

## Pseudonitrosites as masked nitroalkenes in the Barton–Zard pyrrole synthesis

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Alexander V. Samet and Victor V. Semenov

**Methyl 3-(4,7-dimethoxy-1,3-benzo[*d*]dioxolan-5-yl)-4-methylpyrrole-2-carboxylate (4a):** 147 mg, 46% yield, mp 138–140 °C. <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.50 (s, 1H; NH), 6.81 (d, *J* = 2.6 Hz, 1H; H-5), 6.30 (s, 1H; Ar), 6.00 (s, 2H; OCH<sub>2</sub>O), 3.75 (s, 3H; OCH<sub>3</sub>), 3.59 (s, 3H; OCH<sub>3</sub>), 3.57 (s, 3H; OCH<sub>3</sub>), 1.80 ppm (s, 3H; CH<sub>3</sub>); <sup>13</sup>C NMR (125 MHz, [D<sub>6</sub>]DMSO): δ=160.6, 138.2, 138.1, 136.0, 135.2, 126.0, 121.4, 121.0, 119.5, 118.5, 110.0, 101.3, 59.3, 56.4, 50.5, 10.2 ppm; MS (EI, 70 eV): *m/z* (%) 319 (100) [M<sup>+</sup>], 304 (6), 287 (36), 272 (8), 242 (7), 214 (6); elemental analysis calcd (%) for C<sub>16</sub>H<sub>17</sub>NO<sub>6</sub>: C 60.18, H 5.37, N 4.39; found: C 60.39, H 5.27, N 4.16.

**Methyl 3-(6,7-dimethoxy-1,3-benzo[*d*]dioxolan-5-yl)-4-methylpyrrole-2-carboxylate (4b):** 201 mg, 63% yield, mp 94–95 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ=8.89 (s, 1H; NH), 6.76 (d, *J* = 3.2 Hz, 1H; H-5), 6.36 (s, 1H; Ar), 5.95 (m, 2H; OCH<sub>2</sub>O), 4.06 (s, 3H; OCH<sub>3</sub>), 3.69 (s, 3H; OCH<sub>3</sub>), 3.48 (s, 3H; OCH<sub>3</sub>), 1.92 ppm (s, 3H; CH<sub>3</sub>); <sup>13</sup>C NMR (125 MHz, [D<sub>6</sub>]DMSO): δ=161.4, 144.9, 144.1, 137.4, 136.9, 127.2, 121.6, 121.5, 120.2, 119.2, 104.6, 101.3, 60.9, 60.2, 51.2, 10.4 ppm; MS (EI, 70 eV): *m/z* (%) 319 (100) [M<sup>+</sup>], 304 (22), 287 (31), 272 (31), 242 (31), 144 (31); elemental analysis calcd (%) for C<sub>16</sub>H<sub>17</sub>NO<sub>6</sub>: C 60.18, H 5.37, N 4.39; found: C 60.42, H 5.43, N 4.06.

**Methyl 3-(7-methoxy-1,3-benzo[*d*]dioxolan-5-yl)-4-methylpyrrole-2-carboxylate (4c):** 127 mg, 44% yield, mp 129–131 °C. <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.55 (s, 1H; NH), 6.83 (d, *J* = 2.9 Hz, 1H; H-5), 6.50 (d, *J* = 1.4 Hz, 1H; Ar), 6.47 (d, *J* = 1.4 Hz, 1H; Ar), 6.00 (s, 2H; OCH<sub>2</sub>O), 3.80 (s, 3H; OCH<sub>3</sub>), 3.61 (s, 3H; OCH<sub>3</sub>), 1.90 ppm (s, 3H; CH<sub>3</sub>); <sup>13</sup>C NMR (125 MHz, [D<sub>6</sub>]DMSO): δ=160.6, 147.6, 142.4, 133.4, 130.0, 129.0, 121.6, 118.7, 117.5, 109.9, 104.1, 100.9, 56.2, 50.6, 10.5 ppm; MS (EI, 70 eV): *m/z* (%) 289 (100) [M<sup>+</sup>], 273 (1), 257 (87), 228 (7), 216 (5), 198 (5), 184 (6), 170 (5), 128 (7), 115 (6); elemental analysis calcd (%) for C<sub>15</sub>H<sub>15</sub>NO<sub>5</sub>: C 62.28, H 5.23, N 4.84; found: C 61.98, H 5.31, N 5.05.

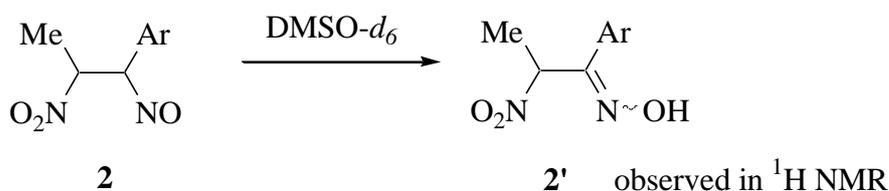
**Methyl 4-methyl-3-(2,3,4,5-tetramethoxyphenyl)-1*H*-pyrrole-2-carboxylate (4d):** 228 mg, 68% yield, yellowish oil. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ=9.00 (s, 1H; NH), 6.79 (d, *J* = 2.8 Hz, 1H; H-5), 6.47 (s, 1H; Ar), 3.95 (s, 3H; OCH<sub>3</sub>), 3.81 (s, 3H; OCH<sub>3</sub>), 3.69 (s, 3H; OCH<sub>3</sub>), 3.52 (s, 3H; OCH<sub>3</sub>), 1.95 ppm (s, 3H; CH<sub>3</sub>); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>): δ= 161.6, 148.6, 146.8, 145.8, 142.0, 127.1, 123.4, 121.3, 120.3, 119.3, 109.5, 61.3, 61.2, 60.9, 56.2, 51.2, 10.5 ppm; MS (EI, 70 eV): *m/z* (%) 335 (100) [M<sup>+</sup>], 320 (23), 303 (12), 288 (12), 273 (4), 260 (7), 245 (4), 230 (3), 202 (3), 174 (4), 152 (2); elemental analysis calcd (%) for C<sub>17</sub>H<sub>21</sub>NO<sub>6</sub>: C 60.89, H 6.31, N 4.18; found: C 61.08, H 6.40, N 3.91.

**1-(4,7-Dimethoxy-1,3-benzo[*d*]dioxolan-5-yl)-1-nitroso-2-nitropropane (2a):** 879 mg, 59% yield, mp 125-128 °C (decomp.). 2:3 Mixture of isomers in [D<sub>6</sub>]DMSO; data for minor isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.55 (s, 1H; NOH), 6.33 (s, 1H; Ar), 6.05 (s, 2H; OCH<sub>2</sub>O), 5.64 (q, *J* = 6.8 Hz, 1H; C(NO<sub>2</sub>)H), 3.79 (s, 3H; OCH<sub>3</sub>), 3.76 (s, 3H; OCH<sub>3</sub>), 1.62 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); data for major isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.90 (s, 1H; NOH), 6.52 (s, 1H; Ar), 6.06 (s, 2H; OCH<sub>2</sub>O), 5.77 (q, *J* = 6.8 Hz, 1H; C(NO<sub>2</sub>)H), 3.79 (s, 3H; OMe), 3.76 (s, 3H; OMe), 1.67 ppm (d, *J* = 6.9 Hz, 3H; CH<sub>3</sub>); IR (KBr): ν<sub>max</sub>/cm<sup>-1</sup> = 1553 (NO<sub>2</sub>), 1352, 1194, 1140, 1068; MS (EI, 70 eV): *m/z* (%) 298 (3) [M<sup>+</sup>], 268 (4), 238 (4), 222 (100), 206 (10), 177 (21), 149 (29); elemental analysis calcd (%) for C<sub>12</sub>H<sub>14</sub>N<sub>2</sub>O<sub>7</sub>: C 48.32, H 4.73, N 9.39; found: C 48.65, H 4.54, N 9.71.

**1-(6,7-Dimethoxy-1,3-benzo[*d*]dioxolan-5-yl)-1-nitroso-2-nitropropane (2b):** 1013 mg, 68% yield, mp 118-120 °C (decomp.). 2:3 Mixture of isomers in [D<sub>6</sub>]DMSO; data for minor isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.62 (s, 1H; NOH), 6.30 (s, 1H; Ar), 6.03 (s, 2H; OCH<sub>2</sub>O), 5.59 (q, *J* = 6.8 Hz, 1H; C(NO<sub>2</sub>)H), 3.66 (s, 3H; OCH<sub>3</sub>), 3.63 (s, 3H; OCH<sub>3</sub>), 1.61 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); data for major isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.92 (s, 1H; NOH), 6.51 (s, 1H; Ar), 6.05 (s, 2H; OCH<sub>2</sub>O), 5.74 (q, *J* = 6.9 Hz, 1H; C(NO<sub>2</sub>)H), 3.94 (s, 3H; OCH<sub>3</sub>), 3.93 (s, 3H; OCH<sub>3</sub>), 1.64 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); IR (KBr): ν<sub>max</sub>/cm<sup>-1</sup>=1558 (NO<sub>2</sub>), 1363, 1288, 1207, 1055; MS (EI, 70 eV): *m/z* (%) 298 (5) [M<sup>+</sup>], 267 (3), 234 (5), 222 (100), 207 (11), 177 (38), 149 (25); elemental analysis calcd (%) for C<sub>12</sub>H<sub>14</sub>N<sub>2</sub>O<sub>7</sub>: C 48.32, H 4.73, N 9.39; found: C 47.98, H 4.84, N 9.12.

**1-(7-Methoxy-1,3-benzo[*d*]dioxolan-5-yl)-1-nitroso-2-nitropropane (2c):** 1243 mg, 86% yield, mp 125-127 °C (decomp) (lit. [S1] mp 130-131 °C). 1:3 Mixture of isomers in [D<sub>6</sub>]DMSO; data for minor isomer <sup>1</sup>H NMR (500 MHz; [D<sub>6</sub>]DMSO): δ=11.71 (s, 1H; NOH), 6.79 (d, *J* = 1.4 Hz, 1H; Ar), 6.73 (d, *J* = 1.4 Hz, 1H; Ar), 6.05 (m, 3H; C(NO<sub>2</sub>)H, OCH<sub>2</sub>O), 3.81 (s, 3H; OCH<sub>3</sub>), 1.66 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); data for major isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.90 (s, 1H; NOH), 6.89 (d, *J* = 1.4 Hz, 1H; Ar), 6.86 (d, *J* = 1.4 Hz, 1H; Ar), 6.05 (m, 3H; C(NO<sub>2</sub>)H, OCH<sub>2</sub>O), 3.88 (s, 3H; OCH<sub>3</sub>), 1.81 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); IR (KBr): ν<sub>max</sub>/cm<sup>-1</sup>=1558 (NO<sub>2</sub>), 1361, 1199, 1131, 1098; MS (EI, 70 eV): *m/z* (%) 268 (9) [M<sup>+</sup>], 237 (3), 205 (4), 192 (100), 191 (26), 179 (17).

**1-(2,3,4,5-Tetramethoxyphenyl)-1-nitroso-2-nitropropane (2d):** 534 mg, 34% yield, mp 132-135 °C (decomp). 1:2 Mixture of isomers in [D<sub>6</sub>]DMSO; data for minor isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=11.65 (s, 1H; NOH), 6.46 (s, 1H; Ar), 5.63 (q, *J* = 6.8 Hz, 1H; C(NO<sub>2</sub>)H), 3.82 (s, 3H; OCH<sub>3</sub>), 3.78 (s, 3H; OCH<sub>3</sub>), 3.73 (s, 3H; OCH<sub>3</sub>), 3.67 (s, 3H; OCH<sub>3</sub>), 1.62 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); data for major isomer <sup>1</sup>H NMR (500 MHz, [D<sub>6</sub>]DMSO): δ=12.00 (s, 1H; NOH), 6.66 (s, 1H; Ar), 5.75 (q, *J* = 6.8 Hz, 1H; C(NO<sub>2</sub>)H), 3.83 (s, 3H; OCH<sub>3</sub>), 3.79 (s, 3H; OCH<sub>3</sub>), 3.77 (s, 3H; OCH<sub>3</sub>), 3.70 (s, 3H; OCH<sub>3</sub>), 1.68 ppm (d, *J* = 6.8 Hz, 3H; CH<sub>3</sub>); IR (KBr): ν<sub>max</sub>/cm<sup>-1</sup>=1549 (NO<sub>2</sub>), 1352, 1134; MS (EI, 70 eV): *m/z* (%) 314 (8) [M<sup>+</sup>], 250 (5), 238 (100), 223 (14), 207 (7), 192 (31); elemental analysis calcd (%) for C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>O<sub>7</sub>: C 49.68, H 5.77, N 8.91; found: C 50.00, H 5.65, N 9.19.



**Scheme S1** Isomerization of pseudonitrosites **2** to the  $\alpha$ -nitro oximes **2'**

Since  $^1\text{H}$  NMR-spectra of the compounds **2** showed only the signals of nitrooximes **2'**, a control experiment was conducted in order to further investigate the isomerization of pseudonitrosites **2** to  $\alpha$ -nitrooximes **2'** - for this purpose, IR- and mass-spectra of pseudonitrosites **2b** and  $\alpha$ -nitrooxime **2'b** were compared. As anticipated, the mass-spectrum of the isomerization product ( $\alpha$ -nitrooxime **2'b**) was quite different from that of the starting pseudonitrosite **2b** (in particular, the former did not show a [M-76] peak which was the most abundant in the mass-spectrum of **2b**). At the same time, IR-spectrum of  $\alpha$ -nitrooxime **2'b** featured an additional absorption band at ca.  $3200\text{ cm}^{-1}$  obviously corresponding to the O-H group.

IR spectra were measured on a Perkin-Elmer RX-1 spectrometer in the range of  $700\text{--}4000\text{ cm}^{-1}$  in pallets with KBr. Mass spectra were obtained using a Finnigan Mat IncoS 50 mass spectrometer, the ionization energy was 70 eV. NMR spectra were recorded on Bruker DRX-500 instrument at  $30\text{ }^\circ\text{C}$ . Elemental analysis was performed on Perkin Elmer 2400 instrument.

**Isomerization of 2b to 2'b** [S2]. A solution of pseudonitrosite **2b** (50 mg) in DMSO (1 ml) was kept at  $50\text{ }^\circ\text{C}$  for 1 h, poured into ice water (10 ml) and extracted with  $\text{CH}_2\text{Cl}_2$  ( $3 \times 5\text{ ml}$ ). The solvent was removed in vacuo to produce 42 mg (84%) of **2'b**.  $^1\text{H}$  NMR of the latter was identical to that of **2b**, IR- and mass-spectra are described below.

**1-(6,7-Dimethoxy-1,3-benzo[*d*]dioxolan-5-yl)-1-hydroxyimino-2-nitropropane (2'b)** IR (KBr)  $\nu_{\text{max}}/\text{cm}^{-1}$  3182 (OH), 1554 ( $\text{NO}_2$ ), 1459, 1388, 1279, 1198, 1055. EIMS  $m/z$  298 ( $\text{M}^+$ , 11%), 234 (27), 193 (45), 77 (48), 66 (50), 30 (78), 15 (100).

**References**

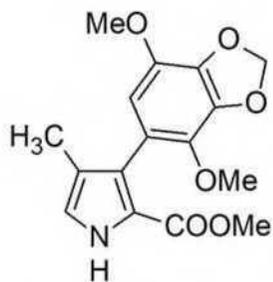
- [S1] E. Rimini, *Gazz. Chim. Ital.*, 1905, **35** (I), 406.  
 [S2] D. Klamann, W. Koser, P. Weyerstahl and M. Fligge, *Chem. Ber.*, 1965, **98**, 1831.



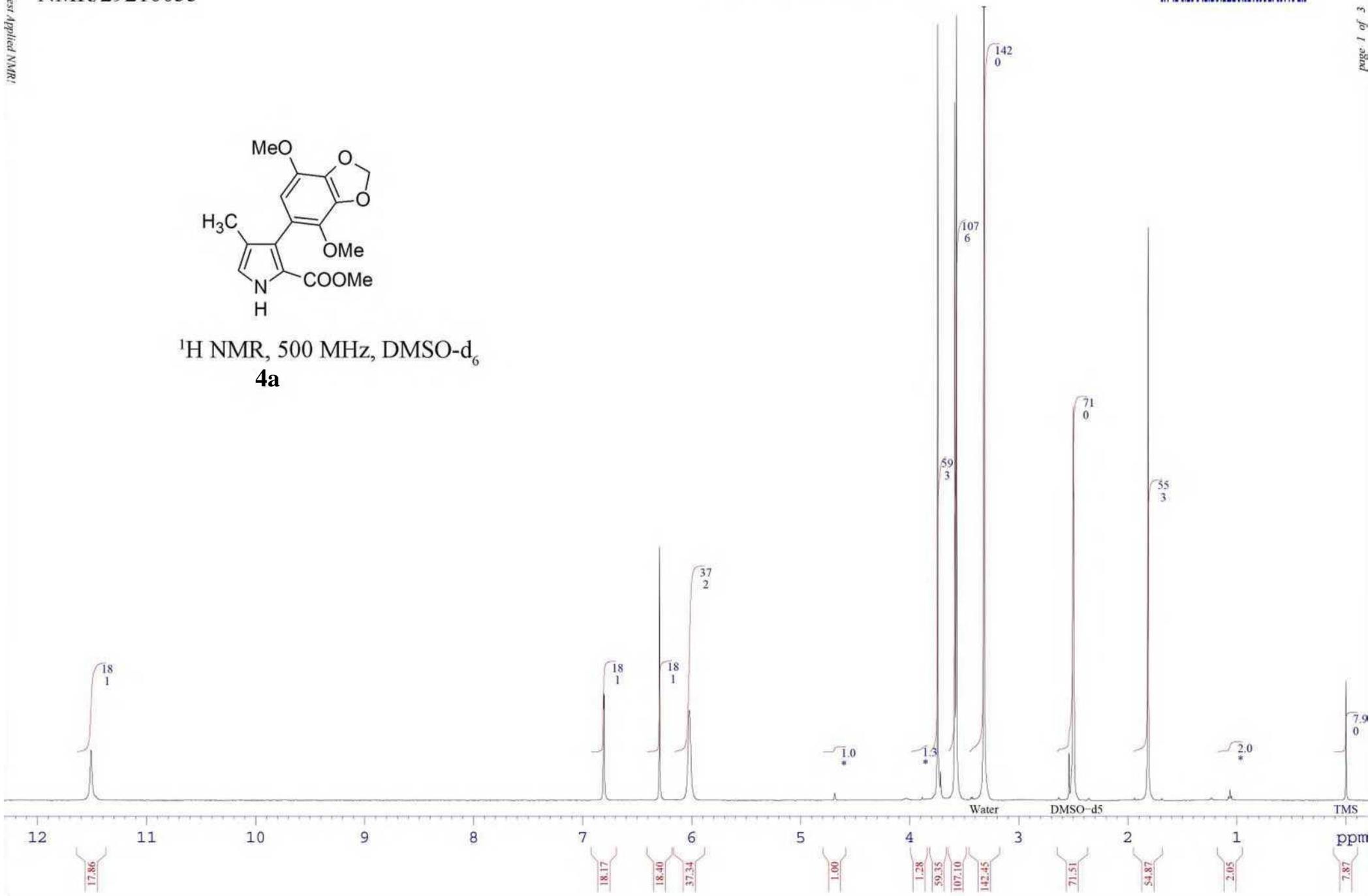
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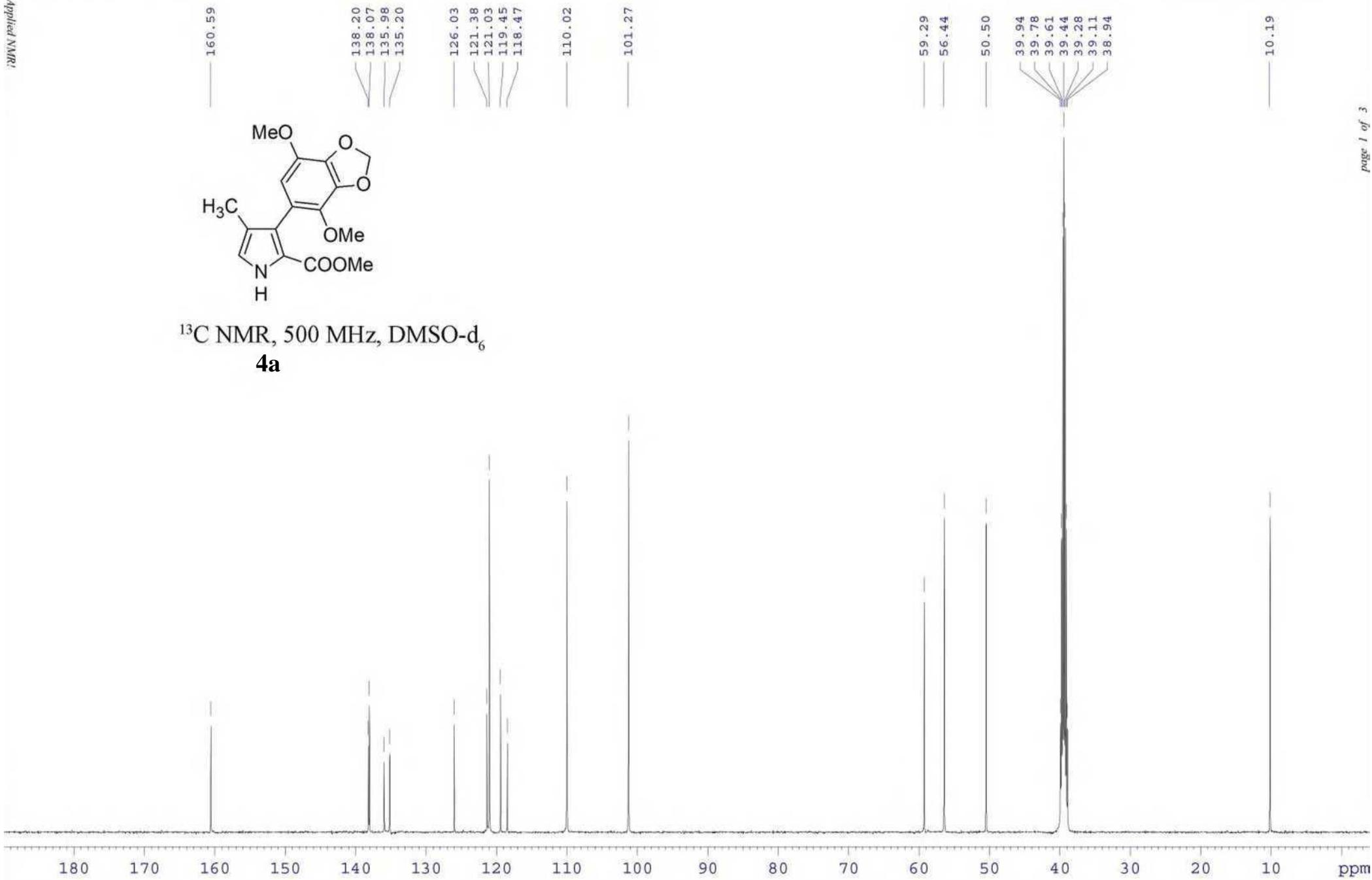
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**4a**



# NMR/29210055



<sup>13</sup>C NMR, 500 MHz, DMSO-d<sub>6</sub>  
**4a**

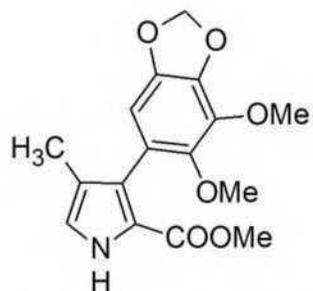


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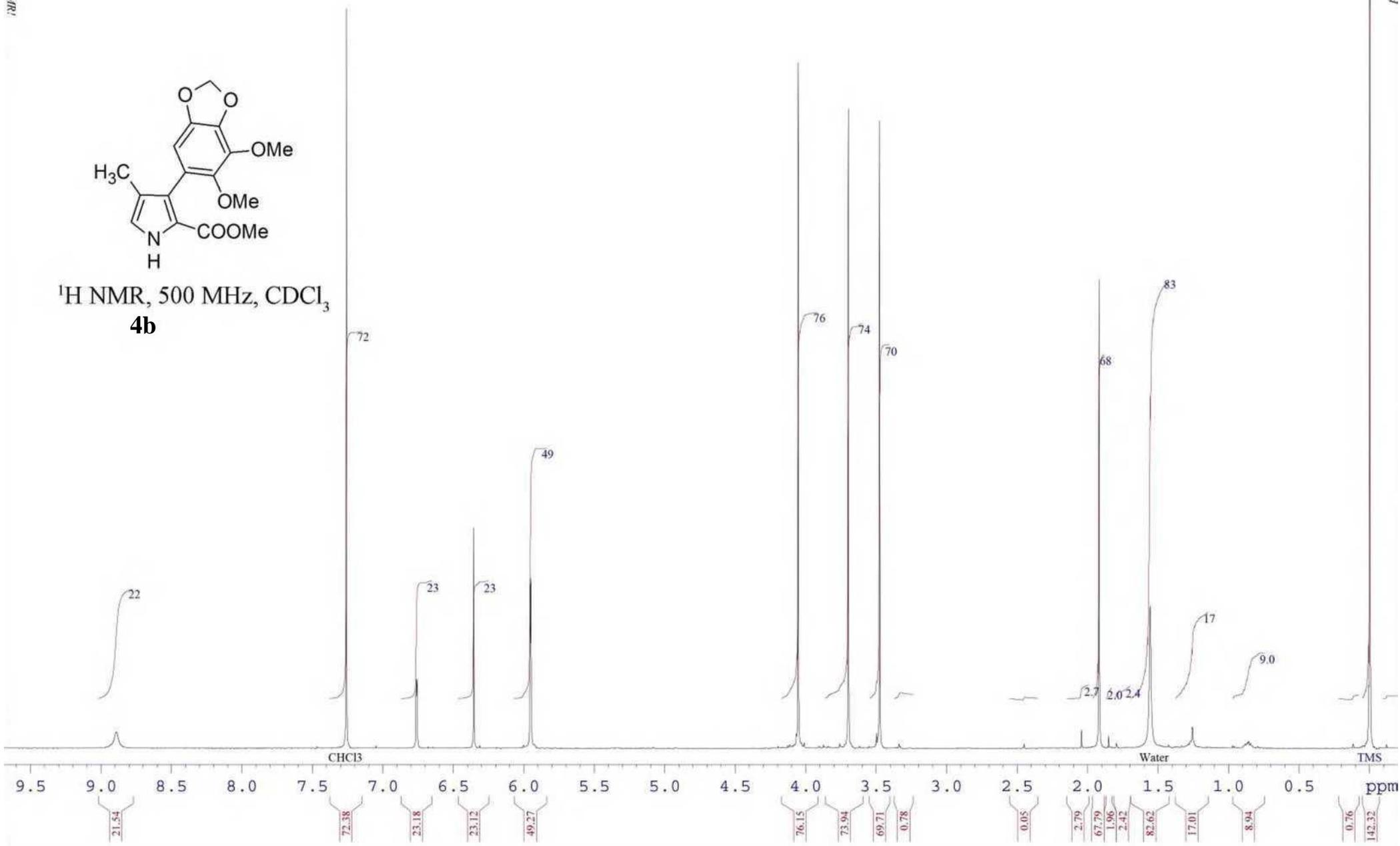


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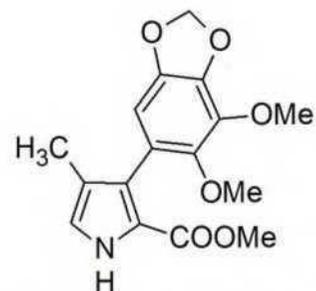
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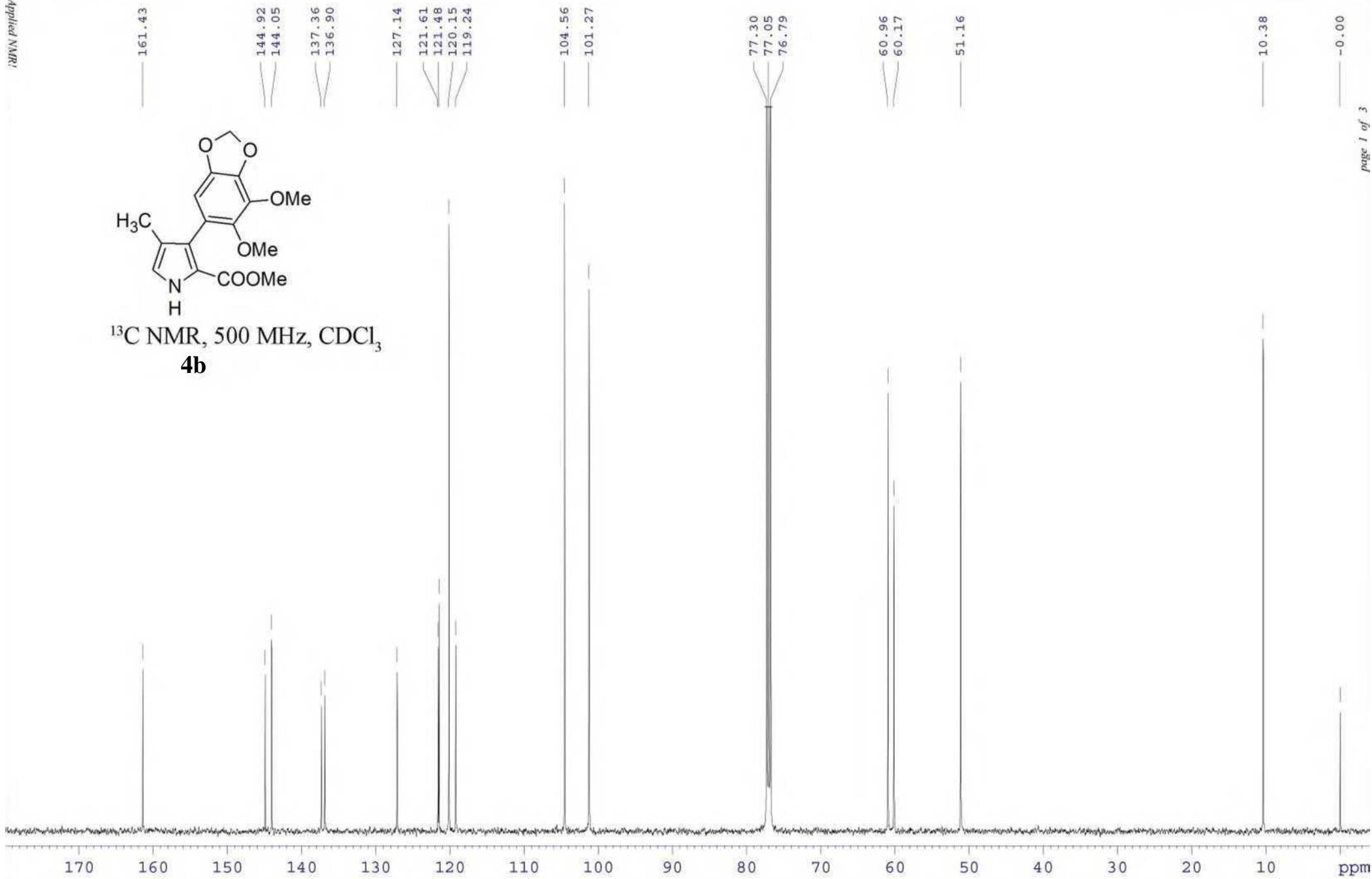
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**4b**



# NMR/29310010



<sup>13</sup>C NMR, 500 MHz, CDCl<sub>3</sub>  
**4b**

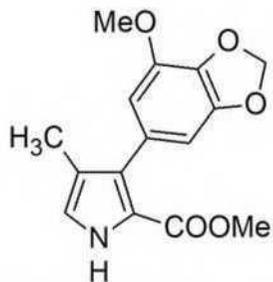




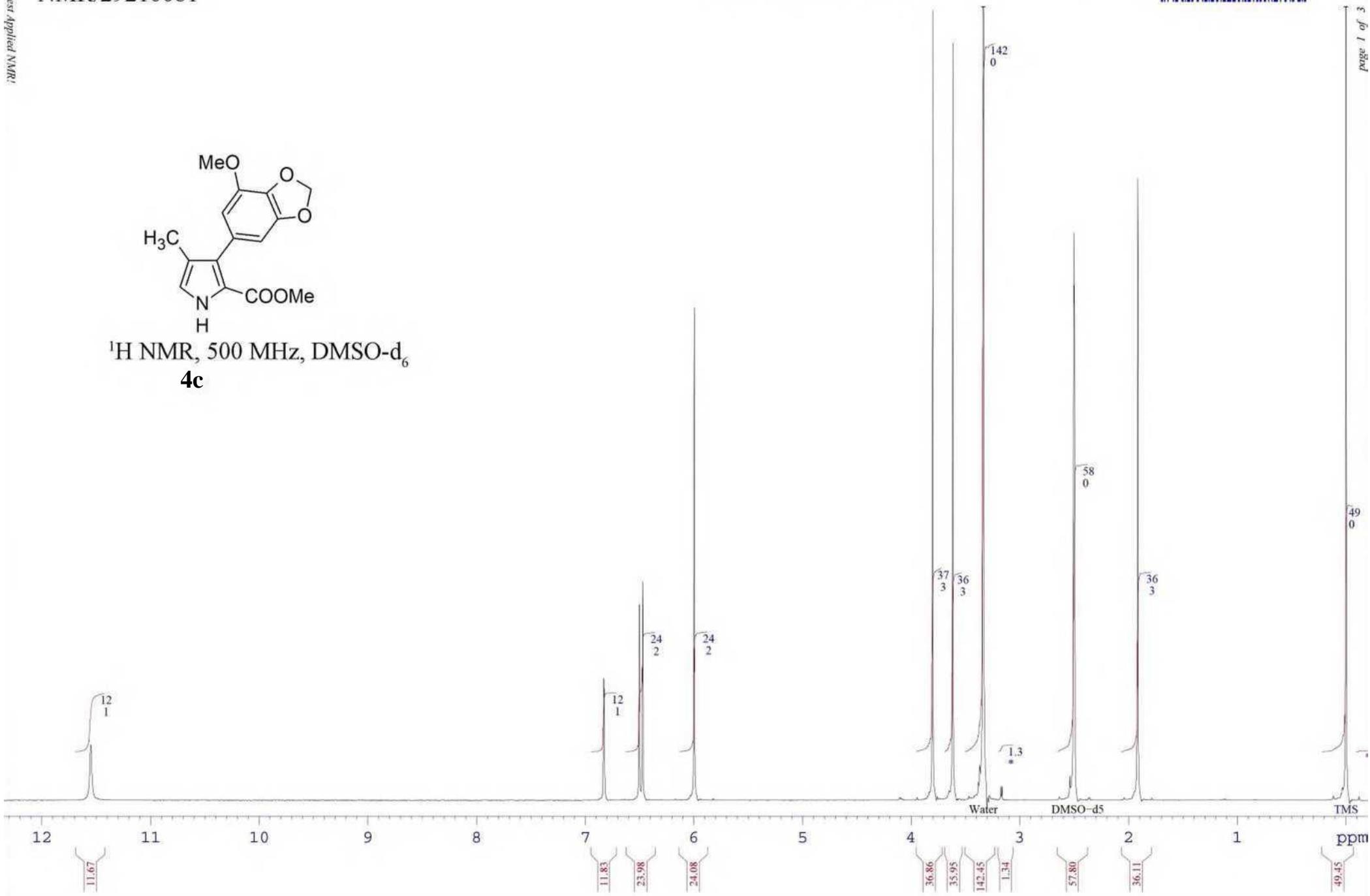
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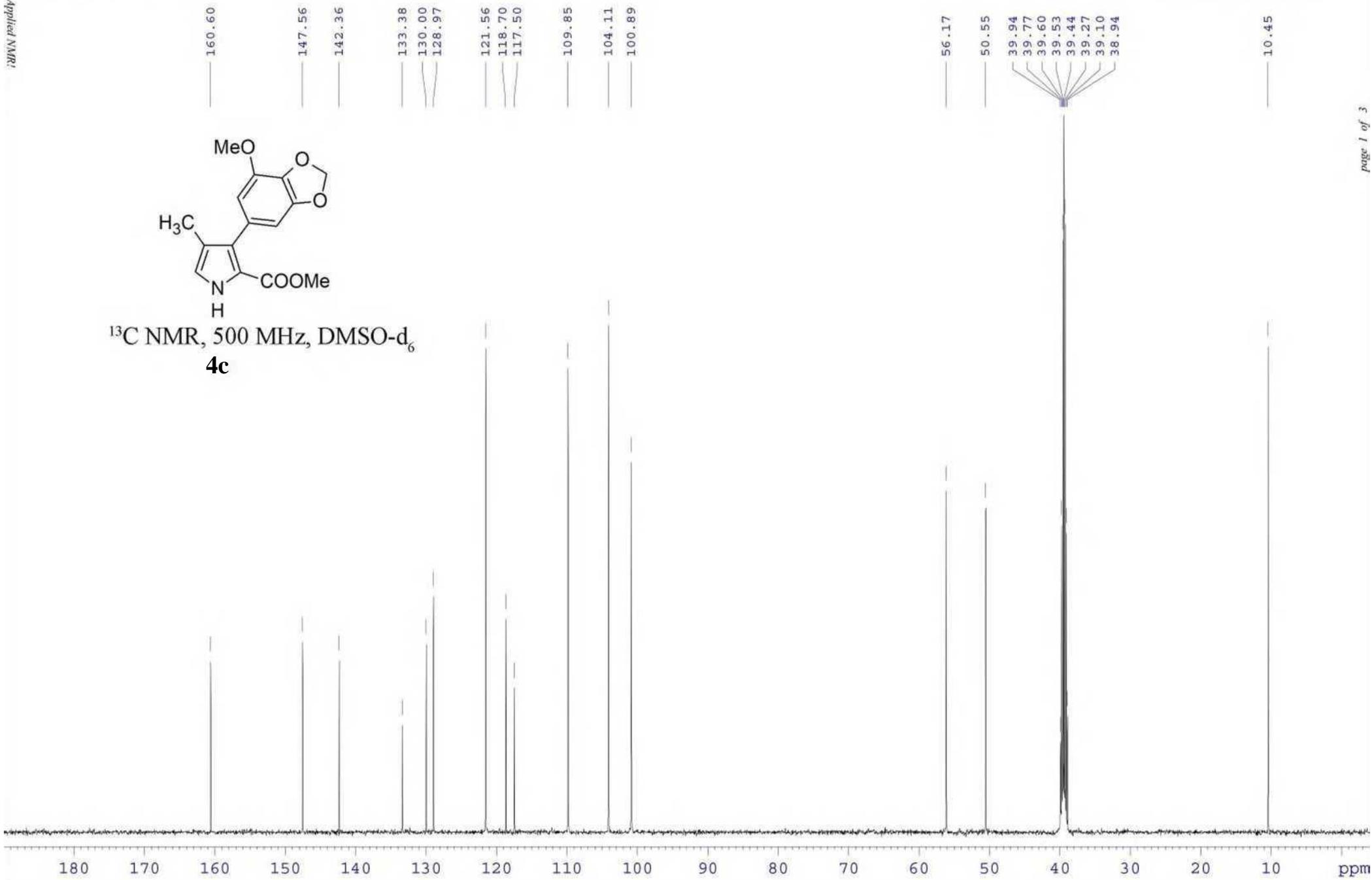
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<sup>1</sup>H NMR, 500 MHz, DMSO-d<sub>6</sub>  
**4c**



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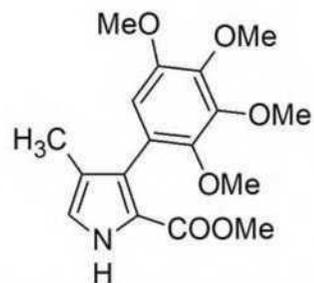




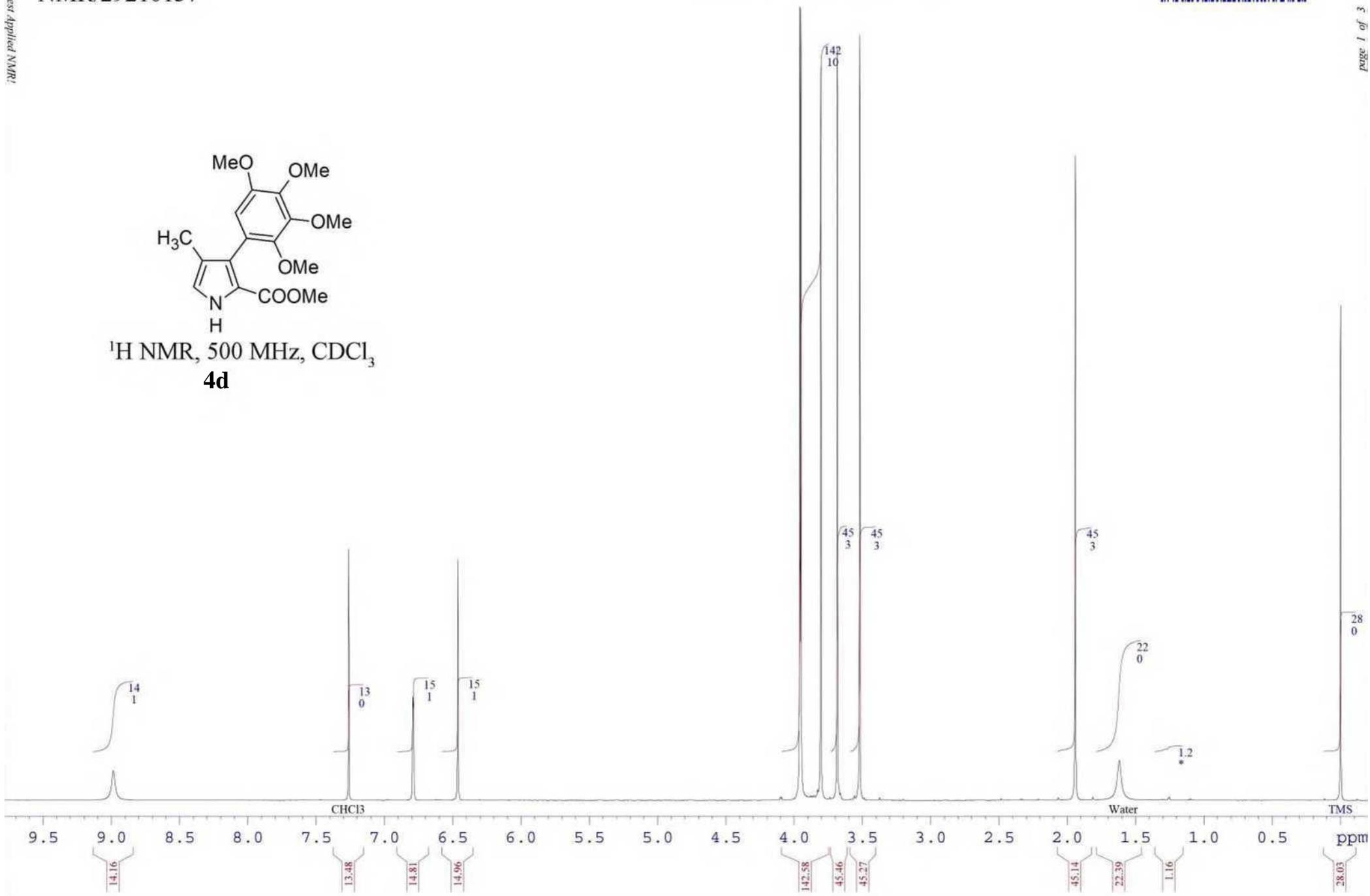
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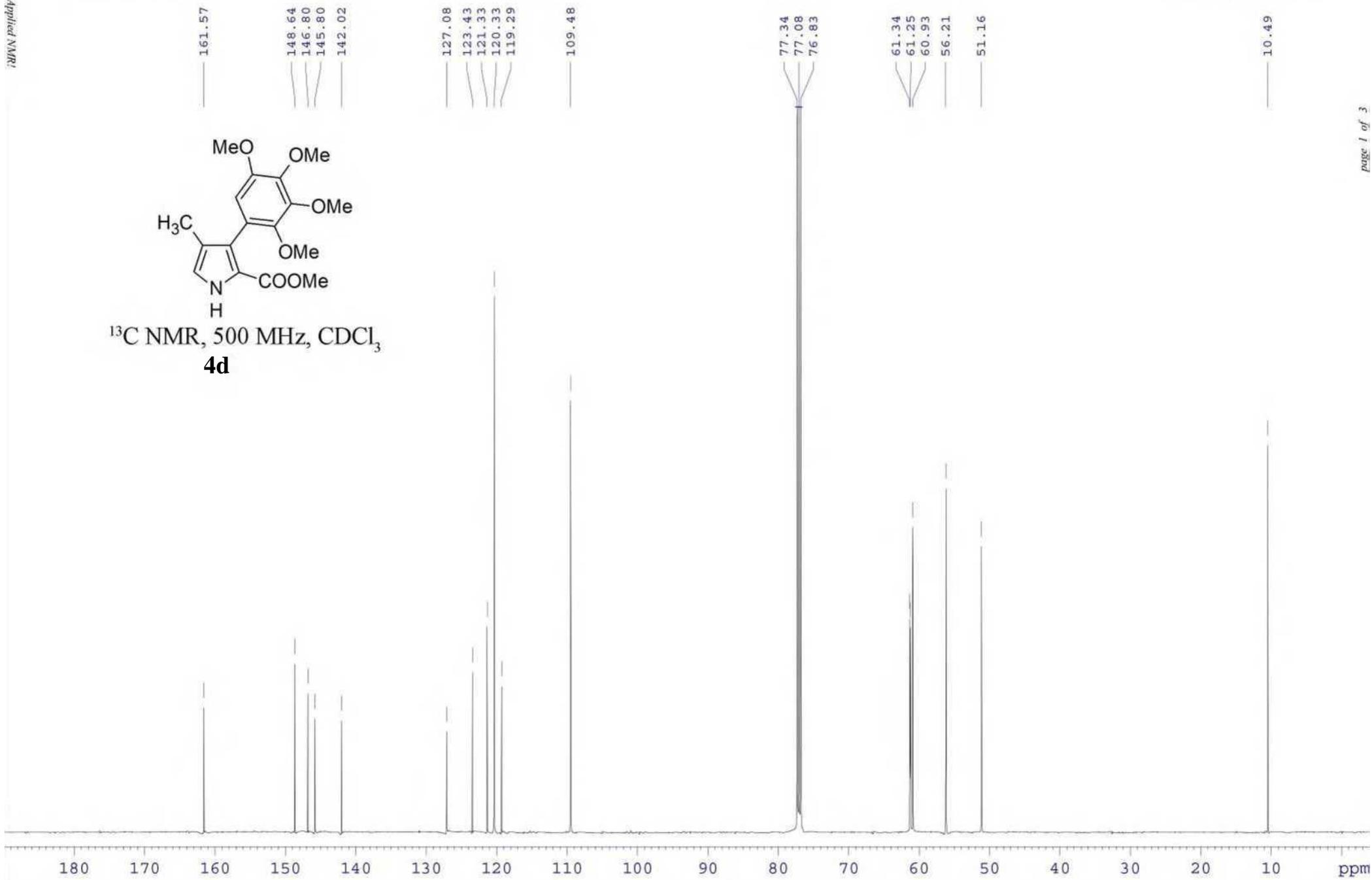
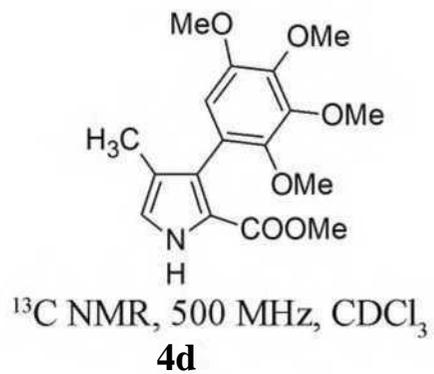
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**4d**



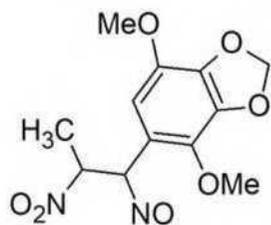
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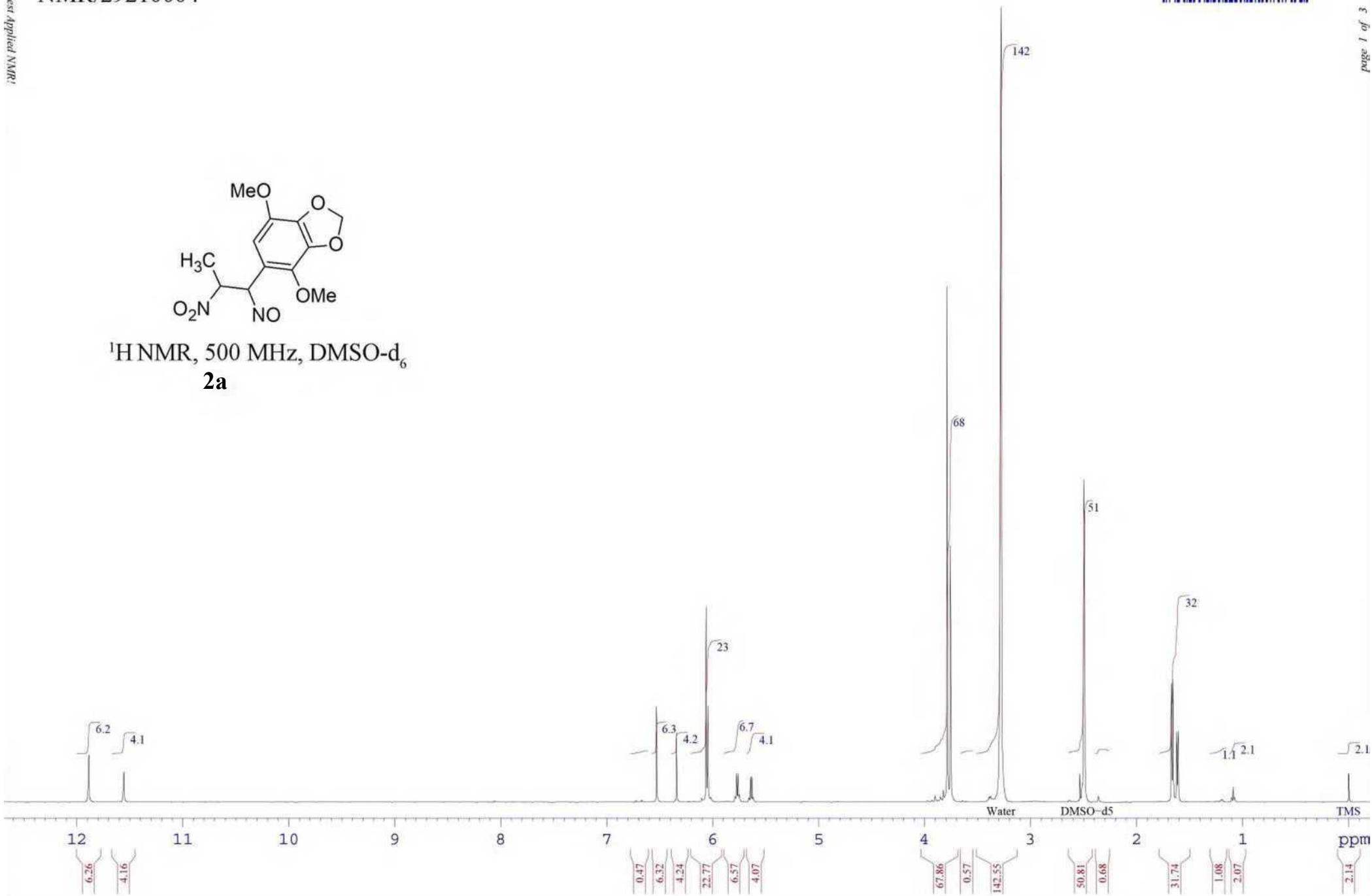
The Best Applied NMR!



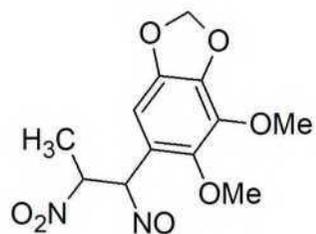
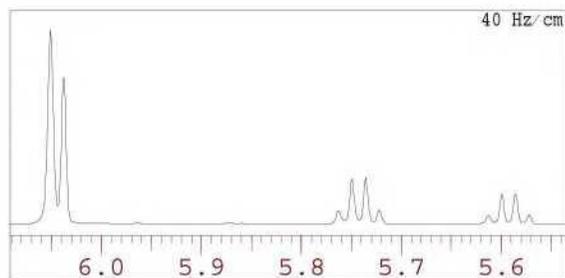
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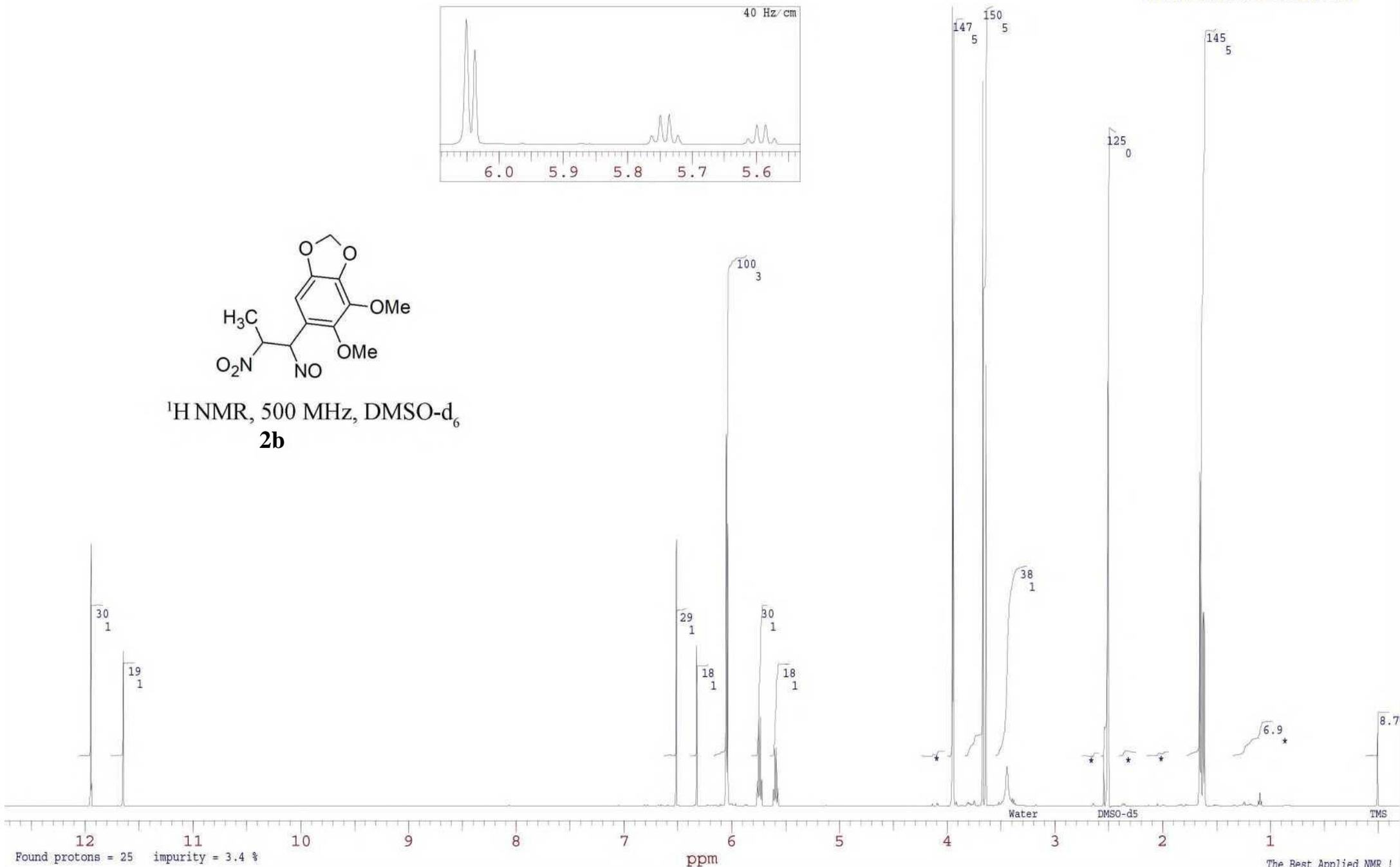
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**2a**



NMR/16307506



<sup>1</sup>H NMR, 500 MHz, DMSO-d<sub>6</sub>  
**2b**

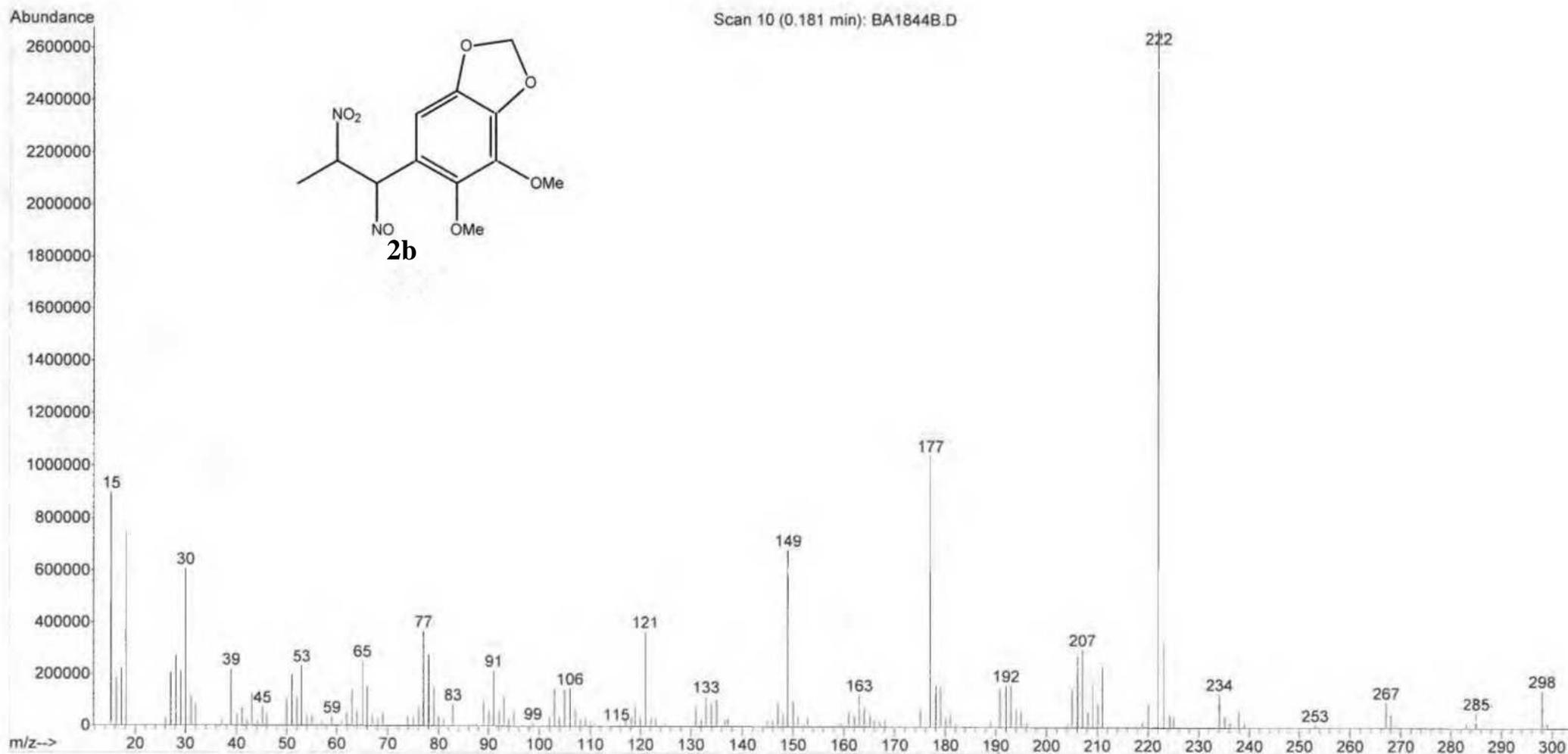


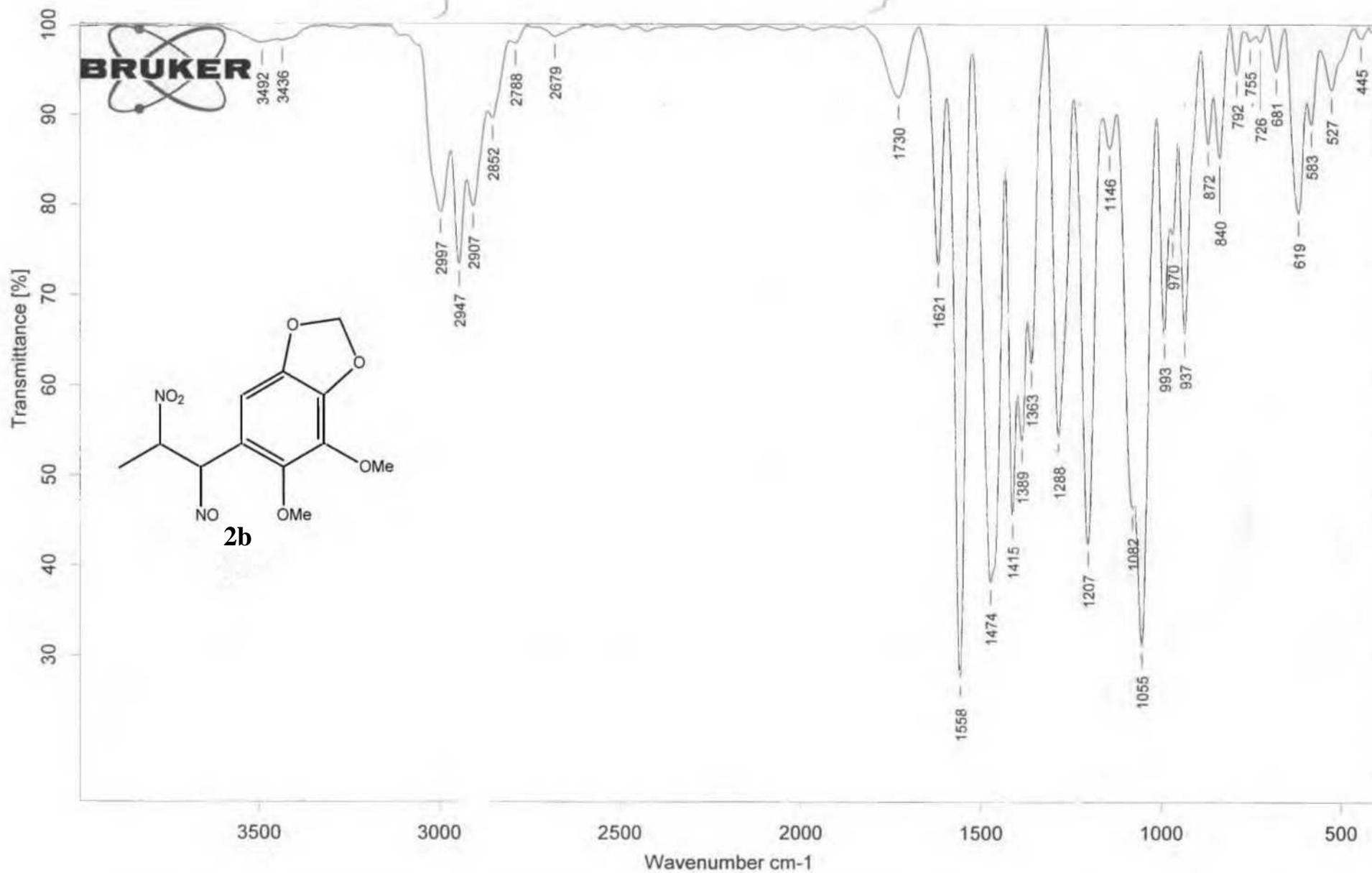
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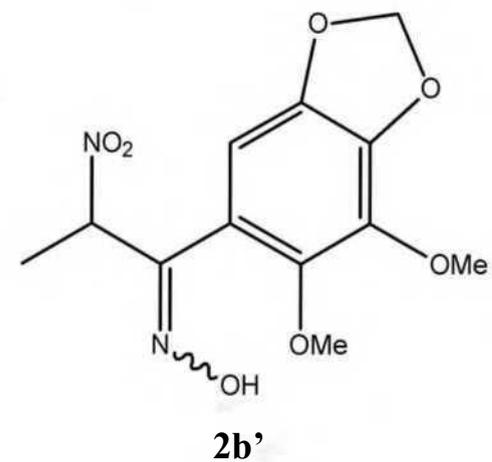
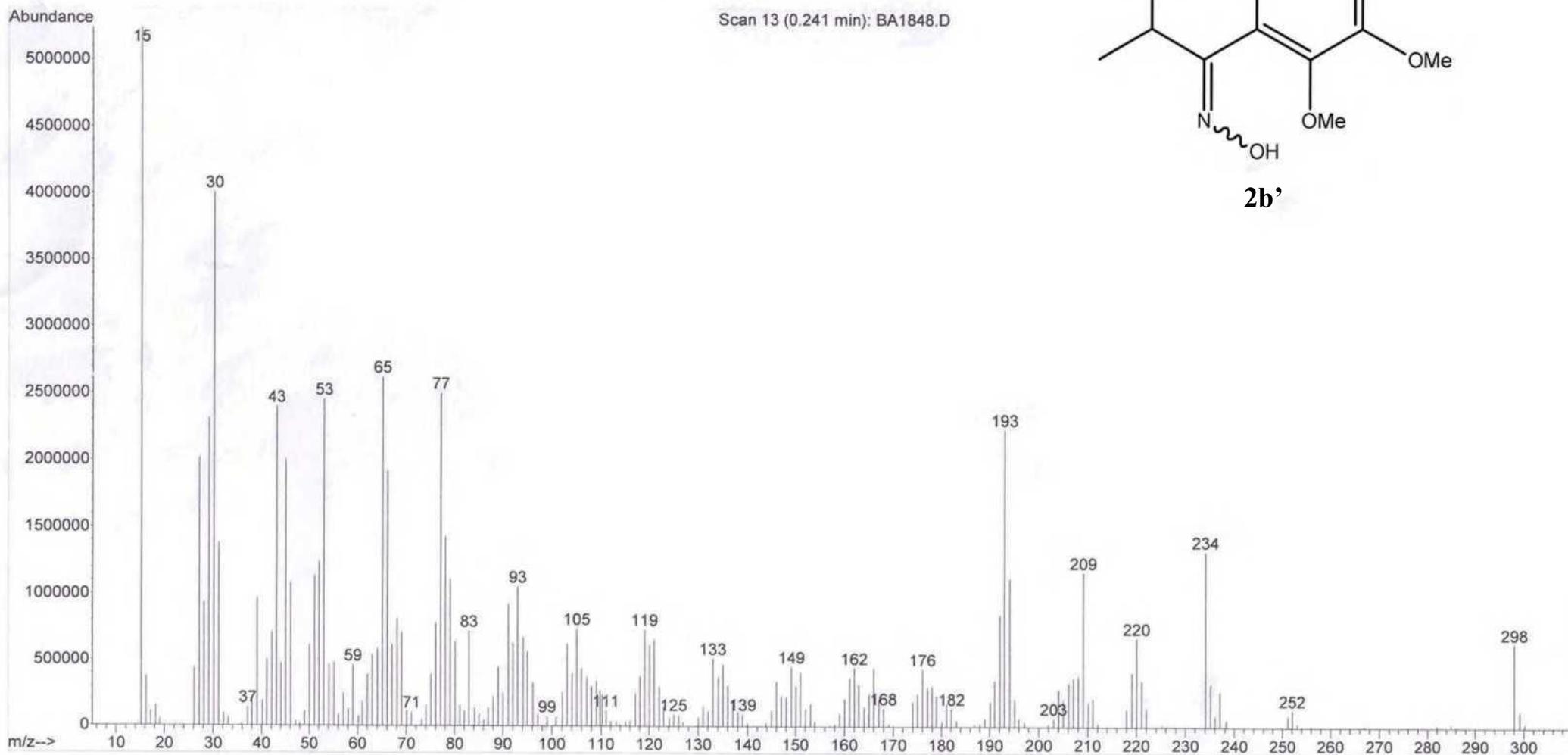
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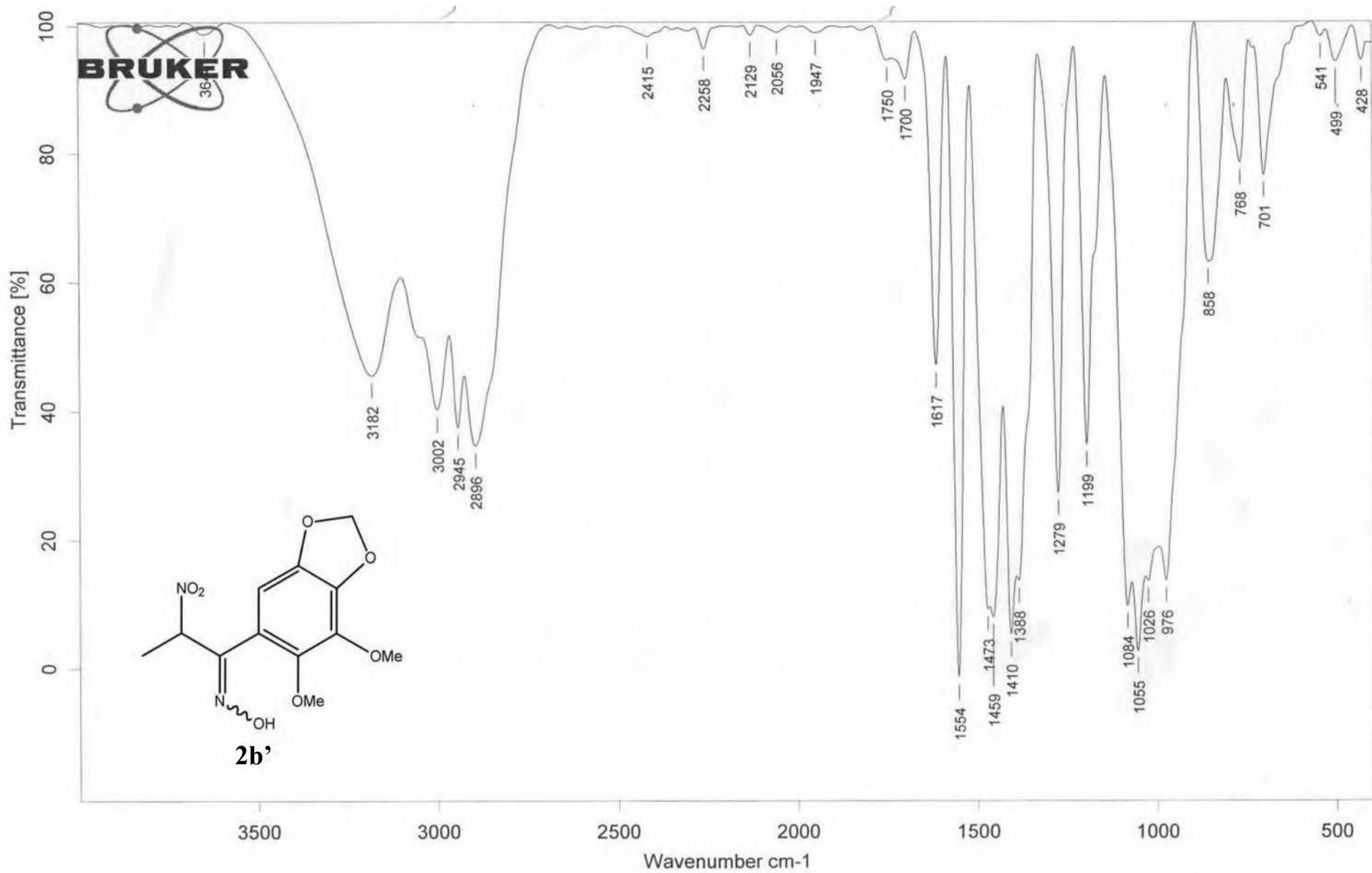
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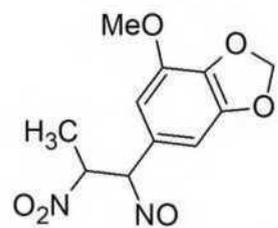
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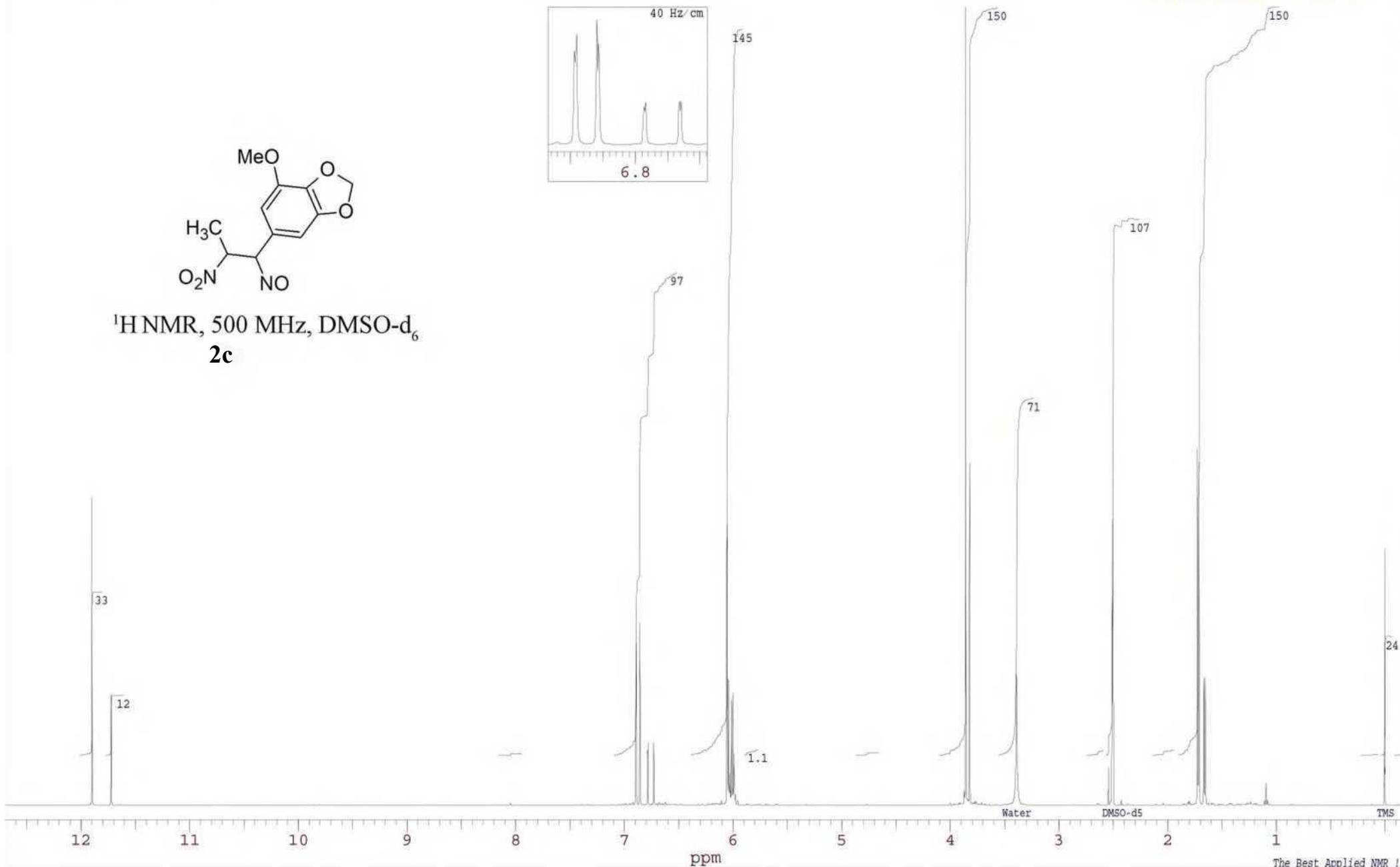
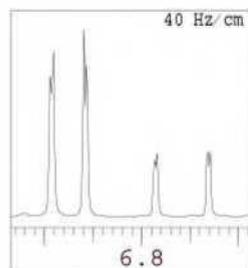
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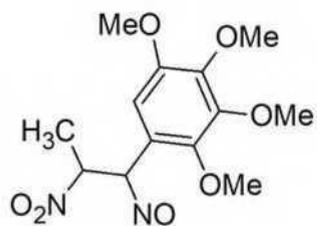


<sup>1</sup>H NMR, 500 MHz, DMSO-d<sub>6</sub>  
2c





NMR/29210121



<sup>1</sup>H NMR, 500 MHz, DMSO-d<sub>6</sub>  
**2d**

