Supporting Information

Aerobic oxidative C-B bond cleavage of arylboronic acids mediated by methylhydrazines

Wei Ding, Jia-Rong Chen,* You-Quan Zou, Shu-Wen Duan, Liang-Qiu Lu, and Wen-Jing Xiao*

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1. General Information

Unless otherwise noted, materials were purchased from commercial suppliers and used without further purification. All the solvents were treated according to general methods. Flash column chromatography was performed using 200-300 mesh silica gel. $^1$H NMR spectra were recorded on 600 MHz spectrophotometers. Chemical shifts ($\delta$) are reported in ppm from the solvent resonance as the internal standard (CDCl$_3$: 7.26 ppm, DMSO-d$_6$: 3.30 ppm, 2.50 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q= quartet, dd = doublet of doublets, m = multiplet), coupling constants (Hz) and integration. $^{13}$C NMR spectra were recorded on Varian Mercury 400 (100 MHz) with complete proton decoupling spectrophotometers (CDCl$_3$: 77.0 ppm, DMSO-d$_6$: 39.5 ppm). Mass spectra were measured on a MS spectrometer.
2. The Optimization of Reaction Conditions

SI-Table 1. Solvent effects on the model reaction and control experiments

<table>
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<th>Entry</th>
<th>Solvent</th>
<th>Time (h)</th>
<th>Yield (%)</th>
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<tr>
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<td>THF</td>
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a Unless otherwise noted, the reaction of 1a (0.5 mmol) with MeNHNH₂ (40% aq., 1.4 equiv) was carried out in the solvent (0.017 M) at room temperature under air atmosphere. b Isolated yield. c The reaction was carried out under O₂ atmosphere. d The reaction was carried out without MeNHNH₂. e The reaction was carried out under N₂ atmosphere. n.r. = no reaction

SI-Table 2. Other reaction parameters effects on the model reaction

<table>
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<th>Hydrazine</th>
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<td>5</td>
<td>43</td>
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</table>

a Unless otherwise noted, the reaction of 1a (0.5 mmol) with hydrazine (X equiv) was carried out in the THF (Y mL) at room temperature under air atmosphere. b Isolated yield.
3. General Procedure and Spectral Data of Products

3.1 General Procedure

A 50 mL round-bottom flask was charged with aryl boronic acids 1 (0.5 mmol), MeNHNH₂ (40% aq. 1.4 equiv, 80 uL) (be potentially dangerous, please be careful!!) and THF (0.017M, 30 mL). Then, the reaction mixture was stirred at room temperature in an open flask. After the reaction was completed monitored by TLC analysis, the mixture was concentrated under reduced pressure and purified by flash chromatography on silica gel (eluting with ethyl acetate / petroleum ether = 1:5) to give the desired product 2.

3.2 Spectral Data of Products.

Prepared according to the general procedure from 1a (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 7 h to provide the desired product 2a¹ as a colorless solid (94% yield). ¹H NMR (600 MHz, CDCl₃) δ (ppm) 6.80–6.76 (4 H, m), 4.65 (1 H, s), 3.77 (3 H, s). ¹³C NMR (100 MHz, CDCl₃) δ (ppm) 153.39, 149.45, 116.07, 114.88, 55.83. MS: m/z = 124.1 (M⁺)

Prepared according to the general procedure from 1b (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 6 h to provide the desired product 2b² as a colorless oil (94% yield). ¹H NMR (600 MHz, CDCl₃) δ (ppm) 7.13 (1 H, t, J = 8.1), 6.49 (1 H, d, J = 8.2), 6.43 (2 H, d, J = 8.9), 5.25 (1 H, s), 3.78 (3 H, s). ¹³C NMR (100 MHz, CDCl₃) δ (ppm) 160.81, 156.75, 130.13, 107.86, 106.31, 101.54, 55.26. MS: m/z = 124.1 (M⁺)

Prepared according to the general procedure from 1c (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 7 h to provide the desired product 2c³ as a white solid (82% yield). ¹H NMR (600 MHz, CDCl₃) δ (ppm) 6.93 (1 H, d, J = 6.7), 6.89–6.82 (3 H, m), 5.64 (1 H, s), 3.88 (3 H, s). ¹³C NMR (100 MHz, CDCl₃) δ (ppm) 146.53, 145.61, 121.40, 120.10, 114.49, 110.68, 55.82. MS: m/z = 124.1 (M⁺)
Prepared according to the general procedure from 1d (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 6 h to provide the desired product 2d$^1$ as a colorless solid (85% yield). $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ (ppm) 7.28–7.21 (2 H, m), 6.93 (1 H, $t$, $J = 7.3$), 6.84 (2 H, $d$, $J = 7.7$), 5.02 (1 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ (ppm) 155.44, 129.64, 120.72, 115.29. MS: m/z = 94.1 (M$^+$)

Prepared according to the general procedure from 1e (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 7 h to provide the desired product 2e$^1$ as a colorless oil (82% yield). $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ (ppm) 7.12 (1 H, $d$, $J = 7.4$), 7.08 (1 H, $t$, $J = 7.7$), 6.85 (1 H, $t$, $J = 7.4$), 6.77 (1 H, $d$, $J = 8.0$), 4.79 (1 H, s), 2.25 (3 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ (ppm) 153.72, 130.99, 127.06, 123.75, 120.68, 114.85, 15.69. MS: m/z = 108.1 (M$^+$)

Prepared according to the general procedure from 1f (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 7 h to provide the desired product 2f$^1$ as a colorless oil (85% yield). $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ (ppm) 7.12 (1 H, $d$, $J = 7.8$), 6.75 (1 H, $d$, $J = 7.5$), 4.95 (1 H, s), 2.30 (3 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ (ppm) 155.39, 139.78, 129.38, 115.07, 21.30. MS: m/z = 108.1 (M$^+$)

Prepared according to the general procedure from 1g (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 7 h to provide the desired product 2g$^1$ as a white solid (86% yield). $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ (ppm) 7.04 (2 H, $d$, $J = 7.7$), 6.73 (2 H, $d$, $J = 8.1$), 4.67 (1 H, s), 2.27 (3 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ (ppm) 153.17, 130.03, 129.92, 115.07, 20.43. MS: m/z = 108.1 (M$^+$)

Prepared according to the general procedure from 1h (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 6 h to provide the desired product 2h$^1$ as a white solid (97% yield). $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ (ppm) 7.06 (2 H, $d$, $J = 8.1$), 6.76 (2 H, $d$, $J = 8.2$), 4.78 (1 H,
Prepared according to the general procedure from 1i (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 7 h to provide the desired product 2i as a white solid (95% yield).

$^1$H NMR (600 MHz, CDCl$_3$) δ (ppm) 7.04 (2 H, d, $J = 8.0$), 6.75 (2 H, d, $J = 8.1$), 4.79 (1 H, s), 2.51 (2 H, t, $J = 7.6$), 1.64–1.55 (2 H, m), 0.92 (3 H, t, $J = 7.3$). $^{13}$C NMR (100 MHz, CDCl$_3$) δ (ppm) 153.30, 134.89, 129.46, 115.07, 37.09, 24.72, 13.70. MS: m/z = 136.1 (M$^+$)

Prepared according to the general procedure from 1j (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 5 h to provide the desired product 2j as a white solid (99% yield).

$^1$H NMR (600 MHz, CDCl$_3$) δ (ppm) 7.25 (2 H, d, $J = 8.6$), 6.77 (2 H, d, $J = 8.5$), 4.89 (1 H, s), 1.29 (9 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) δ (ppm) 152.89, 143.57, 126.42, 114.79, 34.03, 31.49. MS: m/z = 150.2 (M$^+$)

Prepared according to the general procedure from 1k (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 5 h to provide the desired product 2k as a white solid (95% yield).

$^1$H NMR (600 MHz, CDCl$_3$) δ (ppm) 7.04 (2 H, d, $J = 8.3$), 6.75 (2 H, d, $J = 8.4$), 5.00 (1 H, s), 2.52 (2 H, t, $J = 9.0$), 1.62–1.50 (2 H, m), 1.37–1.24 (4 H, m), 0.88 (3 H, t, $J = 7.0$). $^{13}$C NMR (100 MHz, CDCl$_3$) δ (ppm) 153.23, 135.14, 129.39, 115.09, 34.97, 31.41, 31.37, 22.50, 13.99. MS: m/z = 164.2 (M$^+$)

Prepared according to the general procedure from 1l (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 8 h to provide the desired product 2l as a white solid (90% yield).

$^1$H NMR (600 MHz, CDCl$_3$) δ (ppm) 7.22 (2 H, d, $J = 8.6$), 6.78 (2 H, d, $J = 8.6$), 4.97 (1 H, s), 2.44 (3 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) δ (ppm) 153.96, 130.30, 128.66, 116.06, 17.95. MS: m/z = 140.2 (M$^+$)

Prepared according to the general procedure from 1m (0.50 mmol), MeNHNH$_2$ (1.4 eq.) and THF (30 mL) for 5 h to provide the desired product 2m as a white solid (89% yield).

$^1$H NMR (600 MHz, CDCl$_3$) δ (ppm) 6.97 (2 H, d, $J = 7.5$), 6.75 (1 H, t, $J = 7.5$), 4.61 (1 H, s), 2.24 (6 H, s). $^{13}$C NMR (100 MHz, CDCl$_3$) δ (ppm) 152.10, 128.56, 122.93, 120.17, 15.81. MS: m/z = 122.1 (M$^+$)
Prepared according to the general procedure from **1n** (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 8 h to provide the desired product **2n** as a white solid (91% yield).

$^1$H NMR (600 MHz, CDCl₃) δ (ppm) 7.90 (1 H, s), 7.57–7.50 (2 H, m), 7.45 (2 H, d, $J = 8.5$), 7.39 (2 H, t, $J = 7.7$), 7.30–7.25 (1 H, m), 6.93 (2 H, d, $J = 8.5$). $^{13}$C NMR (100 MHz, CDCl₃) δ (ppm) 156.47, 140.81, 132.30, 128.46, 127.90, 126.31, 126.17, 115.68. MS: m/z = 170.1 (M⁺)

Prepared according to the general procedure from **1o** (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 4 h to provide the desired product **2o** as a colorless oil (89% yield).

$^1$H NMR (600 MHz, CDCl₃) δ (ppm) 7.19 (2 H, d, $J = 7.9$), 6.77 (2 H, d, $J = 7.8$), 5.13 (1 H, s).

$^{13}$C NMR (100 MHz, CDCl₃) δ (ppm) 153.88, 129.51, 125.69, 116.65. MS: m/z = 130.1 (M⁺)

Prepared according to the general procedure from **1p** (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 4 h to provide the desired product **2p** as a white solid (94% yield).

$^1$H NMR (600 MHz, CDCl₃) δ (ppm) 7.56 (2 H, d, $J = 8.5$), 6.95 (2 H, d, $J = 8.3$), 6.88 (1 H, s).

$^{13}$C NMR (100 MHz, CDCl₃) δ (ppm) 160.59, 134.30, 119.26, 116.50, 102.31. MS: m/z = 119.1 (M⁺)

Prepared according to the general procedure from **1q** (0.50 mmol), MeNHNH₂ (2.8 eq.) and THF (30 mL) for 4 h to provide the desired product **2q** as a white solid (86% yield).

$^1$H NMR (600 MHz, CDCl₃) δ (ppm) 9.24 (2 H, s), 7.94 (2 H, d, $J = 8.5$), 6.88 (2 H, d, $J = 8.6$). $^{13}$C NMR (100 MHz, CDCl₃) δ (ppm) 169.31, 161.52, 131.77, 121.00, 115.00. MS: m/z = 138.1 (M⁺)

Prepared according to the general procedure from **1r** (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 4 h to provide the desired product **2r** as a yellow solid (89% yield).

$^1$H NMR (600 MHz, CDCl₃) δ (ppm) 7.84–7.79 (1 H, m), 7.72 (1 H, t, $J = 2.3$), 7.42 (1 H, t, $J = 8.2$), 7.23–7.18 (1 H, m), 5.94 (1 H, s).

$^{13}$C NMR (100 MHz, CDCl₃) δ (ppm) 154.27, 139.30, 137.43, 124.12, 123.14. MS: m/z = 139.1 (M⁺)

Prepared according to the general procedure from **1s** (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 24 h to provide the desired product **2s** as a white solid (71% yield).

$^1$H NMR (600 MHz, CDCl₃) δ (ppm) 8.28 (1 H, s), 8.09 (1 H, d, $J = 3.8$), 7.33 (1 H, d, $J = 8.2$), 7.30–7.25 (1 H, m).

$^{13}$C NMR (100 MHz, CDCl₃) δ (ppm) 154.27, 139.30, 137.43, 124.12, 123.14. MS: m/z = 95.0 (M⁺)
Prepared according to the general procedure from 1t (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 6 h to provide the desired product 2t as a white solid (88% yield). ¹H NMR (600 MHz, CDCl₃) δ (ppm) 7.80–7.70 (2 H, m), 7.67 (1 H, d, J = 8.2), 7.42 (1 H, t, J = 7.5), 7.32 (1 H, t, J = 7.5), 7.14 (1 H, d, J = 2.2), 7.10 (1 H, dd, J = 8.8, 2.4), 5.10 (1 H, s). ¹³C NMR (100 MHz, CDCl₃) δ (ppm) 153.16, 134.52, 129.85, 128.92, 127.73, 126.52, 126.35, 123.63, 117.68, 109.53. MS: m/z = 144.1 (M⁺)

Prepared according to the general procedure from 1u (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 6 h to provide the desired product 2u as a brown solid (80% yield). ¹H NMR (600 MHz, CDCl₃) δ (ppm) 8.35 (1 H, s), 7.60 (1 H, d, J = 8.7), 7.55 (1 H, d, J = 9.2), 7.12 (2 H, dd, J = 13.4, 4.7), 7.07 (2 H, d, J = 7.8), 3.88 (3 H, s). ¹³C NMR (100 MHz, CDCl₃) δ (ppm) 155.22, 153.10, 129.82, 128.68, 127.73, 127.35, 118.58, 118.46, 109.18, 105.67, 54.94. MS: m/z = 174.1 (M⁺)

Prepared according to the general procedure from 1v (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 4 h to provide the desired product 2v as a brown solid (90% yield). ¹H NMR (600 MHz, DMSO) δ (ppm) 10.66 (1 H, s), 8.33 (1 H, d, J = 9.1), 8.13 (3 H, dd, J = 12.2, 4.7), 8.03 (2 H, dd, J = 17.4, 9.0), 7.97 (1 H, t, J = 7.6), 7.90 (1 H, d, J = 8.9), 7.60 (1 H, d, J = 8.2). ¹³C NMR (100 MHz, DMSO) δ (ppm) 152.17, 131.33, 127.39, 126.10, 125.45, 124.46, 123.87, 123.77, 123.59, 121.42, 118.08, 113.23. MS: m/z = 218.2 (M⁺)

Prepared according to the general procedure from 1x (0.50 mmol), MeNHNH₂ (2.8 eq.) and THF (60 mL) for 8 h to provide the desired product 2x as a white solid (92% yield). ¹H NMR (600 MHz, DMSO) δ (ppm) 8.63 (2 H, s), 6.55 (4 H, s). ¹³C NMR (100 MHz, DMSO) δ (ppm) 149.74, 115.67. MS: m/z = 110.0 (M⁺)

Prepared according to the general procedure from 5 (0.50 mmol), MeNHNH₂ (1.4 eq.) and THF (30 mL) for 6 h to provide the desired product 6 as a colorless oil (85% yield). ¹H NMR (600 MHz, CDCl₃) δ (ppm) 7.90 (2 H, d, J = 8.5), 7.44 (2 H, d, J = 8.5), 2.60 (3 H, s). ¹³C NMR (100 MHz, CDCl₃) δ (ppm) 196.79, 139.53, 135.39, 129.69, 128.85, 26.52. MS: m/z = 156.1 (M⁺)
3.3 References


4. $^{18}$O Labeling Experiments

4.1 The MS data of 2a for the reaction in the presence of air

![Diagram](image-url)
4.2 The MS data of 2a for the reaction in the presence of $^{18}$O$_2$

![Diagram showing the reaction](image)

$\text{MeO-}\text{B(OH)}_2\text{MeNHNH}_2(1.4\text{ equiv})$ in THF, $^{18}$O$_2$, RT, 6 h to give $\text{MeO-}^{18}\text{OH}$ with 93% yield.
4.3 The MS data of 2a for the reaction in the presence of H$_2^{18}$O
4.4 Using H\textsubscript{2}O\textsubscript{2} as oxidant

The use of H\textsubscript{2}O\textsubscript{2} (30% aq. 1.2 equiv) as the only oxidant for the model reaction could give the desired product in good yield after 5 h. More importantly, the addition of MeNHNH\textsubscript{2} (1.4 equiv) to reaction mixture had no deleterious effect on the reaction, which implied that methylhydrazine and the in situ generated H\textsubscript{2}O\textsubscript{2} are compatible with each other.

\[
\begin{align*}
\text{MeO-} & \text{-B(OH)\textsubscript{2}}_1 1a & \overset{\text{H}_2\text{O}_2 (30\% \text{ aq.} 1.2 \text{ equiv})}{\text{THF, air, RT, 5 h}} & \overset{2a}{\text{MeO-} \text{-OH}} & \text{84\% yield} \\
\text{MeO-} & \text{-B(OH)\textsubscript{2}}_1 1a & \overset{\text{H}_2\text{O}_2 (30\% \text{ aq.} 1.2 \text{ equiv}) \text{MeNHNH}_2 (1.4 \text{ equiv})}{\text{THF, air, RT, 4 h}} & \overset{2a}{\text{MeO-} \text{-OH}} & \text{82\% yield}
\end{align*}
\]
5. NMR and MS Data of phenols

$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2a
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2b
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2c
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2d
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2e
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2f

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$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2g
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2h
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2i
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2j
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2k
^1\text{H} \text{NMR} \ (600 \text{ MHz, CDCl}_3) \text{ and } ^{13}\text{C} \text{NMR} \ (100 \text{ MHz, CDCl}_3) \text{ spectrum of product 2l}
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2m
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2n
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2o
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2p

Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers
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$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2q
\(^1\)H NMR (600 MHz, CDCl\(_3\)) and \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) spectrum of product \(2r\)
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2s
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2t
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 2u
\(^1\)H NMR (600 MHz, DMSO) and \(^{13}\)C NMR (100 MHz, DMSO) spectrum of product 2v
$^1$H NMR (600 MHz, DMSO) and $^{13}$C NMR (100 MHz, DMSO) spectrum of product 2x
$^1$H NMR (600 MHz, CDCl$_3$) and $^{13}$C NMR (100 MHz, CDCl$_3$) spectrum of product 8
MS spectrum of product 2a

![MS spectrum of product 2a](image-url)
MS spectrum of product 2b

\[ \text{MeO} - \text{CH} \]

2b

\( F_w = 124.14 \)
MS spectrum of product 2c
MS spectrum of product 2d
MS spectrum of product 2e

![Graph showing the MS spectrum of product 2e]
MS spectrum of product 2f
MS spectrum of product 2g

![MS spectrum of product 2g](image)
MS spectrum of product 2h

![MS spectrum of product 2h](image)
MS spectrum of product 2i

\[
\text{Fw}=136.19
\]

\[
\text{nPr}
\]

The diagram shows the mass spectrum of product 2i, with the molecular weight (Fw) indicated as 136.19. The spectrum includes peaks at various m/z values, corresponding to different fragments of the molecule.
MS spectrum of product 2j
MS spectrum of product 2k
MS spectrum of product 2I

FW = 140.20
MS spectrum of product 2m
MS spectrum of product 2n

\[ \text{FW} = 170.21 \]
MS spectrum of product 2o
MS spectrum of product 2p

![Graph showing the MS spectrum of product 2p with a formula Fw=119.12](image-url)
MS spectrum of product 2q

\[
\text{Fw}=138.12
\]
MS spectrum of product 2r

![MS Spectrum](image)

Fw = 139.11
MS spectrum of product 2s
MS spectrum of product 2t

2t
Fw = 144.17
MS spectrum of product 2u

2u
Fw=174.20
MS spectrum of product 2v

\[ \text{Fw=218.25} \]
MS spectrum of product 2x

Fw=110.11
MS spectrum of product 6

6
Cl
Fw=154.59