub>2</sub>), 60.75 (-OCH<sub>2</sub>), 64.13 (-OCH<sub>2</sub>), 83.63 (C<sup>1</sup>), 114.06 (C<sup>3a</sup> and CH of alken), 117.50 (CH<sup>6</sup> of coumarin), 121.78 (C<sup>9a</sup>), 122.53 (C-Br), 123.86 (CH<sup>8</sup> of coumarin), 125.78 (CH<sup>9</sup> of coumarin), 126.19 (CH of Ar), 129.69 (CH of Ar), 131.25 (CH of Ar), 132.15 (CH of Ar), 132.85 (CH<sup>7</sup> of coumarin), 135.33 (C<sup>3</sup>), 138.64 (CH of alkene, C<sub>ipso</sub>-Ar), 145.64 (C<sup>9b</sup>), 153.48 (C<sup>5a</sup>), 154.83 (CO<sub>2</sub>), 163.25 (CO<sub>2</sub>), 167.70 (CO<sub>2</sub>). MS (EI, 70 eV) *m/z* (%): 541 (M<sup>+1</sup>, 36), 539 (M<sup>-1</sup>, 35), 522 (2), 496 (2), 466 (25), 450 (23),

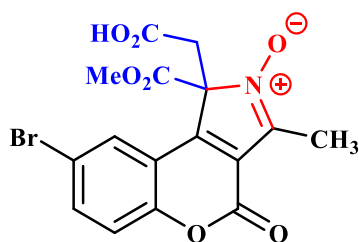
451 (23), 424 (5), 432 (5), 378 (49), 377 (49), 351 (16), 352 (16), 298 (26), 255 (21), 184 (71), 183 (71), 97 (88), 57 (100). Anal. calcd. for  $C_{26}H_{22}BrClNO_7$  (540.36): C, 57.79; H, 4.10; N, 2.59. Found: C, 57.76; H, 4.11; N, 2.60%.

**1-(Methoxycarbonyl)-3-methyl-2-oxido-4-oxo-1,4-dihydrochromeno[3,4-c]pyrrol-1-yl]acetic acid (6j).**



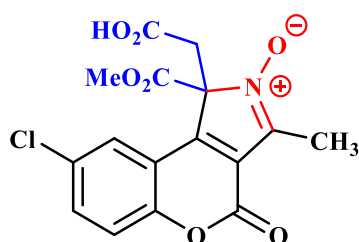
White solid, m.p = 230-231 °C (dec.), 0.13 g, yield: 78%. IR (KBr) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1735 ( $\text{CO}_2\text{Me}$ ), 1679 ( $\text{CO}_2\text{H}$ ), 1658 (COO of lactone ring), 1608, 1544 and 1474 (Ar), 1580 ( $-\text{C}=\text{N}-\text{O}$ ), 1223, 1202 and 1200 (C-O), 1053 (N-O), 755 (C-H)  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (300.13 MHz,  $\text{DMSO}-d_6$ ): 2.53 (3H, s, Me), 3.62 (3H, s, OMe), 4.10 (2H, bs,  $\text{CH}_2$ ), 7.19 (1H, t  $^3J_{\text{HH}} = 7.5$  Hz,  $\text{CH}^8$  of coumarin), 7.23 (1H, d,  $^3J_{\text{HH}} = 7.4$  Hz,  $\text{CH}^6$  of coumarin), 7.27 (1H, t  $^3J_{\text{HH}} = 7.9$  Hz,  $\text{CH}^7$  of coumarin), 7.70 (1H, d,  $^3J_{\text{HH}} = 7.6$  Hz,  $\text{CH}^9$  coumarin), 12.10 (1H, bs, OH).  $^{13}\text{C}$  NMR (75.46 MHz,  $\text{DMSO}-d_6$ ): 9.54 ( $\text{CH}_3$ ), 29.71 ( $\text{CH}_2$ ), 52.18 (OMe), 99.23 ( $\text{C}^1$ ), 112.68 ( $\text{C}^{3a}$ ), 116.32, ( $\text{C}^{9a}$ ), 116.93 ( $\text{CH}^6$  of coumarin), 122.62 ( $\text{CH}^8$  of coumarin), 122.94 ( $\text{CH}^9$  of coumarin), 124.09 ( $\text{CH}^7$  of coumarin), 126.95 ( $\text{C}^3$ ), 130.29 ( $\text{C}^{9b}$ ), 150.58 ( $\text{C}^{5a}$ ), 158.06 ( $\text{CO}_2$ ), 169.82 ( $\text{CO}_2$ ), 170.79 ( $\text{CO}_2\text{H}$ ). MS (EI, 70 eV)  $m/z$  (%): 331 ( $\text{M}^+$ , 2), 302 (3), 276 (9), 262 (9), 244 (5), 232 (5), 201 (7), 183 (15), 120 (20), 111 (25), 91 (36), 77 (54), 61 (100), 58 (77). Anal. calcd. for  $\text{C}_{16}\text{H}_{13}\text{NO}_7$  (331.28): C, 58.01; H, 3.96; N, 4.23. Found: C, 58.06, H, 3.93; N, 4.21%.

**8-Bromo-1-(methoxycarbonyl)-3-methyl-2-oxido-4-oxo-1,4-dihydrochromeno[3,4-c]pyrrol-1-yl]acetic acid (6k).**



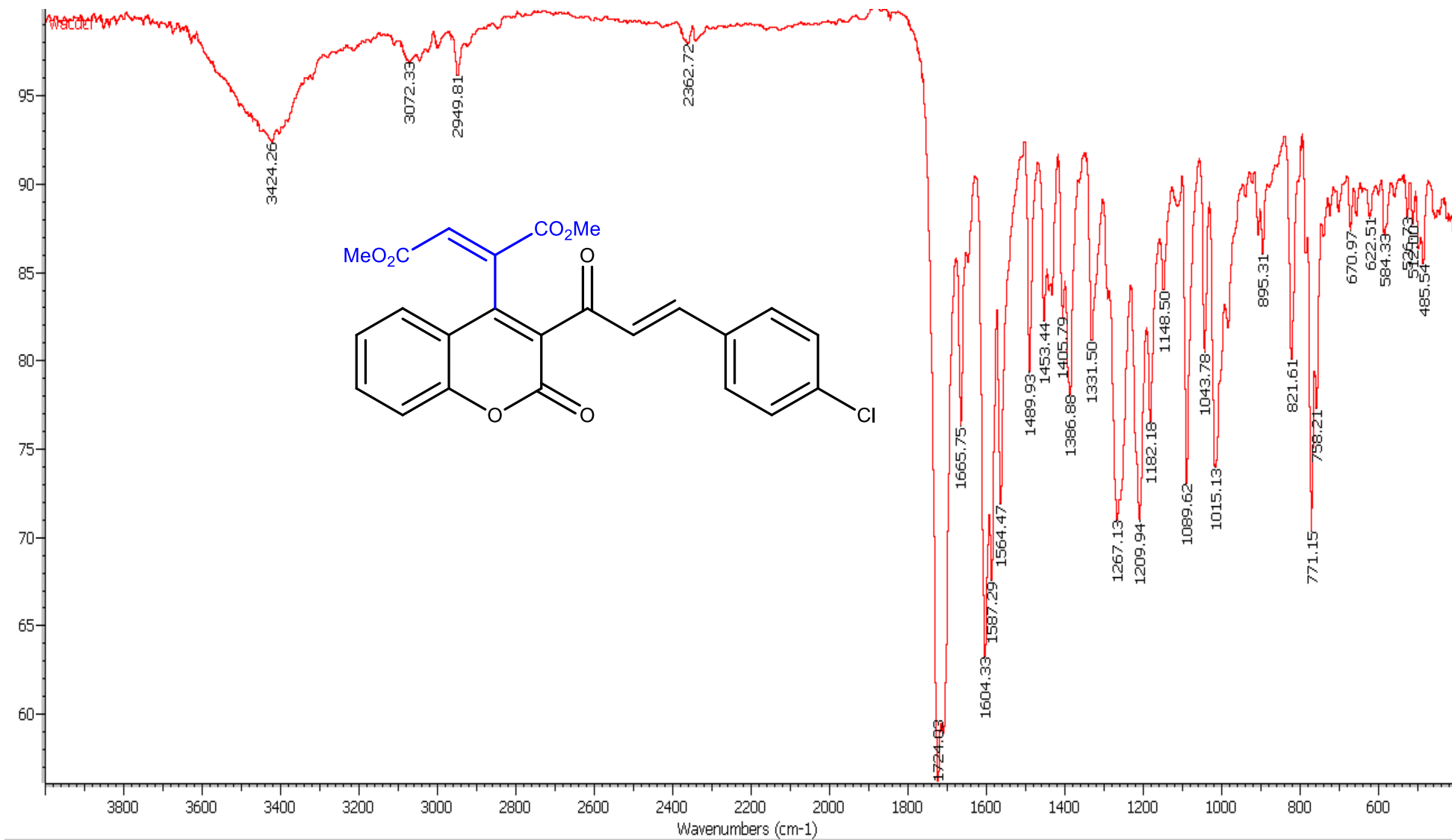
White solid, m.p = 260-261 °C (dec.), 0.17 g, yield: 83%. IR (KBr) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1732 ( $\text{CO}_2\text{Me}$ ), 1692 ( $\text{CO}_2\text{H}$ ), 1675 (COO of lactone ring), 1607, 1545 and 1477 (Ar), 1568 ( $-\text{C}=\text{N}-\text{O}$ ), 1222 and 1205 (C-O), 1088 (C-Br) 1041 (N-O), 771 (C-H)  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500.13 MHz,  $\text{DMSO}-d_6$ ): 2.53 (3H, s, Me), 3.65 (3H, s, OMe), 4.14 (2H, bs,  $\text{CH}_2$ ), 7.20 (1H, d,  $^3J_{\text{HH}} = 8.8$  Hz,  $\text{CH}^6$  of coumarin), 7.41 (1H, d,  $^3J_{\text{HH}} = 8.7$  Hz,  $\text{CH}^7$  of coumarin), 7.80 (1H, s,  $\text{CH}^9$  coumarin), 12.06 (1H, bs, OH).  $^{13}\text{C}$  NMR (125.13 MHz,  $\text{DMSO}-d_6$ ): 10.01 ( $\text{CH}_3$ ), 30.15 ( $\text{CH}_2$ ), 52.61 (OMe), 99.60 ( $\text{C}^1$ ), 111.95 ( $\text{C}^{3a}$ ), 116.45 ( $\text{C}^{9a}$ ), 117.59 ( $\text{CH}^6$  of coumarin), 119.56 (C-Br), 125.49 ( $\text{CH}^9$  of coumarin), 129.88 ( $\text{C}^3$ ), 131.10 ( $\text{C}^{9b}$  and  $\text{CH}^7$  of coumarin), 150.15 ( $\text{C}^{5a}$ ), 157.80 ( $\text{CO}_2$ ), 169.65 ( $\text{CO}_2$ ), 170.16 ( $\text{CO}_2\text{H}$ ). MS (EI, 70 eV)  $m/z$  (%): 410 ( $\text{M}^+$ , 2), 380 (30), 381 (30), 364 (97), 363 (97), 289 (80), 226 (38), 210 (35), 182 (33), 153 (35), 127 (35), 112 (55), 87 (22), 58 (59). Anal. calcd. for  $\text{C}_{16}\text{H}_{12}\text{BrNO}_7$  (410.17): C, 46.85; H, 2.95; N, 3.41. Found: C, 46.80; H, 2.97; N, 3.44%.

**8-Chloro-1-(methoxycarbonyl)-3-methyl-2-oxido-4-oxo-1,4-dihydrochromeno[3,4-c]pyrrol-1-yl]acetic acid (6l).**



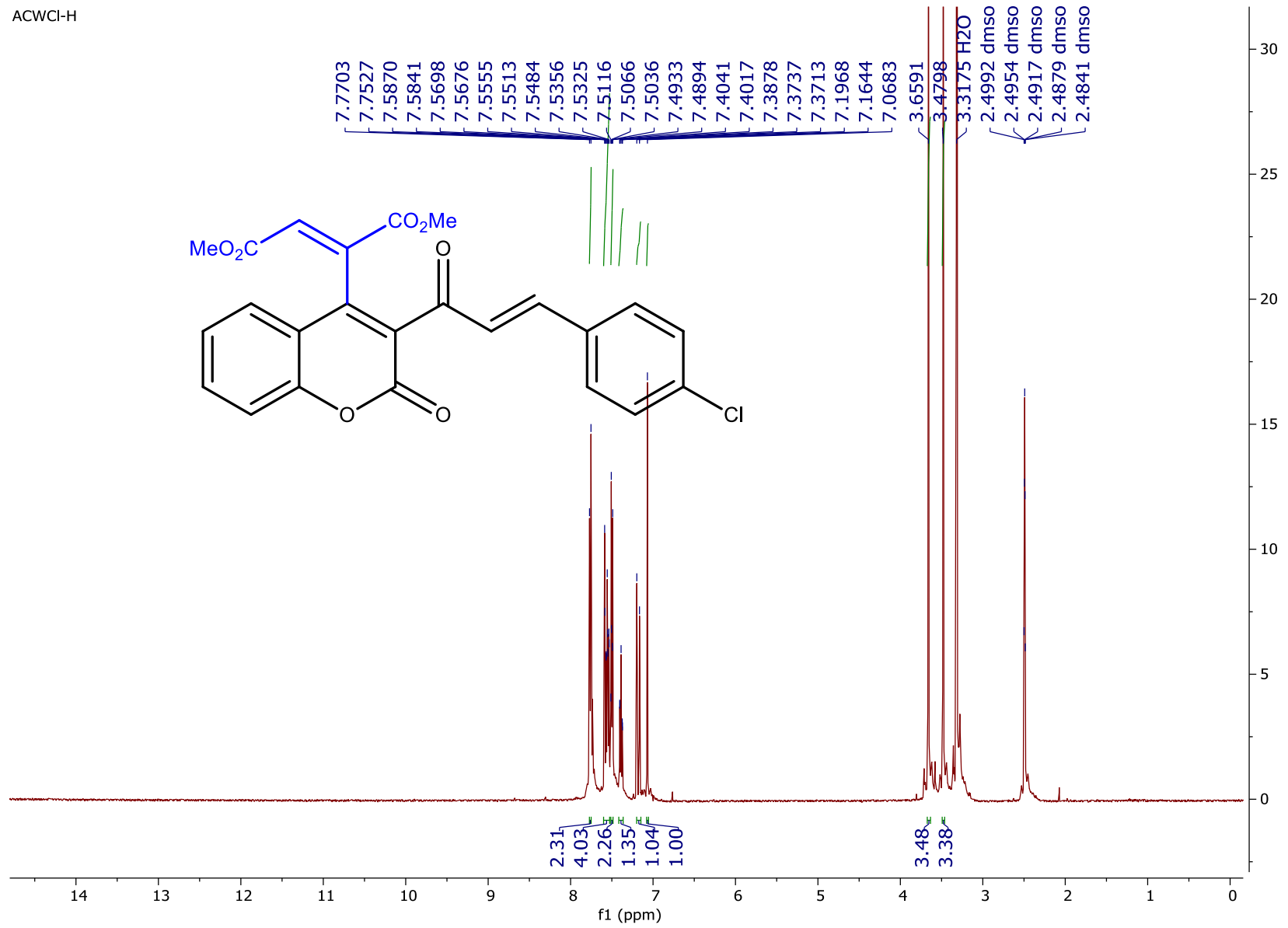
White solid, m.p = 255-256 °C (dec.), 0.15 g, yield: 82%. IR (KBr) ( $\nu_{\max}$ ,  $\text{cm}^{-1}$ ): 1732 ( $\text{CO}_2\text{Me}$ ), 1692 ( $\text{CO}_2\text{H}$ ), 1678 (COO of lactone ring), 1607, 1545 and 1476 (Ar), 1567 ( $-\text{C}=\text{N}-\text{O}$ ), 1220 and 1205 (C-O), 1089 (C-Cl) 1041 (N-O), 771 (C-H)  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR (500.13 MHz,  $\text{DMSO}-d_6$ ): 2.54 (3H, s, Me), 3.65 (3H, s, OMe), 4.16 (2H, bs,  $\text{CH}_2$ ), 7.26 (1H, d,  $^3J_{\text{HH}} = 8.8$  Hz,  $\text{CH}^6$  of coumarin), 7.30 (1H, d,  $^3J_{\text{HH}} = 8.9$  Hz,  $\text{CH}^7$  of coumarin), 7.70 (1H, s,  $\text{CH}^9$  coumarin), 12.05 (1H, bs, OH).  $^{13}\text{C}$  NMR (125

MHz, DMSO-*d*<sub>6</sub>): 10.00 (CH<sub>3</sub>), 30.13 (CH<sub>2</sub>), 52.60 (OMe), 99.59 (C<sup>1</sup>), 112.07 (C<sup>3a</sup>), 117.62 (CH<sup>6</sup> of coumarin), 119.00 (C<sup>9a</sup>), 119.20 (CH<sup>9</sup> of coumarin), 122.63 (CH<sup>7</sup> of coumarin), 127.01 (C-Cl), 128.49 (C<sup>3</sup>), 131.10 (C<sup>9b</sup>), 149.74 (C<sup>5a</sup>), 157.85 (CO<sub>2</sub>), 168.78 (CO<sub>2</sub>), 170.15 (CO<sub>2</sub>H). MS (EI, 70 eV) *m/z* (%): 365 (M<sup>+</sup>, 2), 350 (2), 335 (11), 322 (35), 304 (21), 303 (64), 245 (60), 244 (64), 227 (29), 210 (23), 112 (52), 59 (41). Anal. calcd. for C<sub>16</sub>H<sub>12</sub>ClNO<sub>7</sub> (365.72): C, 52.55; H, 3.31; N, 3.83. Found: C, 52.50, H, 3.33; N, 3.85%.



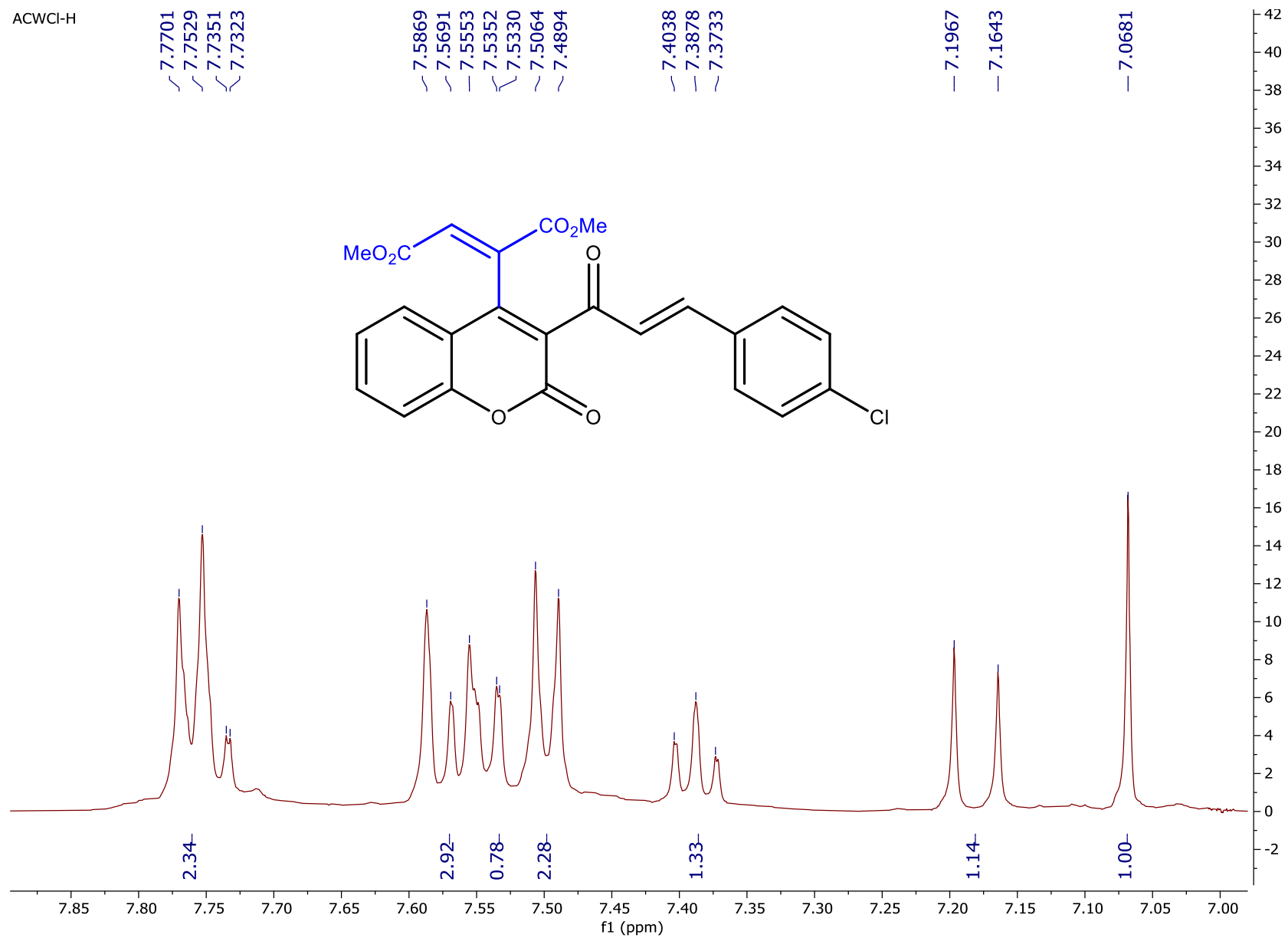
IR spectrum of **5b**

ACWCI-H

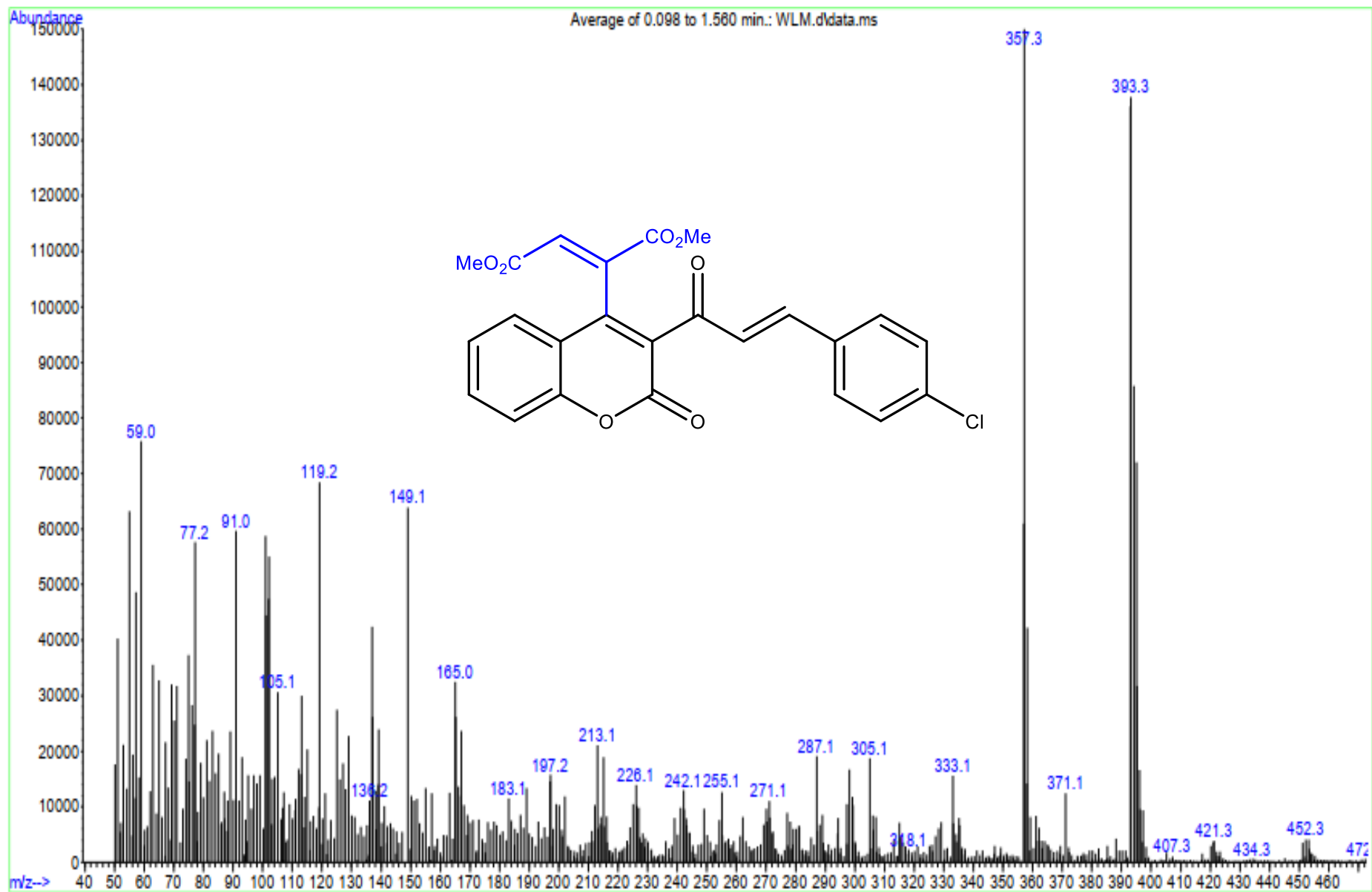


<sup>1</sup>H NMR Spectrum of **5b**

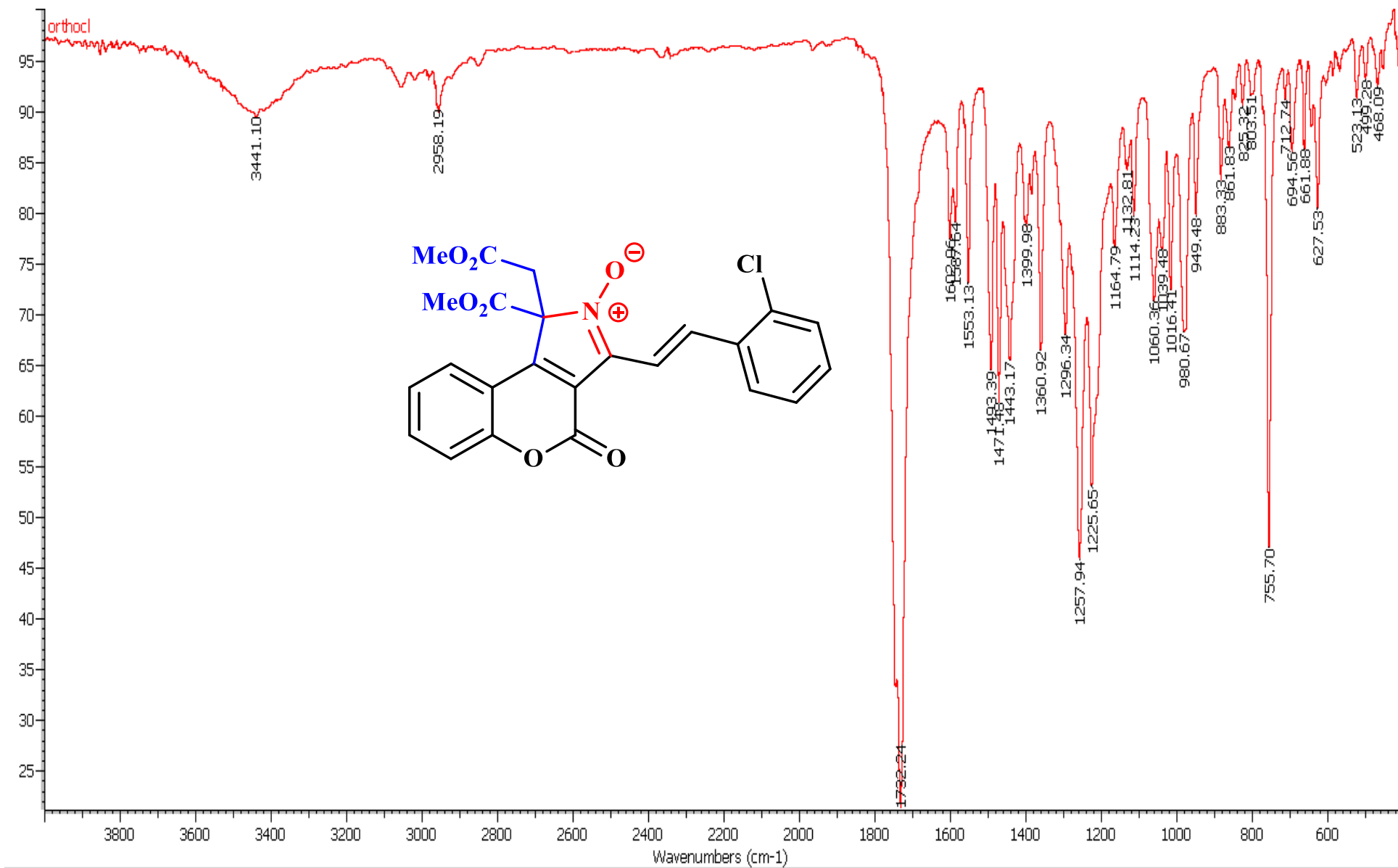
ACWCI-H



<sup>1</sup>H NMR Spectrum of **5b**

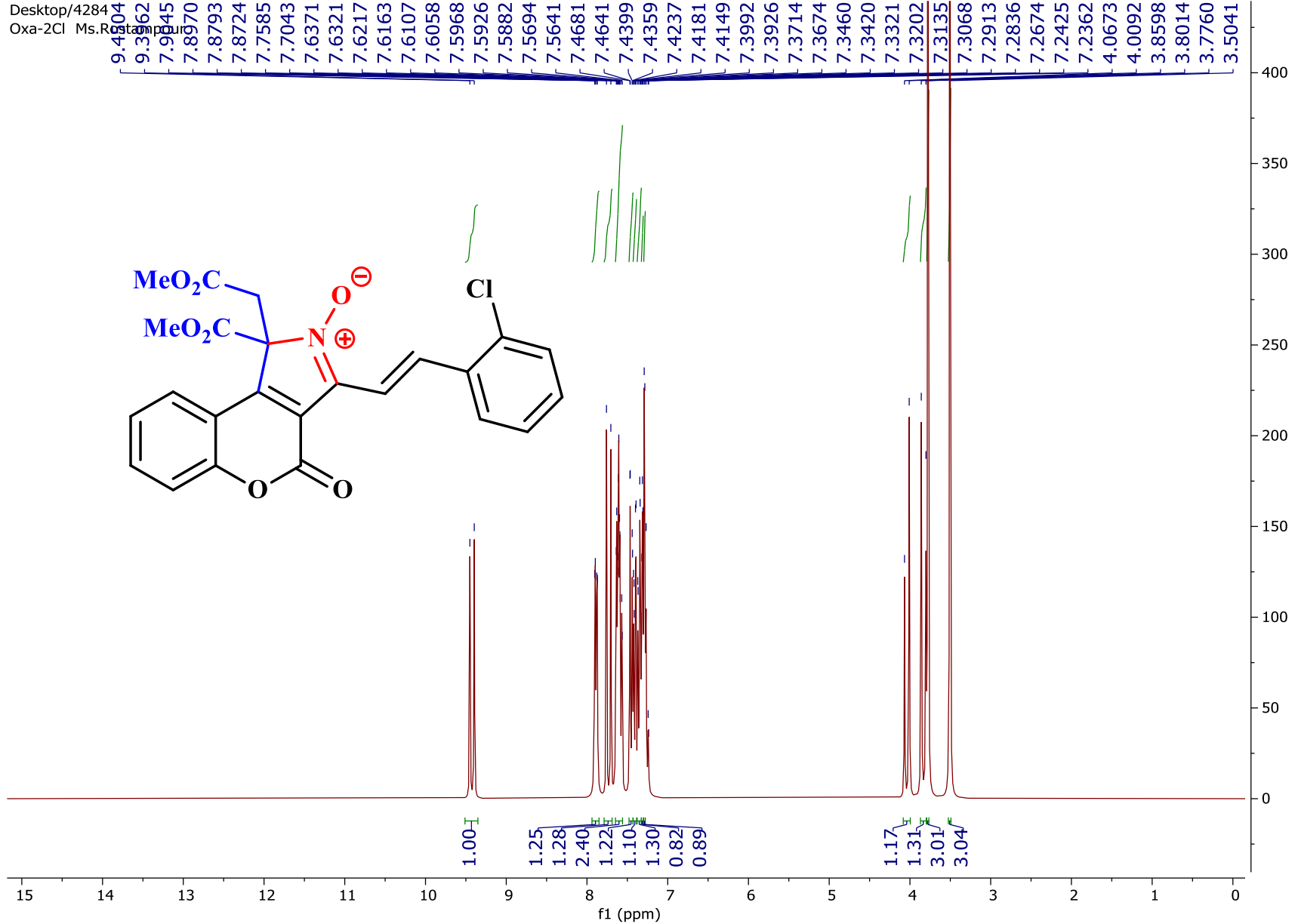


Mass spectrum of **5b**



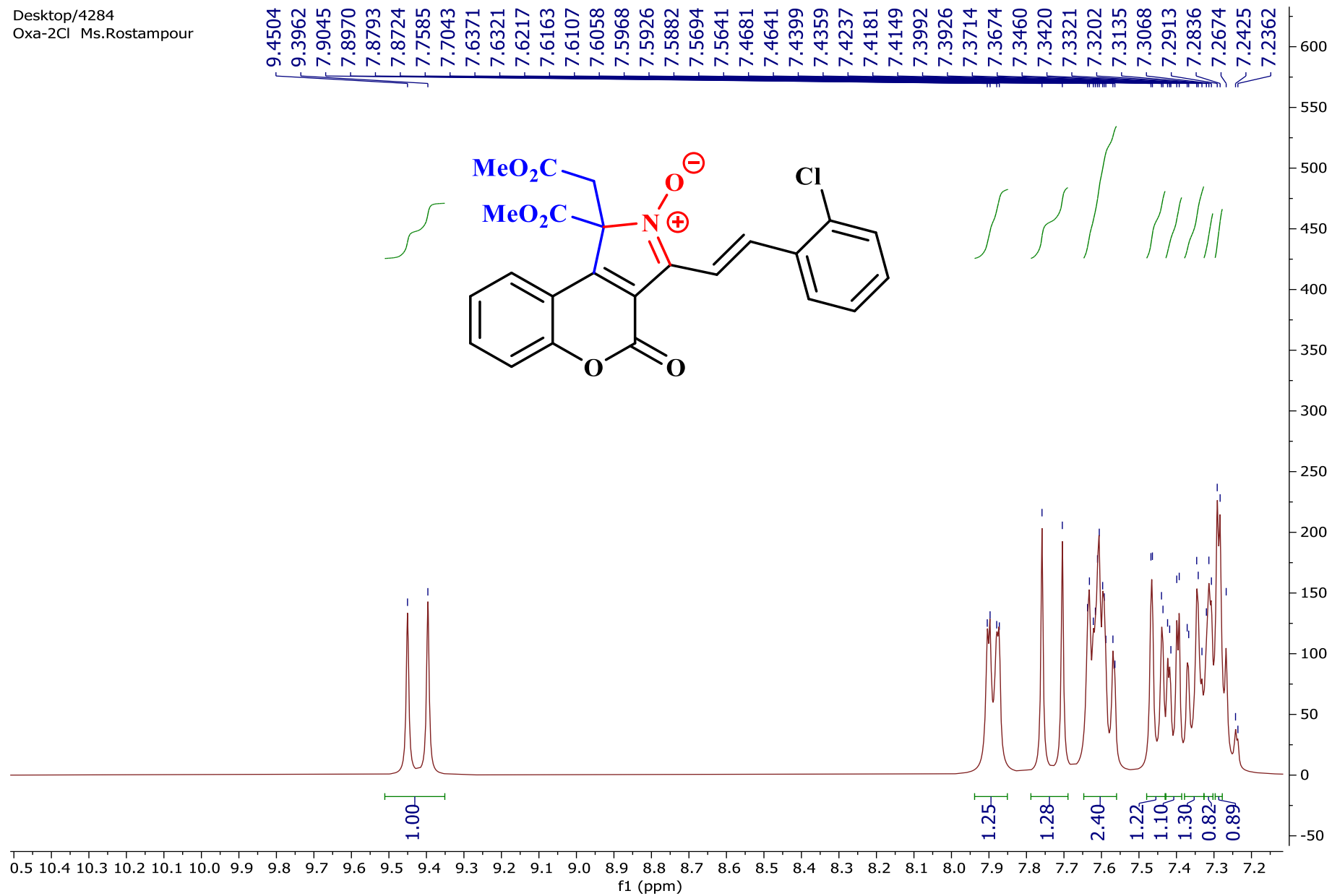
IR spectrum of **6a**

Desktop/4284  
Oxa-2Cl Ms.R



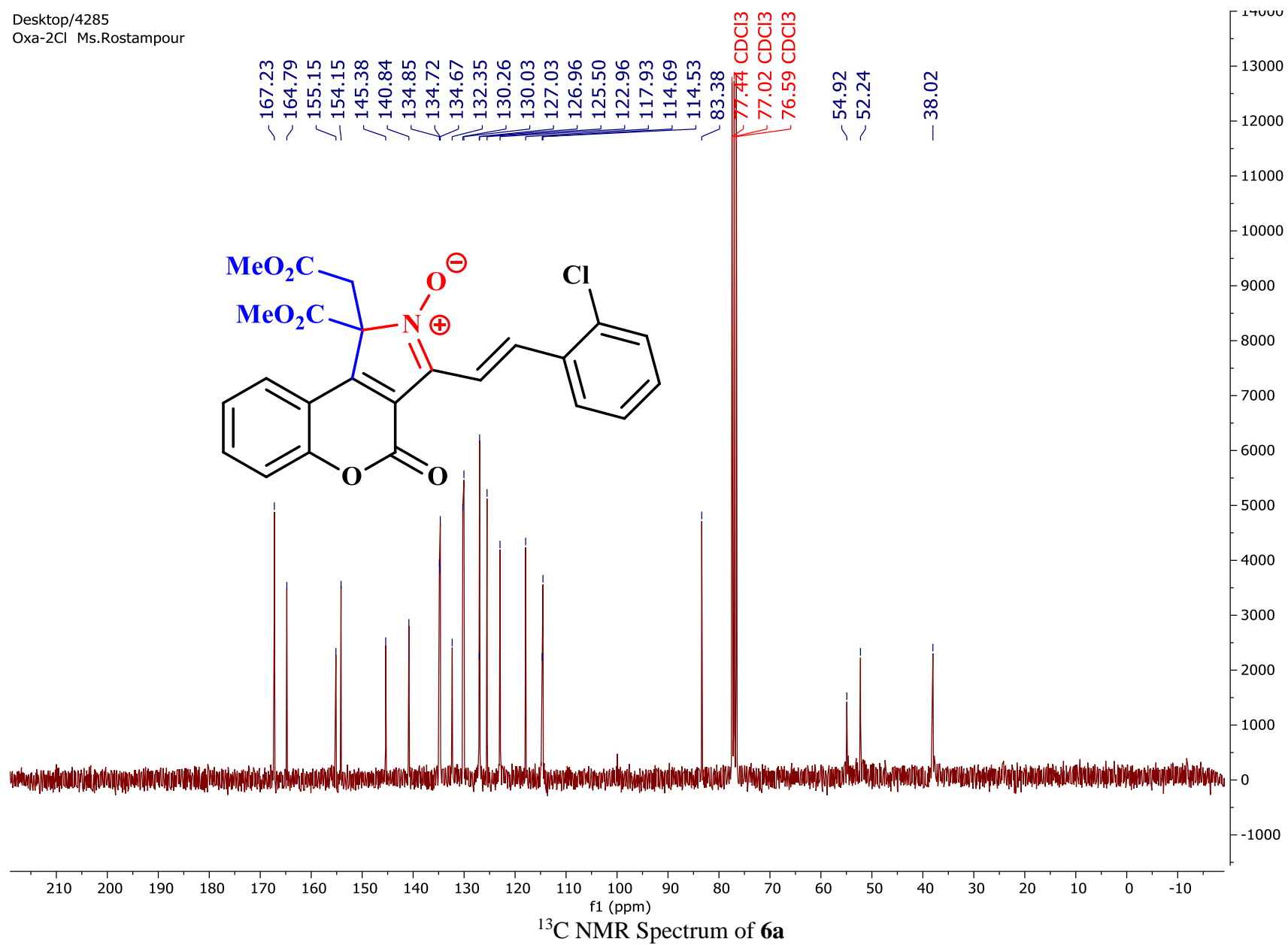
<sup>1</sup>H NMR Spectrum of **6a**

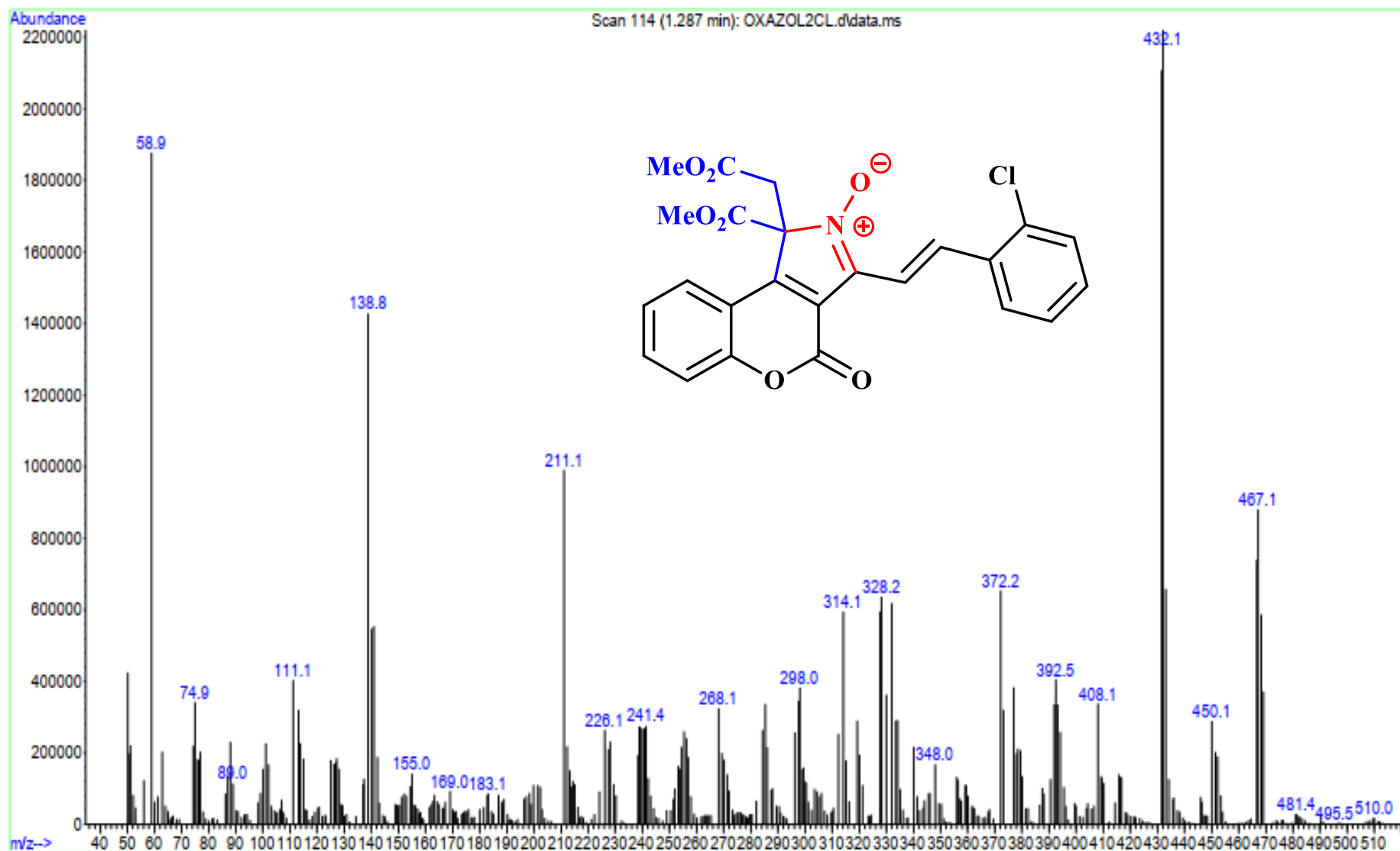
S21



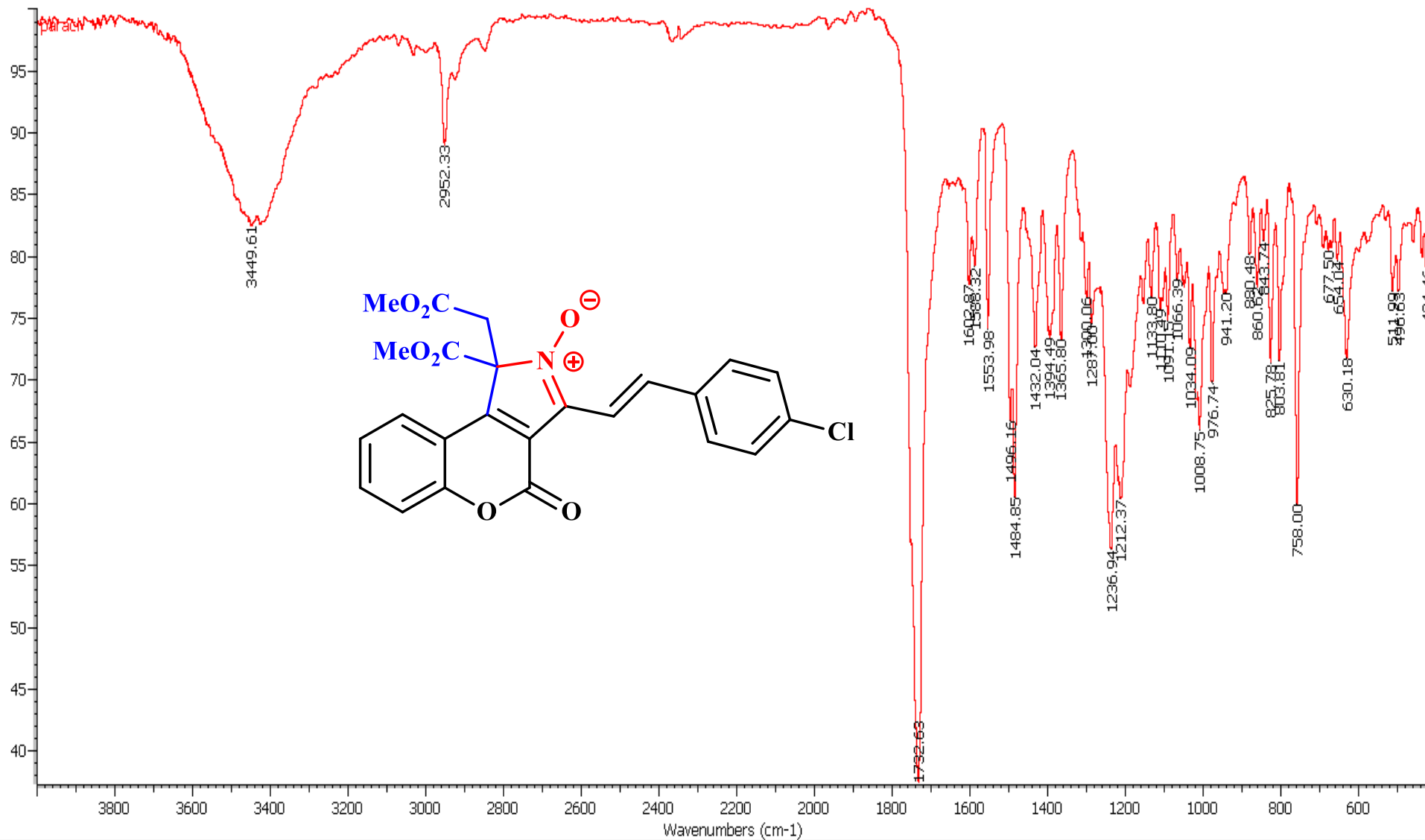
<sup>1</sup>H NMR Spectrum of **6a**  
S22

Desktop/4285  
Oxa-2Cl Ms.Rostampour



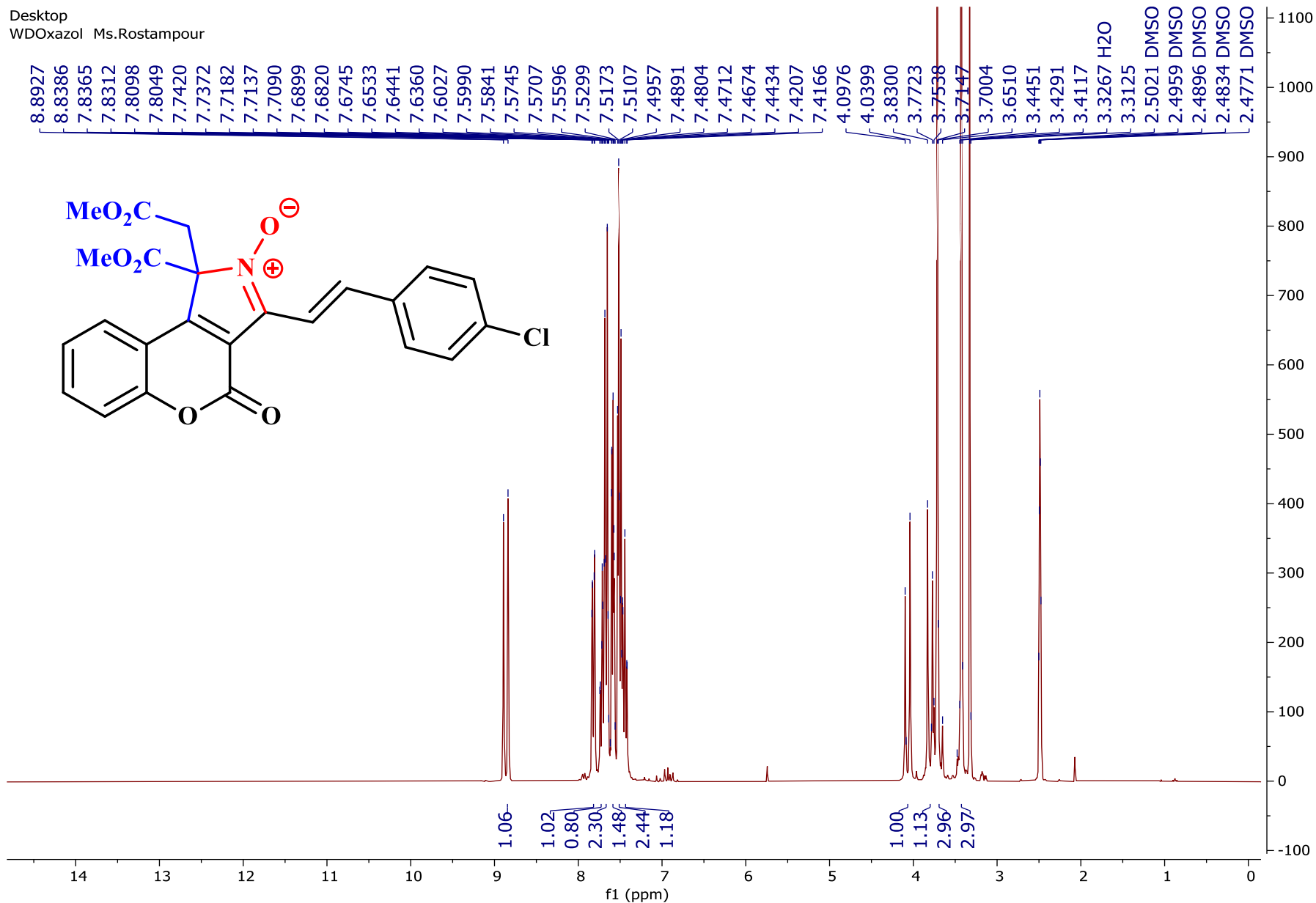


Mass spectrum of **6a**



IR spectrum of **6b**

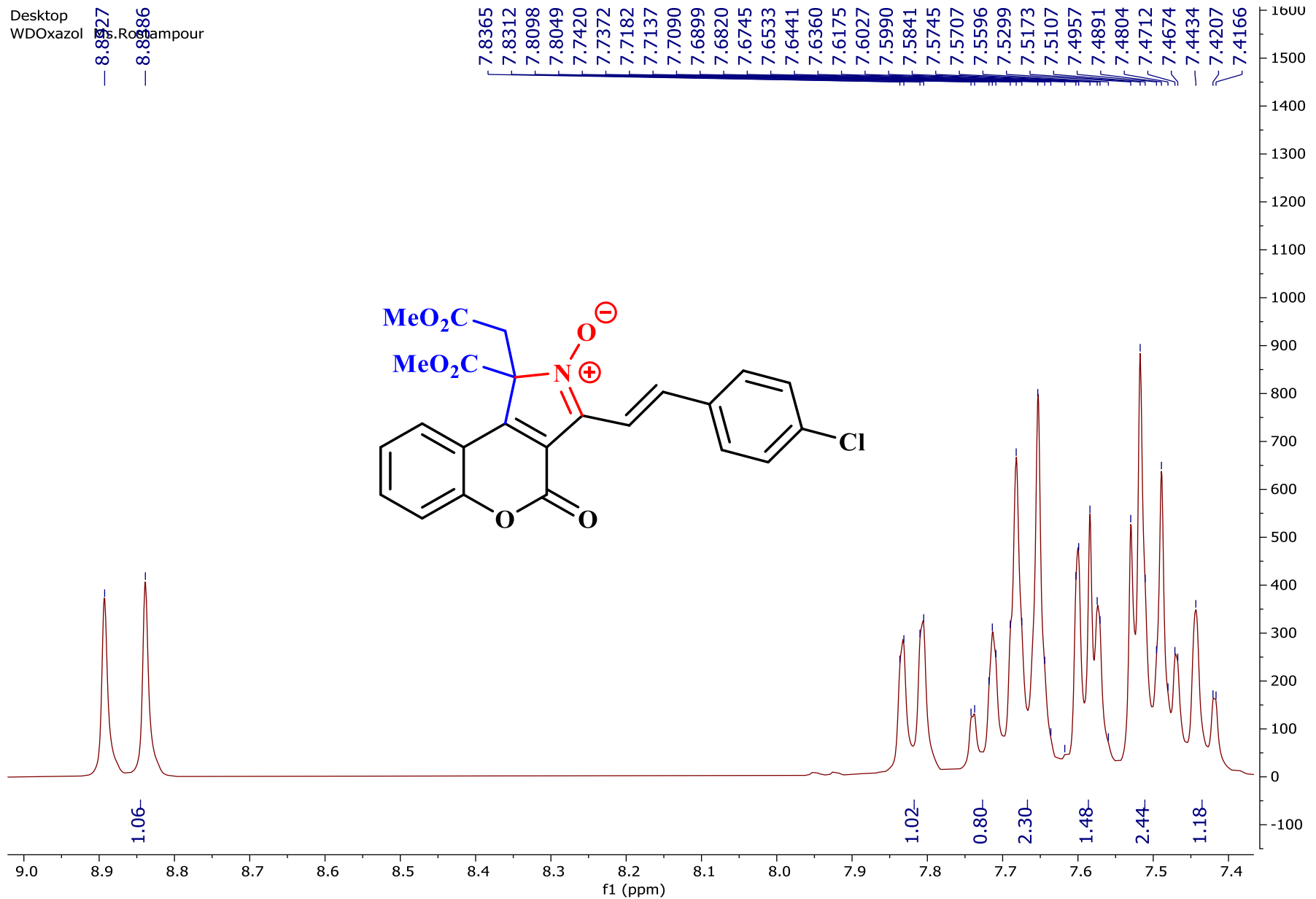
Desktop  
WDOxazol Ms.Rostampour



<sup>1</sup>H NMR Spectrum of **6b**

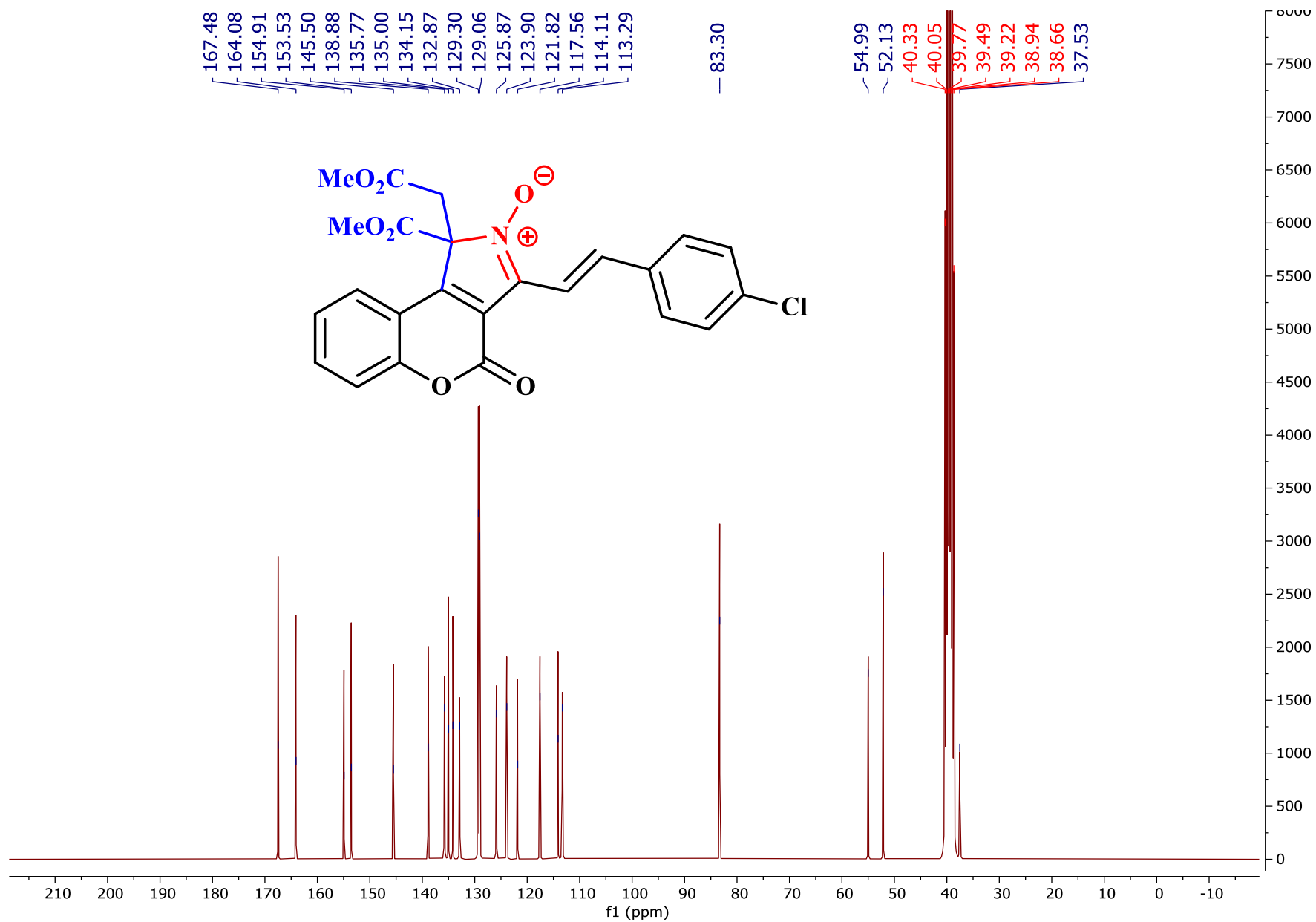
S26

Desktop  
WDOxazol  
S. R. Rampour



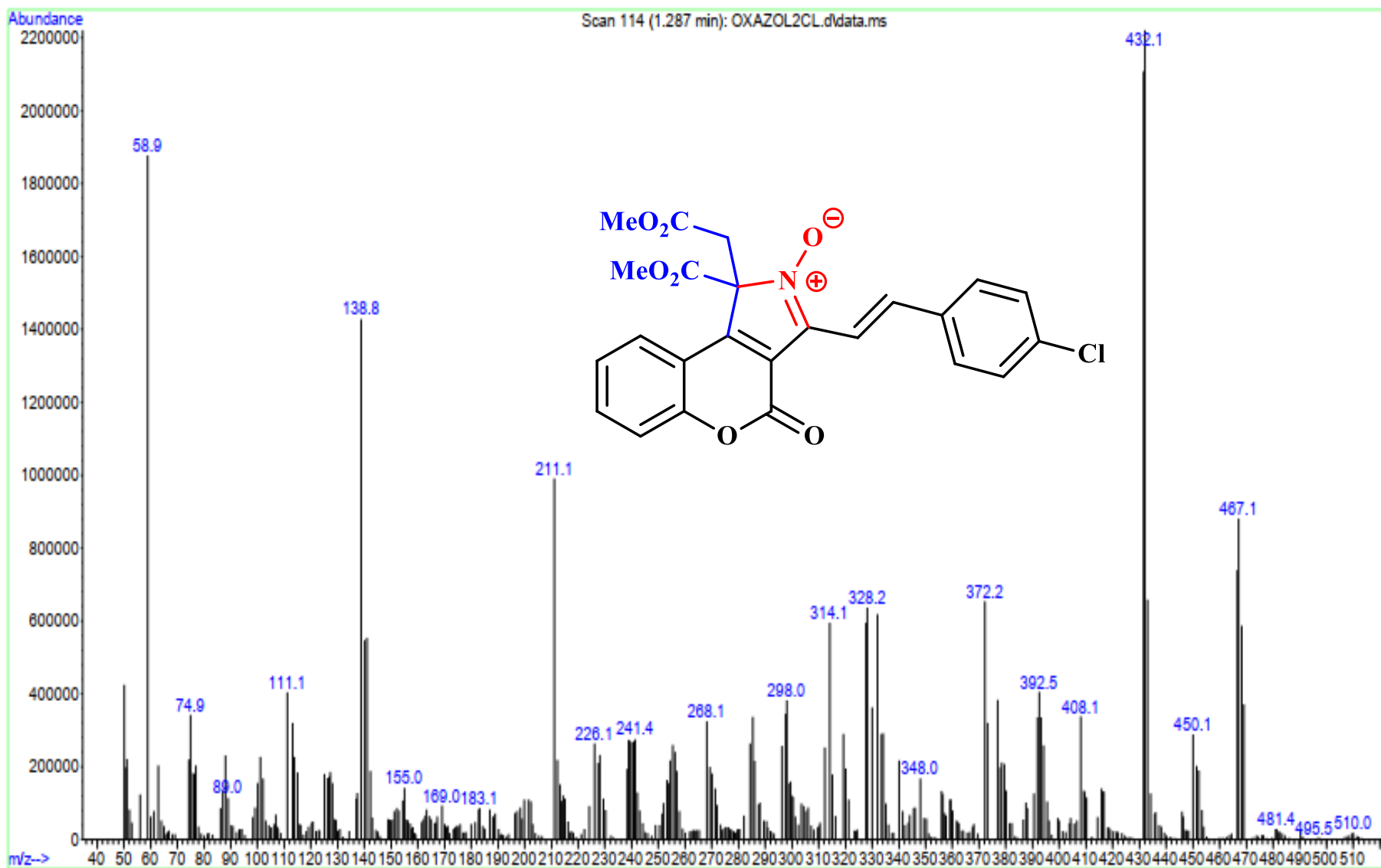
<sup>1</sup>H NMR Spectrum of **6b**

S27

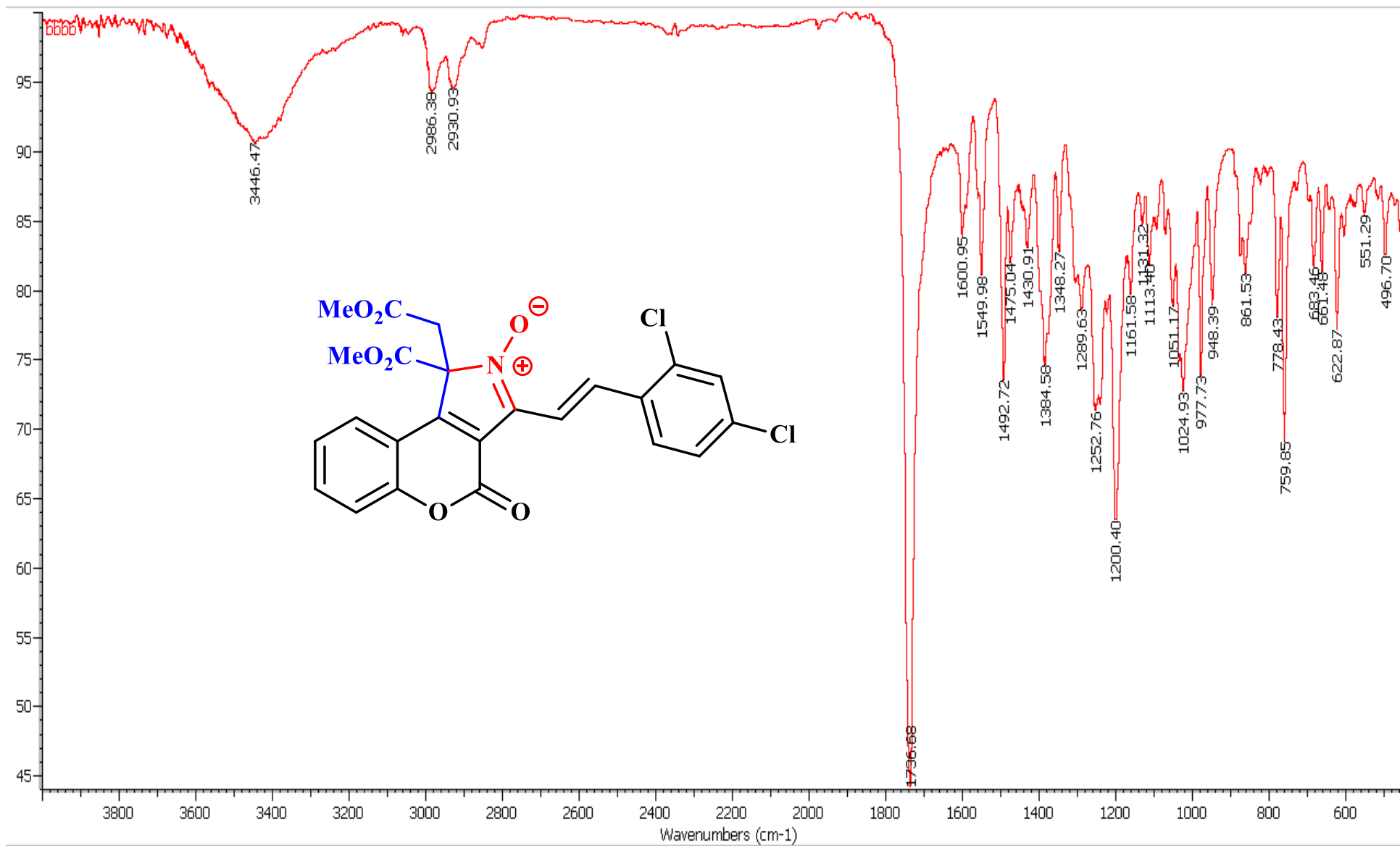


<sup>13</sup>C NMR Spectrum of **6b**

S28

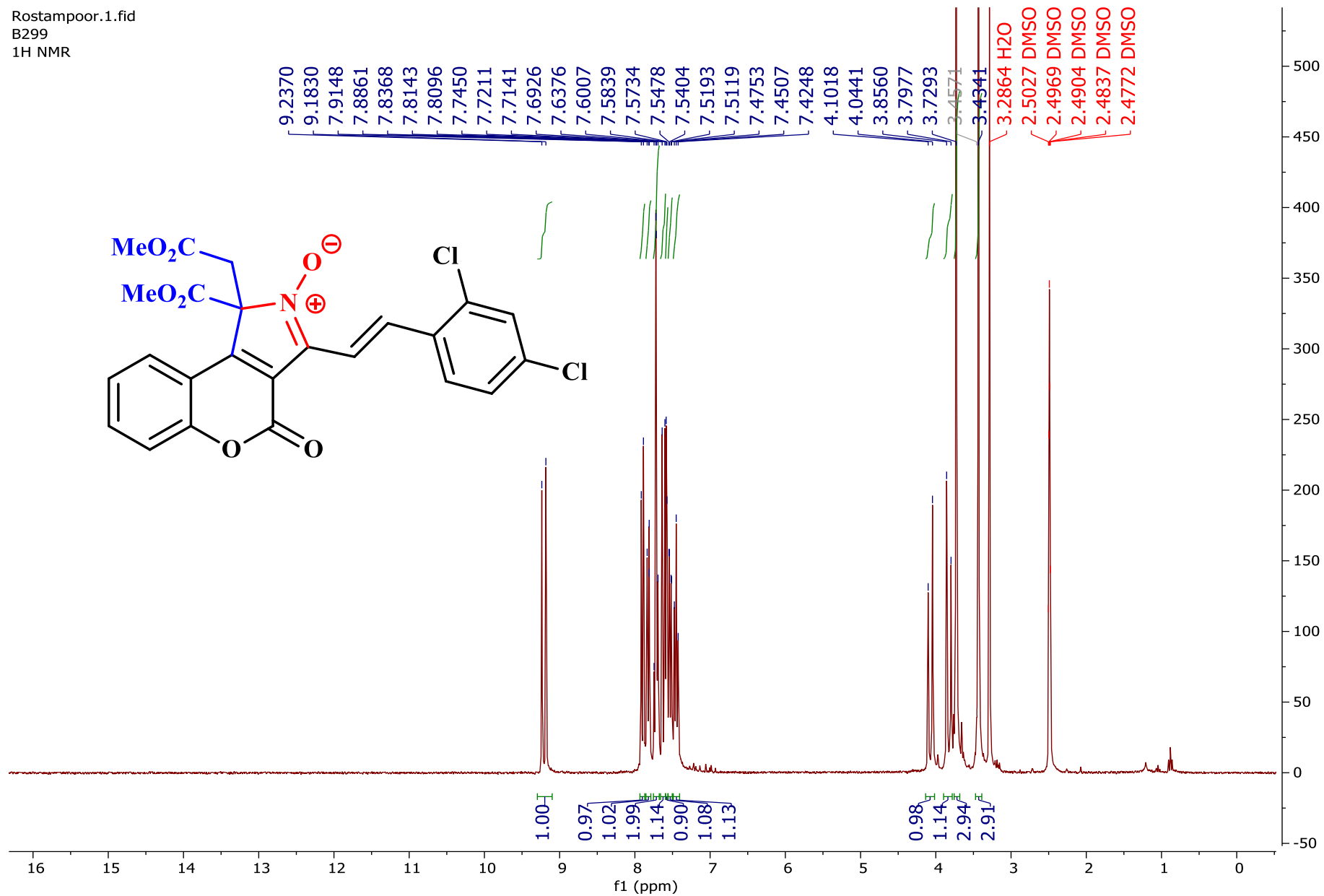


Mass spectrum of **6b**



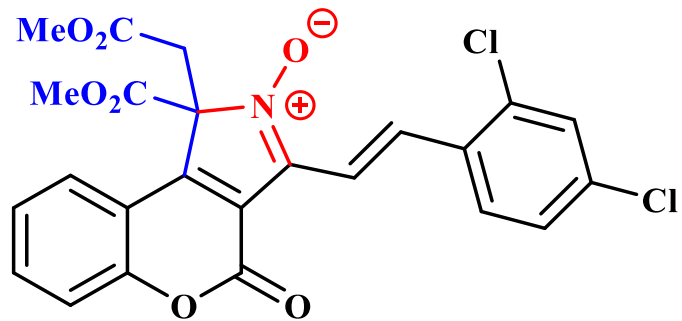
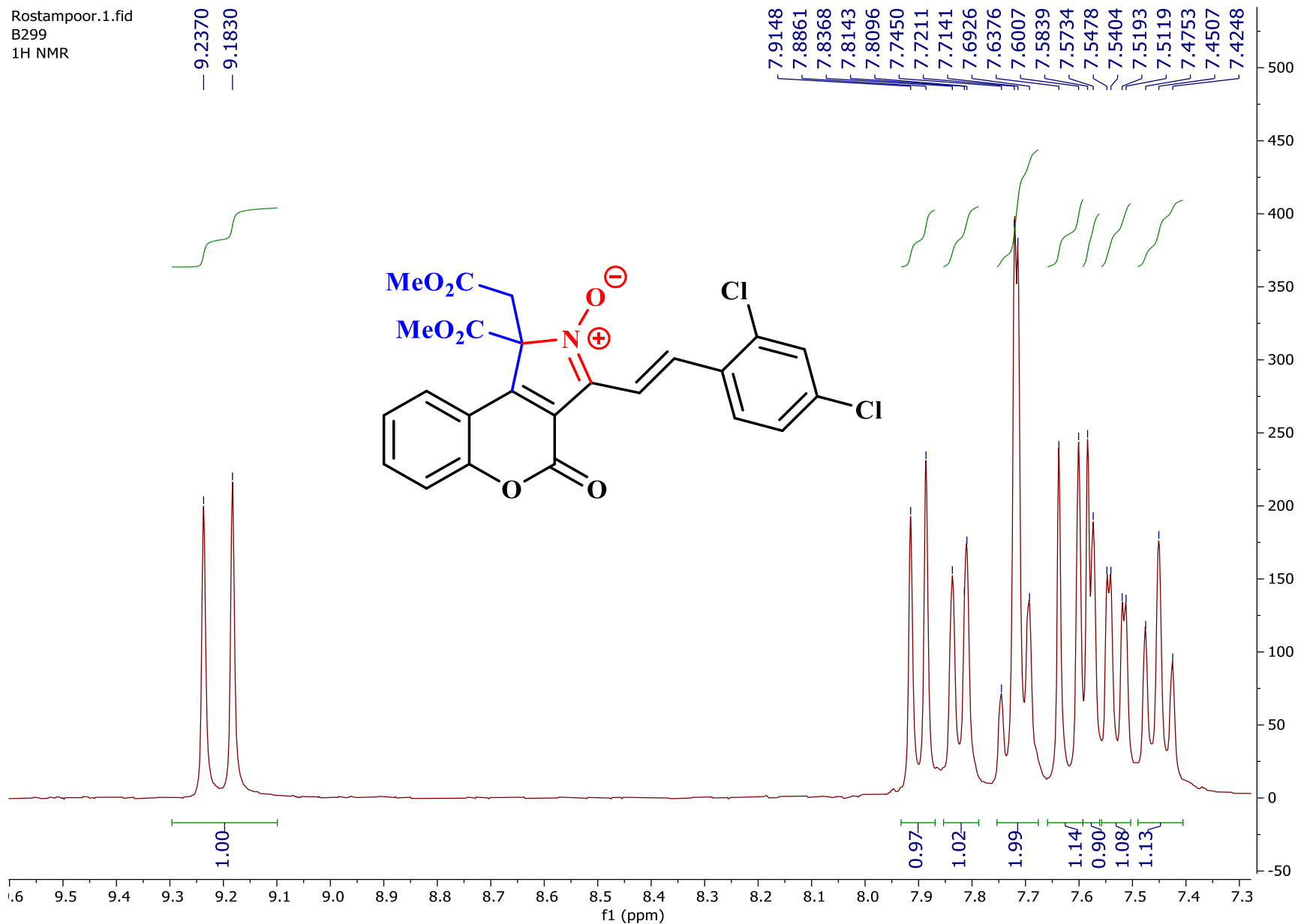
IR spectrum of **6c**

Rostampoor.1.fid  
B299  
1H NMR

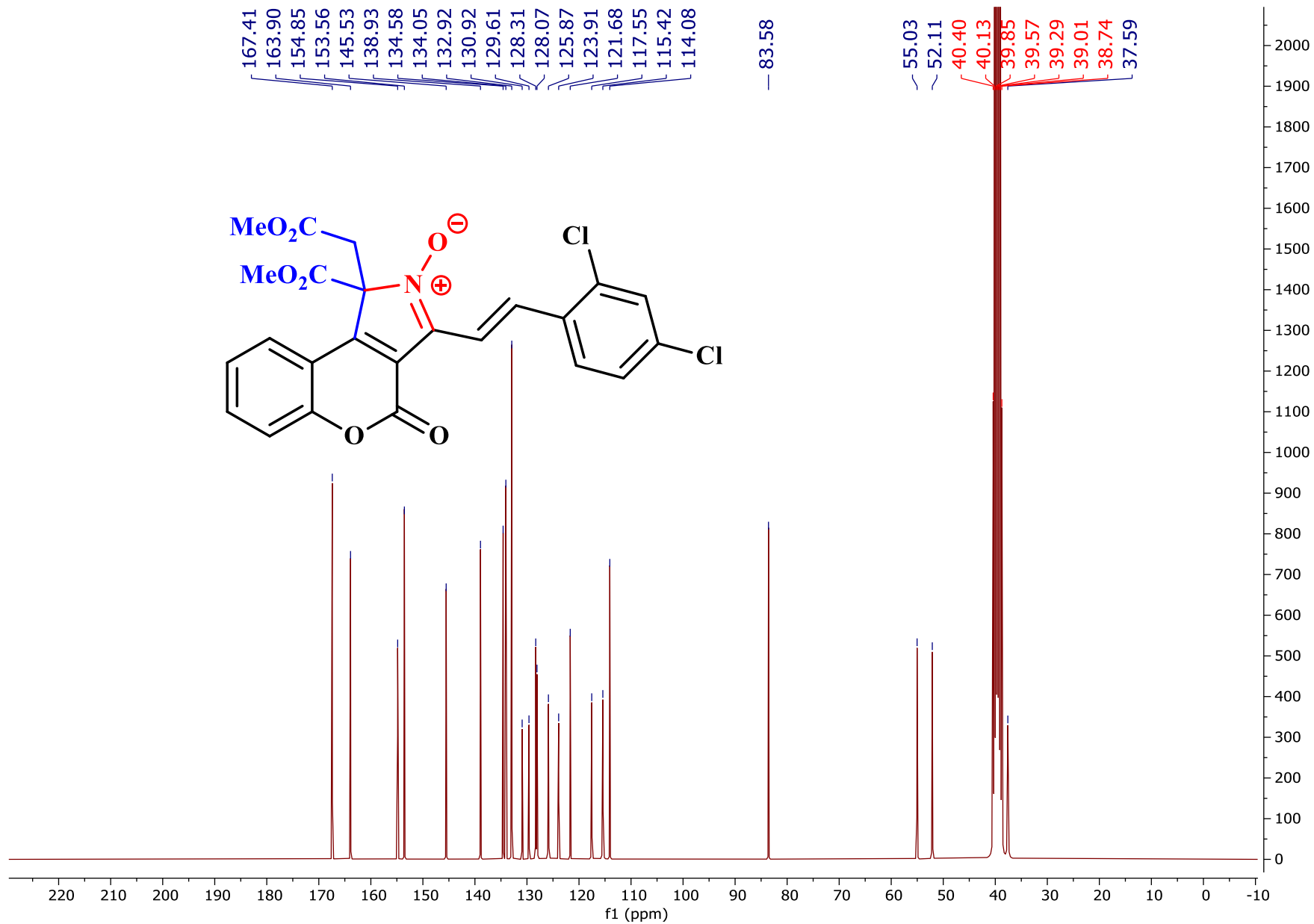


<sup>1</sup>H NMR Spectrum of **6c**  
S31

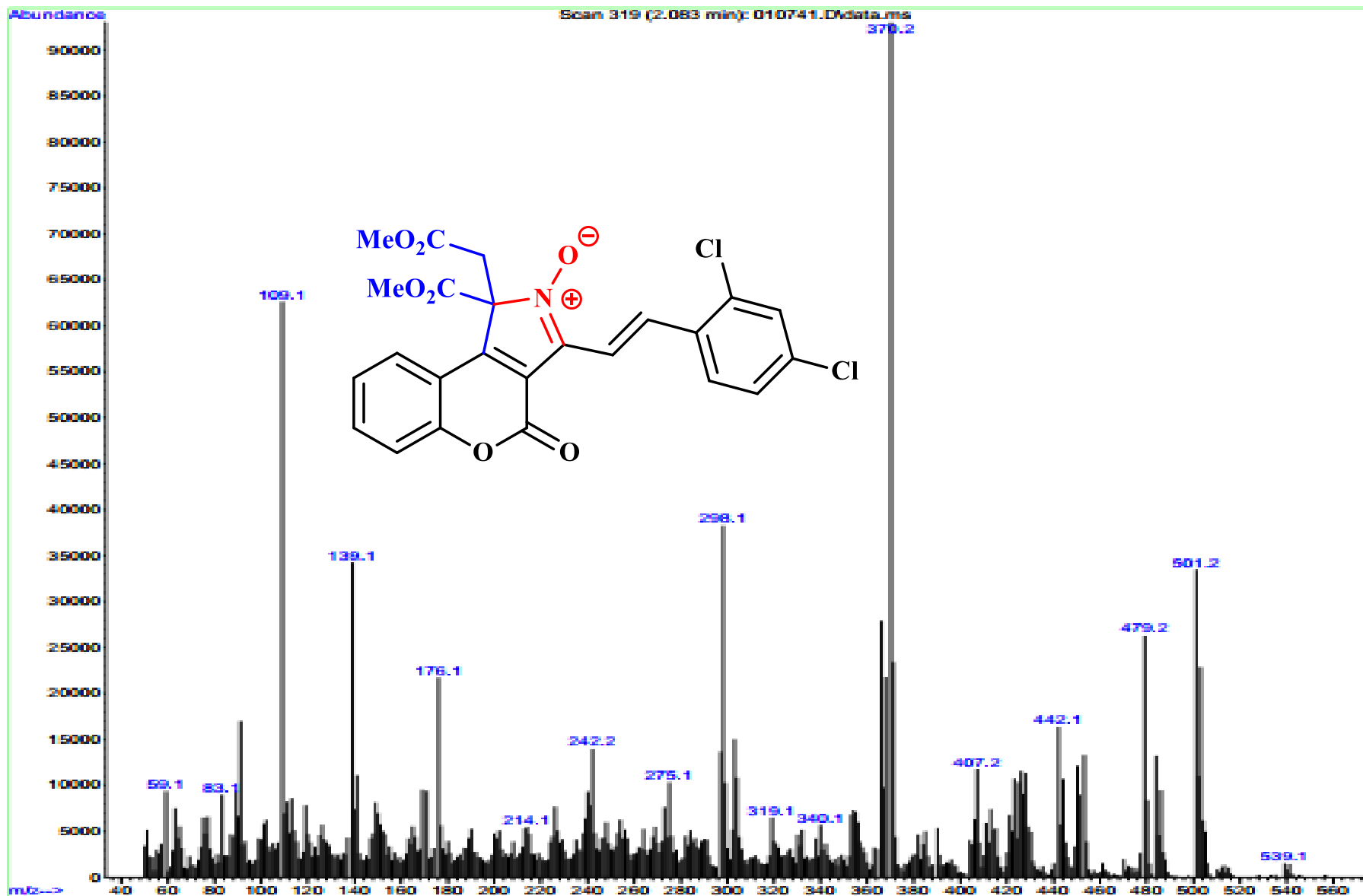
Rostampoor.1.fid  
B299  
1H NMR



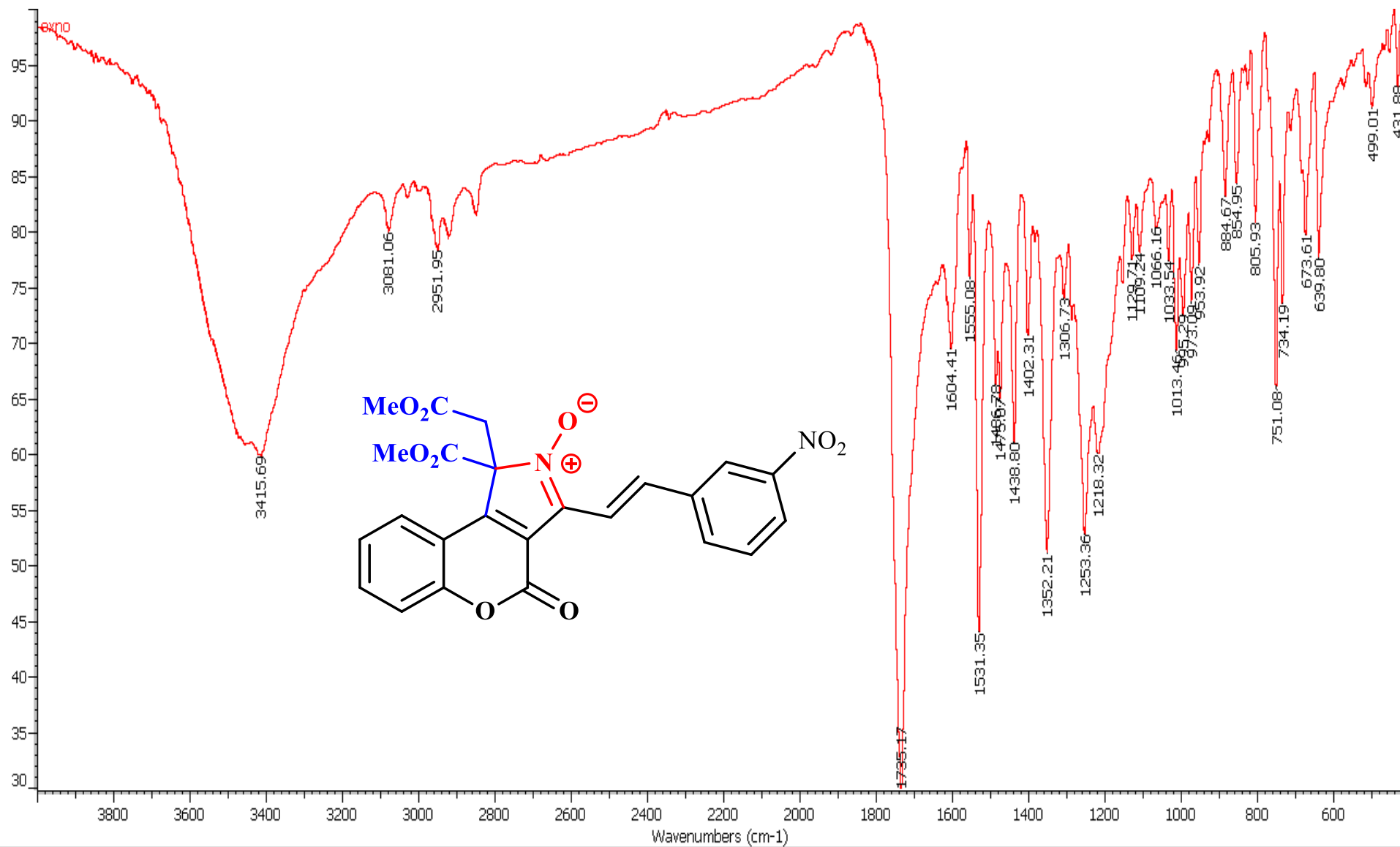
<sup>1</sup>H NMR Spectrum of 6c



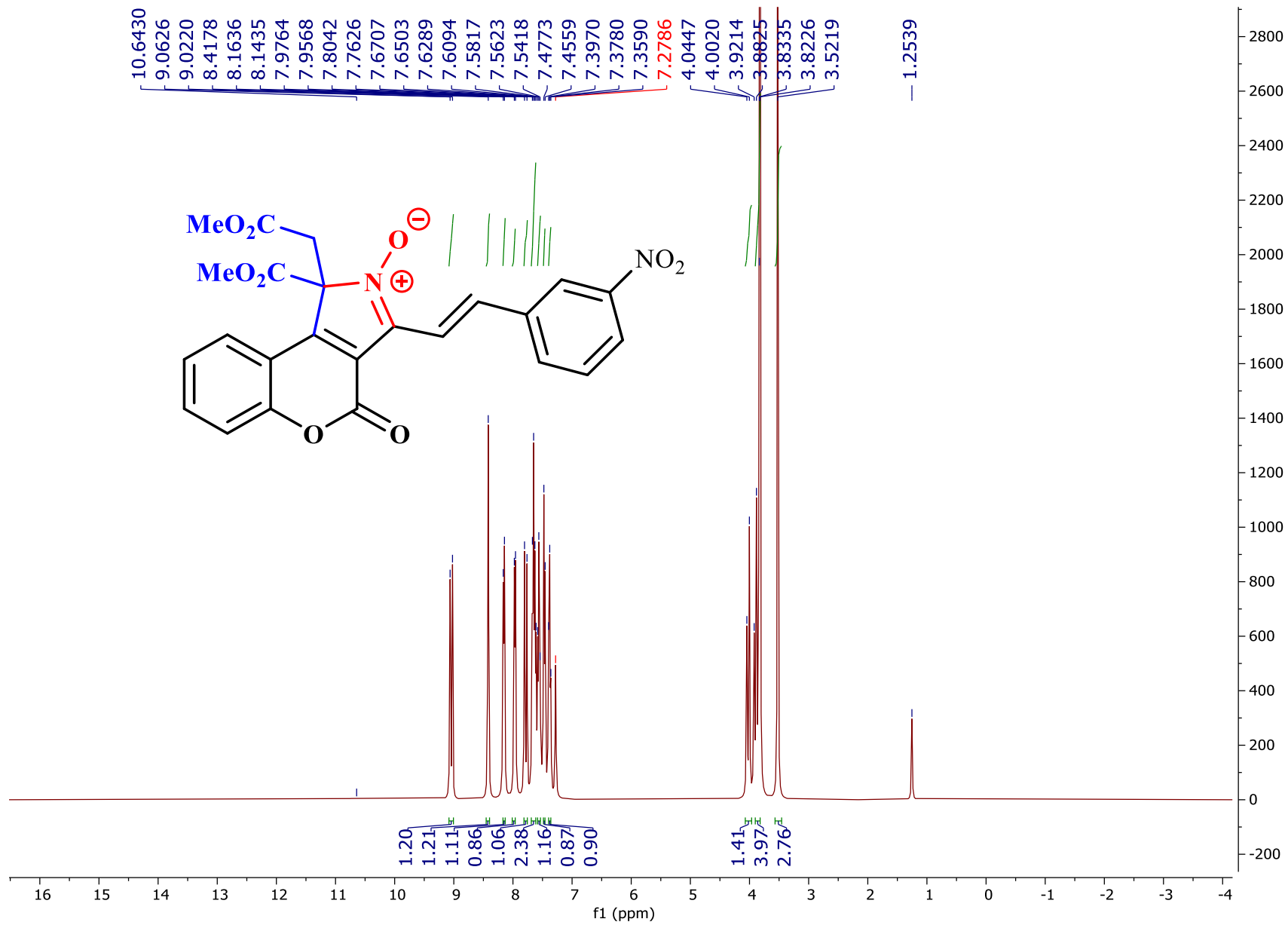
<sup>13</sup>C NMR Spectrum of **6c**  
S33



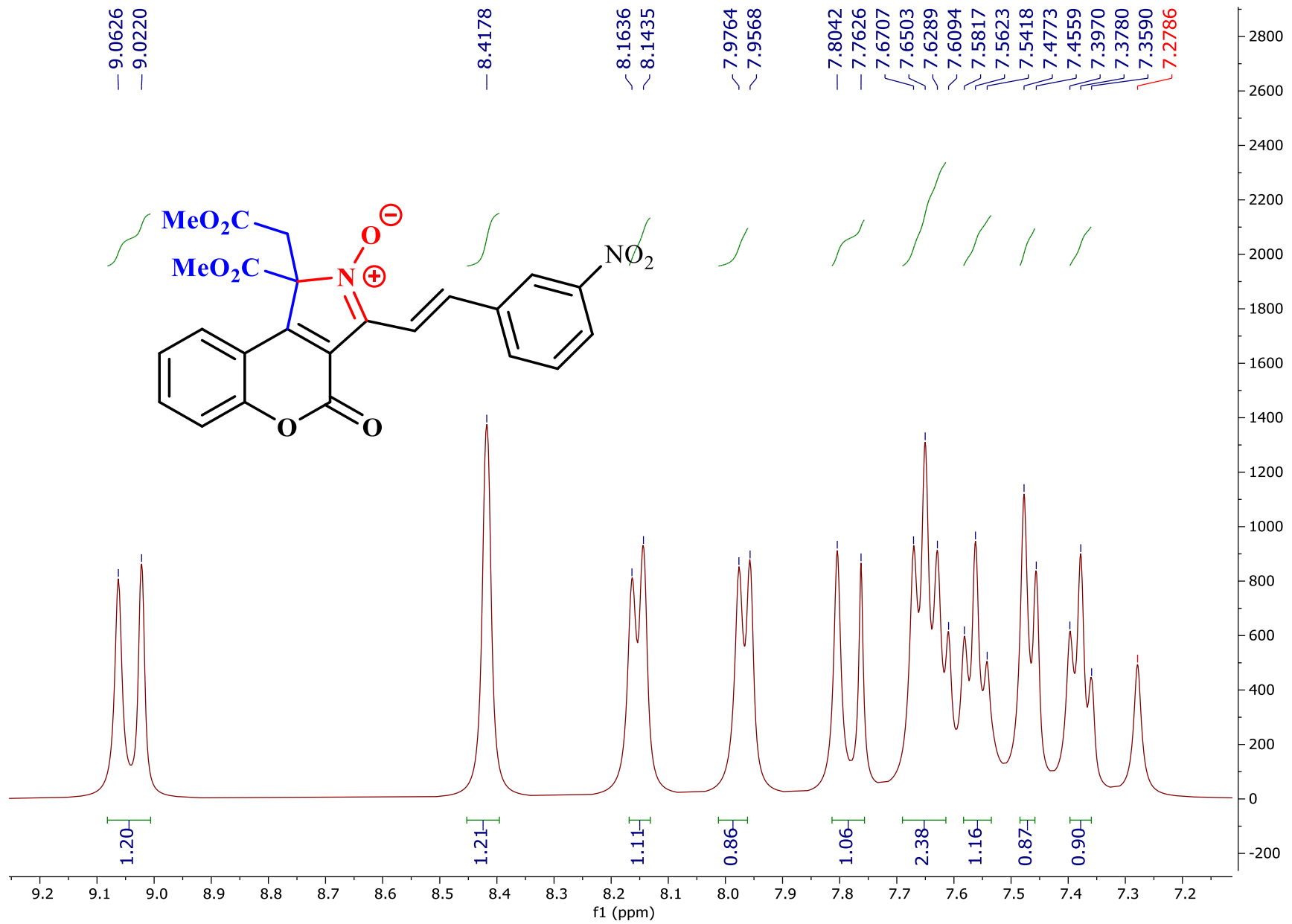
Mass spectrum of **6c**



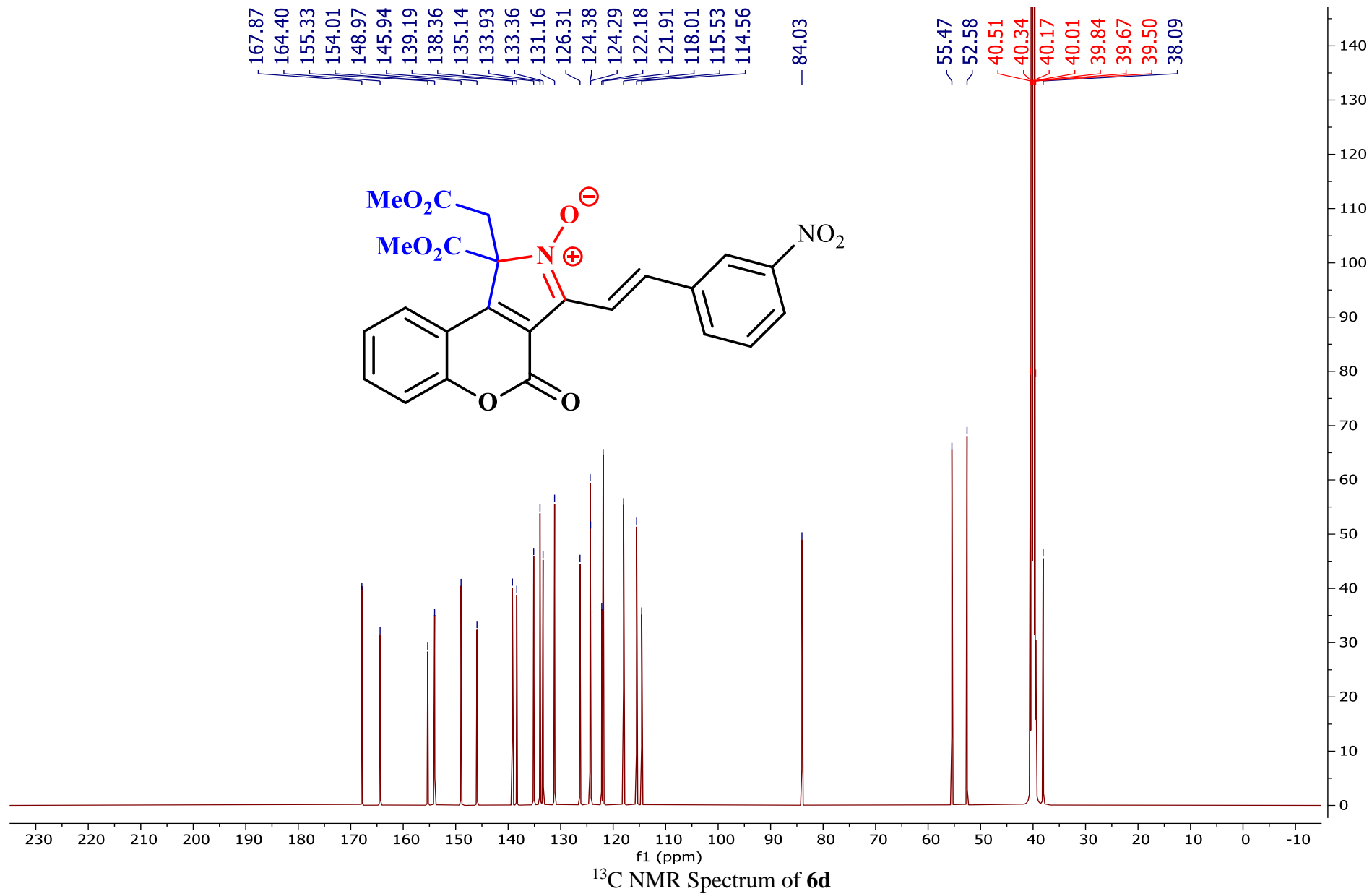
IR spectrum of **6d**

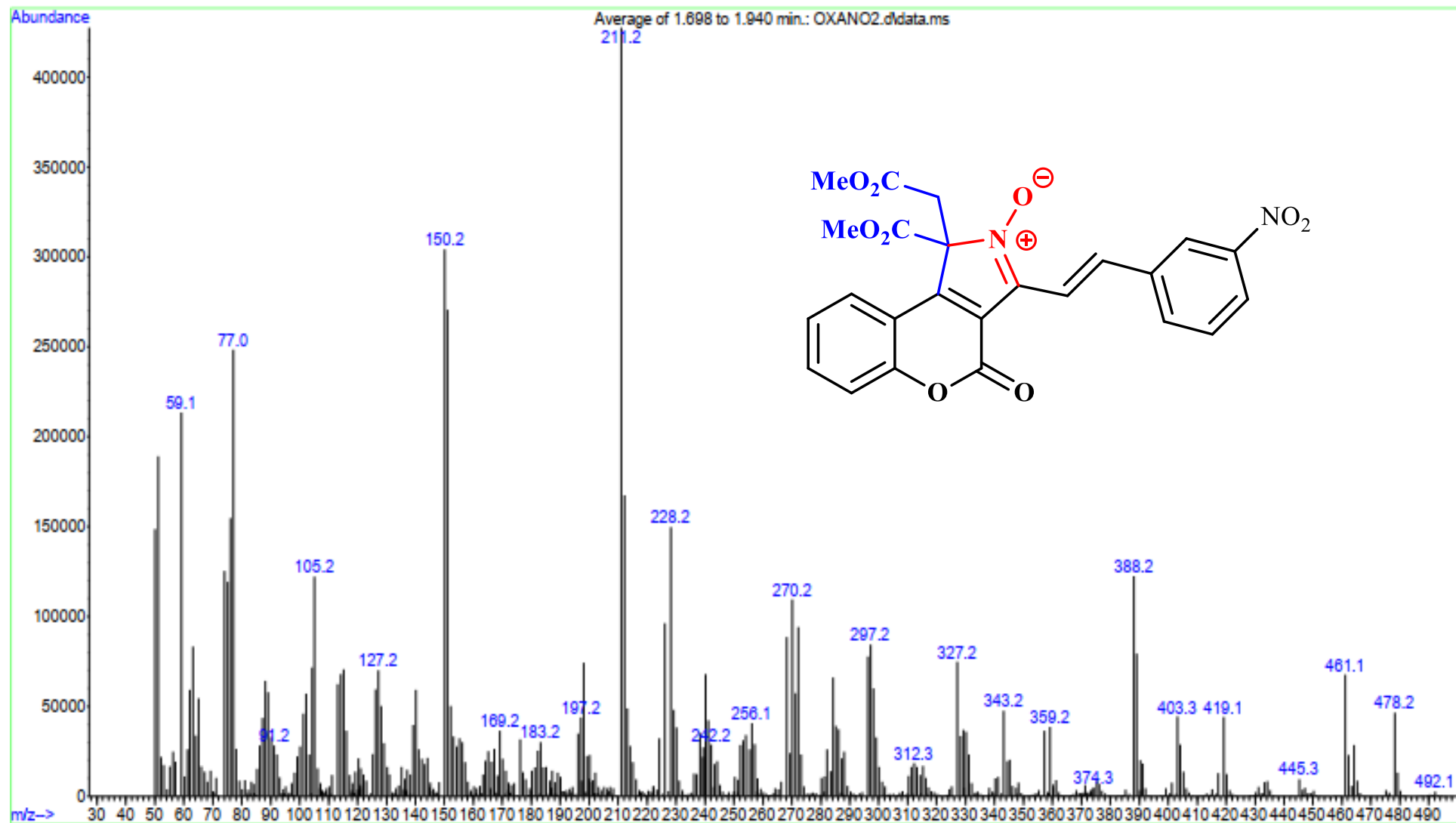


<sup>1</sup>H NMR Spectrum of 6d

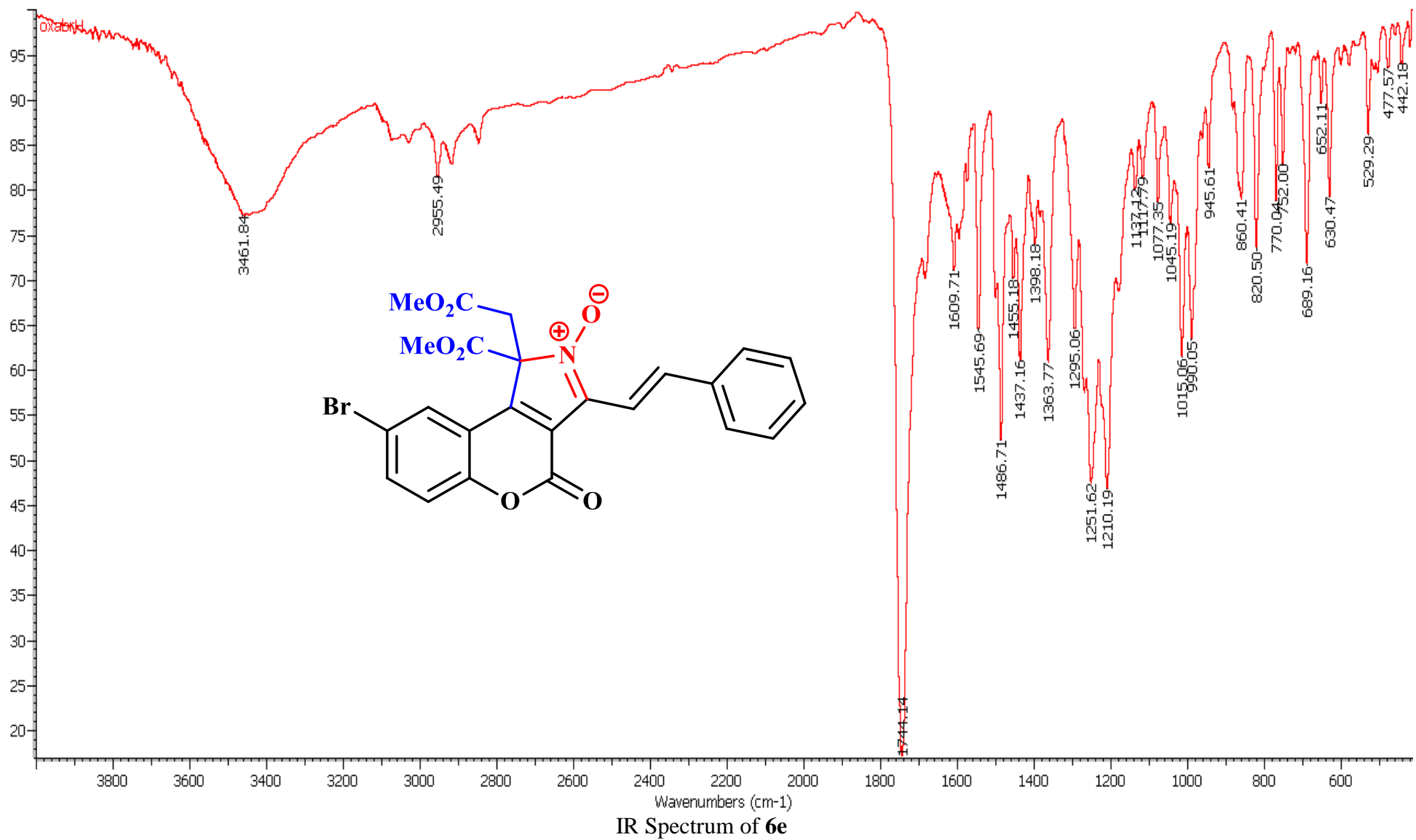


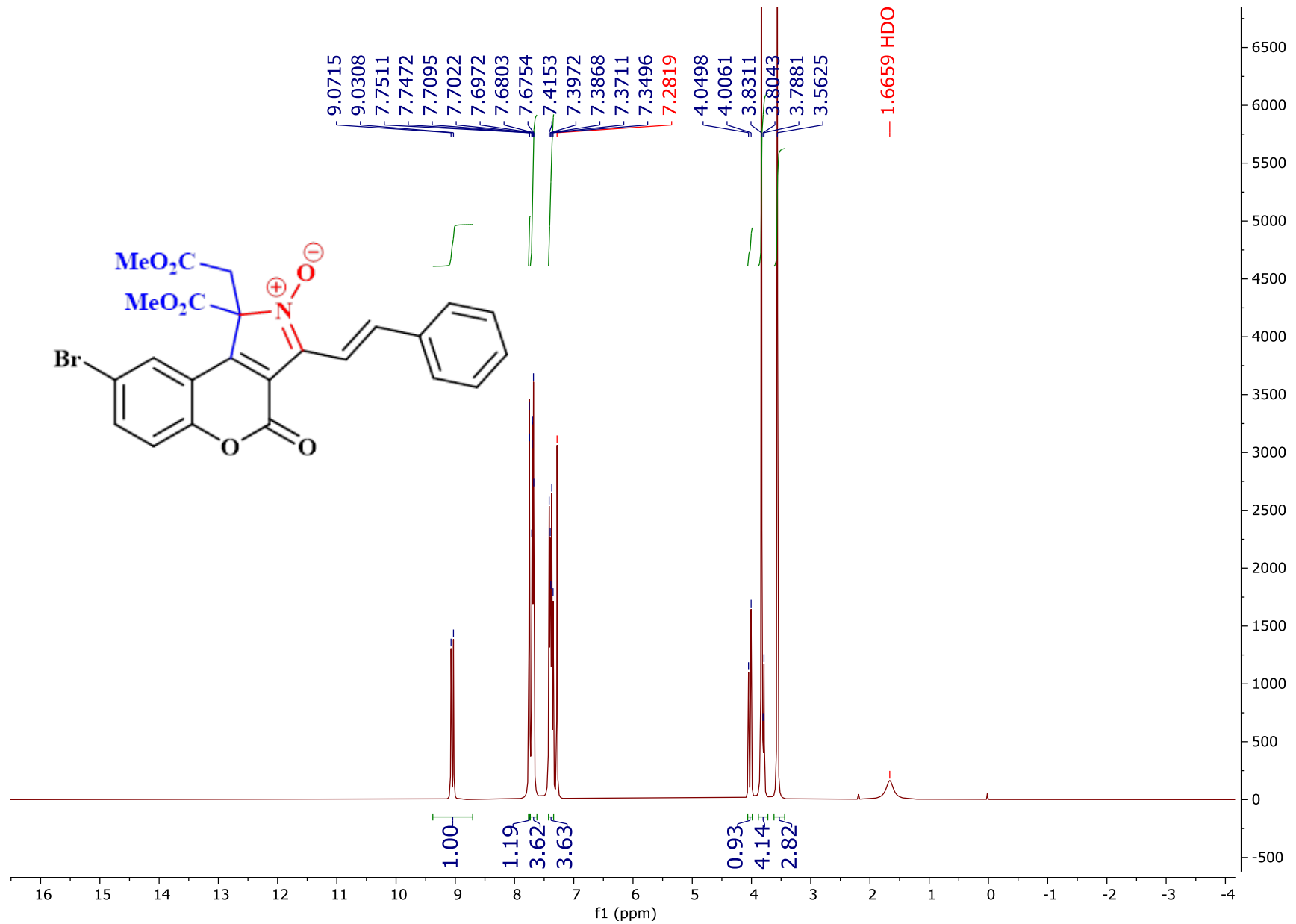
<sup>1</sup>H NMR Spectrum of **6d**  
S37





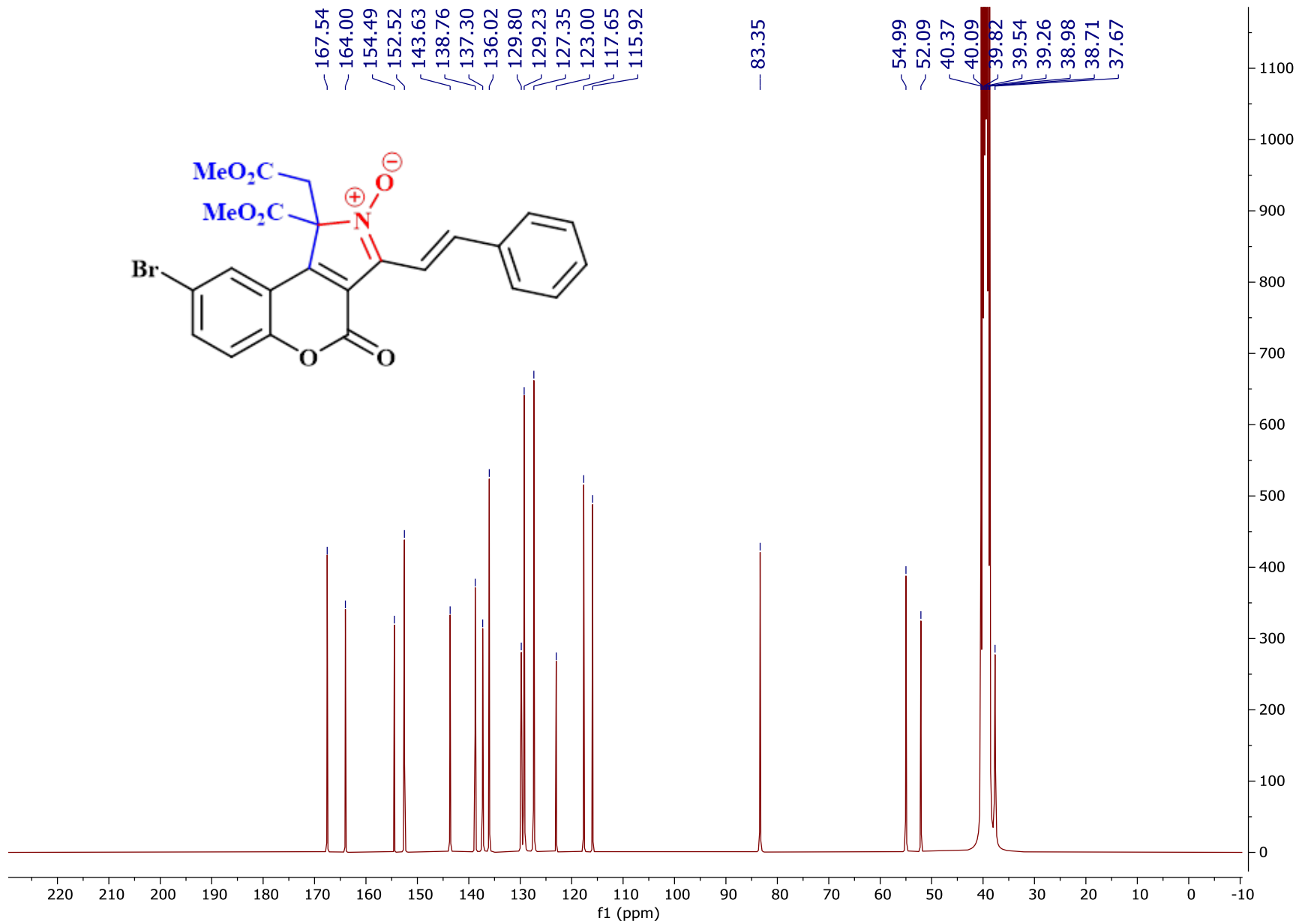
Mass spectrum of **6d**



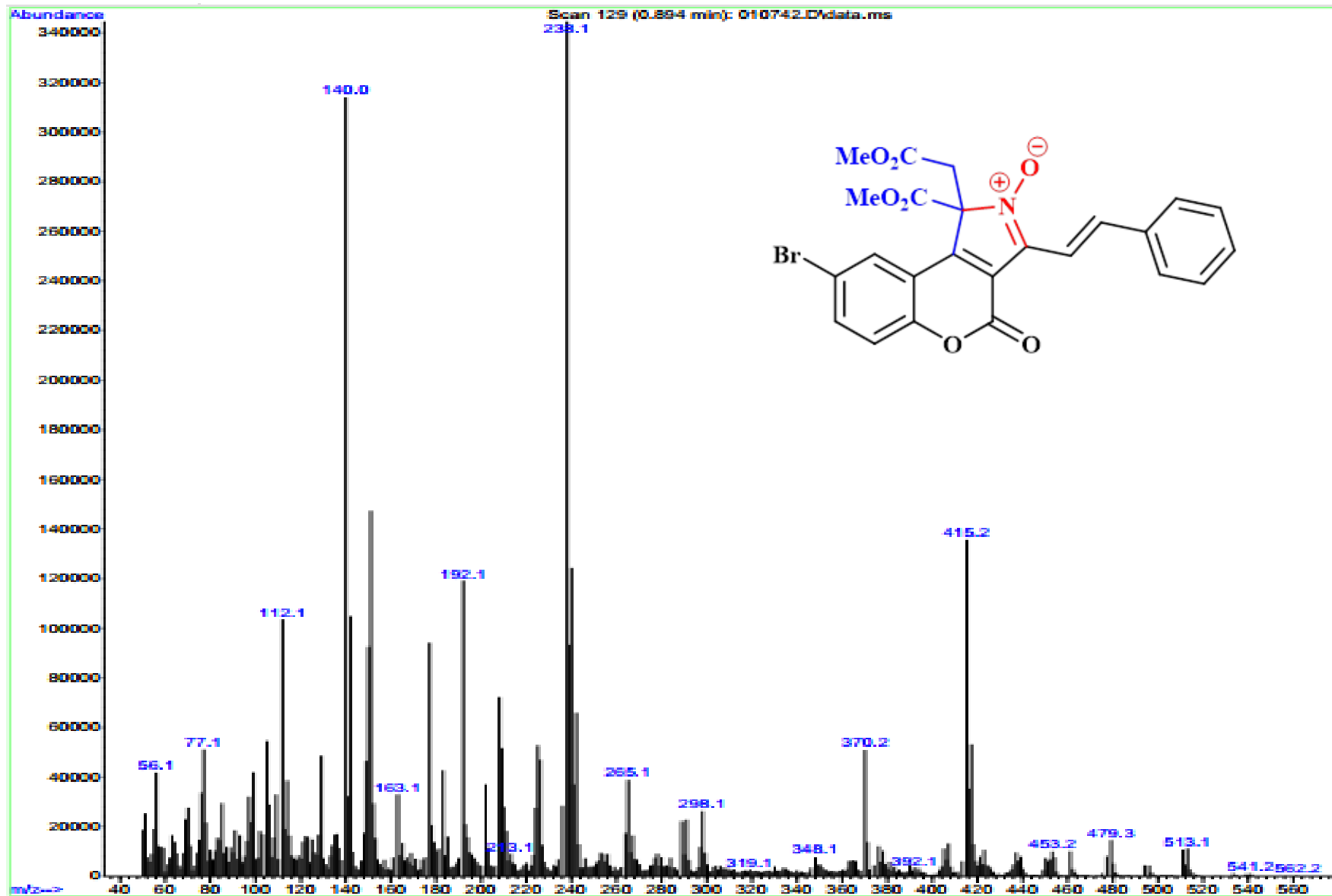


<sup>1</sup>H NMR Spectrum of **6e**

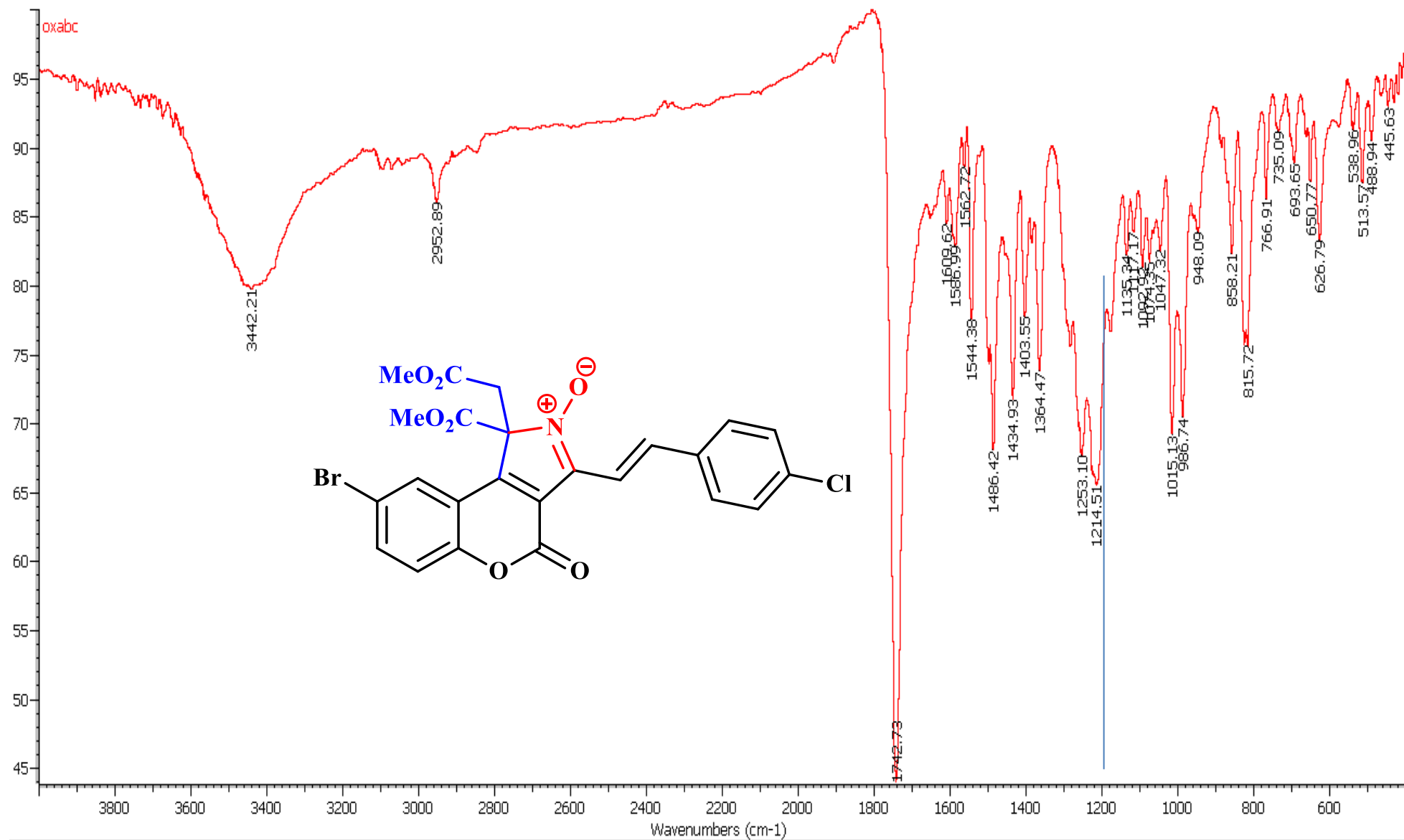
S41



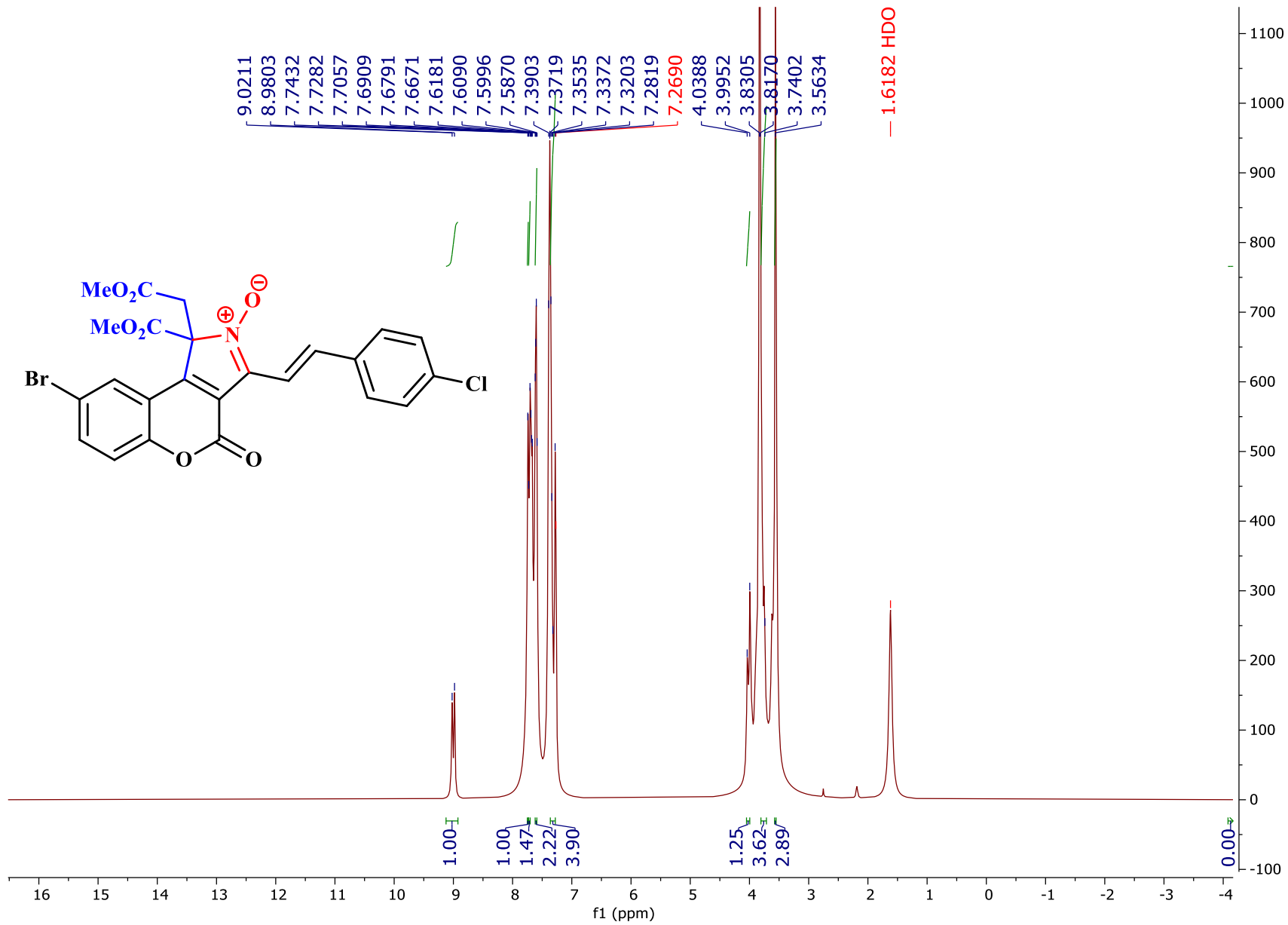
<sup>13</sup>C NMR Spectrum of **6e**



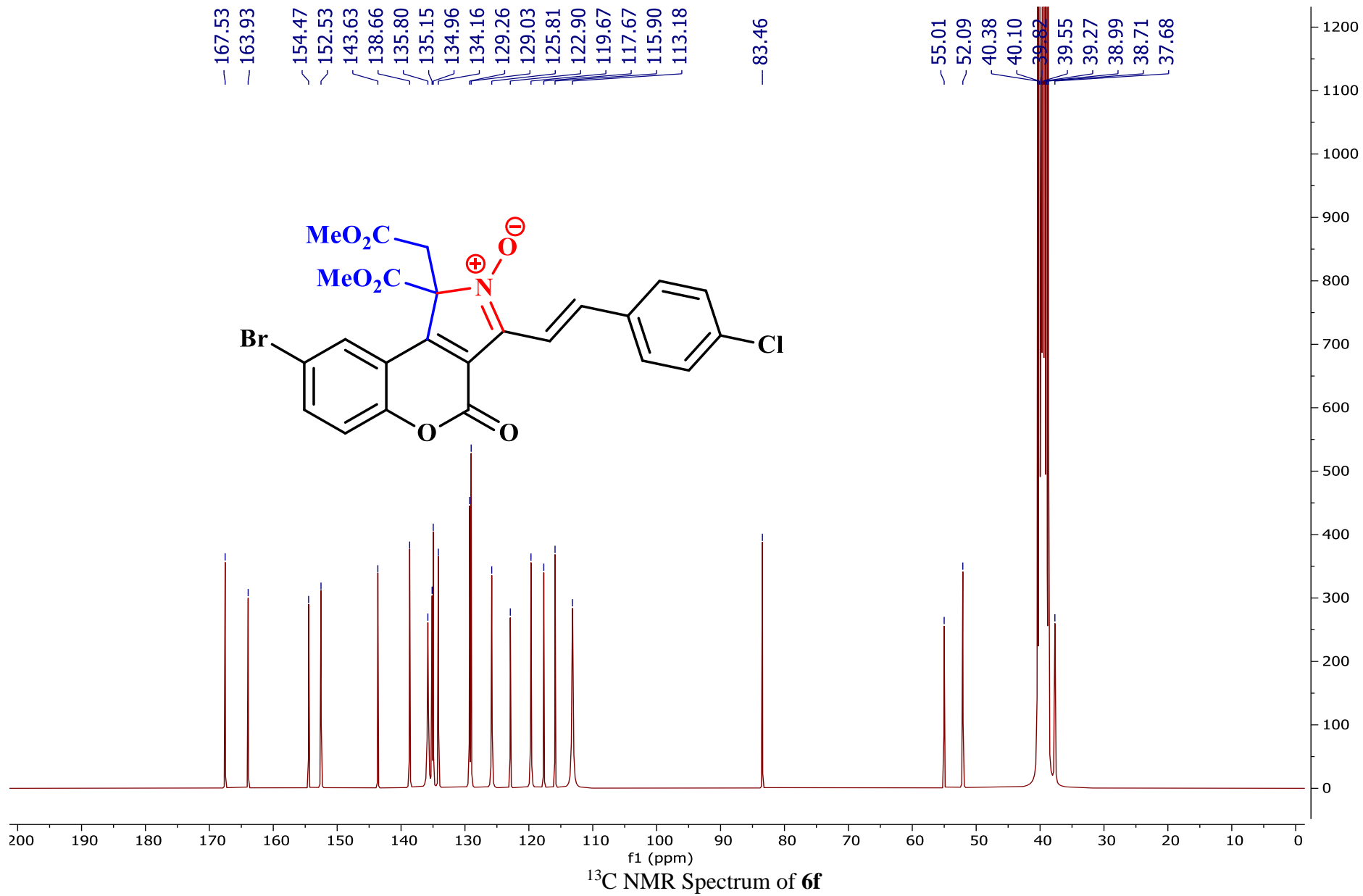
Mass spectrum of **6e**

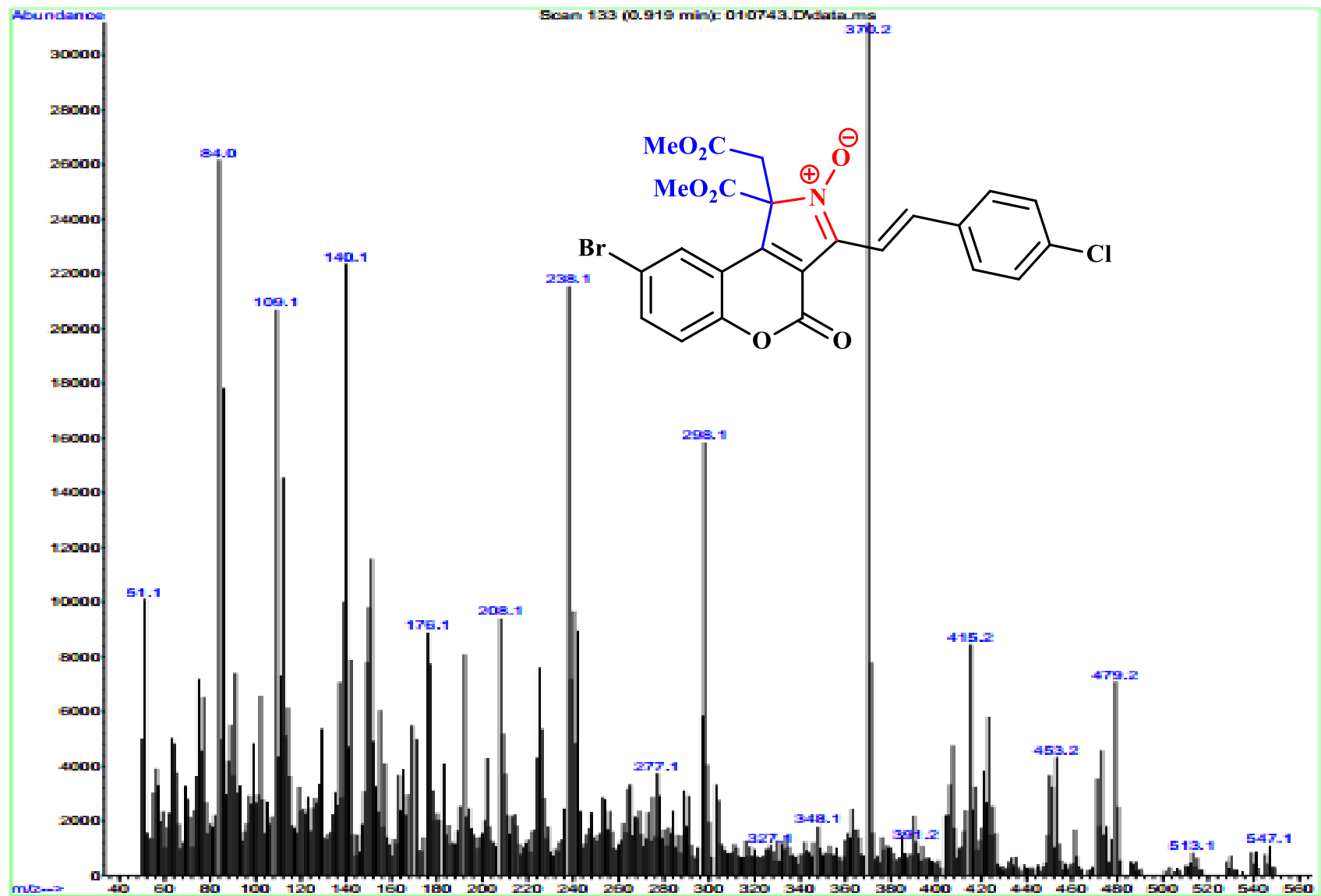


IR spectrum of **6f**

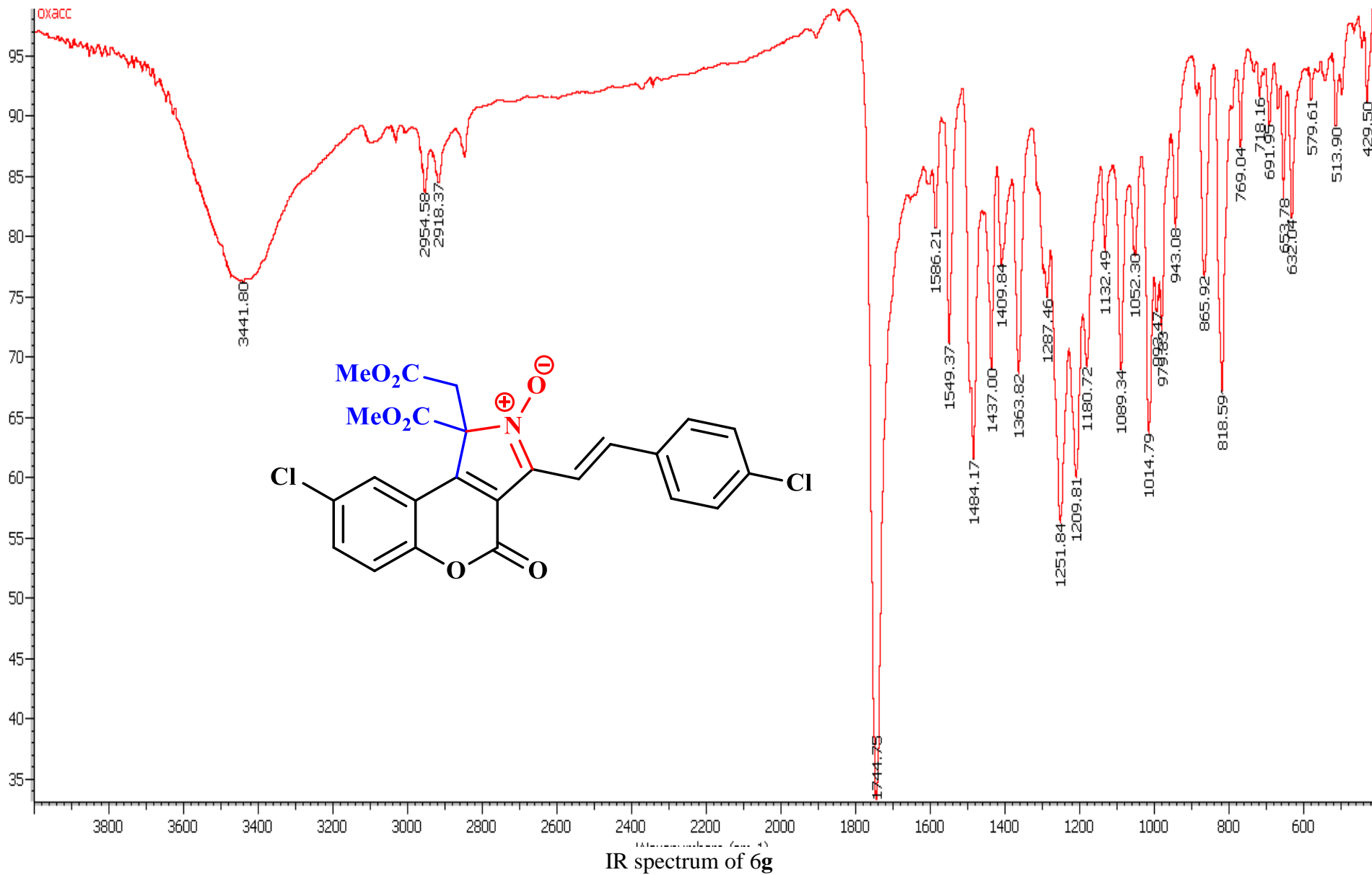


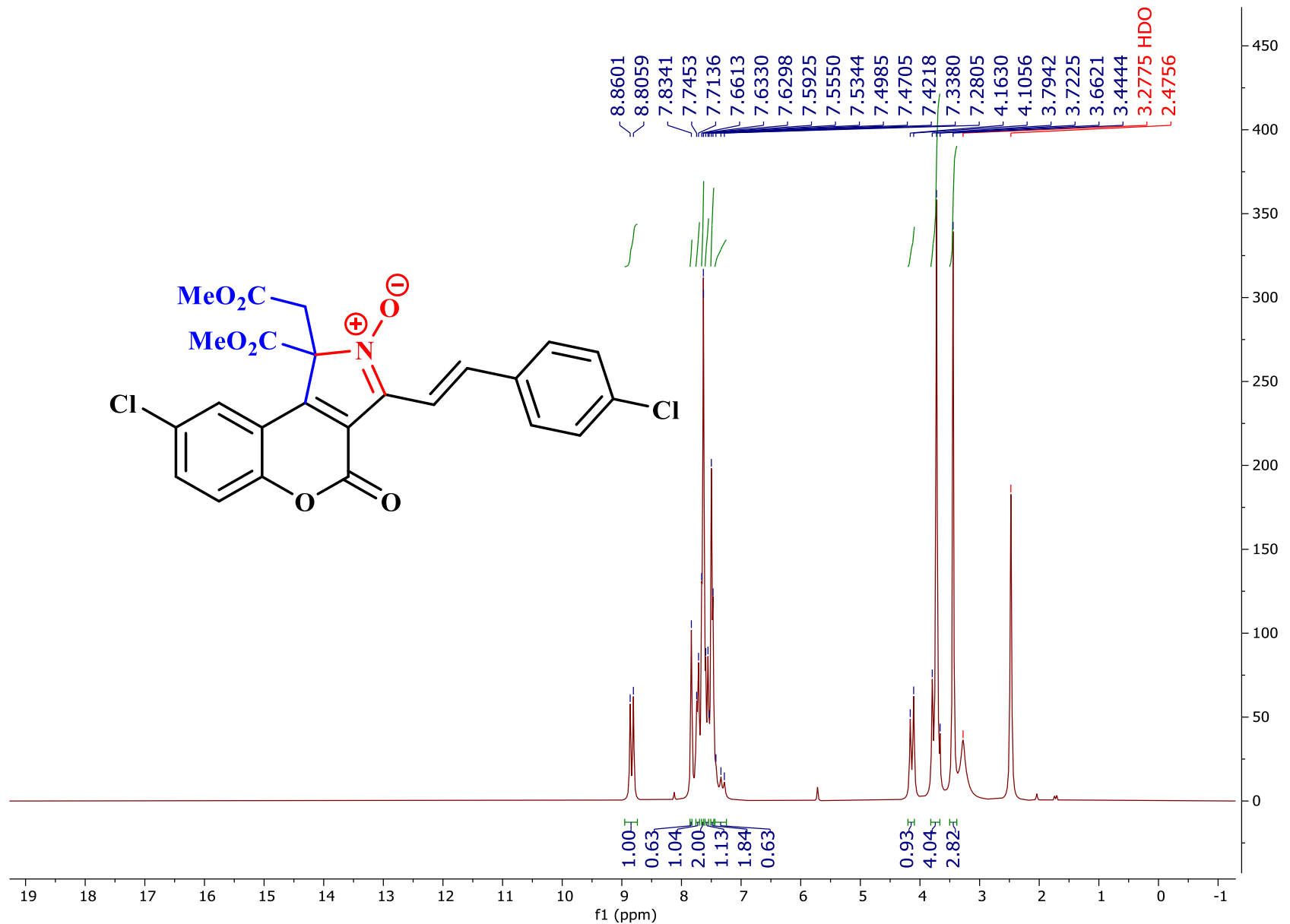
**<sup>1</sup>H NMR Spectrum of 6f**



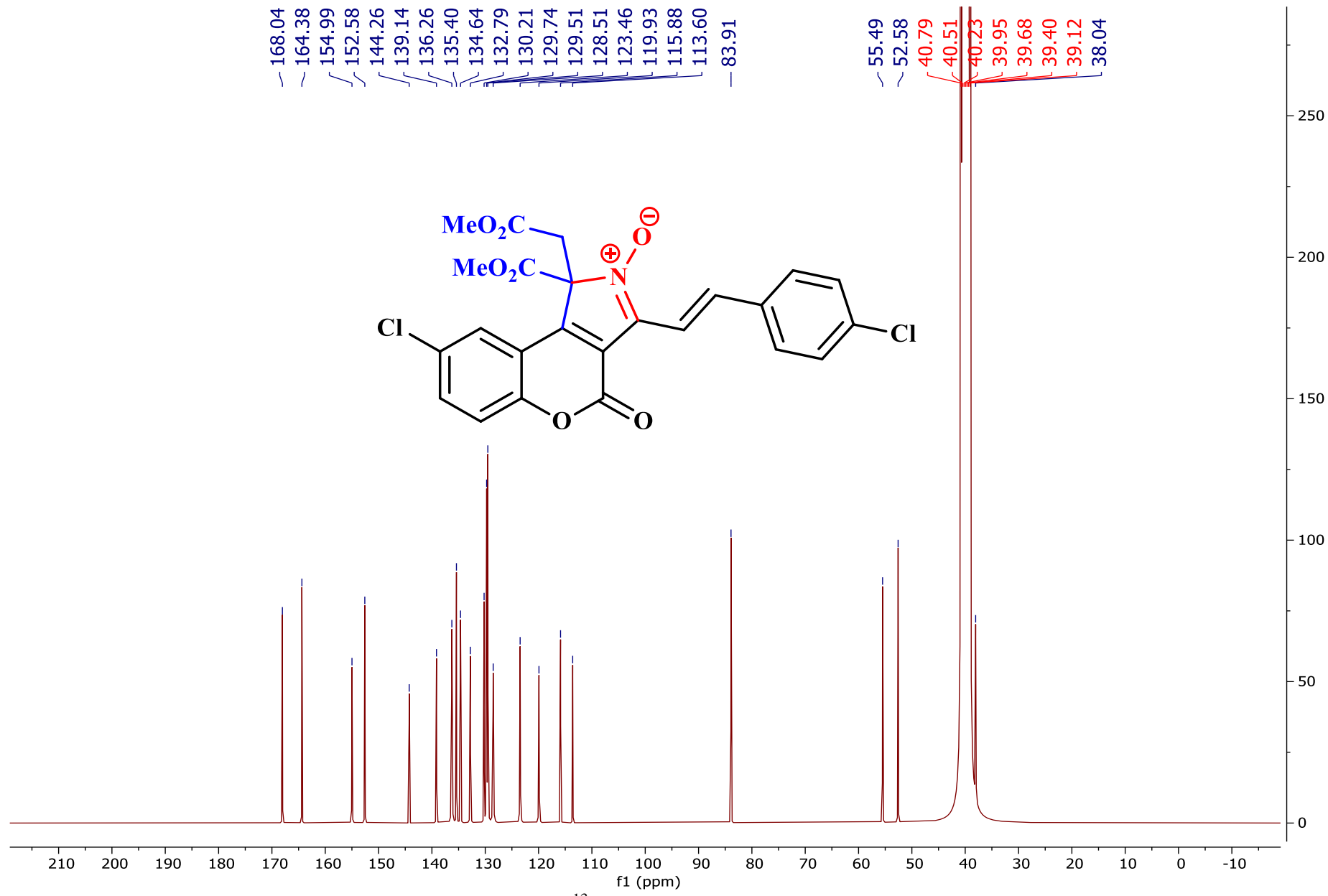


Mass spectrum of **6f**

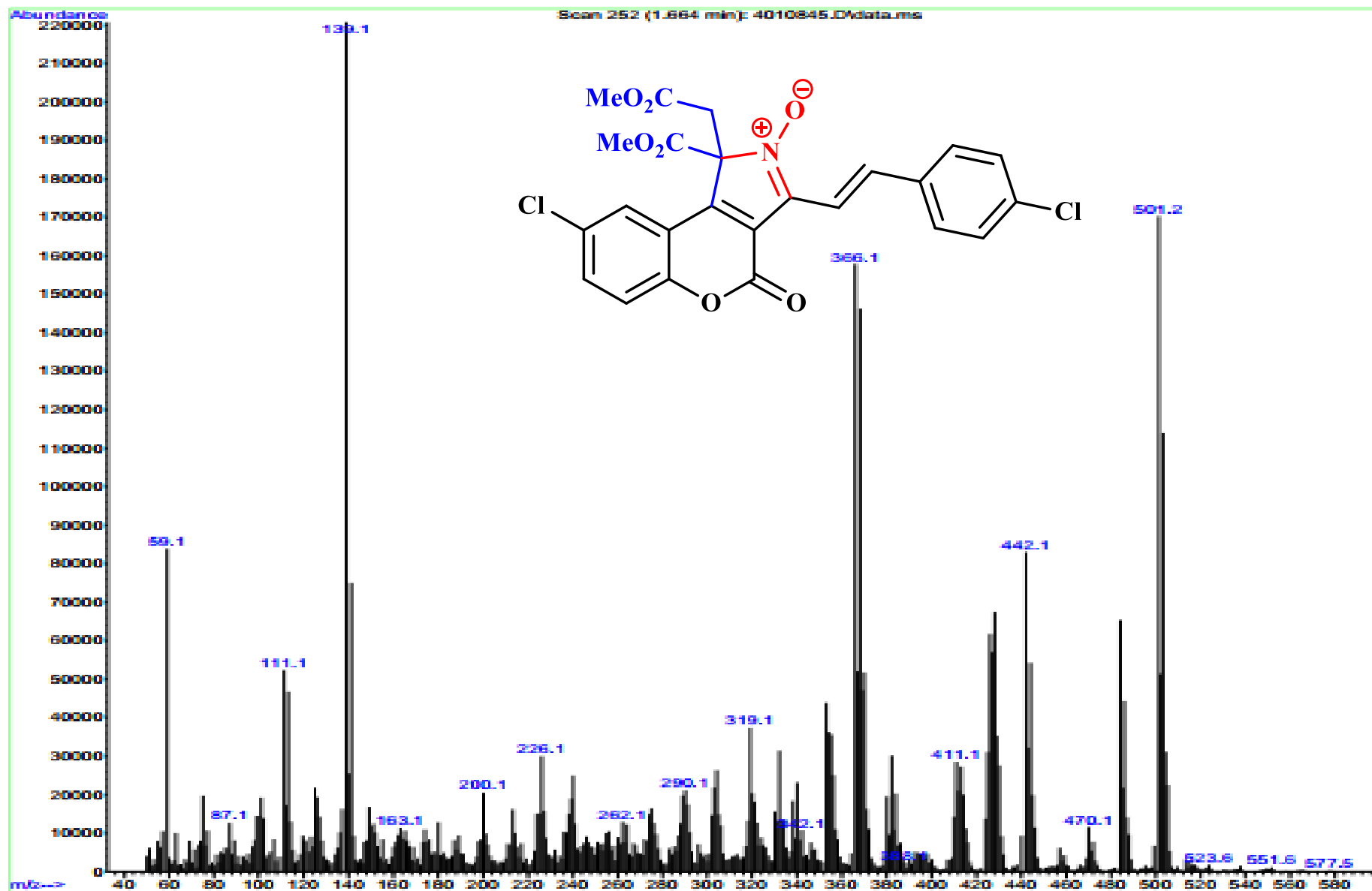




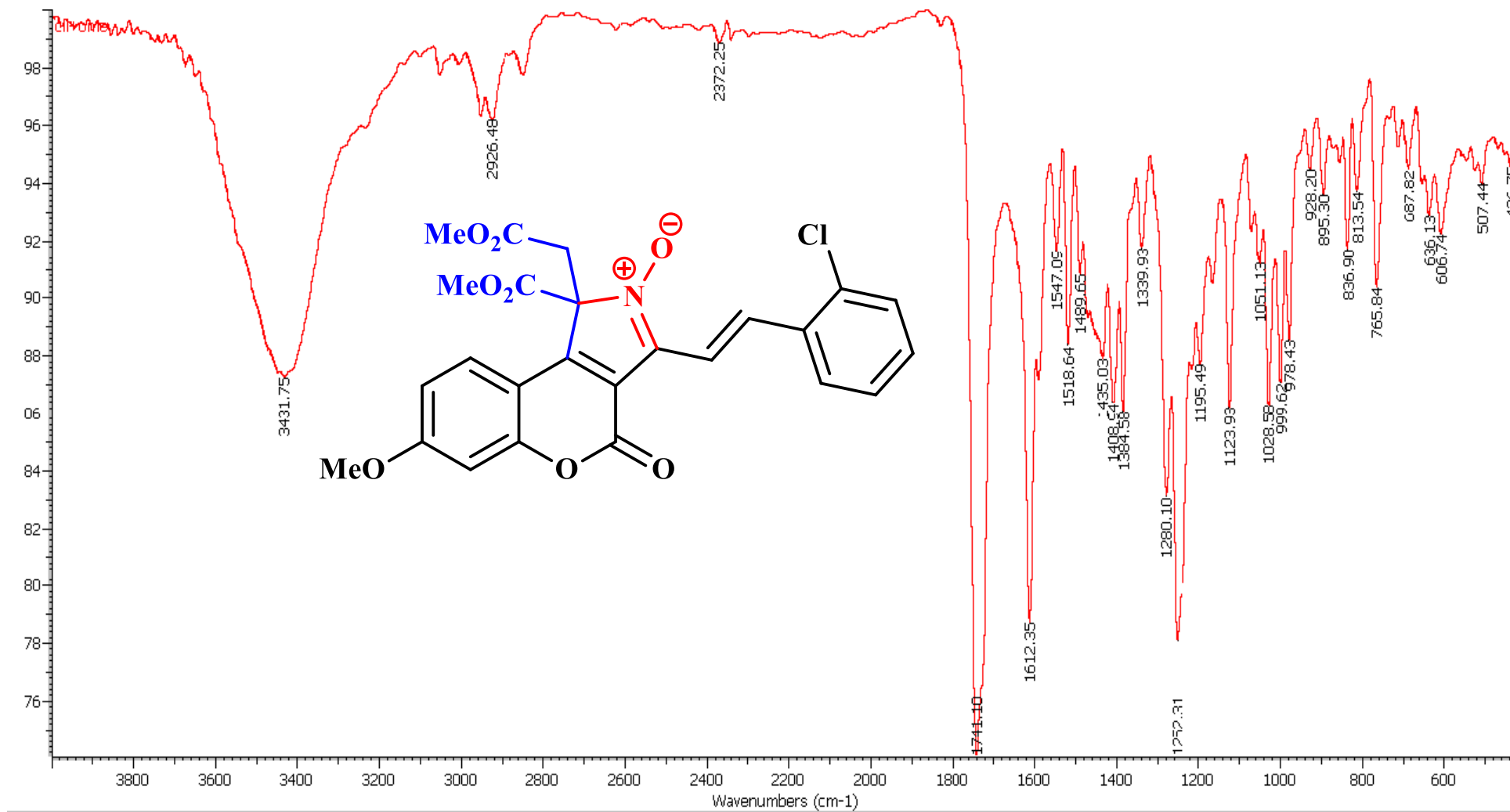
<sup>1</sup>H NMR Spectrum of **6g**



<sup>13</sup>C NMR Spectrum of **6g**  
S50

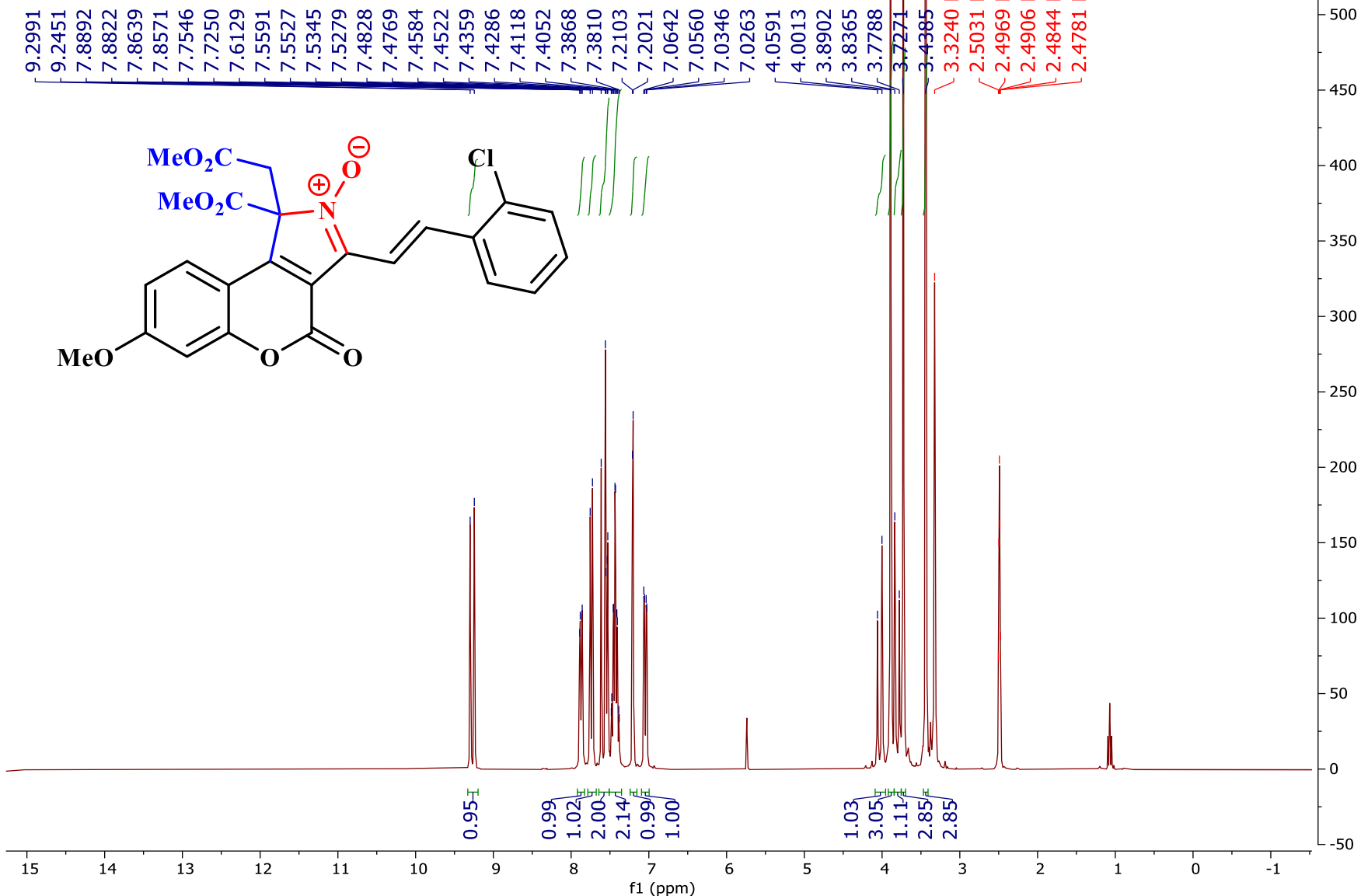


Mass spectrum of 6g



IR spectrum of 6h

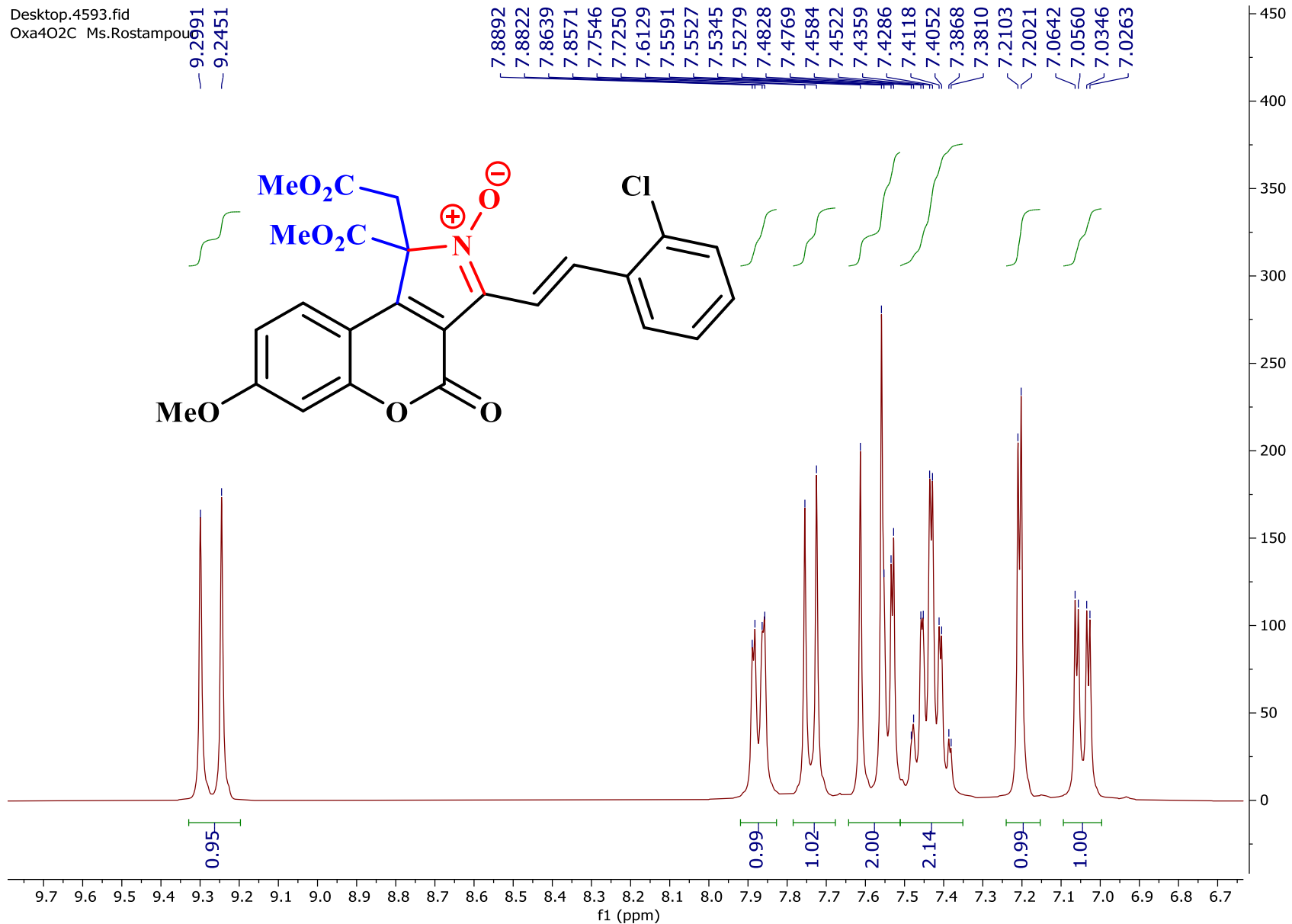
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Oxa4O2C Ms.Rostampour



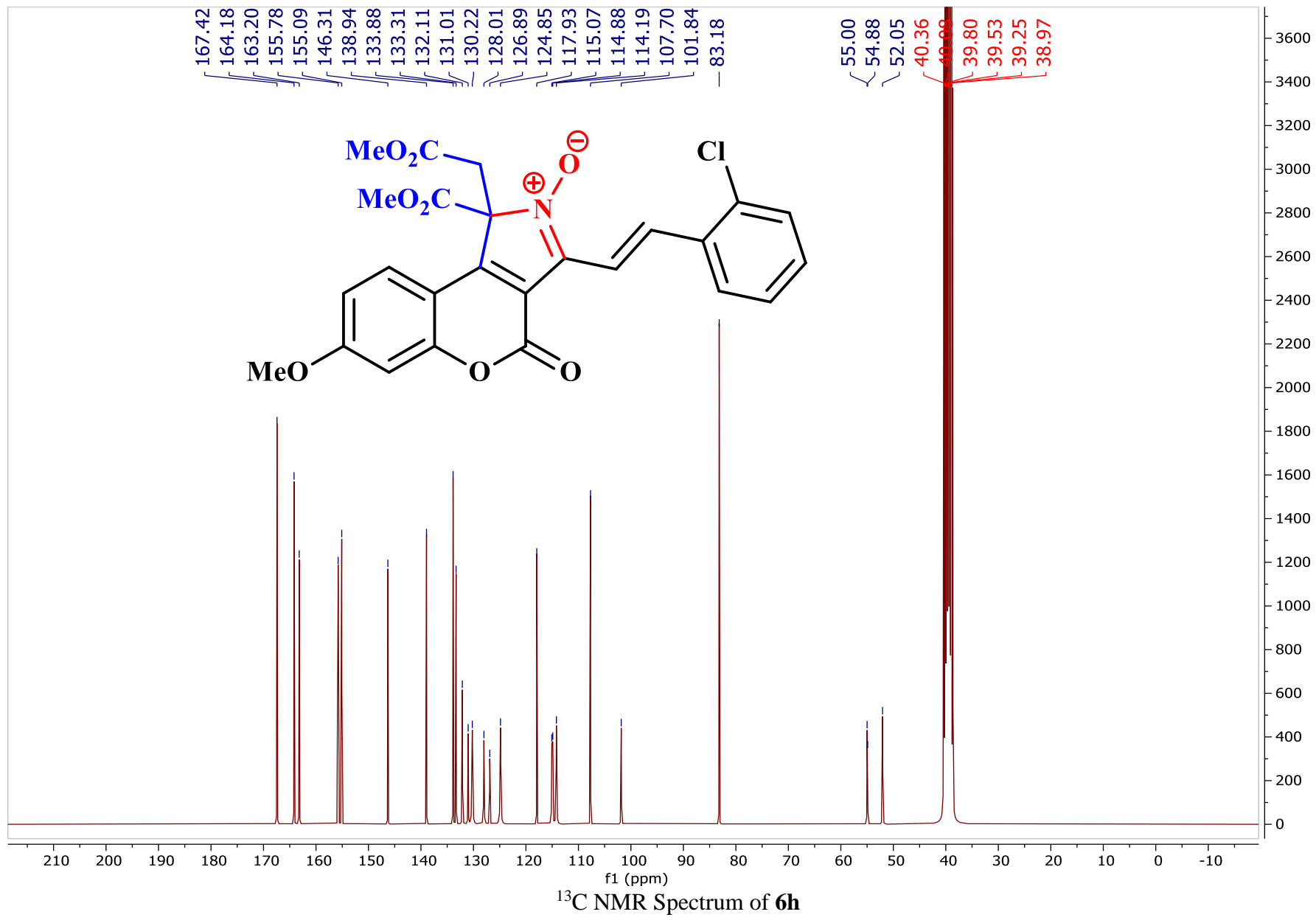
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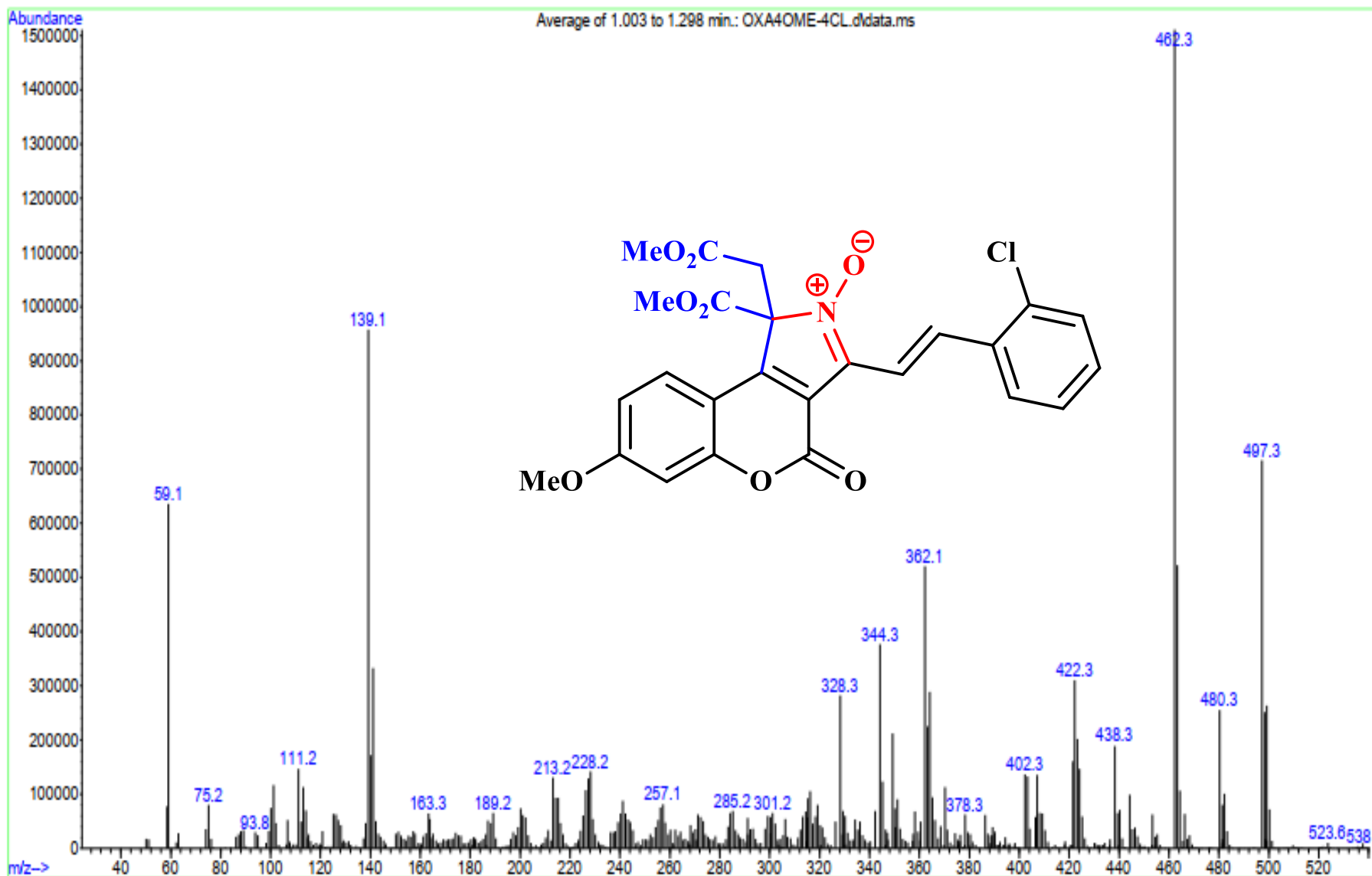
S53

Desktop.4593.fid  
Oxa4O2C Ms.Rostampou



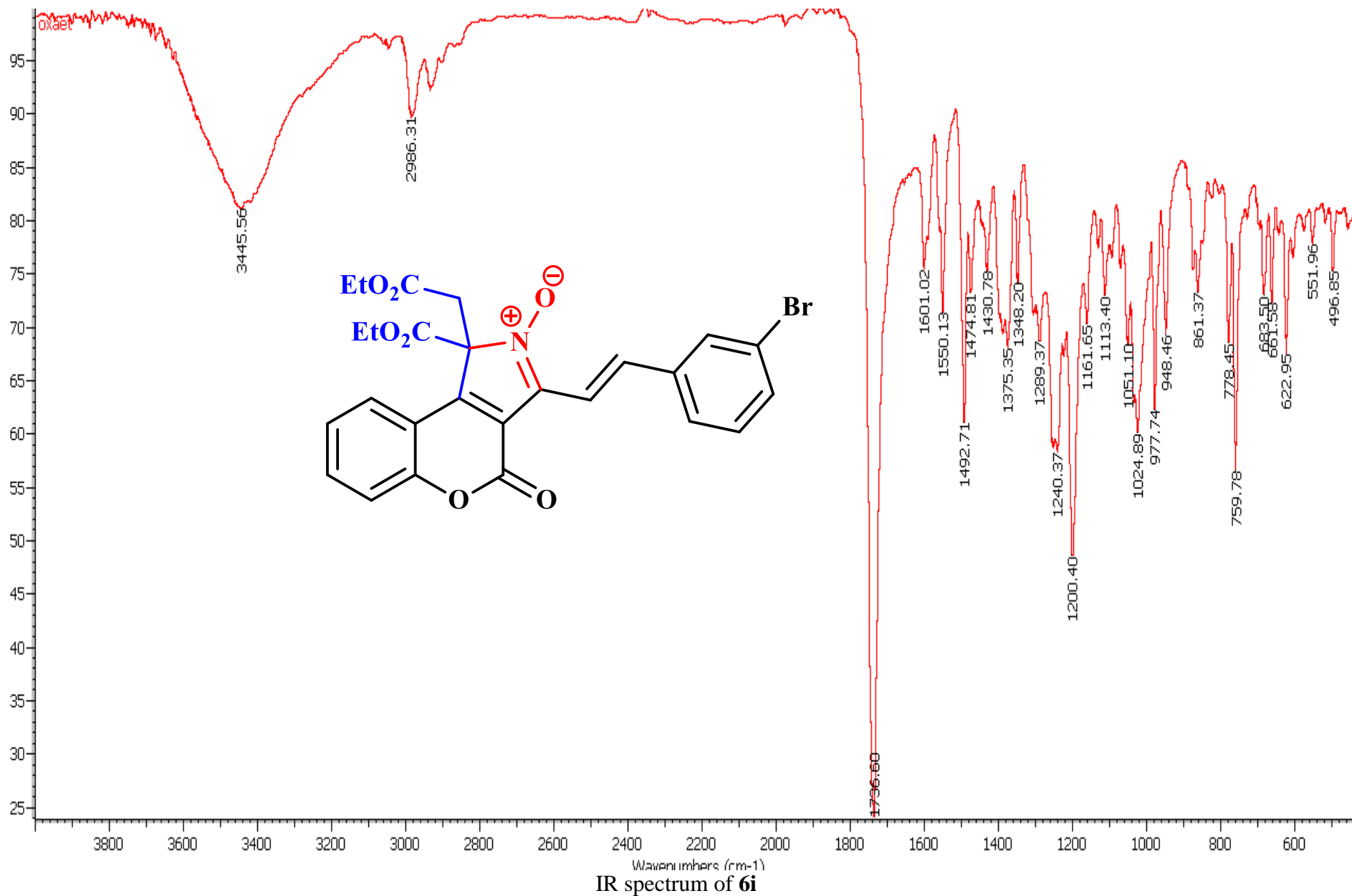
<sup>1</sup>H NMR Spectrum of **6h**



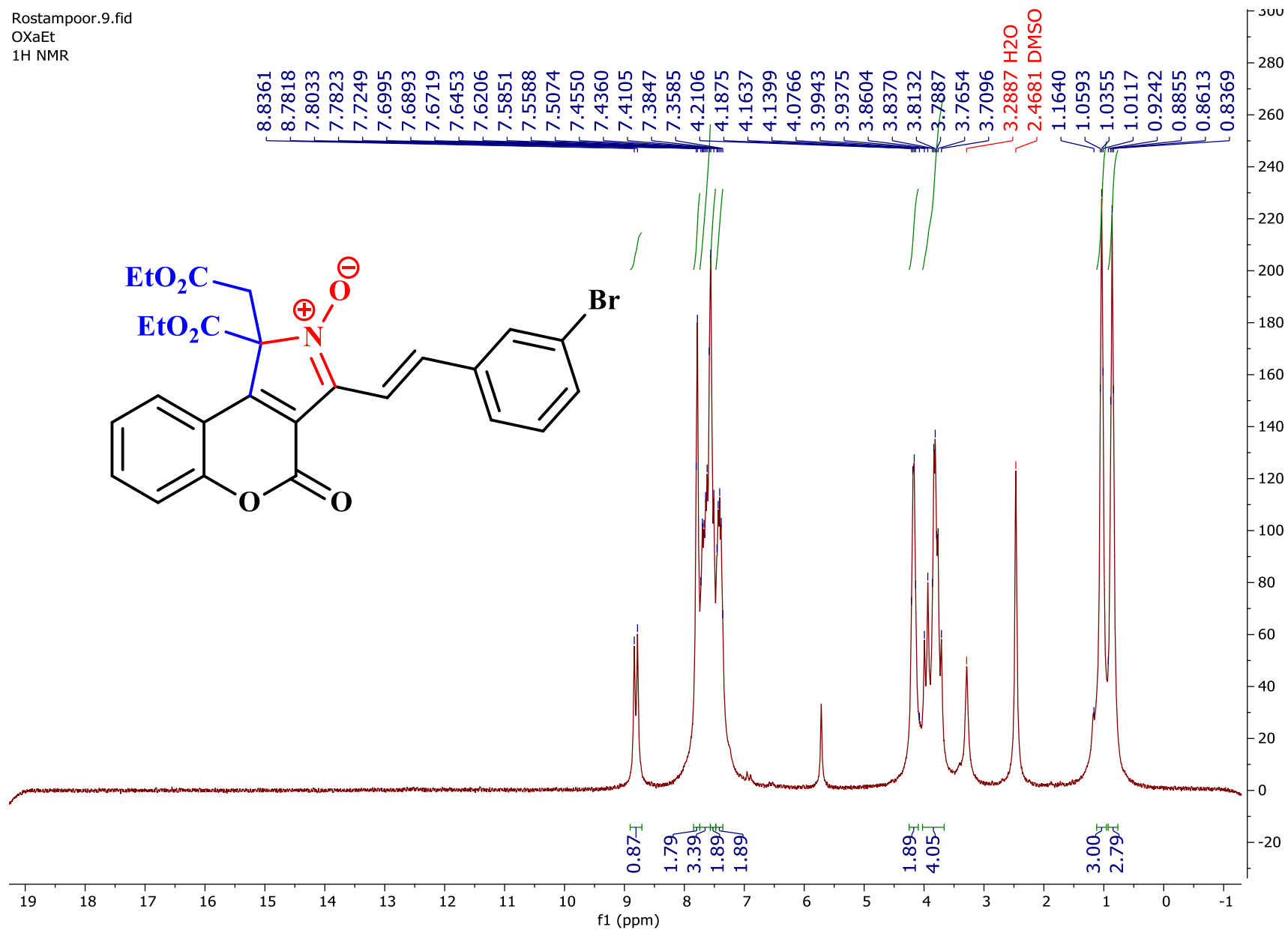


Mass spectrum of **6h**

S56

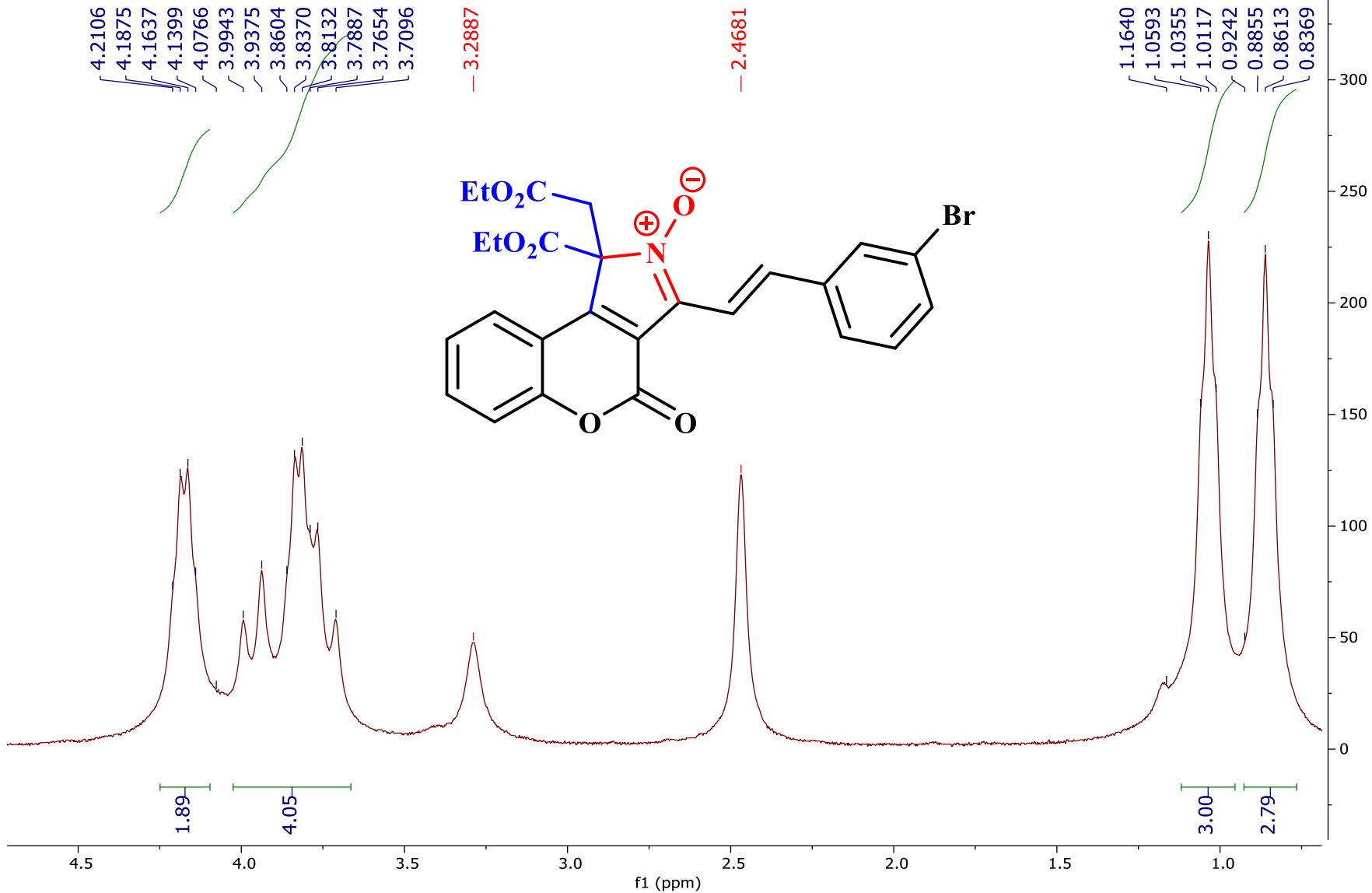


Rostampoor.9.fid  
OXaEt  
1H NMR



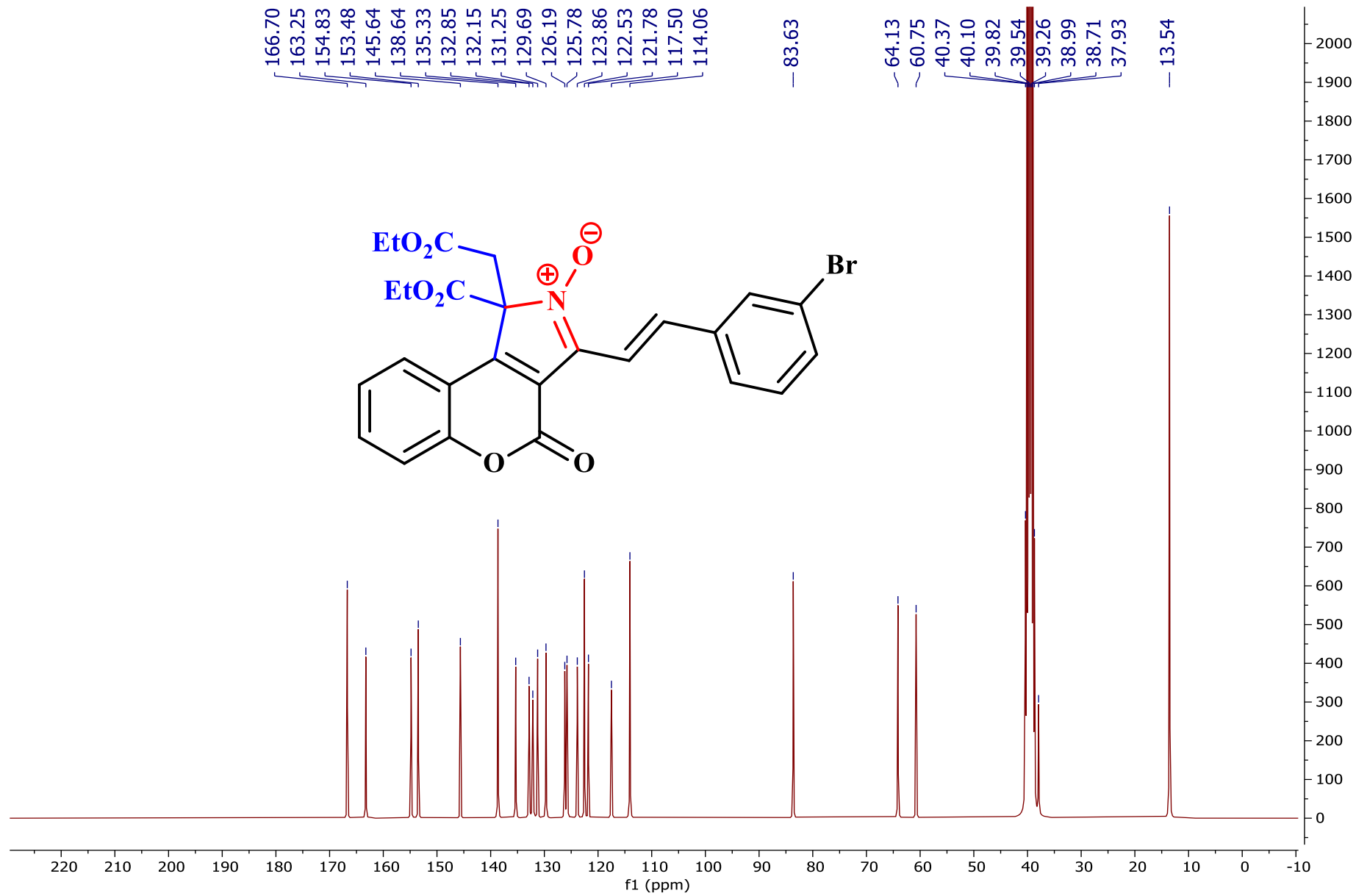
<sup>1</sup>H NMR Spectrum of **6i**  
S58

Rostampoor.9.fid  
OXaEt  
1H NMR

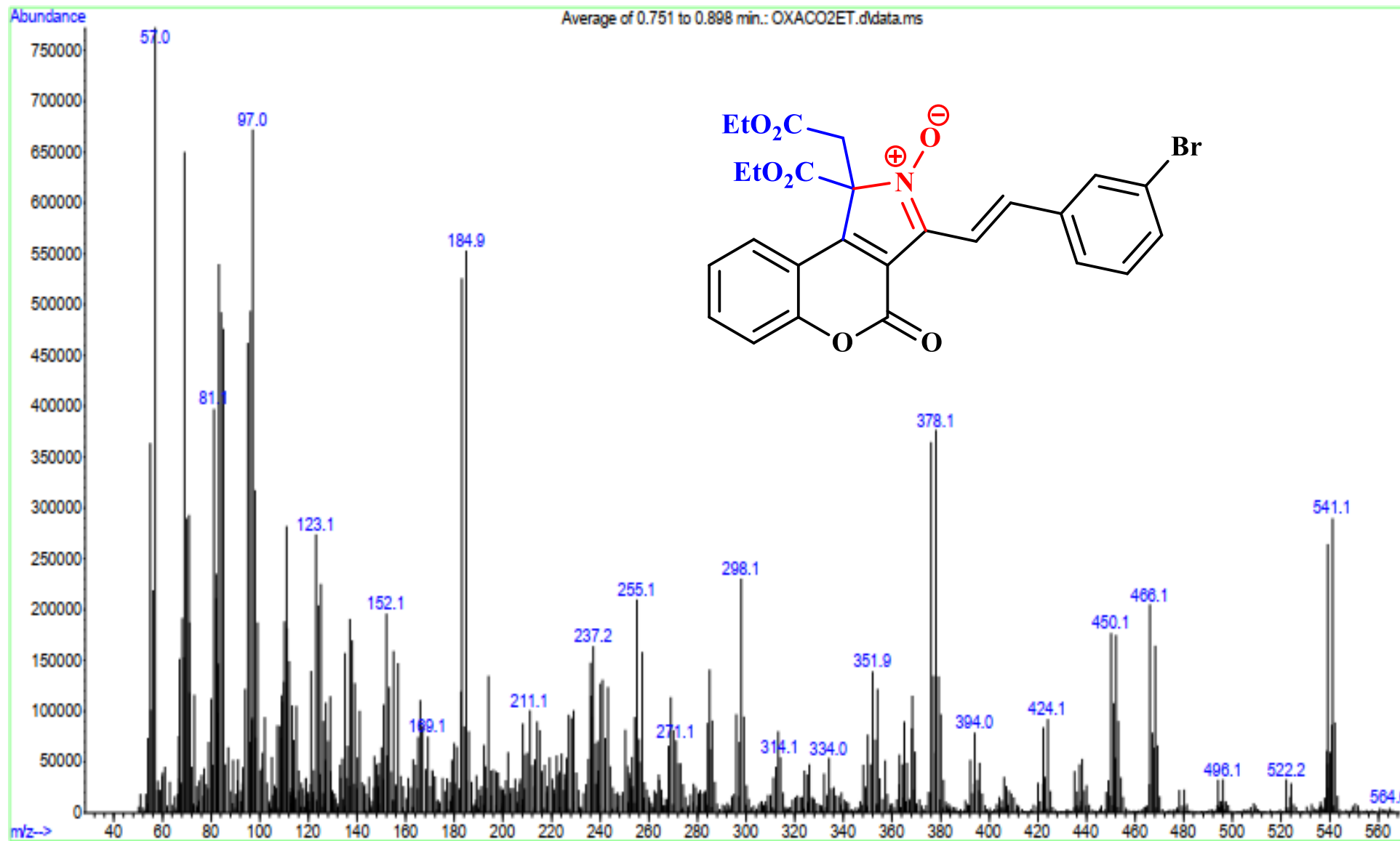


<sup>1</sup>H NMR Spectrum of **6i**

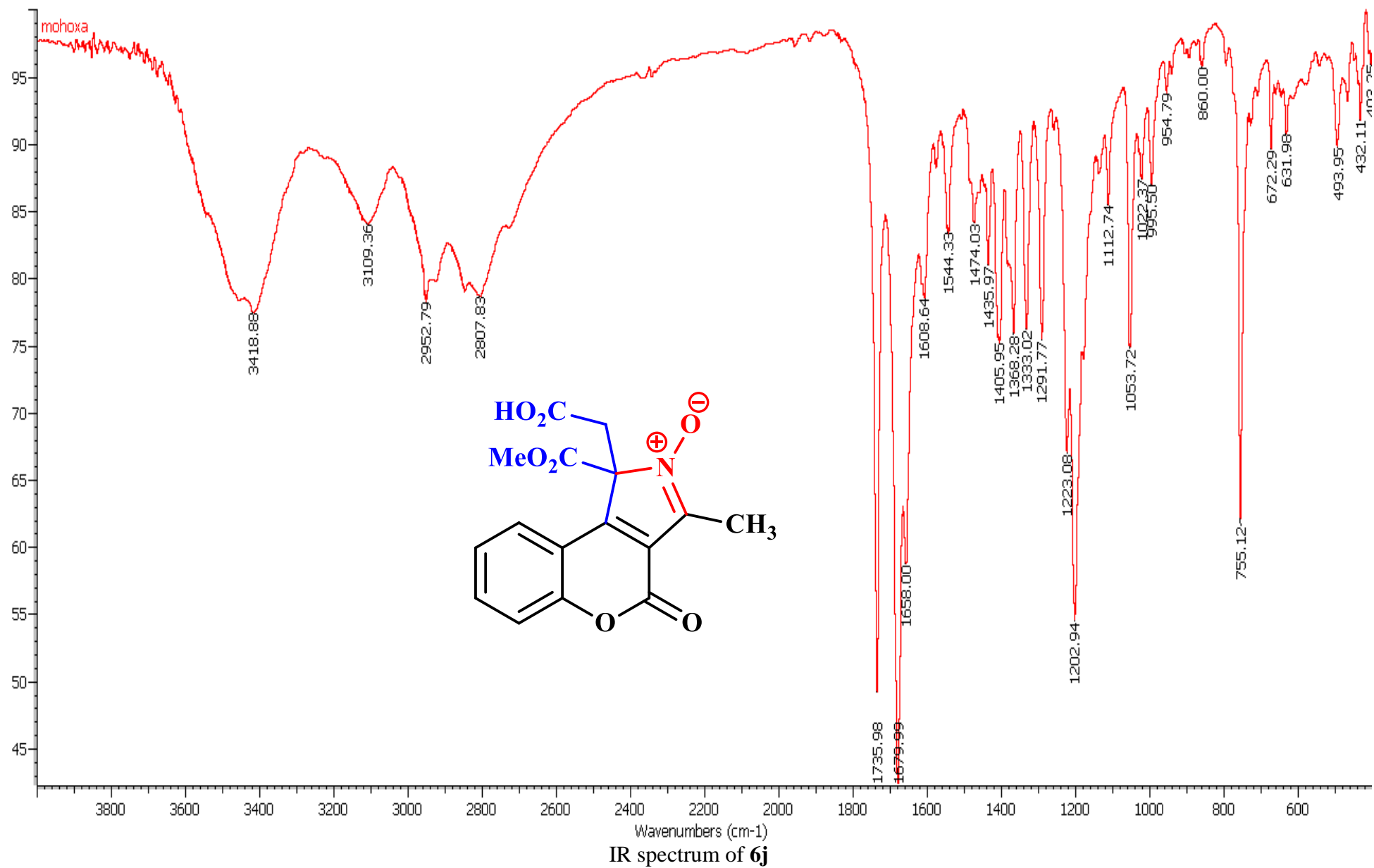
S59



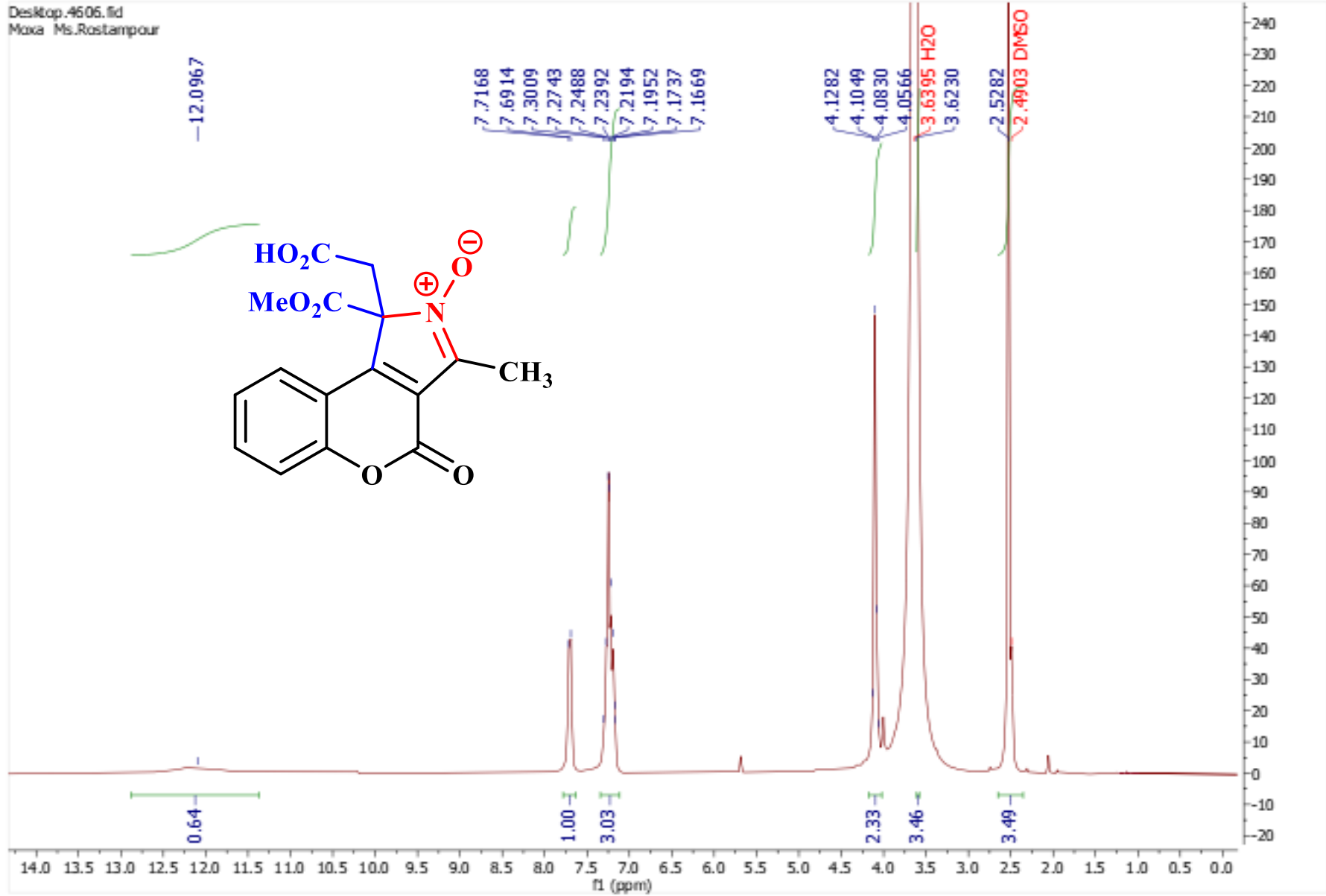
<sup>13</sup>C NMR Spectrum of **6i**



Mass spectrum of **6i**



Desktop\_4606.fid  
Moxa Ms.Rostampour

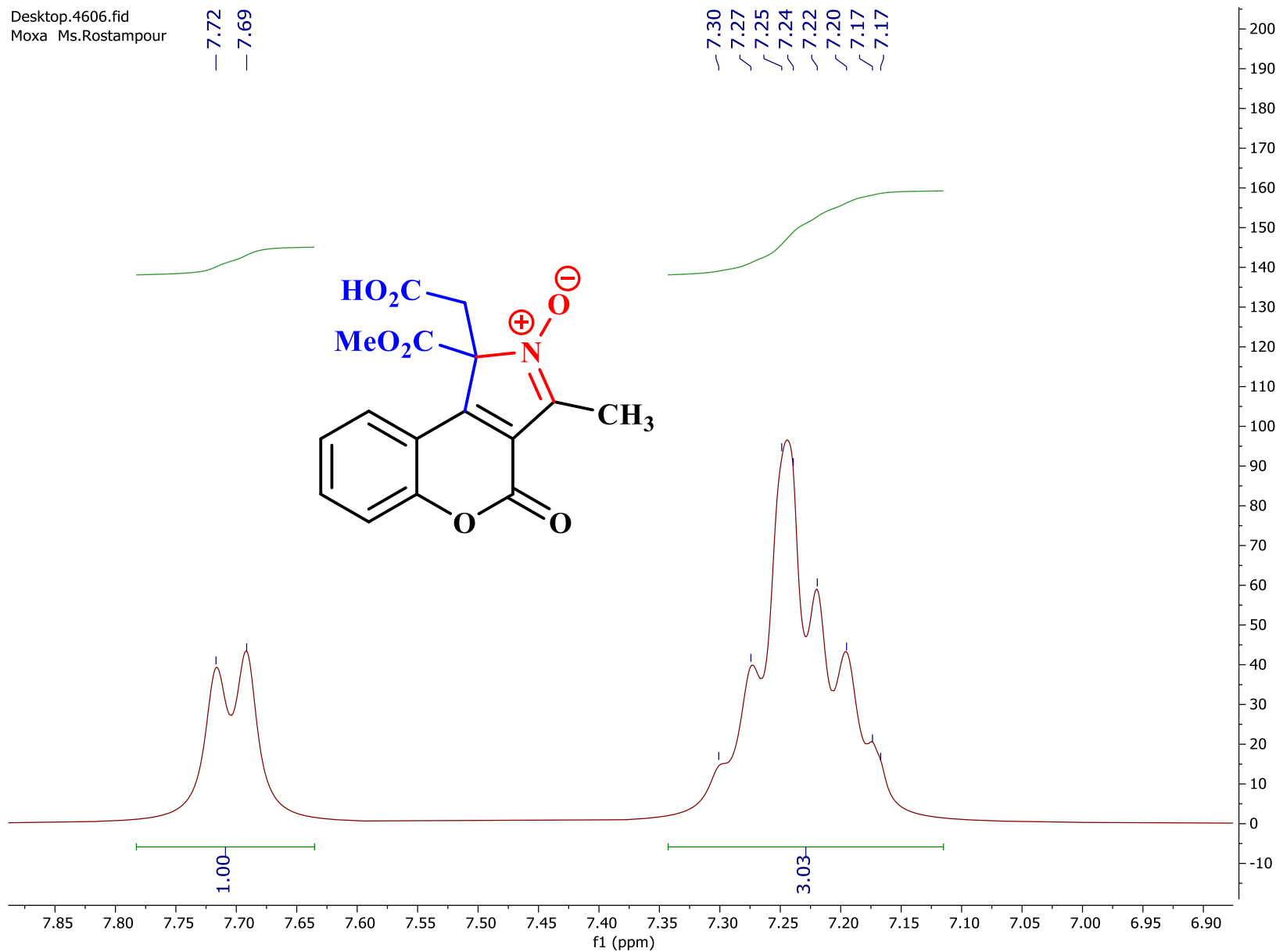


<sup>1</sup>H NMR Spectrum of **6j**  
S63

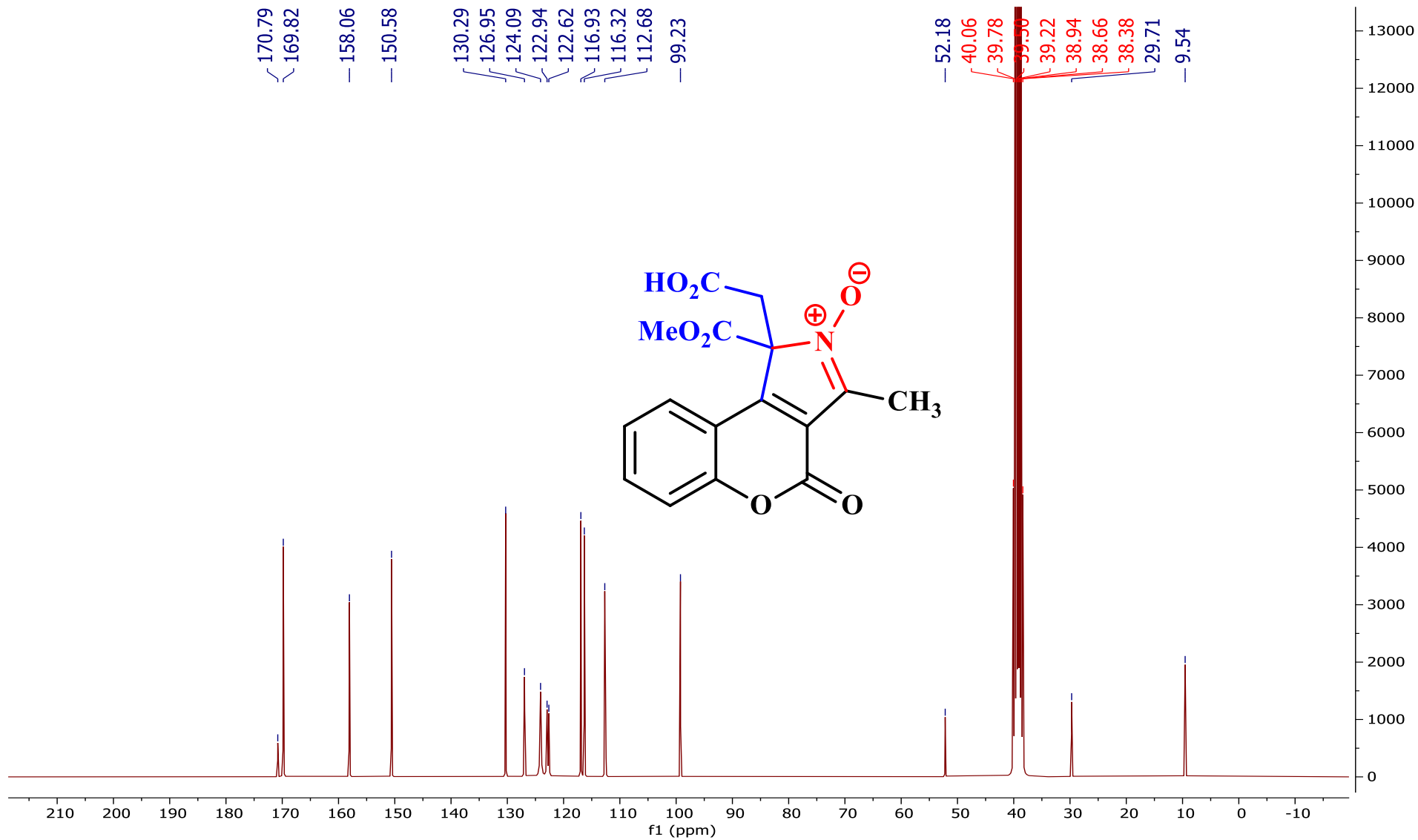
Desktop.4606.fid  
Moxa Ms.Rostampour

7.72  
7.69

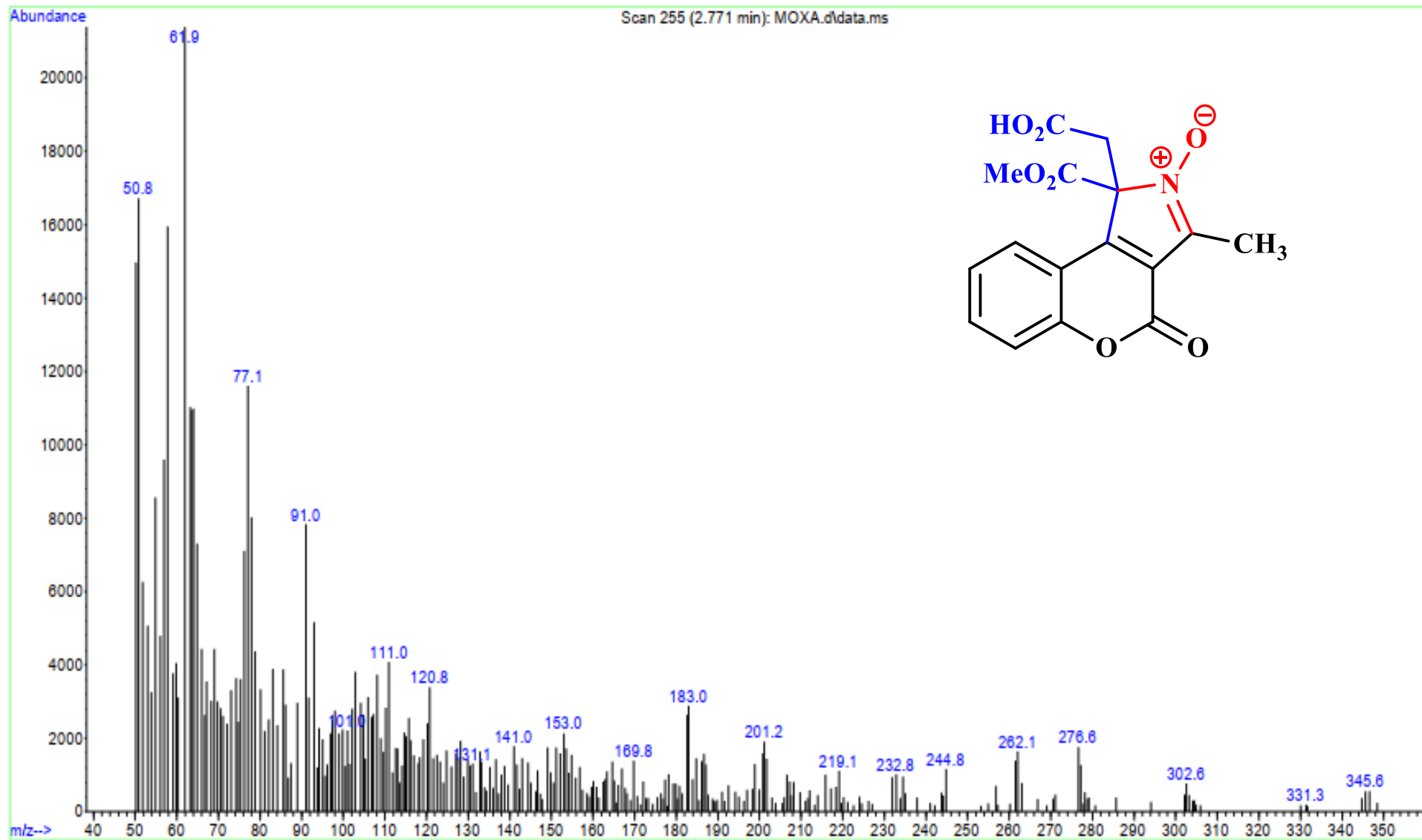
7.30  
7.27  
7.25  
7.24  
7.22  
7.20  
7.17  
7.17



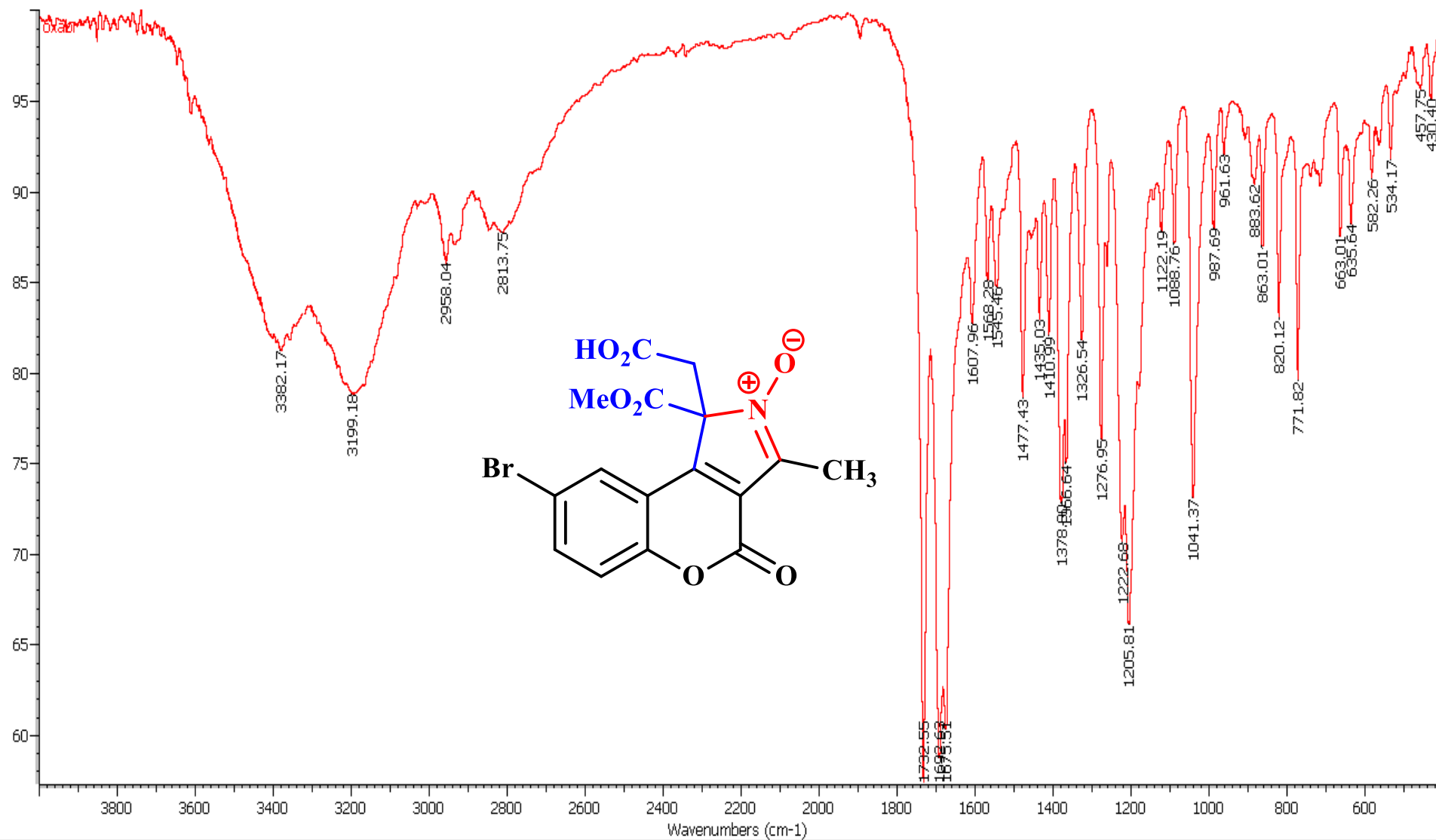
<sup>1</sup>H NMR Spectrum of **6j**



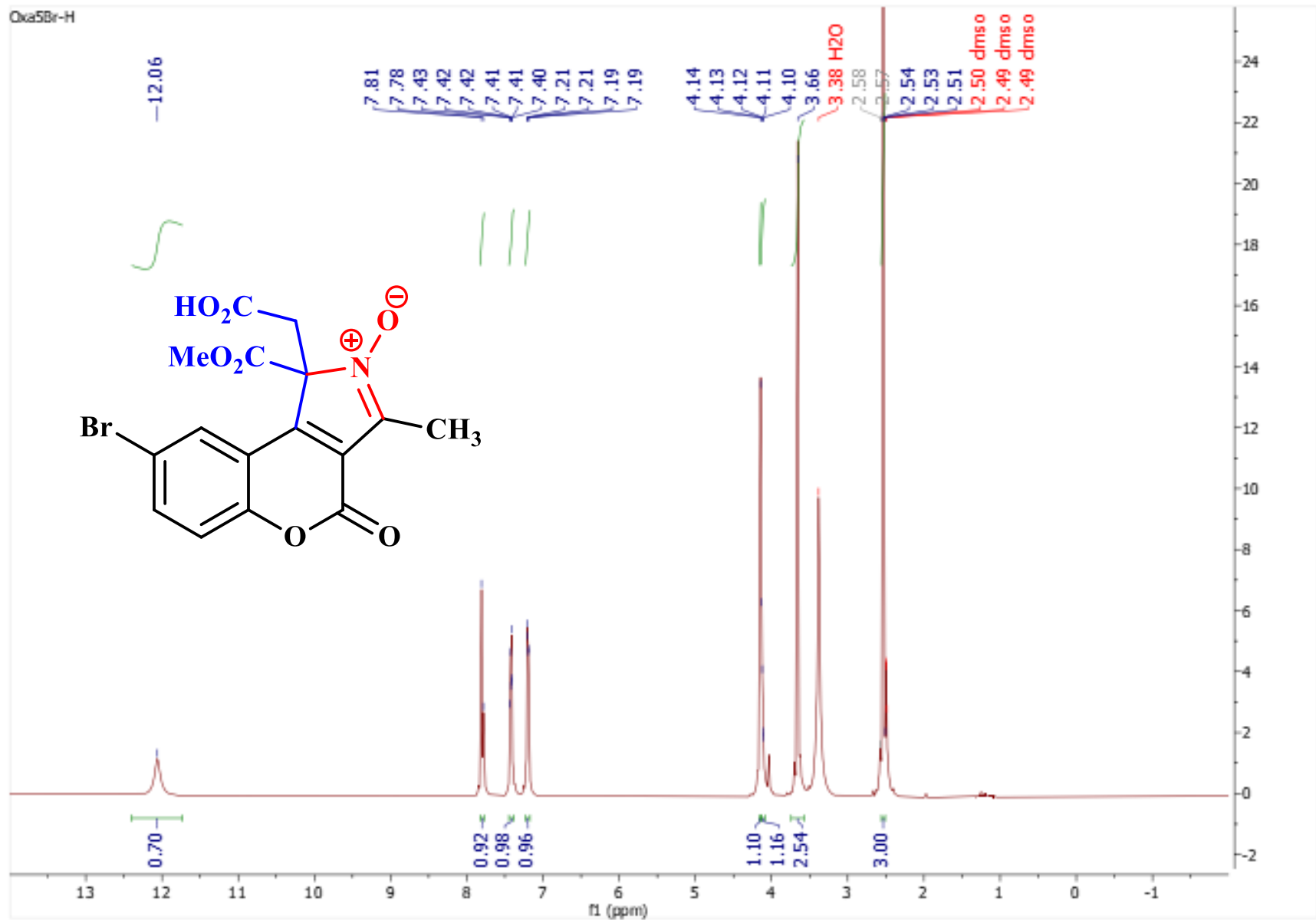
**<sup>13</sup>C NMR Spectrum of 6j**



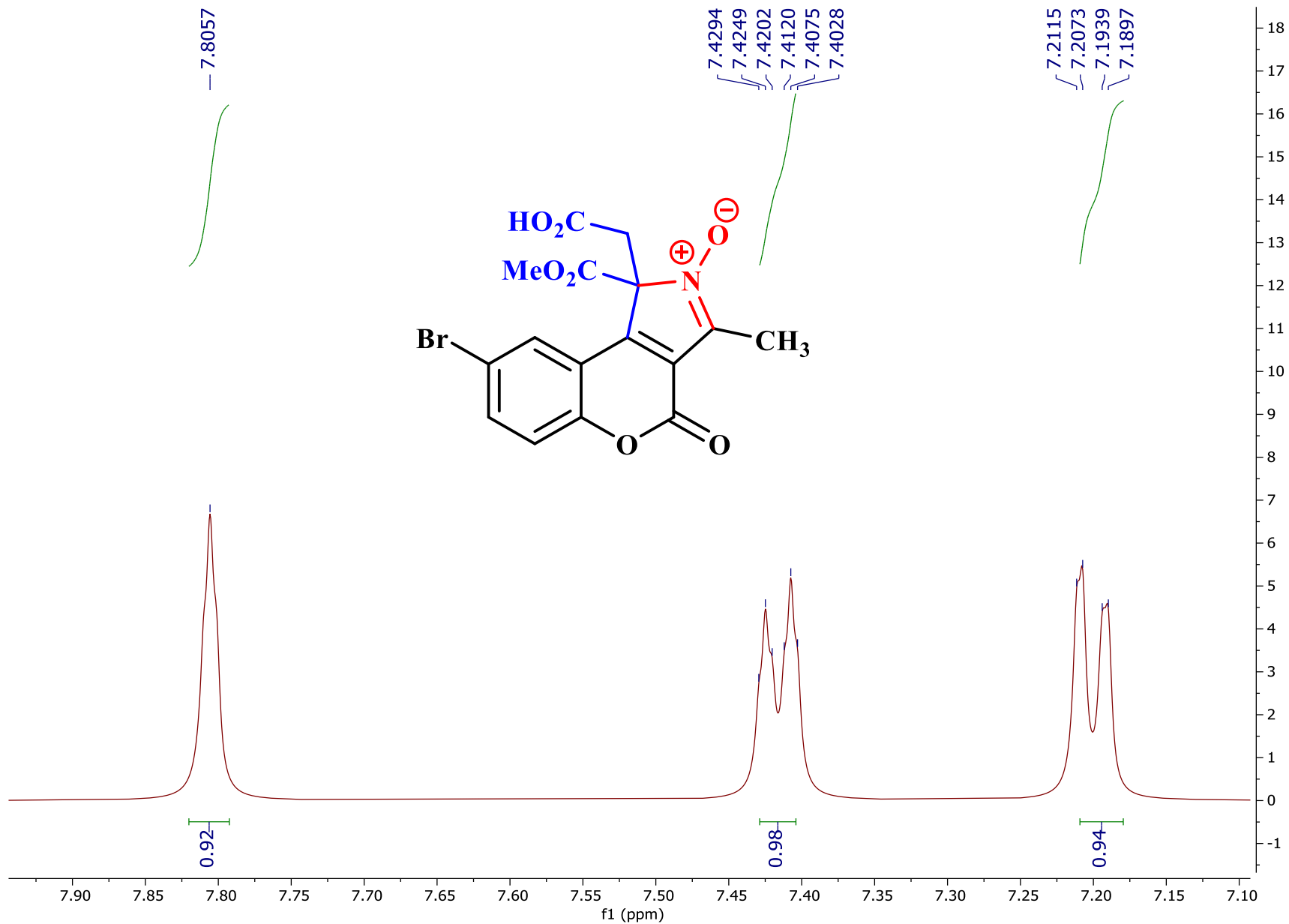
Mass spectrum of **6j**



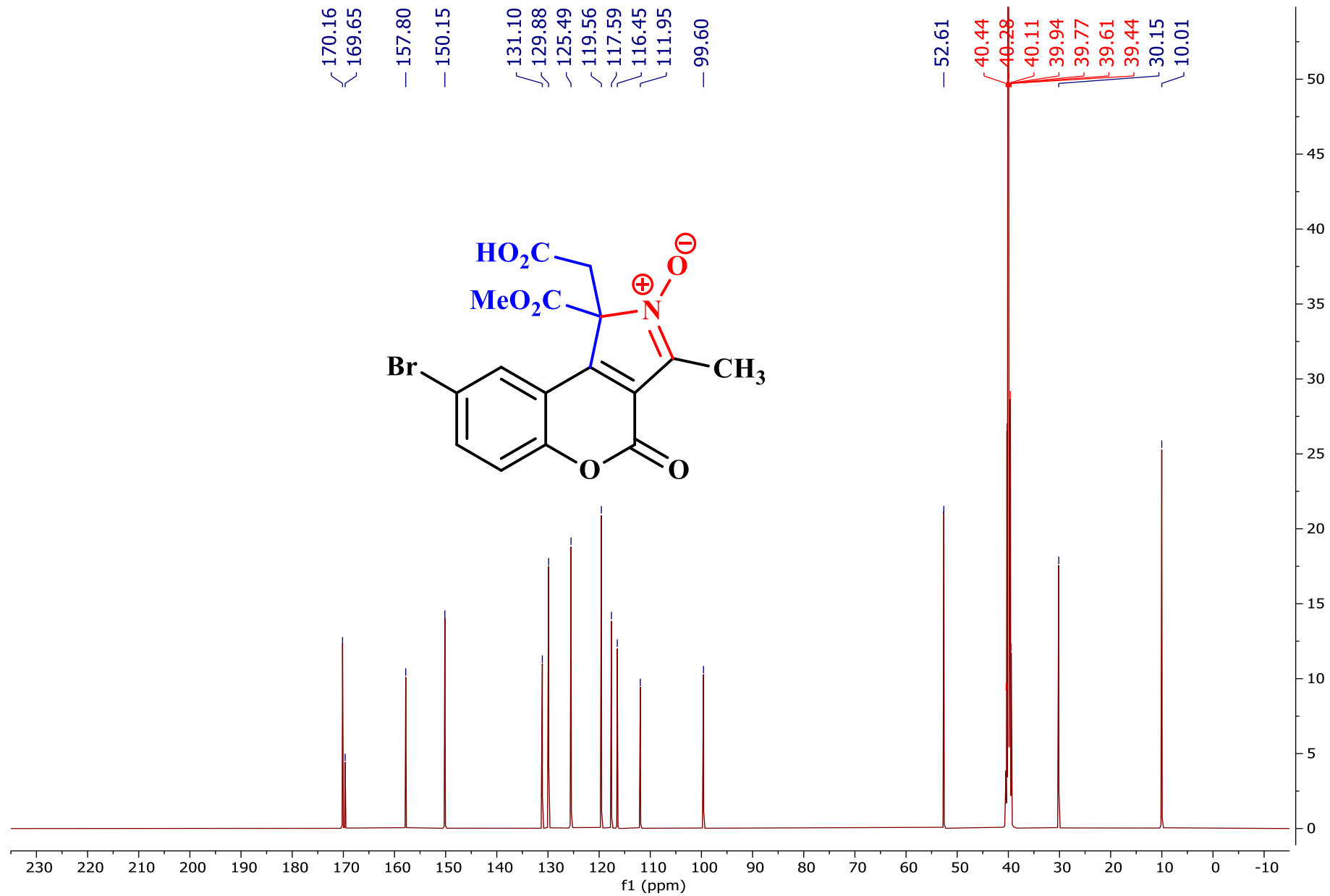
IR spectrum of **6k**



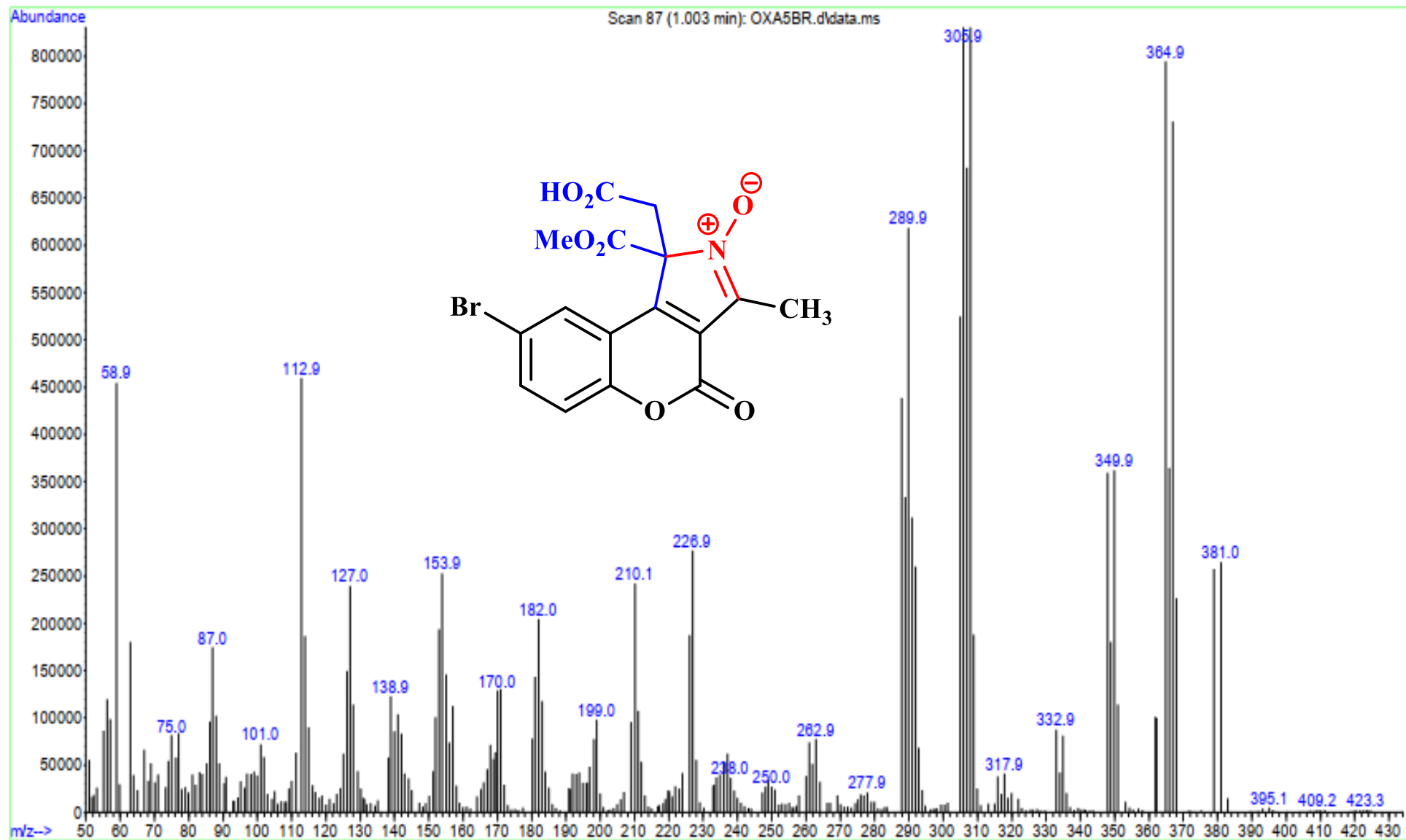
<sup>1</sup>H NMR Spectrum of **6k**



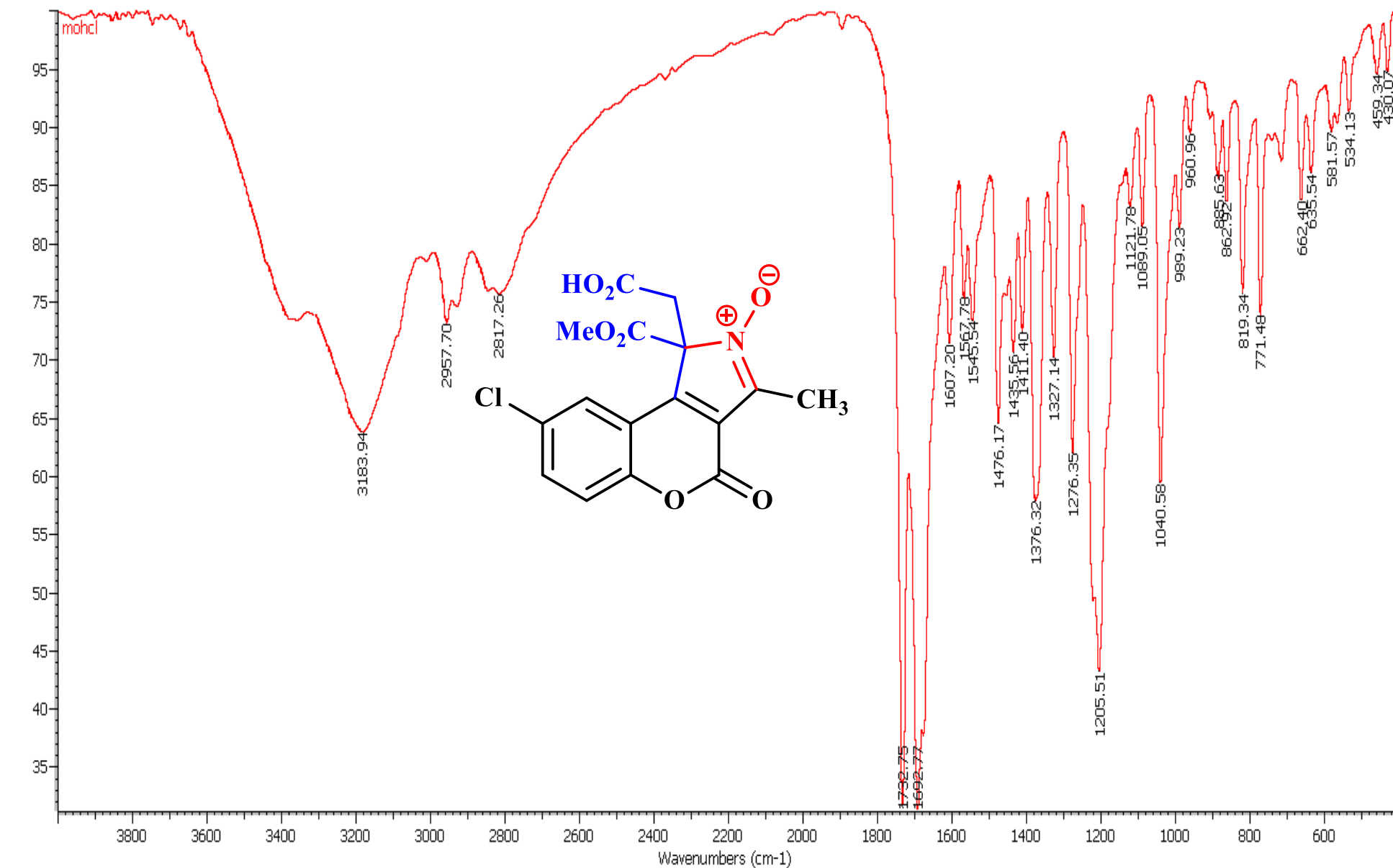
<sup>1</sup>H NMR Spectrum of **6k**  
S69



<sup>13</sup>C NMR Spectrum of **6k**  
S70

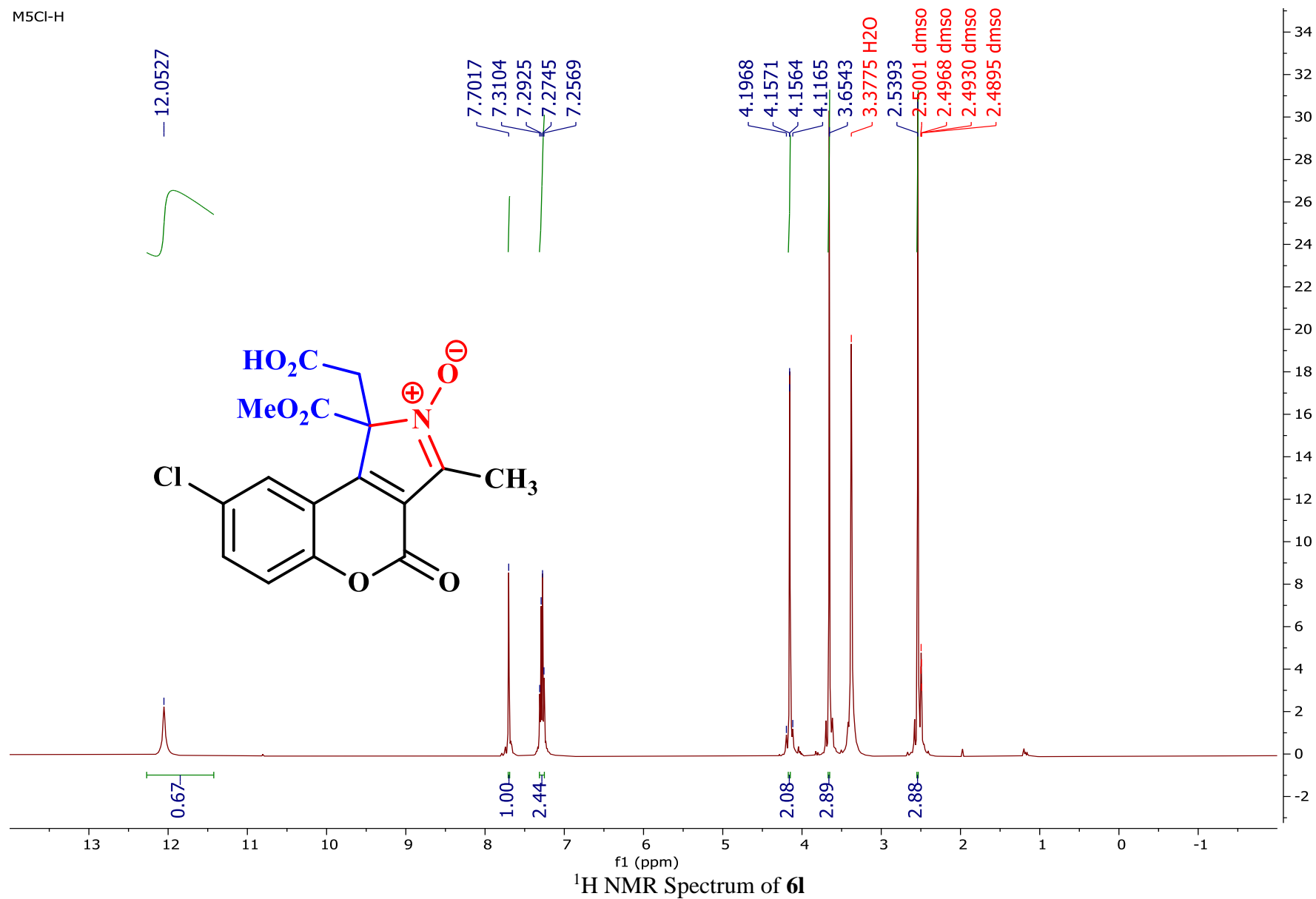


Mass spectrum of **6k**

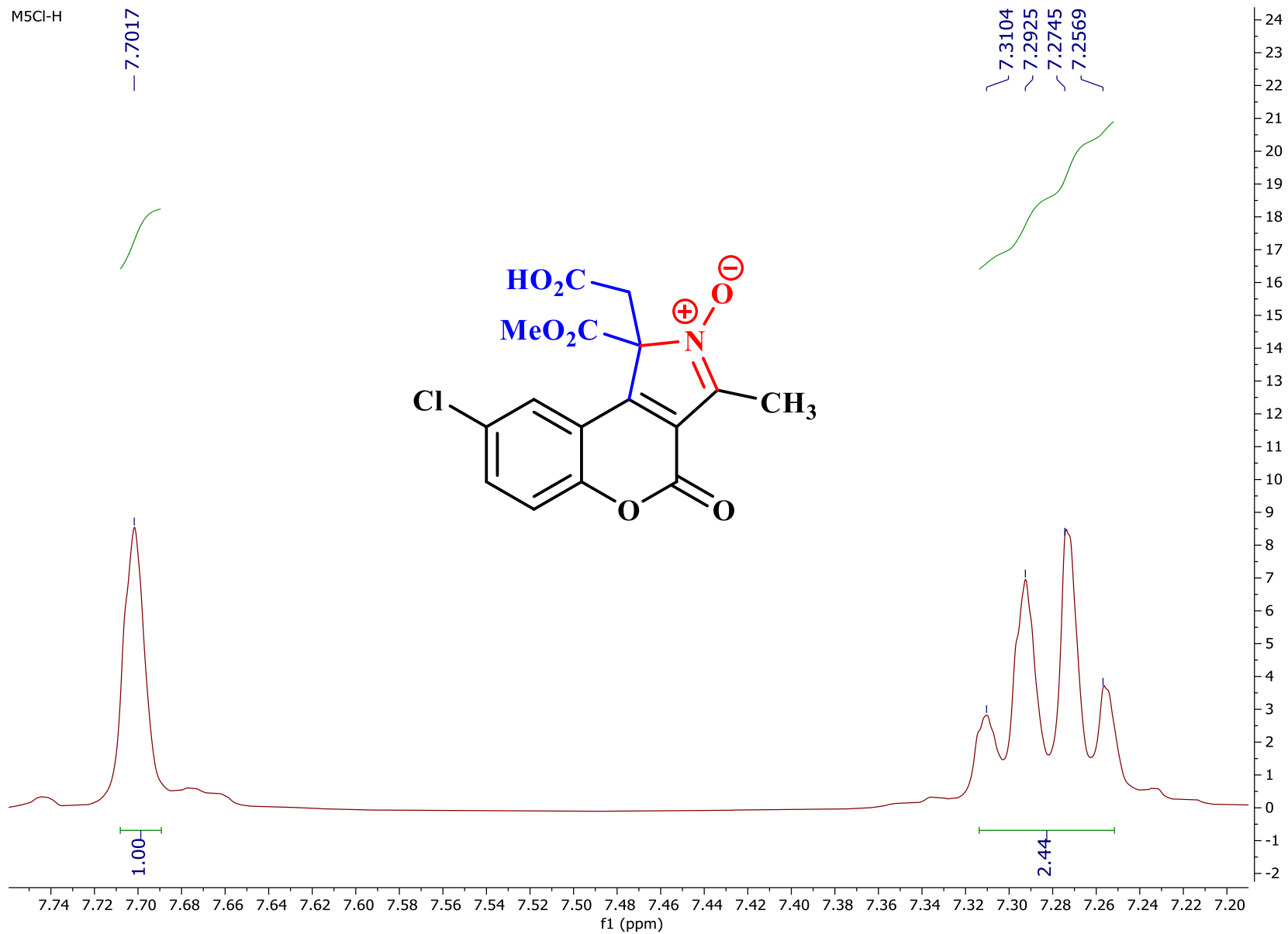


IR spectrum of **6l**

M5Cl-H

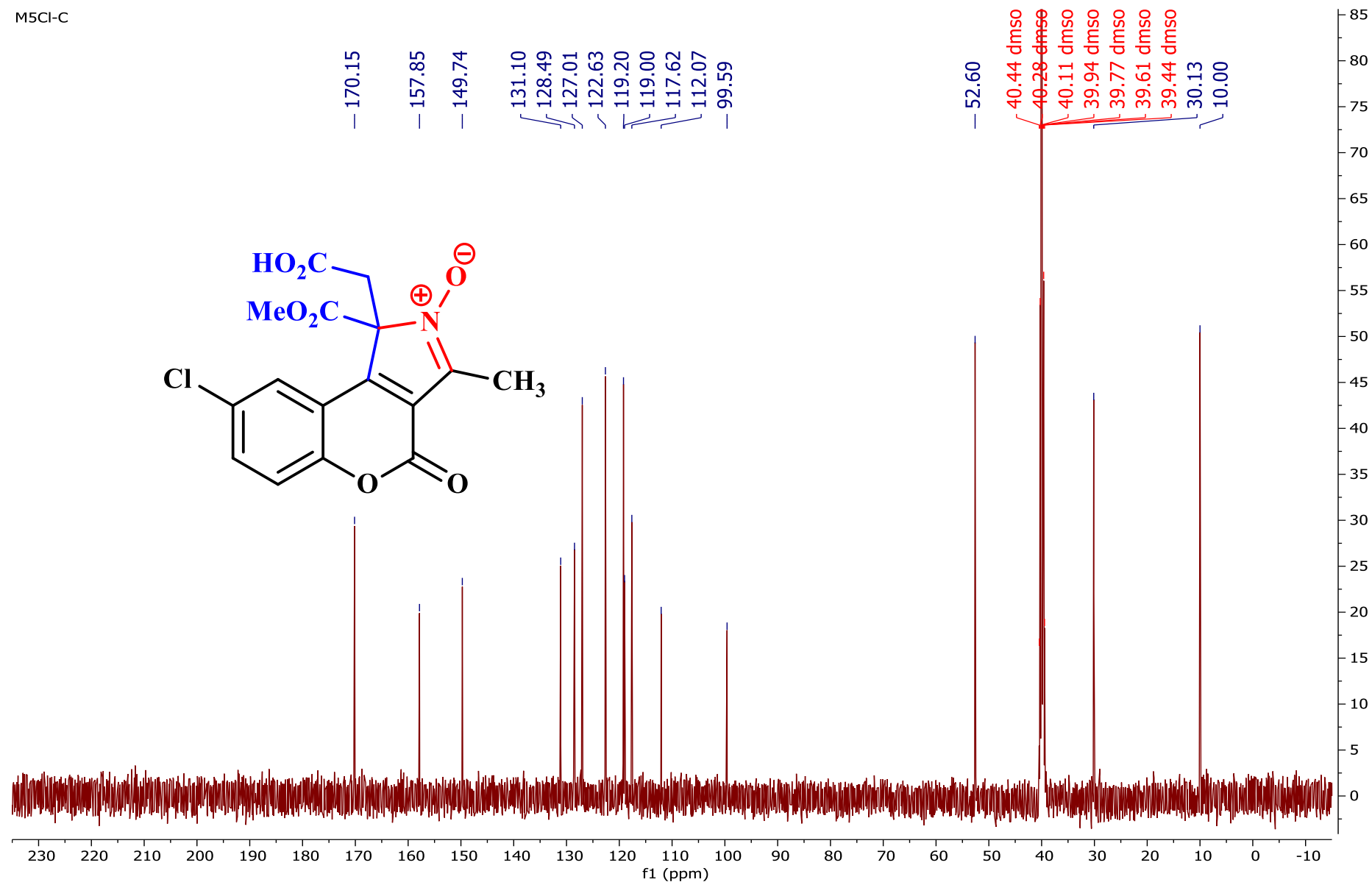


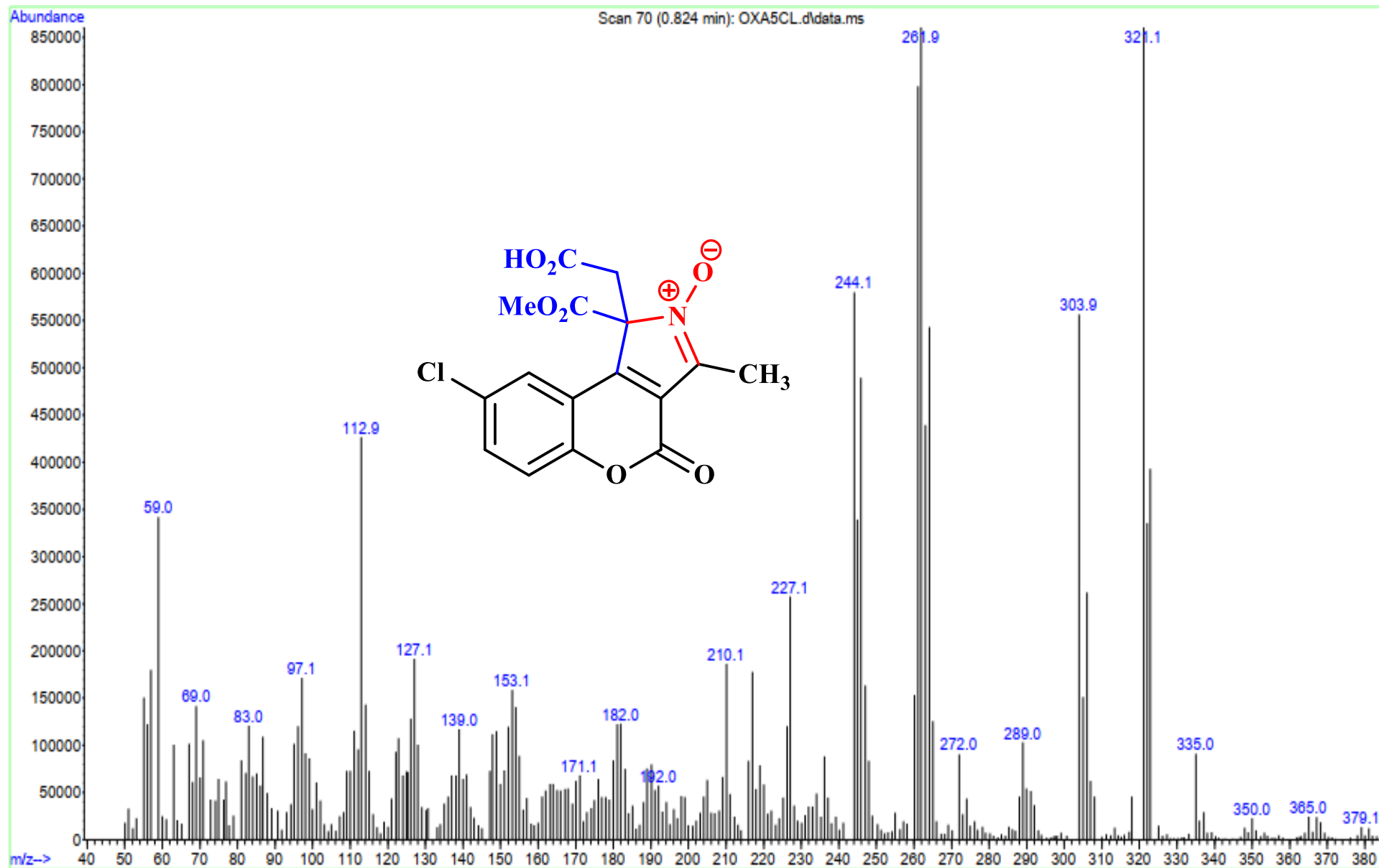
M5Cl-H



<sup>1</sup>H NMR Spectrum of **6l**

M5Cl-C





Mass spectrum of **61**