Supporting Information

Synthesis of naphthalene amino esters and arylnaphthalene lactone lignans through tandem reactions of 2-alkynylbenzonitriles

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>General Experimental Information</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Experimental Procedures and Spectroscopic Data</td>
<td>3-18</td>
</tr>
<tr>
<td>III</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of 1a-1m</td>
<td>19-31</td>
</tr>
<tr>
<td>IV</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of 4a-4k</td>
<td>32-42</td>
</tr>
<tr>
<td>V</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of 3a-3m</td>
<td>43-55</td>
</tr>
<tr>
<td>VI</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of 5a-5k</td>
<td>56-66</td>
</tr>
<tr>
<td>VII</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of 6</td>
<td>67</td>
</tr>
<tr>
<td>VIII</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of taiwanin C</td>
<td>68</td>
</tr>
<tr>
<td>IX</td>
<td>Copies of $^1$H and $^{13}$C NMR spectra of chinensin</td>
<td>69</td>
</tr>
<tr>
<td>X</td>
<td>References</td>
<td>70</td>
</tr>
</tbody>
</table>
I. General Experimental Information

Commercial reagents were used without further purification, and the solvents were dried before using. 2-Alkynylbenzonitriles (1 and 4) were prepared according to published method.\(^1\) Melting points were recorded with a micro melting point apparatus and uncorrected. \(^1\)H and \(^{13}\)C NMR spectra were recorded at 400 and 100 MHz, respectively. High-resolution mass spectra (HRMS) were obtained by using a MicrOTOF mass spectrometer. All reactions were monitored by thin-layer chromatography (TLC) using silica gel plates (silica gel 60 F254 0.25 mm) and components were visualized by observation under UV light (254 and 365 nm).
II. Experimental Procedures and Spectroscopic Data

1. Typical procedure for the preparation of 2-(phenylethynyl)benzonitrile (1a)

To a flask containing 2-bromobenzonitrile (2 mmol) and ethynylbenzene (2.4 mmol) in Et₃N (8 mL) was added Pd(PPh₃)₂Cl₂ (0.04 mmol) and CuI (0.02 mmol). After the mixture was stirred at 50 ºC under N₂ atmosphere for 2 h, the reaction was quenched with aqueous NH₄Cl and extracted with ethyl acetate (10 mL × 3). The combined organic layers were washed with water and brine, and then dried over anhydrous Na₂SO₄. The solvent was evaporated under vacuum and the crude product was purified by chromatography on silica-gel to afford 1a in 90% yield. Other 2-alkynylbenzonitriles (1b-1m) were prepared in a similar manner.

2-(Phenylethynyl)benzonitrile (1a)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (365 mg, 90%). ¹H NMR (400 MHz, CDCl₃) δ: 7.33-7.41 (m, 4H), 7.51-7.63 (m, 5H). ¹³C NMR (100 MHz, CDCl₃) δ: 85.8, 96.0, 115.2, 117.6, 122.0, 127.7, 128.4, 129.3, 132.1, 132.5, 132.6, 133.2, 134.3. MS: m/z 204 [MH]⁺. HRMS calcd for C₁₆H₁₂N: 204.0970 [M+H], found: 204.0974.

2-(m-Tolylethynyl)benzonitrile (1b)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (382 mg, 88%). ¹H NMR (400 MHz, CDCl₃) δ: 2.37 (s, 3H), 7.20 (d, J = 8.0 Hz, 1H), 7.25-7.29 (m, 1H), 7.38-7.44 (m, 3H), 7.54-7.58 (m, 1H), 7.62 (d, J = 7.2 Hz, 1H), 7.67 (d, J = 7.6 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 21.3, 85.3, 96.3, 115.2, 117.7, 121.8, 127.3, 128.2, 128.4, 129.2, 130.2, 132.1, 132.4, 132.5, 132.7, 138.2. MS: m/z 218 [MH]⁺. HRMS calcd for C₁₆H₁₂N: 218.0970 [M+H], found: 218.0974.

2-((4-Methoxyphenyl)ethynyl)benzonitrile (1c)

Eluent: ethyl acetate/hexanes (5%); yellow solid (387 mg, 83%), mp 77-79 ºC. ¹H NMR (400 MHz, CDCl₃) δ: 3.81 (s, 3H), 6.87-6.90 (m, 2H), 7.33-7.37 (m, 1H), 7.50-7.58 (4H), 7.63 (d, J = 7.6 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 55.4, 84.7, 96.4, 114.08, 114.15, 114.9, 117.8, 127.6, 127.9, 131.8, 132.4,
132.6, 133.6, 160.4. MS: m/z 234 [MH]^+. HRMS calcd for C_{16}H_{12}NO: 234.0919 [M+H], found: 234.0921.

2-(p-Tolylethynyl)benzonitrile (1d)
Eluent: ethyl acetate/hexanes (5%); yellow liquid (373 mg, 86%). ^1H NMR (400 MHz, CDCl_3) δ: 2.30 (s, 3H), 7.10 (d, J = 8.0 Hz, 2H), 7.30-7.57 (m, 6H). ^13C NMR (100 MHz, CDCl_3) δ: 21.6, 85.3, 96.3, 115.0, 117.7, 119.0, 127.8, 128.2, 129.3, 132.0, 132.5, 134.1, 134.3, 139.6. MS: m/z 218 [MH]^+. HRMS calcd for C_{16}H_{12}N: 218.0970 [M+H], found: 218.0978.

2-((4-Fluorophenyl)ethynyl)benzonitrile (1e)
Eluent: ethyl acetate/hexanes (5%); yellow solid (398 mg, 90%), mp 86-88 ºC. ^1H NMR (400 MHz, CDCl_3) δ: 7.05-7.10 (m, 2H), 7.39-7.44 (m, 1H), 7.55-7.62 (m, 4H), 7.68 (d, J = 7.6 Hz, 1H). ^13C NMR (100 MHz, CDCl_3) δ: 85.4, 94.9, 115.3, 115.8, 116.0, 117.6, 118.1, 118.2, 127.1, 128.3, 132.0, 132.5, 132.7, 134.0, 134.1, 161.9, 164.4. MS: m/z 222 [MH]^+. HRMS calcd for C_{15}H_{9}FN: 222.0719 [M+H], found: 222.0725.

2-((4-Chlorophenyl)ethynyl)benzonitrile (1f)
Eluent: ethyl acetate/hexanes (5%); yellow solid (436 mg, 92%), mp 60-61 ºC. ^1H NMR (400 MHz, CDCl_3) δ: 7.35 (d, J = 8.4 Hz, 2H), 7.41-7.45 (m, 1H), 7.54 (d, J = 7.2 Hz, 2H), 7.58-7.63 (m, 2H), 7.68 (d, J = 8.0 Hz, 1H). ^13C NMR (100 MHz, CDCl_3) δ: 86.5, 94.8, 115.3, 117.6, 120.5, 126.9, 128.5, 128.9, 132.1, 132.5, 132.7, 133.2, 135.4. MS: m/z 238 [MH]^+. HRMS calcd for C_{15}H_{9}ClN: 238.0424 [M+H], found: 238.0430.

2-Ethynylbenzonitrile (1g)
Eluent: ethyl acetate/hexanes (5%); yellow solid (234 mg, 92%), mp 65-66 ºC. ^1H NMR (400 MHz, CDCl_3) δ: 3.48 (s, 1H), 7.46 (t, J = 7.6 Hz, 1H), 7.55-7.62 (m, 2H), 7.67 (d, J = 8.0 Hz, 1H). ^13C NMR
(100 MHz, CDCl₃) δ: 79.5, 83.8, 115.8, 117.2, 125.9, 129.0, 132.4, 132.7, 133.0. MS: m/z 128 [MH]^+. HRMS calcd for C₉H₆N: 128.0500 [M+H], found: 128.0507.

2-(Dec-1-ynyl)benzonitrile (1h)

Eluent: ethyl acetate/hexanes (5%); yellow liquid (392 mg, 82%). ¹H NMR (400 MHz, CDCl₃) δ: 0.87 (t, J = 6.8 Hz, 3H), 1.28-1.30 (m, 8H), 1.45-1.49 (m, 2H), 1.63 (q, J = 7.2 Hz, 2H), 2.47 (t, J = 6.8 Hz, 2H), 7.31-7.35 (m, 1H), 7.46-7.49 (m, 2H), 7.59 (d, J = 8.0 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 14.1, 19.6, 22.7, 28.4, 28.9, 29.1, 29.2, 31.8, 98.1, 115.3, 117.8, 127.5, 128.1, 132.2, 132.3, 132.5. MS: m/z 240 [MH]^+. HRMS calcd for C₁₇H₂₂N: 240.1752 [M+H], found: 240.1757.

5-Methoxy-2-((4-methoxyphenyl)ethynyl)benzonitrile (1i)

Eluent: ethyl acetate/hexanes (5%); yellow solid (458 mg, 87%), mp 103-105 ºC. ¹H NMR (400 MHz, CDCl₃) δ: 3.81 (s, 3H), 3.82 (s, 3H), 6.87 (d, J = 8.4 Hz, 2H), 7.06 (dd, J₁ = 8.8 Hz, J₂ = 2.8 Hz, 1H), 7.12 (d, J = 2.8 Hz, 1H), 7.47-7.52 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ: 55.3, 55.7, 84.4, 94.4, 114.1, 114.5, 115.9, 117.2, 117.6, 119.2, 119.8, 133.30, 133.33, 158.8, 160.1. MS: m/z 264 [MH]^+. HRMS calcd for C₁₇H₁₄NO₂: 264.1025 [M+H], found: 264.1029.

5-Fluoro-2-((4-methoxyphenyl)ethynyl)benzonitrile (1j)

Eluent: ethyl acetate/hexanes (5%); yellow syrup (462 mg, 92%). ¹H NMR (400 MHz, CDCl₃) δ: 3.82 (s, 3H), 6.88 (d, J = 7.6 Hz, 2H), 7.23-7.28 (m, 1H), 7.34 (dd, J₁ = 8.4 Hz, J₂ = 2.4 Hz, 1H), 7.51-7.58 (m, 3H). ¹³C NMR (100 MHz, CDCl₃) δ: 55.4, 83.6, 96.1, 113.9, 114.2, 116.4, 116.5, 116.56, 116.59, 119.5, 119.7, 120.3, 120.5, 124.15, 124.19, 133.5, 133.8, 133.9, 159.8, 160.5, 162.3. MS: m/z 252 [MH]^+. HRMS calcd for C₁₆H₁₁FNO: 252.0825 [M+H], found: 252.0831.

5-Fluoro-2-(p-tolylethynyl)benzonitrile (1k)

Eluent: ethyl acetate/hexanes (5%); yellow solid (428 mg, 91%), mp 55-57 ºC. ¹H NMR (400 MHz, CDCl₃) δ: 2.37 (s, 3H), 7.16-7.34 (m, 4H), 7.45-7.48 (m, 2H), 7.54-7.59 (m, 1H). ¹³C NMR (100 MHz,
CDCl$_3$ $\delta$: 21.6, 84.2, 96.1, 116.5, 116.6, 118.8, 119.5, 119.7, 120.3, 120.6, 123.9, 124.0, 129.3, 131.9, 134.0, 134.1, 139.7, 159.9, 162.4. MS: m/z 236 [MH]$^+$ HRMS calcd for C$_{16}$H$_{11}$FN: 236.0876 [M+H], found: 236.0882.

2-((4-Chlorophenyl)ethynyl)-5-fluorobenzonitrile (1l)
Eluent: ethyl acetate/hexanes (5%); yellow syrup (434 mg, 85%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 7.17-7.21 (m, 1H), 7.26-7.37 (m, 3H), 7.49 (d, $J = 8.4$ Hz, 1H), 7.57-7.65 (m, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 85.5, 94.5, 116.9, 117.0, 119.9, 120.3, 121.2, 121.4, 121.8, 122.0, 128.9, 133.1, 134.1, 134.9, 135.5, 159.8, 162.3. MS: m/z 256 [MH]$^+$. HRMS calcd for C$_{15}$H$_{8}$ClFN: 256.0329 [M+H], found: 256.0333.

5-Chloro-2-((4-methoxyphenyl)ethynyl)benzonitrile (1m)
Eluent: ethyl acetate/hexanes (5%); yellow solid (497 mg, 93%), mp 118-120 ºC. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 3.82 (s, 3H), 6.88 (d, $J = 8.8$ Hz, 2H), 7.49-7.53 (m, 4H), 7.59 (s, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 55.4, 83.9, 97.5, 113.7, 114.2, 116.2, 116.5, 126.2, 132.3, 132.88, 132.91, 133.66, 133.70, 160.6. MS: m/z 268 [MH]$^+$. HRMS calcd for C$_{16}$H$_{11}$ClNO: 268.0529 [M+H], found: 268.0534.

2. Typical procedure for the preparation of 2-(3-hydroxyprop-1-ynyl)benzonitrile (4a)
To a flask containing 2-bromobenzonitrile (2 mmol) and prop-2-yn-1-ol (2.4 mmol) in Et$_3$N (8 mL) was added Pd(PPh$_3$)$_2$Cl$_2$ (0.04 mmol) and CuI (0.02 mmol). After the mixture was stirred at 50 ºC under N$_2$ atmosphere for 2 h, the reaction was quenched with aqueous NH$_4$Cl and extracted with ethyl acetate (10 mL $\times$ 3). The combined organic layers were washed with water and brine, and then dried over anhydrous Na$_2$SO$_4$. The solvent was evaporated under vacuum and the crude product was purified by chromatography on silica-gel to afford 4a in 81% yield. Other 2-(3-hydroxyprop-1-ynyl)benzonitriles (4b-4k) were prepared in a similar manner.

2-(3-Hydroxyprop-1-ynyl)benzonitrile (4a)
Eluent: ethyl acetate/hexanes (20%); yellow solid (254 mg, 81%), mp 57-59 °C. $^1$H NMR (400 MHz, CDCl$_3$) δ: 3.68 (s, 1H), 4.51 (s, 2H), 7.28-7.33 (m, 1H), 7.43 (d, $J = 4.8$ Hz, 2H), 7.52 (d, $J = 7.6$ Hz, 1H).

$^{13}$C NMR (100 MHz, CDCl$_3$) δ: 51.0, 81.3, 94.4, 114.8, 117.7, 126.6, 128.5, 132.5, 132.6. MS: m/z 158 [MH]$^+$. HRMS calcd for C$_{10}$H$_8$NO: 158.0606 [M+H], found: 158.0610.

2-(3-Hydroxyprop-1-ynyl)-5-methoxybenzonitrile (4b)

Eluent: ethyl acetate/hexanes (20%); yellow liquid (318 mg, 85%). $^1$H NMR (400 MHz, CDCl$_3$) δ: 3.83 (s, 3H), 4.53 (s, 2H), 7.05 (dd, $J_1 = 8.4$ Hz, $J_2 = 2.8$ Hz, 1H), 7.10 (d, $J = 2.8$ Hz, 1H), 7.44 (d, $J = 8.8$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 51.4, 55.8, 81.5, 92.3, 116.3, 117.3, 117.4, 118.7, 119.2, 134.0, 159.3. MS: m/z 188 [MH]$^+$. HRMS calcd for C$_{11}$H$_{10}$NO$_2$: 188.0712 [M+H], found: 188.0718.

4-Fluoro-2-(3-hydroxyprop-1-ynyl)benzonitrile (4c)

Eluent: ethyl acetate/hexanes (20%); yellow solid (305 mg, 87%), mp 45-47 ºC. $^1$H NMR (400 MHz, CDCl$_3$) δ: 3.23 (s, 1H), 4.55 (s, 2H), 7.07-7.12 (m, 1H), 7.19 (dd, $J_1 = 8.8$ Hz, $J_2 = 2.4$ Hz, 1H), 7.61 (dd, $J_1 = 8.4$ Hz, $J_2 = 1.6$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 51.1, 80.37, 80.41, 95.6, 111.3, 111.4, 116.5, 116.8, 117.0, 119.7, 119.9, 129.2, 129.4, 134.9, 135.0, 163.1, 165.7. MS: m/z 176 [MH]$^+$. HRMS calcd for C$_{10}$H$_7$FNO: 176.0512 [M+H], found: 176.0517.

5-Fluoro-2-(3-hydroxyprop-1-ynyl)benzonitrile (4d)

Eluent: ethyl acetate/hexanes (20%); yellow solid (280 mg, 80%), mp 88-89 ºC. $^1$H NMR (400 MHz, CDCl$_3$) δ: 2.88 (s, 1H), 4.54 (s, 2H), 7.22-7.27 (m, 1H), 7.32 (dd, $J_1 = 8.4$ Hz, $J_2 = 2.4$ Hz, 1H), 7.52 (dd, $J_1 = 8.4$ Hz, $J_2 = 3.2$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 51.2, 80.5, 94.1, 116.4, 116.5, 116.6, 116.7, 119.5, 119.8, 120.5, 120.7, 123.08, 123.12, 134.6, 134.7, 160.1, 162.7. MS: m/z 176 [MH]$^+$. HRMS calcd for C$_{10}$H$_7$FNO: 176.0512 [M+H], found: 176.0518.

5-Chloro-2-(3-hydroxyprop-1-ynyl)benzonitrile (4e)
Eluent: ethyl acetate/hexanes (20%); yellow solid (317 mg, 83%), mp 80-82 ºC. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 3.31 (s, 1H), 4.54 (s, 2H), 7.42-7.48 (m, 2H), 7.55 (d, $J = 2.0$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 51.2, 80.5, 95.4, 116.4, 125.1, 132.2, 133.1, 133.7, 134.6. MS: m/z 192 [MH]$^+$. HRMS calcd for C$_{10}$H$_7$ClNO: 192.0216 [M+H], found: 192.0219.

2-(3-Hydroxypent-1-ynyl)benzonitrile (4f)
Eluent: ethyl acetate/hexanes (20%); yellow liquid (326 mg, 88%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 1.07-1.11 (m, 3H), 1.84-1.87 (m, 2H), 2.81 (d, $J = 3.6$ Hz, 1H), 4.60 (d, $J = 5.6$ Hz, 1H), 7.36-7.40 (m, 1H), 7.51 (d, $J = 3.6$ Hz, 2H), 7.61 (d, $J = 7.6$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 9.4, 30.7, 64.0, 80.9, 96.9, 115.2, 126.7, 128.4, 132.36, 132.41, 132.5. MS: m/z 186 [MH]$^+$. HRMS calcd for C$_{12}$H$_{12}$NO: 186.0919 [M+H], found: 186.0925.

6-(3-Hydroxypent-1-ynyl)benzo[d][1,3]dioxole-5-carbonitrile (4g)
Eluent: ethyl acetate/hexanes (20%); yellow solid (412 mg, 90%), mp 63-64 ºC. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 1.03-1.07 (m, 3H), 1.80-1.83 (m, 2H), 3.00 (s, 1H), 4.55 (s, 1H), 6.05 (s, 2H), 6.86 (d, $J = 0.8$ Hz, 1H), 6.93 (d, $J = 0.8$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 9.4, 30.6, 63.9, 80.7, 95.5, 102.8, 108.5, 111.3, 112.0, 117.7, 122.5, 147.8, 151.2. MS: m/z 230 [MH]$^+$. HRMS calcd for C$_{13}$H$_{12}$NO$_3$: 230.0817 [M+H], found: 230.0822.

2-(3-Hydroxy-3-phenylprop-1-ynyl)benzonitrile (4h)
Eluent: ethyl acetate/hexanes (20%); yellow solid (410 mg, 88%), mp 182-184 ºC. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 3.46 (s, 1H), 5.74 (s, 1H), 7.33-7.42 (m, 4H), 7.48-7.54 (m, 2H), 7.60 (d, $J = 8.0$ Hz, 1H), 7.65 (d, $J = 7.6$ Hz, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 64.8, 82.5, 95.7, 115.2, 117.7, 126.5, 126.7, 126.9, 128.6, 128.7, 128.8, 132.5, 132.58, 132.60, 139.9. MS: m/z 234 [MH]$^+$. HRMS calcd for C$_{16}$H$_{12}$NO: 234.0919 [M+H], found: 234.0923.

2-(3-Hydroxy-3-phenylprop-1-ynyl)-5-methoxybenzonitrile (4i)
Eluent: ethyl acetate/hexanes (20%); yellow solid (447 mg, 85%), mp 192-194 ºC. ¹H NMR (400 MHz, CDCl₃) δ: 3.59 (s, 1H), 3.77 (s, 3H), 5.71 (s, 1H), 7.00 (dd, J₁ = 8.4 Hz, J₂ = 2.4 Hz, 1H), 7.05 (d, J = 2.0 Hz, 1H), 7.33 (d, J = 7.6 Hz, 1H), 7.39-7.42 (m, 3H), 7.65 (d, J = 8.0 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 55.8, 64.8, 82.4, 93.9, 116.2, 117.4, 117.6, 118.6, 119.1, 126.7, 127.0, 128.5, 128.7, 134.1, 140.2, 159.3. MS: m/z 264 [MH]+. HRMS calcd for C₁₇H₁₄NO₂: 264.1025 [M+H], found: 264.1027.

5-Fluoro-2-(3-hydroxy-3-phenylprop-1-ynyl)benzonitrile (4j)

Eluent: ethyl acetate/hexanes (20%); yellow liquid (457 mg, 91%). ¹H NMR (400 MHz, CDCl₃) δ: 3.47 (s, 1H), 5.72 (d, J = 3.2 Hz, 1H), 7.21-7.40 (m, 5H), 7.50-7.55 (m, 1H), 7.64 (d, J = 5.2 Hz, 2H). ¹³C NMR (100 MHz, CDCl₃) δ: 64.8, 81.4, 95.5, 116.5, 116.8, 116.9, 119.6, 119.8, 120.4, 120.6, 123.0, 126.9, 128.6, 128.8, 134.7, 134.8, 139.8, 160.2, 162.8. MS: m/z 252 [MH]+. HRMS calcd for C₁₆H₁₁FNO: 252.0825 [M+H], found: 252.0831.

6-(3-Hydroxyprop-1-ynyl)benzo[d][1,3]dioxole-5-carbonitrile (4k)

Eluent: ethyl acetate/hexanes (20%); white solid (306 mg, 76%), mp 139-141 ºC. ¹H NMR (400 MHz, acetone-d₆) δ: 4.45 (s, 2H), 4.53 (s, 1H), 6.21 (s, 2H), 7.03 (s, 1H), 7.22 (s, 1H). ¹³C NMR (100 MHz, acetone-d₆) δ: 49.9, 80.0, 93.7, 103.3, 108.2, 111.3, 111.9, 117.1, 122.0, 148.4, 151.6. MS: m/z 202 [MH]+. HRMS calcd for C₁₁H₈NO₃: 202.0504 [M+H], found: 202.0509.

3. Typical procedure for the preparation of ethyl 1-amino-3-phenyl-2-naphthoate (3a)

To a flask containing 2-(phenylethynyl)benzonitrile (1a, 1 mmol), THF (3 mL), and ethyl 2-bromoacetate (2, 2 mmol) were added activated zinc dust (3 mmol) portion-wise with stirring. The mixture was then stirred at 80 ºC. Upon completion, it was diluted with saturated aqueous NH₄Cl (10 mL) and the excess zinc was filtered. The filtrate was concentrated and to the residue was added water. The aqueous phase was extracted with EtOAc (10 mL × 3). The combined organic phases were dried with anhydrous Na₂SO₄ and concentrated. The residue was purified by column chromatography on silica gel with
EtOAc/hexane (5%) to give 3a in 75% yield. Other 1-aminonaphthalene-2-carboxylates (3b-3m) were obtained in a similar manner from 1b-1m. 9-Aminonaphtho[2,3-c]furan-1(3H)-ones (5a-5k) were obtained in a similar manner from 4a-4k, respectively.

**Ethyl 1-amino-3-phenyl-2-naphthoate (3a)**

Eluent: ethyl acetate/hexanes (5%); yellow syrup (218 mg, 75%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 0.72 (t, $J = 7.6$ Hz, 3H), 3.94 (q, $J = 7.2$ Hz, 2H), 7.14 (s, 1H), 7.26-7.35 (m, 5H), 7.45-7.49 (m, 1H), 7.53-7.57 (m, 1H), 7.75 (d, $J = 7.6$ Hz, 1H), 7.88 (d, $J = 7.6$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 13.1, 60.3, 107.8, 119.1, 121.5, 122.5, 125.5, 126.5, 128.1, 128.4, 130.5, 133.4, 134.8, 140.1, 144.0, 146.3, 170.1. MS: m/z 292 [MH]$^+$.

**Ethyl 1-amino-3-m-tolyl-2-naphthoate (3b)**

Eluent: ethyl acetate/hexanes (5%); yellow syrup (223 mg, 73%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 0.80 (t, $J = 6.8$ Hz, 3H), 2.46 (s, 3H), 4.02 (q, $J = 6.8$ Hz, 2H), 6.13 (s, 2H), 7.19-7.36 (m, 5H), 7.44 (t, $J = 8.0$ Hz, 1H), 7.55 (t, $J = 7.6$ Hz, 1H), 7.77 (d, $J = 8.4$ Hz, 1H), 7.87 (d, $J = 8.4$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 13.3, 21.5, 60.4, 107.8, 119.0, 121.6, 122.5, 125.3, 125.5, 127.3, 128.0, 128.4, 128.7, 128.9, 134.9, 137.5, 140.2, 144.0, 146.5, 170.3. MS: m/z 306 [MH]$^+$. HRMS calc'd for C$_{20}$H$_{21}$NO$_2$: 306.1494 [M+H], found: 306.1498.

**Ethyl 1-amino-3-(4-methoxyphenyl)-2-naphthoate (3c)**

Eluent: ethyl acetate/hexanes (5%); yellow solid (221 mg, 69%), mp 128-130 ºC. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 0.81 (t, $J = 7.2$ Hz, 3H), 3.86 (s, 3H), 3.98 (q, $J = 7.2$ Hz, 2H), 6.95 (d, $J = 8.8$ Hz, 2H), 7.12 (s, 1H), 7.32 (d, $J = 8.8$ Hz, 2H), 7.43-7.47 (m, 1H), 7.53 (t, $J = 7.2$ Hz, 1H), 7.74 (d, $J = 7.6$ Hz, 1H), 7.86 (d, $J = 8.4$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 13.4, 55.4, 60.4, 108.2, 113.4, 118.9, 121.5, 122.3, 125.3, 128.3, 128.6, 129.1, 134.9, 136.5, 139.6, 146.1, 158.6, 170.3. MS: m/z 322 [MH]$^+$. HRMS calc'd for C$_{20}$H$_{20}$NO$_3$: 322.1443 [M+H], found: 322.1450.
Ethyl 1-amino-3-\(p\)-tolyl-2-naphthoate (3d)

Eluent: ethyl acetate/hexanes (5%); yellow syrup (217 mg, 71%). \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\): 0.75 (t, \(J = 6.8\) Hz, 3H), 2.40 (s, 3H), 3.95 (q, \(J = 7.6\) Hz, 2H), 7.16-7.28 (m, 5H), 7.46-7.50 (m, 1H), 7.55 (t, \(J = 7.2\) Hz, 1H), 7.75 (d, \(J = 7.6\) Hz, 1H), 7.92 (d, \(J = 8.0\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\) \(\delta\): 13.2, 21.1, 60.5, 119.5, 121.5, 125.5, 122.5, 127.9, 128.3, 128.6, 130.0, 130.5, 133.4, 134.9, 136.1, 140.0, 140.9, 145.4, 170.1. MS: m/z 306 [MH\(^+\)]. HRMS calcd for C\(_{20}\)H\(_{20}\)NO\(_2\): 306.1494 [M+H], found: 306.1498.

Ethyl 1-amino-3-(4-fluorophenyl)-2-naphthoate (3e)

Eluent: ethyl acetate/hexanes (5%); yellow solid (238 mg, 77%), mp 68-69 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\): 0.80 (t, \(J = 7.2\) Hz, 3H), 3.97 (q, \(J = 7.6\) Hz, 2H), 6.20 (s, 2H), 7.06-7.12 (m, 3H), 7.32-7.35 (m, 2H), 7.52 (t, \(J = 7.6\) Hz, 1H), 7.71 (d, \(J = 8.4\) Hz, 1H), 7.85 (d, \(J = 8.4\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\) \(\delta\): 13.3, 60.4, 107.2, 114.6, 114.8, 119.0, 121.6, 122.5, 125.6, 128.5, 128.6, 129.5, 129.6, 134.8, 139.0, 140.18, 140.21, 146.9, 160.4, 163.2, 170.0. MS: m/z 310 [MH\(^+\)]. HRMS calcd for C\(_{19}\)H\(_{17}\)FNO\(_2\): 310.1243 [M+H], found: 310.1247.

Ethyl 1-amino-3-(4-chlorophenyl)-2-naphthoate (3f)

Eluent: ethyl acetate/hexanes (5%); yellow syrup (244 mg, 75%). \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\): 0.76 (t, \(J = 7.6\) Hz, 3H), 3.93 (q, \(J = 7.2\) Hz, 2H), 6.19 (s, 2H), 7.03 (s, 1H), 7.19-7.30 (m, 4H), 7.46 (t, \(J = 7.6\) Hz, 1H), 7.53 (t, \(J = 8.4\) Hz, 1H), 7.71 (d, \(J = 8.4\) Hz, 1H), 7.87 (d, \(J = 8.4\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\) \(\delta\): 13.3, 60.4, 106.1, 122.5, 125.7, 128.56, 128.64, 129.4, 132.4, 134.8, 138.8, 142.7, 147.0, 159.9, 169.8. MS: m/z 326 [MH\(^+\)]. HRMS calcd for C\(_{19}\)H\(_{17}\)ClNO\(_2\): 326.0948 [M+H], found: 326.0952.

Ethyl 1-amino-2-naphthoate (3g)

Eluent: ethyl acetate/hexanes (5%); white solid (146 mg, 68%), mp 103-105 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\): 1.42 (t, \(J = 7.2\) Hz, 3H), 4.38 (q, \(J = 7.2\) Hz, 2H), 6.82 (s, 2H), 7.08 (d, \(J = 8.8\) Hz, 1H), 7.47 (t, \(J = 7.6\) Hz, 1H), 7.55 (t, \(J = 7.6\) Hz, 1H), 7.75 (d, \(J = 8.0\) Hz, 1H), 7.89-7.91 (m, 2H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\) \(\delta\): 13.2, 21.1, 60.5, 119.5, 121.5, 125.5, 122.5, 127.9, 128.3, 128.6, 130.0, 130.5, 133.4, 134.9, 136.1, 140.0, 140.9, 145.4, 170.1. MS: m/z 306 [MH\(^+\)]. HRMS calcd for C\(_{20}\)H\(_{20}\)NO\(_2\): 306.1494 [M+H], found: 306.1498.
Ethyl 1-amino-3-octyl-2-naphthoate (3h)

Eluent: ethyl acetate/hexanes (5%); yellow syrup (213 mg, 65%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 0.92 (t, $J = 7.6$ Hz, 3H), 1.31-1.47 (m, 13H), 1.60-1.65 (m, 2H), 2.97 (t, $J = 8.0$ Hz, 2H), 4.45 (q, $J = 7.6$ Hz, 2H), 5.73 (s, 2H), 7.03 (s, 1H), 7.36-7.40 (m, 1H), 7.49 (t, $J = 8.0$ Hz, 1H), 7.67 (d, $J = 8.8$ Hz, 1H), 7.80 (d, $J = 8.0$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 14.2, 14.3, 22.7, 29.4, 29.6, 29.9, 31.9, 32.0, 36.6, 60.8, 108.6, 118.5, 121.4, 122.1, 124.7, 127.90, 127.94, 135.2, 140.0, 146.3, 170.2. MS: m/z 328 $[\text{MH}]^+$. HRMS calcd for C$_{21}$H$_{30}$NO$_2$: 328.2277 [M+H], found: 328.2282.

Ethyl 1-amino-7-methoxy-3-(4-methoxyphenyl)-2-naphthoate (3i)

Eluent: ethyl acetate/hexanes (5%); yellow solid (239 mg, 68%), mp 153-154 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 0.81 (t, $J = 7.6$ Hz, 3H), 3.85 (s, 3H), 3.92 (s, 3H), 3.98 (q, $J = 7.2$ Hz, 2H), 5.79 (s, 2H), 6.94 (d, $J = 8.4$ Hz, 2H), 7.10 (s, 1H), 7.13 (s, 1H), 7.20-7.22 (m, 1H), 7.31 (d, $J = 9.2$ Hz, 2H), 7.66 (d, $J = 9.2$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 13.4, 55.38, 55.40, 60.5, 100.9, 109.2, 113.4, 119.0, 120.0, 123.3, 129.0, 130.0, 130.2, 136.4, 137.1, 144.7, 157.6, 158.5, 170.4. MS: m/z 352 [MH]$^+$. HRMS calcd for C$_{21}$H$_{22}$NO$_4$: 352.1549 [M+H], found: 352.1556.

Ethyl 1-amino-7-fluoro-3-(4-methoxyphenyl)-2-naphthoate (3j)

Eluent: ethyl acetate/hexanes (5%); yellow solid (285 mg, 84%), mp 139-141 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 0.81 (t, $J = 6.8$ Hz, 3H), 3.86 (s, 3H), 3.98 (q, $J = 7.2$ Hz, 2H), 6.94 (dd, $J_1 = 9.2$ Hz, $J_2 = 2.8$ Hz, 2H), 6.95 (s, 1H), 7.28-7.33 (m, 3H), 7.50 (dd, $J_1 = 10.0$ Hz, $J_2 = 2.0$ Hz, 1H), 7.71-7.75 (m, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 13.4, 55.4, 60.6, 105.8, 106.0, 109.6, 113.5, 118.0, 118.3, 118.9, 123.1, 129.1, 130.9, 131.0, 131.7, 136.0, 138.8, 144.9, 158.7, 159.3, 161.7, 170.0. MS: m/z 340 [MH]$^+$. HRMS calcd for C$_{20}$H$_{19}$FNO$_3$: 340.1349 [M+H], found: 340.1353.
Ethyl 1-amino-7-fluoro-3-p-tolyl-2-naphthoate (3k)

Eluent: ethyl acetate/hexanes (5%); yellow solid (268 mg, 83%), mp 124-126 °C. $^1$H NMR (400 MHz, CDCl$_3$) δ: 0.75-0.80 (m, 3H), 2.42 (s, 3H), 3.95-4.01 (m, 2H), 5.56 (s, 2H), 7.14 (d, $J = 2.8$ Hz, 1H), 7.20-7.33 (m, 5H), 7.51 (d, $J = 10.8$ Hz, 1H), 7.71-7.75 (m, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 13.2, 21.1, 60.6, 105.8, 106.0, 109.3, 118.0, 118.3, 118.9, 123.1, 123.2, 127.9, 128.7, 130.9, 131.0, 131.7, 136.3, 139.3, 140.6, 145.1, 145.2, 159.3, 161.8, 170.1. MS: m/z 324 [MH$^+$]. HRMS calcd for C$_{20}$H$_{19}$FNO$_2$: 324.1400 [M+H$^+$], found: 324.1408.

Ethyl 1-amino-3-(4-chlorophenyl)-7-fluoro-2-naphthoate (3l)

Eluent: ethyl acetate/hexanes (5%); yellow syrup (295 mg, 86%). $^1$H NMR (400 MHz, CDCl$_3$) δ: 0.80 (t, $J = 7.2$ Hz, 3H), 3.97 (q, $J = 7.2$ Hz, 2H), 7.07 (s, 1H), 7.27-7.37 (m, 5H), 7.49-7.56 (m, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 13.3, 60.6, 105.9, 106.1, 108.3, 118.3, 118.5, 118.9, 123.38, 123.45, 128.1, 129.3, 131.0, 131.1, 131.6, 132.6, 138.08, 138.11, 142.2, 145.7, 159.5, 162.0, 169.6. MS: m/z 344 [MH$^+$]. HRMS calcd for C$_{19}$H$_{16}$ClFNO$_2$: 344.0854 [M+H$^+$], found: 344.0859.

Ethyl 1-amino-7-chloro-3-(4-methoxyphenyl)-2-naphthoate (3m)

Eluent: ethyl acetate/hexanes (5%); yellow solid (312 mg, 88%), mp 133-135 °C. $^1$H NMR (400 MHz, CDCl$_3$) δ: 0.80 (t, $J = 7.2$ Hz, 3H), 3.85 (s, 3H), 3.98 (q, $J = 7.6$ Hz, 2H), 5.89 (s, 2H), 6.94 (d, $J = 8.8$ Hz, 2H), 7.06 (s, 1H), 7.29 (d, $J = 8.4$ Hz, 2H), 7.43 (dd, $J_1 = 8.8$ Hz, $J_2 = 1.6$ Hz, 1H), 7.62 (d, $J = 8.8$ Hz, 1H), 7.84 (d, $J = 1.2$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 13.4, 55.4, 60.6, 109.2, 113.5, 118.5, 121.0, 123.0, 128.9, 129.0, 130.1, 131.0, 133.1, 136.0, 139.9, 145.1, 158.7, 170.0. MS: m/z 356 [MH$^+$]. HRMS calcd for C$_{20}$H$_{19}$ClNO$_3$: 356.1053 [M+H$^+$], found: 356.1060.

9-Aminonaphtho[2,3-c]furan-1(3H)-one (5a)

Eluent: ethyl acetate/hexanes (20%); yellow solid (139 mg, 70%), mp 178-180 °C. $^1$H NMR (400 MHz, CDCl$_3$) δ: 5.35 (s, 2H), 6.10 (s, 2H), 7.06 (s, 1H), 7.26-7.52 (m, 1H), 7.57-7.61 (m, 1H), 7.79 (d, $J = 8.4$ Hz, 1H), 7.81 (d, $J = 8.4$ Hz, 1H), 7.88 (d, $J = 8.4$ Hz, 1H). MS: m/z 222 [MH$^+$]. HRMS calcd for C$_{13}$H$_{13}$NO$_2$: 222.0950 [M+H$^+$], found: 222.0947.
Hz, 1H), 7.90 (d, J = 7.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 69.6, 108.1, 121.69, 121.73, 125.0, 128.9, 129.0, 137.8, 140.9, 145.0, 145.6, 173.1. MS: m/z 200 [MH]$^+$. HRMS calcd for C$_{12}$H$_{10}$NO$_2$: 200.0712 [M+H], found: 200.0716.

9-Amino-7-methoxynaphtho[2,3-c]furan-1(3H)-one (5b)

Eluent: ethyl acetate/hexanes (20%); yellow solid (142 mg, 62%), mp 191-193 ºC. $^1$H NMR (400 MHz, CDCl$_3$) δ: 3.95 (s, 3H), 5.33 (s, 2H), 7.03 (s, 1H), 7.11 (d, J = 2.0 Hz, 1H), 7.26 (dd, $J_1$ = 9.2 Hz, $J_2$ = 2.0 Hz, 1H), 7.70 (d, J = 9.2 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 55.5, 69.5, 100.9, 102.8, 108.3, 121.2, 122.7, 130.3, 133.0, 138.6, 144.4, 157.3, 174.1. MS: m/z 230 [MH]$^+$. HRMS calcd for C$_{13}$H$_{12}$NO$_3$: 230.0817 [M+H], found: 230.0828.

9-Amino-6-fluoronaphtho[2,3-c]furan-1(3H)-one (5c)

Eluent: ethyl acetate/hexanes (5%); brown solid (167 mg, 77%), mp 185-187 ºC. $^1$H NMR (400 MHz, DMSO-$d_6$) δ: 5.32 (s, 2H), 7.00 (s, 1H), 7.30-7.35 (m, 3H), 7.57 (d, J = 10.0 Hz, 1H), 8.42 (dd, $J_1$ = 9.6 Hz, $J_2$ = 2.0 Hz, 1H). $^{13}$C NMR (100 MHz, DMSO-$d_6$) δ: 69.3, 100.2, 106.29, 106.33, 111.8, 112.0, 114.2, 114.4, 118.9, 127.3, 127.4, 139.8, 139.9, 143.7, 147.3, 161.3, 163.7, 172.6. MS: m/z 218 [MH]$^+$. HRMS calcd for C$_{12}$H$_{9}$FNO$_2$: 218.0617 [M+H], found: 218.0623.

9-Amino-7-fluoronaphtho[2,3-c]furan-1(3H)-one (5d)

Eluent: ethyl acetate/hexanes (20%); brown solid (163 mg, 75%), mp 250-251 ºC. $^1$H NMR (400 MHz, CDCl$_3$) δ: 5.35 (s, 2H), 5.98 (s, 2H), 7.09 (s, 1H), 7.35-7.40 (m, 1H), 7.51 (dd, $J_1$ = 10.0 Hz, $J_2$ = 2.4 Hz, 1H), 7.79 (dd, $J_1$ = 9.2 Hz, $J_2$ = 1.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ: 69.5, 102.9, 105.9, 106.1, 108.2, 119.0, 119.3, 131.1, 131.2, 134.6, 140.3, 144.86, 144.92, 172.8. MS: m/z 218 [MH]$^+$. HRMS calcd for C$_{12}$H$_9$FNO$_2$: 218.0617 [M+H], found: 218.0624.

9-Amino-7-chloronaphtho[2,3-c]furan-1(3H)-one (5e)
Eluent: ethyl acetate/hexanes (5%); brown solid (182 mg, 78%), mp 177-179 °C. $^1$H NMR (400 MHz, DMSO-$d_6$) $\delta$: 5.35 (s, 2H), 7.08 (s, 1H), 7.31 (s, 2H), 7.59 (dd, $J_1 = 8.8$ Hz, $J_2 = 1.6$ Hz, 1H), 7.85 (d, $J = 8.8$ Hz, 1H), 8.50 (d, $J = 1.2$ Hz, 1H). $^{13}$C NMR (100 MHz, DMSO-$d_6$) $\delta$: 69.5, 106.8, 122.6, 123.4, 129.5, 129.7, 130.8, 136.4, 142.8, 146.4, 172.5. MS: m/z 234 [MH]$^+$. HRMS calcd for C$_{12}$H$_9$ClNO$_2$: 234.0322 [M+H], found: 234.0328.

9-Amino-3-ethylnaphtho[2,3-c]furan-1(3H)-one (5f)

Eluent: ethyl acetate/hexanes (5%); brown solid (163 mg, 72%), mp 111-113 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 1.01 (t, $J = 7.6$ Hz, 3H), 1.80-2.13 (m, 2H), 5.42-5.44 (m, 1H), 6.19 (s, 2H), 6.96 (s, 1H), 7.44 (t, $J = 8.0$ Hz, 1H), 7.56 (t, $J = 8.0$ Hz, 1H), 7.75 (d, $J = 8.0$ Hz, 1H), 7.90 (d, $J = 8.4$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 8.8, 28.2, 82.2, 102.4, 107.8, 121.7, 121.9, 124.9, 128.8, 128.9, 137.7, 144.4, 145.6, 172.7. MS: m/z 228 [MH]$^+$. HRMS calcd for C$_{14}$H$_{14}$NO$_2$: 228.1025 [M+H], found: 228.1036.

9-Amino-6,7-methylenedioxy-3-ethylnaphtho[2,3-c]furan-1(3H)-one (5g)

Eluent: ethyl acetate/hexanes (5%); brown solid (179 mg, 66%), mp 195-197 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 1.00-1.04 (m, 3H), 1.82-2.12 (m, 2H), 5.41-5.43 (m, 1H), 5.80 (s, 2H), 6.09 (s, 2H), 6.87 (s, 1H), 7.07 (s, 1H), 7.15 (s, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 8.9, 28.2, 82.0, 98.4, 101.7, 102.9, 105.1, 107.9, 117.7, 135.7, 143.8, 144.3, 147.4, 150.0, 172.6. MS: m/z 272 [MH]$^+$. HRMS calcd for C$_{15}$H$_{14}$NO$_4$: 272.0923 [M+H], found: 272.0929.

9-Amino-3-phenylnaphtho[2,3-c]furan-1(3H)-one (5h)

Eluent: ethyl acetate/hexanes (20%); brown solid (226 mg, 82%), mp 200-202 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 6.41 (d, $J = 0.4$ Hz, 1H), 6.90 (s, 1H), 7.35-7.38 (m, 5H), 7.45-7.49 (m, 1H), 7.54-7.58 (m, 1H), 7.70 (d, $J = 8.8$ Hz, 1H), 7.92 (d, $J = 8.0$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 82.5, 101.8, 109.3, 121.8, 125.2, 127.1, 128.9, 129.05, 129.08, 129.12, 137.7, 137.9, 144.3, 145.6, 172.4. MS: m/z 276 [MH]$^+$. HRMS calcd for C$_{18}$H$_{14}$NO$_2$: 276.1025 [M+H], found: 276.1033.
9-Amino-7-methoxy-3-phenylnaphtho[2,3-c]furan-1(3H)-one (5i)

Eluent: ethyl acetate/hexanes (20%); brown solid (226 mg, 74%), mp 222-224 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\): 3.94 (s, 3H), 6.40 (s, 1H), 6.88 (s, 1H), 7.15 (d, \(J = 1.6\) Hz, 1H), 7.23-7.26 (m, 1H), 7.36 (s, 5H), 7.62 (dd, \(J_1 = 8.8\) Hz, \(J_2 = 2.0\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\): 55.5, 82.5, 100.9, 102.6, 109.5, 121.2, 122.9, 127.1, 128.8, 129.0, 130.5, 133.0, 137.9, 142.0, 144.3, 157.5, 172.6. MS: m/z 306 [MH]\(^+\). HRMS calcd for C\(_{19}\)H\(_{16}\)NO\(_3\): 306.1130 [M+H], found: 306.1132.

9-Amino-7-fluoro-3-phenylnaphtho[2,3-c]furan-1(3H)-one (5j)

Eluent: ethyl acetate/hexanes (20%); brown solid (258 mg, 88%), mp 213-215 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\): 6.08 (s, 2H), 6.42 (s, 1H), 6.92 (s, 1H), 7.32-7.41 (m, 6H), 7.55 (dd, \(J_1 = 10.0\) Hz, \(J_2 = 2.0\) Hz, 1H), 7.71 (dd, \(J_1 = 9.6\) Hz, \(J_2 = 2.0\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\): 82.5, 102.6, 106.0, 106.2, 109.3, 119.0, 119.3, 122.5, 122.6, 127.1, 128.9, 129.1, 131.27, 131.34, 134.7, 137.6, 143.7, 144.8, 144.9, 159.0, 161.5, 172.2. MS: m/z 294 [MH]\(^+\). HRMS calcd for C\(_{18}\)H\(_{13}\)FNO\(_2\): 294.0930 [M+H], found: 294.0938.

9-Amino-6,7-methylenedioxy-naphtho[2,3-c]furan-1(3H)-one (5k)

Eluent: ethyl acetate/hexanes (33.3%); white solid (170 mg, 70%), mp 233-235 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\): 5.29 (s, 2H), 5.80 (s, 2H), 6.09 (s, 2H), 6.93 (s, 1H), 7.06 (s, 1H), 7.15 (s, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\): 69.3, 98.4, 101.7, 104.9, 108.0, 117.6, 134.6, 144.5, 147.4, 150.0, 155.0, 161.0, 171.6. MS: m/z 244 [MH]\(^+\). HRMS calcd for C\(_{13}\)H\(_{10}\)NO\(_4\): 244.0610 [M+H], found: 244.0613.

4. Procedure for the preparation of 9-iodo-6,7-methylenedioxy-naphtho[2,3-c]furan-1(3H)-one (6)

To a flask containing 9-amino-6,7-methylenedioxy-naphtho[2,3-c]furan-1(3H)-one (5k, 1 mmol) and hydrochloric acid (w/w = 25%, 0.2 mL) were added NaNO\(_2\) (1.1 mmol) with stirring at 0 °C. The mixture was then stirred at 5 °C for 30 minutes. To the resulting mixture was added aqueous KI (w/w = 40%, 0.5 mL) at room temperature. Upon completion, it was diluted with saturated aqueous NH\(_4\)Cl (10 mL). The
filtrate was concentrated and to the residue was added water. The aqueous phase was extracted with EtOAc (10 mL × 3). The combined organic phases were dried with anhydrous Na₂SO₄ and concentrated. The residue was purified by column chromatography on silica gel with EtOAc/hexane (10%) to give 6 in 85% yield.

**9-Iodo-6,7-methylenedioxynaphtho[2,3-c]furan-1(3H)-one (6)**

Eluent: ethyl acetate/hexanes (20%); white solid (301 mg, 85%), mp 238-240 °C. ¹H NMR (400 MHz, CDCl₃) δ: 5.29 (s, 2H), 6.17 (s, 2H), 7.12 (s, 1H), 7.66 (s, 1H), 7.88 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 66.7, 66.8, 98.5, 102.3, 103.7, 110.0, 124.2, 133.4, 134.4, 141.0, 150.4, 150.6, 169.7. MS: m/z 355 [MH]⁺. HRMS calcd for C₁₃H₈IO₄: 354.9467 [M+H], found: 354.9471.

**5. Typical procedure for the preparation of taiwanin C and chinensin**

To a flask containing 9-iodo-6,7-methylenedioxynaphtho[2,3-c]furan-1(3H)-one (6, 0.2 mmol), Pd(OAc)₂ (0.002 mmol), PPh₃ (0.006 mmol) and benzo[d][1,3]dioxol-5-ylboronic acid (7a, 0.22 mmol) in 1,4-dioxane (2 mL) was added Cs₂CO₃ (0.6 mmol). Then, the mixture was stirred at 80 °C under N₂ atmosphere for 8 h. Upon completion, the reaction was quenched with aqueous NH₄Cl and extracted with ethyl acetate (3 mL × 3). The combined organic layers were washed with water and brine, and then dried over anhydrous Na₂SO₄. The solvent was evaporated under vacuum and the crude product was purified by chromatography on silica-gel to afford taiwanin C. Chinensin was prepared in a similar manner through the coupling of 6 with 3,4-dimethoxyphenylboronic acid (7b).

**Taiwanin C⁵**

Eluent: ethyl acetate/hexanes (20%); white solid (65 mg, 93%), mp 272-273 °C. ¹H NMR (400 MHz, CDCl₃) δ: 5.37 (s, 2H), 6.06-6.09 (m, 4H), 6.78-6.81 (m, 2H), 6.79 (dd, J₁ = 10.0 Hz, J₂ = 2.0 Hz, 1H), 7.11 (s, 1H), 7.20 (s, 1H), 7.69 (s, 1H). ¹³C NMR (100 MHz, CDCl₃) δ: 68.0, 101.3, 101.8, 103.7, 108.3,
110.6, 118.9, 119.1, 123.5, 128.4, 130.5, 134.6, 139.8, 140.1, 147.5, 147.6, 148.7, 150.0, 169.9. MS: m/z 349 [MH]$^+$.  

**Chinensin**

Eluent: ethyl acetate/hexanes (33.3%); white solid (69 mg, 95%), mp 224-226 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$: 3.87 (s, 3H), 3.98 (s, 3H), 5.38 (s, 2H), 6.08 (s, 2H), 6.86 (d, $J = 2.0$ Hz, 1H), 6.91 (dd, $J_1 = 9.6$ Hz, $J_2 = 1.6$ Hz, 1H), 7.03 (d, $J = 8.4$ Hz, 1H), 7.12 (s, 1H), 7.20 (s, 1H), 7.69 (s, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$: 55.85, 55.95, 68.0, 101.8, 103.7, 103.8, 110.8, 113.4, 118.8, 119.0, 122.4, 127.2, 130.5, 134.6, 139.9, 140.5, 148.5, 148.6, 148.9, 149.9, 169.9. MS: m/z 365 [MH]$^+$. 

III. Copies of $^1$H and $^{13}$C NMR spectra of 1a-1m
IV. Copies of $^1$H and $^{13}$C NMR spectra of 4a-4k
V. Copies of $^1$H and $^{13}$C NMR spectra of 3a-3m
VI. Copies of $^1$H and $^{13}$C NMR spectra of 5a-5k
VII. Copies of $^1$H and $^{13}$C NMR spectra of 6
VIII. Copies of $^1$H and $^{13}$C NMR spectra of taiwanin C
IX. Copies of $^1$H and $^{13}$C NMR spectra of chinensin
X. References


