Supporting Information
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Supporting Information

Hydroalkylation of Unactivated Alkenes with Ketones and 5-Benzylfurfurals
Enabled by Amine/Pd(II) Cooperative Catalysis

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General data:

NMR spectra were recorded on a Brucker-400 MHz spectrometer. Chemical shifts(δ) are given in ppm relative to TMS. The residual solvent signals were used as references and the chemical shifts converted to the TMS scale (CDCl3: δH = 7.26 ppm, δC = 77.16 ppm). The high resolution mass spectra were recorded on a Thermo LTQ Orbitrap XL (ESI+) or a P-SIMS-Gly of Brucker Daltonics Inc (EI+).

Materials:

Analytical grade solvents for the column chromatography were used as received. Starting materials were purchased from commercial suppliers (Aldrich, Alfa, TCI, Adamas-beta, Energy chemical, and Accela) and used as supplied unless otherwise stated. All solvents were purified and dried according to standard methods prior to use, unless stated otherwise. Pd(CH3CN)2Cl2 was purchased from TCI. 3-butenamide were prepared according to the literature reported procedure.1
Table S1. Optimization of Reaction Conditions for 3-Butenamide and 5-alkylfural

Unless noted otherwise, the reaction of 1f (0.2 mmol) and 4 (3 eq.) was carried out with Pd catalyst (0.02 mmol), an amine (0.04 mmol), and acid (0.2 mmol) in solvent (1 M) at T °C for 22h.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Amine</th>
<th>[Pd]</th>
<th>Solvent</th>
<th>Acid</th>
<th>T/ °C</th>
<th>Yield (%)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>Pd(CH₃CN)₂Cl₂</td>
<td>THF</td>
<td>AcOH</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>A1</td>
<td>Pd(OAc)₂</td>
<td>THF</td>
<td>AcOH</td>
<td>120</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>A1</td>
<td>Pd(OAc)₂</td>
<td>THF</td>
<td>PhCOOH</td>
<td>120</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>A6</td>
<td>Pd(OAc)₂</td>
<td>THF</td>
<td>PhCOOH</td>
<td>120</td>
<td>73 (72)³</td>
</tr>
<tr>
<td>5</td>
<td>A7</td>
<td>Pd(OAc)₂</td>
<td>THF</td>
<td>PhCOOH</td>
<td>120</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>A6</td>
<td>Pd(OAc)₂</td>
<td>THF</td>
<td>PhCOOH</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>A6</td>
<td>Pd(OAc)₂</td>
<td>DCM</td>
<td>PhCOOH</td>
<td>120</td>
<td>56</td>
</tr>
<tr>
<td>8</td>
<td>A6</td>
<td>Pd(OAc)₂</td>
<td>Tol</td>
<td>PhCOOH</td>
<td>120</td>
<td>55</td>
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<tr>
<td>9</td>
<td>A6</td>
<td>Pd(OAc)₂</td>
<td>MeOH</td>
<td>PhCOOH</td>
<td>120</td>
<td>18</td>
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<tr>
<td>10</td>
<td>A6</td>
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<td>EtOH</td>
<td>PhCOOH</td>
<td>120</td>
<td>45</td>
</tr>
</tbody>
</table>

¹ Unless noted otherwise, the reaction of 1f (0.2 mmol) and 4 (3 eq.) was carried out with Pd catalyst (0.02 mmol), an amine (0.04 mmol), and acid (0.2 mmol) in solvent (1 M) at T °C for 22h. b Determined by 1H NMR analysis of the crude product. c Isolated Yield
General Experimental Procedure for synthesis of (3aa-3ia)

To a flame-dried and Ar-purged Schlenk tube (10 mL) were added Pd(CH$_3$CN)$_2$Cl$_2$ (0.02 mmol, 5.2 mg), A1 (0.04 mmol, 8.6 mg), and a stirring bar. The Schlenk tube was then evacuated and filled with argon. This cycle was repeated three times and followed by addition of acetone 2a (6.8 eq., 100 µL), AcOH (0.2 mmol, 11.5 µL) and 1a (0.2 mmol) in THF (0.2 mL) via syringe. The mixture was stirred at 100 °C for the mentioned time. Afterwards the solvent was evaporated and the residue was purified by flash column chromatography (petroleum ether/EtOAc= 5:1) on silica gel to afford the 3aa.

General Experimental Procedure for synthesis of (3fb-3fe)

To a flame-dried and Ar-purged Schlenk tube (10 mL) were added Pd(CH$_3$CN)$_2$Cl$_2$ (0.02 mmol, 5.2 mg), ketone 2 (0.6 mmol), A1 (0.04 mmol, 8.6 mg), and a stirring bar. The Schlenk tube was then evacuated and filled with argon. This cycle was repeated three times and followed by addition of AcOH (0.2 mmol, 11.5 µL), 1f (0.2 mmol, 42.4 mg) and THF (0.2 mL) via syringe. The mixture was stirred at 100 °C for the mentioned time. Afterwards the solvent was evaporated and the residue was purified by flash column chromatography (petroleum ether/EtOAc= 5:1) on silica gel to afford the 3 and 3'.
General Experimental Procedure for synthesis of (5)

To a flame-dried and Ar-purged Schlenk tube (10 mL) were added \( \text{Pd(OAc)}_2 \) (0.02 mmol, 4.5 mg), 4 (0.6 mmol), A6 (0.04 mmol, 10.6 mg), PhCOOH (0.2 mmol, 24.4 mg) and a stirring bar. The Schlenk tube was then evacuated and filled with argon. This cycle was repeated three times and followed by addition of 1f (0.2 mmol, 42.4 mg), THF (0.2 mL) via syringe. The mixture was stirred at 120 °C for the mentioned time. Afterwards the solvent was evaporated and the residue was purified by flash column chromatography (petroleum ether/EtOAc = 6:1) on silica gel to afford the 5.

Synthesis of Asymmetric version of 3aa by Optically Pure Amine Catalyst A1

Synthesis of Asymmetric version of 5fd by Optically Pure Amine Catalyst A6
HPLC data for compound 3aa

**Sample Information**

- **Sample Name:** Krac-as-30%-1ml
- **Sample Type:** Unknown
- **Wax:** 53
- **Injection #:** 1
- **Injection Volume:** 10.00 ul
- **Run Time:** 30.0 Minutes
- **Acquired By:** System
- **Sample Set Name:** 20191003
- **Acq. Method Set:** 30%-1ml
- **Processing Method:** Krac
- **Channel Name:** 2998 Ch1 254nm@4.8nm
- **Proc. Chnl. Descr.:** 2998 Ch1 254nm@4.8nm

**Processed Channel Descr.:** 2998 Ch1 254nm@4.8nm

<table>
<thead>
<tr>
<th>Processed Channel Descr.</th>
<th>RT</th>
<th>Area</th>
<th>% Area</th>
<th>Height</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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<td>6821905</td>
<td>50.02</td>
<td>393443</td>
</tr>
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<td>2</td>
<td>10.884</td>
<td>6817447</td>
<td>49.98</td>
<td>305451</td>
</tr>
</tbody>
</table>

---

**Diagram:**

- **Channel:** 2998 Ch1 254nm@4.8nm
- **Processed Channel:** 2998 Ch1 254nm@4.8nm
- **Result Id:** 1087; Processing Method: Krac
HPLC data for compound 5fd
**SAMPLE INFORMATION**

Sample Name: F3a - 30%1ml-IC
Sample Type: Unknown
Vial: 1
Injection #: 1
Injection Volume: 10.00 ul
Run Time: 25.0 Minutes
Date Acquired: 10/11/2019 1:49:22 AM CST
Date Processed: 10/11/2019 12:32:04 AM CST

**Sample Information**

Sample Name: F3a - 30%1ml-IC
Sample Type: Unknown
Vial: 10
Injection #: 1
Injection Volume: 10.00 ul
Run Time: 25.0 Minutes
Date Acquired: 10/11/2019 1:10:22 AM CST
Date Processed: 10/11/2019 1:49:22 AM CST

**Processed Channel Descr.: 2998 Ch1 254nm@4.8nm**

<table>
<thead>
<tr>
<th>Processed Channel Descr.</th>
<th>RT</th>
<th>Area</th>
<th>% Area</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>2998 Ch1 <a href="mailto:254nm@4.8nm">254nm@4.8nm</a></td>
<td>10.83</td>
<td>812052</td>
<td>49.98</td>
<td>106672</td>
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<tr>
<td>2998 Ch1 <a href="mailto:254nm@4.8nm">254nm@4.8nm</a></td>
<td>11.47</td>
<td>101661</td>
<td>50.02</td>
<td>71866</td>
</tr>
</tbody>
</table>

**Sample Information**

Sample Name: F3a - 30%1ml-IC
Sample Type: Unknown
Vial: 1
Injection #: 1
Injection Volume: 10.00 ul
Run Time: 25.0 Minutes
Date Acquired: 10/11/2019 1:49:22 AM CST
Date Processed: 10/11/2019 12:32:04 AM CST

**Sample Information**

Sample Name: F3a - 30%1ml-IC
Sample Type: Unknown
Vial: 10
Injection #: 1
Injection Volume: 10.00 ul
Run Time: 25.0 Minutes
Date Acquired: 10/11/2019 1:10:22 AM CST
Date Processed: 10/11/2019 1:49:22 AM CST

**Processed Channel Descr.: 2998 Ch1 254nm@4.8nm**

<table>
<thead>
<tr>
<th>Processed Channel Descr.</th>
<th>RT</th>
<th>Area</th>
<th>% Area</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>2998 Ch1 <a href="mailto:254nm@4.8nm">254nm@4.8nm</a></td>
<td>8.253</td>
<td>1015007</td>
<td>49.42</td>
<td>393443</td>
</tr>
<tr>
<td>2998 Ch1 <a href="mailto:254nm@4.8nm">254nm@4.8nm</a></td>
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<td>103661</td>
<td>50.58</td>
<td>291451</td>
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Figure S1: X-ray Single Crystal Data for 3fa

![Crystal structure diagram]

Table 1. Crystal data and structure refinement for 3fa.

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<th>Property</th>
<th>Value</th>
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<tr>
<td>Identification code</td>
<td>mj18575_0m</td>
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<tr>
<td>Empirical formula</td>
<td>C₁₆H₁₈N₂O₂</td>
</tr>
<tr>
<td>Formula weight</td>
<td>270.32</td>
</tr>
<tr>
<td>Temperature</td>
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</tr>
<tr>
<td>Wavelength</td>
<td>1.34139 Å</td>
</tr>
<tr>
<td>Crystal system</td>
<td>Monoclinic</td>
</tr>
<tr>
<td>Space group</td>
<td>P 1 21/n 1</td>
</tr>
<tr>
<td>Unit cell dimensions</td>
<td>a = 11.7091(10) Å, b = 8.3274(6) Å, c = 14.7123(11) Å</td>
</tr>
<tr>
<td>Volume</td>
<td>1430.33(19) Å³</td>
</tr>
<tr>
<td>Z</td>
<td>4</td>
</tr>
<tr>
<td>Density (calculated)</td>
<td>1.255 Mg/m³</td>
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<tr>
<td>Absorption coefficient</td>
<td>0.432 mm⁻¹</td>
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<tr>
<td>F(000)</td>
<td>576</td>
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<tr>
<td>Crystal size</td>
<td>0.12 x 0.08 x 0.05 mm³</td>
</tr>
<tr>
<td>Theta range for data collection</td>
<td>4.050 to 55.135°</td>
</tr>
<tr>
<td>Index ranges</td>
<td>-14&lt;=h&lt;=14, -10&lt;=k&lt;=10, -17&lt;=l&lt;=17</td>
</tr>
<tr>
<td>Reflections collected</td>
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<tr>
<td>Independent reflections</td>
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<tr>
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<td>Absorption correction</td>
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<td>Max. and min. transmission</td>
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<tr>
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<tr>
<td>R indices (all data)</td>
<td>R₁ = 0.0654, w R₂ = 0.1508</td>
</tr>
<tr>
<td>Extinction coefficient</td>
<td>n/a</td>
</tr>
<tr>
<td>Largest diff. peak and hole</td>
<td>0.250 and -0.213 e.Å⁻³</td>
</tr>
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</table>
Analytical Data for the Products:

4-methyl-6-oxo-N-(quinolin-8-yl) heptanamide (3aa)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 89%, 50.5 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.70 (s, 1H), 8.88 – 8.50 (m, 2H), 8.01 (dd, \(J = 8.3, 1.6 \text{ Hz}, 1\)H), 7.42 – 7.33 (m, 2H), 7.31 (dd, \(J = 8.3, 4.2 \text{ Hz}, 1\)H), 2.51 – 2.33 (m, 3H), 2.20 (dd, \(J = 16.2, 8.0 \text{ Hz}, 1\)H), 2.03 (m, 1H), 1.78 – 1.67 (m, 1H), 1.63 – 1.51 (m, 1H), 0.87 (d, \(J = 6.7 \text{ Hz}, 3\)H); \(^13\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 208.41, 171.40, 148.11, 138.22, 136.31, 134.43, 127.87, 127.30, 121.58, 121.41, 116.35, 77.51, 77.19, 76.87, 50.83, 35.63, 32.26, 30.40, 28.82, 19.57; HRMS (ESI) m/z (M+H): calculated for C\(_{17}\)H\(_{20}\)N\(_2\)O\(_2\): 285.1603, found: 285.1607.

4-ethyl-6-oxo-N-(quinolin-8-yl) heptanamide (3ba)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 87%, 51.9 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.80 (s, 1H), 8.79 (dd, \(J = 4.2, 1.7 \text{ Hz}, 1\)H), 8.76 (dd, \(J = 7.3, 1.6 \text{ Hz}, 1\)H), 8.13 (dd, \(J = 8.3, 1.6 \text{ Hz}, 1\)H), 7.54 – 7.45 (m, 2H), 7.43 (dd, \(J = 8.3, 4.2 \text{ Hz}, 1\)H), 2.55 (ddd, \(J = 8.9, 6.7, 3.1 \text{ Hz}, 2\)H), 2.43 (dd, \(J = 6.6, 1.6 \text{ Hz}, 2\)H), 2.15 (s, 3H), 1.88 – 1.70 (m, 2H), 1.49 – 1.28 (m, 2H), 0.91 (t, \(J = 7.4 \text{ Hz}, 3\)H); \(^13\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 208.77, 171.52, 148.12, 138.26, 136.33, 134.47, 127.90, 127.35, 121.59, 121.40, 116.36, 47.95, 35.44, 34.71, 30.45, 29.15, 26.25, 10.77; HRMS (ESI) m/z (M+H): calculated for C\(_{18}\)H\(_{22}\)N\(_2\)O\(_2\): 299.1760, found: 299.1762.

4-benzyl-6-oxo-N-(quinolin-8-yl) heptanamide (3ca)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 31%, 22.3 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.71 (s, 1H), 8.73 (dd, \(J = 4.2, 1.6 \text{ Hz}, 1\)H), 8.68 (dd, \(J = 7.2, 1.5 \text{ Hz}, 1\)H), 8.08 (dd, \(J = 8.3, 1.5 \text{ Hz}, 1\)H), 7.48 – 7.40 (m, 2H), 7.38 (dd, \(J = 8.3, 4.2 \text{ Hz}, 1\)H), 7.22 – 7.08 (m, 5H), 2.64 (m, 1H), 2.54 – 2.47 (m, 3H), 2.35 (s, 2H), 2.34 – 2.28 (m, 1H), 2.00 (s, 3H), 1.78 (dt, \(J = 14.4, 8.1 \text{ Hz}, 2\)H); \(^13\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 207.37, 170.34, 147.11, 139.78, 138.88, 137.29, 135.34, 128.27, 127.90, 127.39, 127.35, 121.40, 115.38, 46.52, 39.32, 34.68, 34.34, 29.46, 28.71; HRMS (ESI) m/z (M+H): calculated for C\(_{23}\)H\(_{24}\)N\(_2\)O\(_2\): 361.1916, found: 361.1903.

6-oxo-4-phenyl-N-(quinolin-8-yl) heptanamide (3da)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 87%, 60.2 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.65 (s, 1H), 8.76 (dd, \(J = 4.2, 1.7 \text{ Hz}, 1\)H), 8.73 (dd, \(J = 7.3, 1.7 \text{ Hz}, 1\)H), 8.13 (dd, \(J = 8.3, 1.7 \text{ Hz}, 1\)H), 7.53 – 7.45 (m, 2H), 7.42 (dd, \(J = 8.3, 4.2 \text{ Hz}, 1\)H), 7.33 – 7.18 (m, 5H), 3.32 – 3.21 (m, 1H), 2.80 (dd, \(J = 7.2, 1.6 \text{ Hz}, 2\)H), 2.45 – 2.31 (m, 2H), 2.21 (tdd, \(J = 8.8, 7.8, 4.6 \text{ Hz}, 1\)H), 2.11 – 1.98 (m, 1H), 2.03 (s, 3H); \(^13\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 207.40, 170.17, 148.07, 143.29, 138.26, 136.34,
134.45, 128.75, 127.91, 127.65, 127.39, 126.76, 121.58, 121.40, 116.40, 50.94, 40.69, 35.79, 31.70, 30.59; HRMS (ESI) m/z (M+H)^+ calculated for C_{22}H_{22}N_{2}O_{2}: 347.1760, found: 347.1766.

3-(2-oxopropyl)-N-(quinolin-8-yl) cyclopentane-1-carboxamide (3ea)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) Yield: 31%, 18.3 mg; 1H NMR (400 MHz, CDCl₃) δ 9.85 (s, 1H), 8.80 (d, J = 3.0 Hz, 1H), 8.77 (d, J = 7.3 Hz, 1H), 8.16 (d, J = 7.9 Hz, 1H), 7.56 – 7.48 (m, 2H), 7.45 (dd, J = 8.2, 4.2 Hz, 1H), 3.17 – 2.98 (m, 1H), 2.66 – 2.45 (m, 3H), 2.37 – 2.25 (m, 1H), 2.16 (s, 3H), 2.14 – 1.98 (m, 3H), 1.63 (dd, J = 7.8, 4.3 Hz, 1H), 1.27 (dd, J = 10.3, 7.7 Hz, 1H); 13C NMR (101 MHz, CDCl₃) δ 208.56, 174.65, 148.14, 138.38, 136.40, 134.62, 127.95, 127.45, 121.60, 121.35, 116.38, 49.82, 46.11, 36.18, 35.29, 33.07, 30.30, 29.97; HRMS (ESI) m/z (M+H)^+ calculated for C_{18}H_{20}N_{2}O_{2}: 297.1603, found: 297.1610.

6-oxo-N-(quinolin-8-yl) heptanamide (3fa)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) Yield: 89%, 48 mg; 1H NMR (400 MHz, CDCl₃) δ 9.80 (s, 1H), 8.80 (dd, J = 4.2, 1.7 Hz, 1H), 8.77 (dd, J = 7.2, 1.7 Hz, 1H), 8.16 (dd, J = 8.3, 1.7 Hz, 1H), 7.51 (dd, J = 7.1, 4.5 Hz, 2H), 7.45 (dd, J = 8.3, 4.2 Hz, 1H), 2.58 (t, J = 7.3 Hz, 2H), 2.52 (t, J = 7.2 Hz, 2H), 2.15 (s, 3H), 1.87 – 1.78 (m, 2H), 1.77 – 1.67 (m, 2H); 13C NMR (101 MHz, CDCl₃) δ 208.67, 171.32, 148.14, 138.31, 136.37, 134.46, 127.93, 127.40, 121.52, 116.41, 43.40, 37.85, 29.94, 25.03, 23.35; HRMS (ESI) m/z (M+H)^+ calculated for C_{16}H_{18}N_{2}O_{2}: 271.1447, found: 271.1437.

2-methyl-6-oxo-N-(quinolin-8-yl) heptanamide (3ga)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) Yield: 69%, 39.2 mg; 1H NMR (400 MHz, CDCl₃) δ 9.81 (s, 1H), 8.74 (dd, J = 4.2, 1.7 Hz, 1H), 8.72 (dd, J = 7.2, 1.8 Hz, 1H), 8.09 (dd, J = 8.3, 1.6 Hz, 1H), 7.48 – 7.41 (m, 2H), 7.38 (dd, J = 8.3, 4.2 Hz, 1H), 2.55 (dd, J = 13.7, 6.9 Hz, 1H), 2.41 (t, J = 7.2 Hz, 2H), 2.04 (s, 3H), 1.83 – 1.64 (m, 2H), 1.59 – 1.41 (m, 2H), 1.27 (d, J = 6.9 Hz, 3H); 13C NMR (101 MHz, CDCl₃) δ 208.77, 175.02, 148.19, 138.43, 136.37, 134.47, 127.94, 127.40, 121.61, 121.46, 116.47, 43.58, 42.91, 33.76, 29.92, 21.71, 18.10. HRMS (ESI) m/z (M+H)^+ calculated for C_{17}H_{21}N_{2}O_{2}: 285.1603, found:285.1603.

2-(but-3-en-1-yl)-6-oxo-N-(quinolin-8-yl) heptanamide (3ha)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) Yield: 65%, 42.2 mg; 1H NMR (400 MHz, CDCl₃) 1H NMR (400 MHz, CDCl₃) δ 9.88 (s, 1H), 8.82 (dd, J = 4.0, 1.6 Hz, 1H), 8.81 (dd, J = 4.8, 1.9 Hz, 1H), 8.17 (dd, J = 8.3, 1.6 Hz, 1H), 7.52 (m, 2H), 7.46 (dd, J = 8.3, 4.2 Hz, 1H), 5.81 (dd, J = 16.9, 10.3 Hz, 1H), 5.04 (dd, J = 17.1, 1.6 Hz, 1H), 4.99 (d, J = 10.2 Hz, 1H), 2.57 – 2.49 (m, 1H), 2.47 (t, J = 7.0 Hz, 2H), 2.21 – 2.12 (m, 1H), 2.11 (s, 3H), 1.92 (dd, J = 11.8, 8.2, 2.7 Hz, 1H), 1.83 – 1.53 (m, 6H); 13C NMR (101 MHz, CDCl₃) δ 208.75, 174.25, 148.24, 138.41, 137.88, 136.36, 134.32,
2,2-dimethyl-6-oxo-N-(quinolin-8-yl) heptanamide (3ia)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 89%, 53 mg; 1H NMR (400 MHz, CDCl3) δ 10.27 (s, 1H), 8.81 (dd, J = 4.2, 1.7 Hz, 1H), 8.79 (dd, J = 7.3, 1.7 Hz, 1H), 8.15 (dd, J = 8.3, 1.7 Hz, 1H), 7.55 – 7.47 (m, 2H), 7.45 (dd, J = 8.3, 4.2 Hz, 1H), 2.45 (t, J = 6.9 Hz, 2H), 2.09 (s, 3H), 1.74 – 1.57 (m, 4H), 1.43 (s, 6H); 13C NMR (101 MHz, CDCl3) δ 208.75, 176.31, 148.27, 138.78, 136.30, 134.53, 127.92, 127.38, 121.58, 121.35, 116.21, 43.97, 43.71, 40.69, 29.85, 25.54, 19.34; HRMS (ESI) m/z (M+H)+: calculated for C20H24N2O2: 325.1916, found: 325.1920.

5,5-dimethyl-6-oxo-N-(quinolin-8-yl) heptanamide (3fb)

7-methyl-6-oxo-N-(quinolin-8-yl)octanamide (3fb’)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 68%, 40.5 mg as an inseparable mixture with (3fb:3fb’ = 3.6:1) ratio; 1H NMR (400 MHz, CDCl3) δ 9.72 (s, 1H), 8.73 (dd, J = 4.2, 1.7 Hz, 1H), 8.10 (dd, J = 8.3, 1.7 Hz, 1H), 7.49 – 7.41 (m, 2H), 7.39 (ddd, J = 8.2, 4.2, 1.4 Hz, 1H), 2.57 – 2.44 (m, 2.74H), 2.08 (s, 2.51H), 1.80 – 1.54 (m, 5.34H), 1.08 (s, 5H), 1.02 (d, J = 6.9 Hz, 1.29H); 13C NMR (101 MHz, CDCl3) δ 213.95, 171.24, 148.12, 138.27, 136.46, 134.41, 127.96, 127.44, 121.62, 121.48, 116.52, 47.72, 39.99, 39.21, 38.24, 37.98, 25.21, 25.17, 24.32, 23.35, 20.82, 18.26. HRMS (ESI) m/z (M+H)+: calculated for C18H22N2O2: 299.1760, found: 299.1760.

6-oxo-N-(quinolin-8-yl) octanamide (3fc)

5-methyl-6-oxo-N-(quinolin-8-yl) heptanamide (3fc)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) **Yield:** 68 %, 38.7 mg as an inseparable mixture with (3fc:3fc’ = 2.1:1) ratio; 1H NMR (400 MHz, CDCl3) δ 9.80 (s, 1H), 8.81 (dd, J = 4.2, 1.5 Hz, 1H), 8.77 (dd, J = 7.2, 1.5 Hz, 1H), 8.16 (d, J = 8.3 Hz, 1H), 7.56 – 7.48 (m, 2H), 7.46 (dd, J = 8.3, 4.2 Hz, 1H), 2.64 – 2.53 (m, 2.95H), 2.50 (t, J = 7.2 Hz, 0.78H), 2.44 (q, J = 7.3 Hz, 0.80H), 2.16(s, 2H), 1.90 – 1.71 (m, 3.88H), 1.55 – 1.39 (m, 1H), 1.14 (d, J = 7.0 Hz, 2.15H), 1.05 (t, J = 7.3 Hz, 1H); 13C NMR (101 MHz, CDCl3) δ 212.55, 211.39, 171.39, 171.26, 148.15, 138.31, 136.40, 134.43, 127.94, 127.42, 121.62, 121.47, 121.44, 116.44, 47.02, 42.04, 37.93, 35.96, 32.21, 28.16, 25.16, 23.45, 23.25, 16.30, 7.84; HRMS (ESI) m/z (M+H)+: calculated for C17H20N2O2: 285.1603, found: 285.1610.
6-oxo-5-phenyl-N-(quinolin-8-yl) heptanamide (3fd)

6-oxo-7-phenyl-N-(quinolin-8-yl) heptanamide (3fd')

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) Yield: 85%, 58.8 mg as an inseparable mixture with (3fd:3fd' = 1.8:1) ratio; 1H NMR (400 MHz, CDCl3) δ 9.76 (s, 1H), 8.81 – 8.72 (m, 2H), 8.16 – 8.12 (m, 1H), 7.57 – 7.40 (m, 2H), 7.36 – 7.17 (m, 3H), 3.73 – 3.64 (t, 1.43H), 2.62 – 2.47 (m, 3H), 2.15 (m, 0.76H), 2.06 (s, 2H), 1.90 – 1.59 (m, 3.74H). 13C NMR (101 MHz, CDCl3) δ 208.22, 208.10, 171.36, 171.30, 148.14, 148.13, 138.65, 138.29, 136.37, 134.43, 134.26, 129.40, 129.01, 128.74, 128.27, 127.93, 127.38, 127.01, 121.60, 121.45, 59.62, 50.20, 41.57, 37.92, 37.79, 31.32, 29.08, 24.95, 23.51, 23.24; HRMS (ESI) m/z (M+H)+: calculated for C22H22N2O2: 347.1772, found: 347.1760.

6-cyclohexyl-6-oxo-N-(quinolin-8-yl) hexanamide (3fe)

4-(1-acetylcyclohexyl)-N-(quinolin-8-yl) butanamide (3fe')

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 5:1) Yield: 63%, 42.6 mg as an inseparable mixture with (3fe:3fe' = 4.8:1) ratio; 1H NMR (400 MHz, CDCl3) δ 9.81 (s, 1H), 8.80 (dd, J = 4.2, 1.6 Hz, 1H), 8.79 – 8.74 (m, 1H), 8.16 (dd, J = 8.3, 1.6 Hz, 1H), 7.56 – 7.48 (m, 2H), 7.45 (dd, J = 8.3, 4.2 Hz, 1H), 2.58 (t, J = 7.4 Hz, 2H), 2.52 (t, 2H), 2.33 (m, 1H), 1.87 – 1.48 (m, 10H), 1.40 – 1.14 (m, 4H); 13C NMR (101 MHz, CDCl3) δ 213.91, 213.59, 171.45, 171.10, 148.14, 138.31, 136.37, 134.47, 134.42, 127.93, 127.40, 121.59, 121.42, 116.44, 116.41, 77.37, 77.05, 76.73, 52.04, 50.85, 40.25, 38.15, 37.99, 33.25, 28.49, 26.04, 25.84, 25.66, 25.36, 25.23, 23.29, 22.91, 19.92; HRMS (ESI) m/z (M+H)+: calculated for C21H26N2O2: 339.2073, found: 339.2069.

5-(5-formylfuran-2-yl)-5-phenyl-N-(quinolin-8-yl) pentanamide (5fa)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) Yield: 72%, 57.3 mg; 1H NMR (400 MHz, CDCl3) δ 9.77 (s, 1H), 9.52 (s, 1H), 8.79 (dd, J = 4.2, 1.6 Hz, 1H), 8.75 (dd, J = 7.0, 1.9 Hz, 1H), 8.16 (dd, J = 8.3, 1.6 Hz, 1H), 7.53 – 7.44 (m, 3H), 7.34 – 7.27 (m, 4H), 7.25 – 7.21 (m, 1H), 7.15 (d, J = 3.6 Hz, 1H), 6.31 (d, J = 3.6 Hz, 1H), 4.09 (t, J = 7.8 Hz, 1H), 2.59 (t, J = 7.4 Hz, 2H), 2.37 – 2.28 (m, 1H), 2.16 – 2.06 (m, 1H), 1.80 (m, 2H). 13C NMR (101 MHz, CDCl3) δ 177.32, 171.06, 164.89, 152.10, 148.15, 140.56, 138.29, 136.41, 134.38, 128.82, 127.94, 127.90, 127.41, 127.22, 121.63, 121.50, 116.44, 109.11, 45.77, 37.61, 33.98, 23.67; HRMS (ESI) m/z (M+H)+: calculated for C25H26N2O3: 399.1709, found: 399.1711.
5-(4-bromophenyl)-5-(5-formylfuran-2-yl)-N-(quinolin-8-yl) pentanamide (5fb)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) **Yield:** 50%, 47.6 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.70 (s, 1H), 9.45 (s, 1H), 8.72 (dd, \(J = 4.2, 1.7\) Hz, 1H), 8.67 (dd, \(J = 6.9, 2.0\) Hz, 1H), 8.09 (dd, \(J = 8.3, 1.7\) Hz, 1H), 7.50 – 7.33 (m, 5H), 7.11 – 7.05 (m, 3H), 6.24 (dd, \(J = 3.6, 0.5\) Hz, 1H), 3.99 (t, \(J = 7.8\) Hz, 1H), 2.52 (t, \(J = 7.3\) Hz, 2H), 2.30 – 2.15 (m, 1H), 2.07 – 1.93 (m, 1H), 1.79 – 1.65 (m, 2H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 177.27, 170.90, 164.02, 152.19, 148.17, 139.55, 138.27, 136.43, 134.33, 131.95, 129.63, 127.95, 127.41, 121.66, 121.55, 121.14, 116.45, 109.16, 45.20, 37.46, 33.74, 23.54; HRMS (ESI) m/z (M+H)^+ calculated for C\(_{25}\)H\(_{21}\)BrN\(_2\)O\(_3\): 477.0814, found: 477.0817.

5-(5-formylfuran-2-yl)-N-(quinolin-8-yl)-5-(p-tolyl) pentanamide (5fc)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) **Yield:** 70%, 57.7 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.69 (s, 1H), 9.42 (s, 1H), 8.70 (dd, \(J = 4.2, 1.6\) Hz, 1H), 8.66 (dd, \(J = 7.0, 1.8\) Hz, 1H), 8.06 (dd, \(J = 8.3, 1.6\) Hz, 1H), 7.44 – 7.39 (m, 2H), 7.36 (dd, \(J = 8.3, 4.3\) Hz, 1H), 7.08 (d, \(J = 8.1\) Hz, 2H), 7.06 (d, \(J = 3.6\) Hz, 1H), 7.03 (d, \(J = 8.0\) Hz, 2H), 6.20 (d, \(J = 3.5\) Hz, 1H), 3.96 (t, \(J = 7.8\) Hz, 1H), 2.49 (t, \(J = 7.4\) Hz, 2H), 2.21 (s, 3H), 2.27 – 2.12 (m, 1H), 2.00 (ddd, \(J = 12.4, 7.7, 3.1\) Hz, 1H), 1.80 – 1.61 (m, 2H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 177.33, 171.18, 165.24, 152.04, 148.16, 138.28, 137.52, 136.83, 136.44, 134.37, 133.46, 130.12, 129.50, 128.44, 127.95, 127.77, 127.40, 121.63, 121.54, 116.54, 108.98, 45.35, 37.61, 33.96, 23.69, 21.03. HRMS (ESI) m/z (M+H)^+ calculated for C\(_{26}\)H\(_{24}\)N\(_2\)O\(_3\): 413.1865, found: 413.1865.

5-(5-formylfuran-2-yl)-5-(4-methoxyphenyl)-N-(quinolin-8-yl) pentanamide (5fd)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) **Yield:** 60%, 49.5 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.77 (s, 1H), 9.51 (s, 1H), 8.80 (dd, \(J = 4.2, 1.7\) Hz, 1H), 8.75 (dd, \(J = 7.0, 1.9\) Hz, 1H), 8.16 (dd, \(J = 8.3, 1.7\) Hz, 1H), 7.51 (dd, \(J = 5.4, 4.6\) Hz, 2H), 7.46 (dd, \(J = 8.3, 4.2\) Hz, 1H), 7.20 (d, \(J = 8.7\) Hz, 2H), 7.14 (d, \(J = 3.5\) Hz, 1H), 6.84 (d, \(J = 8.8\) Hz, 2H), 6.27 (dd, \(J = 3.6, 0.5\) Hz, 1H), 4.06 – 4.00 (t, 1H), 3.77 (s, 3H), 2.58 (t, \(J = 7.4\) Hz, 2H), 2.30 (ddt, \(J = 13.1, 10.1, 6.5\) Hz, 1H), 2.08 (ddd, \(J = 8.9, 7.8, 4.0\) Hz, 1H), 1.86 – 1.72 (m, 2H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 177.30, 171.14, 165.37, 158.68, 152.03, 148.15, 138.29, 136.41, 134.38, 133.55, 132.56, 130.14, 128.89, 128.47, 127.95, 127.41, 121.62, 121.50, 116.48, 114.19, 108.89, 55.25, 44.92, 37.62, 34.01, 23.66; HRMS (ESI) m/z (M+H)^+ calculated for C\(_{26}\)H\(_{24}\)N\(_2\)O\(_4\): 429.1814, found: 429.1809.
5-(4-fluorophenyl)-5-(5-formylfuran-2-yl)-N-(quinolin-8-yl) pentanamide (5fe)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) Yield: 55%, 45.8 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.78 (s, 1H), 9.51 (s, 1H), 8.83 – 8.66 (m, 2H), 8.15 (d, \(J = 8.3\) Hz, 1H), 7.56 – 7.41 (m, 3H), 7.25 (dd, \(J = 12.9, 4.3\) Hz, 2H), 7.15 (d, \(J = 3.3\) Hz, 1H), 6.99 (t, \(J = 8.5\) Hz, 2H), 6.30 (d, \(J = 3.1\) Hz, 1H), 4.07 (t, \(J = 7.7\) Hz, 1H), 2.59 (t, \(J = 7.2\) Hz, 2H), 2.37 – 2.21 (m, 1H), 2.14 – 2.00 (m, 1H), 1.90 – 1.67 (m, 2H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 177.29, 171.01, 164.54, 163.13, 160.69, 152.14, 148.17, 138.27, 136.44, 136.28, 136.25, 134.33, 133.45, 130.10, 129.45, 129.37, 128.45, 127.95, 127.40, 121.65, 121.57, 116.49, 115.78, 115.57, 109.06, 44.99, 37.49, 33.98, 23.57; HRMS (ESI) m/z (M+H)\(^+\): calculated for C\(_{25}\)H\(_{21}\)FN\(_2\)O\(_3\): 417.1614, found: 417.1611.

5-(4-(tert-butyl) phenyl)-5-(5-formylfuran-2-yl)-N-(quinolin-8-yl) pentanamide (5ff)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) Yield: 55%, 50 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.79 (dd, \(J = 4.2, 1.7\) Hz, 1H), 8.75 (dd, \(J = 7.1, 1.9\) Hz, 1H), 8.15 (dd, \(J = 8.3, 1.7\) Hz, 1H), 7.55 – 7.46 (m, 2H), 7.44 (dd, \(J = 5.2, 3.0\) Hz, 1H), 7.33 – 7.29 (m, 2H), 7.22 – 7.18 (m, 2H), 7.14 (d, \(J = 3.6\) Hz, 1H), 6.30 (d, \(J = 3.6\) Hz, 1H), 4.06 (t, \(J = 7.7\) Hz, 1H), 2.58 (t, \(J = 7.4\) Hz, 2H), 2.35 – 2.23 (m, 1H), 2.10 (m, 1H), 1.87 – 1.74 (m, 2H), 1.28 (s, 9H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 177.34, 171.24, 165.24, 152.03, 149.99, 148.17, 138.29, 137.48, 136.45, 134.37, 133.52, 130.14, 128.46, 127.96, 127.49, 127.42, 125.70, 121.64, 121.55, 116.56, 109.07, 45.29, 37.66, 34.45, 34.07, 31.34, 23.75; HRMS (ESI) m/z (M+H)\(^+\): calculated for C\(_{20}\)H\(_{30}\)N\(_2\)O\(_3\): 455.2335, found: 455.2339.

5-(5-formylfuran-2-yl)-5-(3-methoxyphenyl)-N-(quinolin-8-yl) pentanamide (5fg)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) Yield: 72%, 61.6 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.77 (s, 1H), 9.51 (s, 1H), 8.80 (dd, \(J = 4.2, 1.7\) Hz, 1H), 7.51 (dd, \(J = 7.0, 1.9\) Hz, 1H), 5.15 (dd, \(J = 5.4, 4.6\) Hz, 2H), 7.46 (dd, \(J = 8.3, 4.2\) Hz, 1H), 7.20 (d, \(J = 8.7\) Hz, 2H), 7.14 (d, \(J = 3.5\) Hz, 1H), 6.84 (d, \(J = 8.8\) Hz, 2H), 6.27 (dd, \(J = 3.6, 0.5\) Hz, 1H), 4.08 – 3.99 (m, 1H), 3.77 (s, 3H), 2.58 (t, \(J = 7.4\) Hz, 2H), 2.35 (ddt, \(J = 13.1, 10.1, 6.5\) Hz, 1H), 2.08 (ddd, \(J = 8.9, 7.8, 4.0\) Hz, 1H), 1.88 – 1.70 (m, 2H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 177.34, 171.12, 164.77, 159.86, 152.07, 148.17, 142.13, 138.28, 136.42, 134.36, 130.10, 129.81, 128.44, 127.95, 127.40, 121.64, 121.54, 120.25, 116.50, 113.88, 112.29, 109.12, 55.20, 45.74, 37.59, 33.89, 23.67; HRMS (ESI) m/z (M+H)\(^+\): calculated for C\(_{26}\)H\(_{24}\)N\(_2\)O\(_4\): 429.1814, found: 429.1809.

5-(2-fluorophenyl)-5-(5-formylfuran-2-yl)-N-(quinolin-8-yl) pentanamide (5fh)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) Yield: 68%, 56.6 mg; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.78 (s, 1H), 9.52 (s, 1H), 8.79 (dd, \(J = 4.2, 1.7\) Hz, 1H), 8.75 (dd, \(J = 7.0, 1.9\) Hz, 1H), 8.15 (dd, \(J = 8.3, 1.7\) Hz, 1H).
1H), 7.55 – 7.47 (m, 2H), 7.45 (dd, \( J = 8.3, 4.2 \) Hz, 1H), 7.29 (dd, \( J = 7.6, 1.7 \) Hz, 1H), 7.25 – 7.19 (m, 1H), 7.16 (d, \( J = 3.6 \) Hz, 1H), 7.12 – 7.01 (m, 2H), 6.36 (d, \( J = 3.6 \) Hz, 1H), 4.49 (t, \( J = 7.8 \) Hz, 1H), 2.60 (t, \( J = 7.4 \) Hz, 2H), 2.39 – 2.26 (m, 1H), 2.21 – 2.06 (m, 1H), 1.91 – 1.74 (m, 2H). \(^{13}\text{C} \) NMR (101 MHz, CDCl\(_3\)) \( \delta \) 177.33, 171.00, 163.52, 161.73, 159.28, 152.16, 148.16, 138.29, 136.40, 134.38, 130.11, 129.08, 129.05, 128.85, 128.77, 127.94, 127.55, 127.41, 124.55, 124.52, 121.63, 121.51, 116.46, 115.82, 115.59, 109.52, 38.11, 38.08, 37.49, 32.92, 23.50; HRMS (ESI) m/z (M+H): calculated for C\(_{25}\)H\(_{21}\)FNN\(_2\)O\(_3\): 417.1614, found: 417.1610.

5-(5-formylfuran-2-yl)-N-(quinolin-8-yl)-5-(o-tolyl) pentanamide (5f)

(Flash column chromatography eluent, petroleum ether/ethyl acetate = 4:1) \textbf{Yield:} 25%, 20.6 mg; \(^{1}\text{H} \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 9.78 (s, 1H), 9.51 (s, 1H), 8.79 (dd, \( J = 4.2, 1.7 \) Hz, 1H), 8.75 (dd, \( J = 7.1, 1.9 \) Hz, 1H), 8.16 (dd, \( J = 8.3, 1.7 \) Hz, 1H), 7.57 – 7.42 (m, 3H), 7.25 – 7.14 (m, 4H), 7.14 (d, \( J = 1.3 \) Hz, 1H), 6.25 (d, \( J = 3.6 \) Hz, 1H), 4.37 (t, \( J = 7.6 \) Hz, 1H), 2.60 (t, \( J = 7.3 \) Hz, 2H), 2.38 (s, 3H), 2.36 – 2.28 (m, 1H), 2.15 – 2.05 (m, 1H), 1.84 (dtd, \( J = 13.4, 10.2, 7.5 \) Hz, 2H). \(^{13}\text{C} \) NMR (101 MHz, CDCl\(_3\)) \( \delta \) 177.11, 171.02, 165.02, 152.07, 148.15, 138.74, 138.29, 136.40, 135.95, 134.39, 130.73, 127.94, 127.41, 126.97, 126.87, 126.54, 121.63, 121.49, 116.44, 109.27, 41.07, 37.70, 33.66, 23.71, 19.77; HRMS (ESI) m/z (M+H): calculated for C\(_{26}\)H\(_{24}\)N\(_2\)O\(_3\): 413.1865, found: 413.1865.

\textbf{References:}

1H-NMR Spectrum of Compound (3aa)

13C-NMR Spectrum of Compound (3aa)
1H-NMR Spectrum of Compound (3ba)

![1H-NMR Spectrum of Compound (3ba)](image1)

13C-NMR Spectrum of Compound (3ba)

![13C-NMR Spectrum of Compound (3ba)](image2)
1H-NMR Spectrum of Compound (3ca)

13C-NMR Spectrum of Compound (3ca)
1H-NMR Spectrum of Compound (3da)

13C-NMR Spectrum of Compound (3da)
1H-NMR Spectrum of Compound (3ea)

13C-NMR Spectrum of Compound (3ea)
135 DEPT 13C-NMR Spectrum of Compound (3ea)

1H-1H-2D NMR Spectrum of Compound (3ea)
1H-13C-2D NMR Spectrum of Compound (3ea)

1H-NMR Spectrum of Compound (3fa)
13C-NMR Spectrum of Compound (3fa)

1H-NMR Spectrum of Compound (3ga)
13C-NMR Spectrum of Compound (3ga)

1H-NMR Spectrum of Compound (3ha)
13C-NMR Spectrum of Compound (3ha)

1H-NMR Spectrum of Compound (3ia)
13C-NMR Spectrum of Compound (3ia)

1H-NMR Spectrum of Compound (3fb and 3fb')
13C-NMR Spectrum of Compound (3fb and 3fb')

1H-NMR Spectrum of Compound (3fc and 3fc')
13C-NMR Spectrum of Compound (3fc and 3fc’)

1H-NMR Spectrum of Compound (3fd and 3fd’)

S28
13C-NMR Spectrum of Compound (3fd and 3fd')

1H-NMR Spectrum of Compound (3fe and 3fe')
13C-NMR Spectrum of Compound (3fe and 3fe')

1H-NMR Spectrum of Compound (3fa)
13C-NMR Spectrum of Compound (5fa)

1H-NMR Spectrum of Compound (5fb)
13C-NMR Spectrum of Compound (5fb)

1H-NMR Spectrum of Compound (5fc)
13C-NMR Spectrum of Compound (5fc)

1H-NMR Spectrum of Compound (5fd)
13C-NMR Spectrum of Compound (5fd)

1H-NMR Spectrum of Compound (5fe)
13C-NMR Spectrum of Compound (5fe)

1H-NMR Spectrum of Compound (5ff)
13C-NMR Spectrum of Compound (5ff)

1H-NMR Spectrum of Compound (5fg)
13C-NMR Spectrum of Compound (5fg)

1H-NMR Spectrum of Compound (5fh)
13C-NMR Spectrum of Compound (5fh)

1H-NMR Spectrum of Compound (5fi)
13C-NMR Spectrum of Compound (5fi)