Supporting Information

Toluene Derivatives as Simple Coupling Precursors for Cascade Palladium-Catalyzed Oxidative C-H bond Acylation of Acetanilides

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![Chemical Structure](image)

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1. General considerations

Unless otherwise noted, all reagents were purchased from commercial suppliers and used without purification. All the reactions were performed in Rotafloro® (England) resealable screw-cap Schlenk flask (approx. 20 mL volume) in the presence of Teflon coated magnetic stirrer bar (4 mm × 10 mm). Dichloroethane (DCE) was distilled under calcium hydride under reduced pressure. Dioxane and toluene were distilled from sodium under nitrogen. Acetonitrile was distilled from calcium hydride under nitrogen prior to use. The concentration of tert-butyl hydroperoxide (TBHP) was determined by means of iodometric method.[1] Thin layer chromatography was performed on Merck precoated silica gel 60 F254 plates. Silica gel (Merck, 70-230 and 230-400 mesh) was used for column chromatography. $^{1}$$H$ NMR spectra were recorded on a Bruker (400 MHz) spectrometer. Spectra were referenced internally to the residual proton resonance in CDCl$_3$ ($\delta$ 7.26 ppm), or with tetramethylsilane (TMS, $\delta$ 0.00 ppm) as the internal standard. Chemical shifts ($\delta$) were reported as part per million (ppm) in $\delta$ scale downfield from TMS. $^{13}$$C$ NMR spectra were referenced to CDCl$_3$ ($\delta$ 77.0 ppm, the middle peak). Coupling constants ($J$) were reported in Hertz (Hz). High-resolution mass spectra (HRMS) were obtained on a Brüker APEX 47e FT-ICR mass spectrometer (ESIMS). GC-MS analysis was conducted on a HP 5973 GCD system using a HP5MS column (30 m $\times$ 0.25 mm). The products described in GC yield were accorded to the authentic samples/dodecane calibration standard from HP 6890 GC-FID system. Compounds described in the literatures were characterized by comparison of their $^{1}$$H$, and/or $^{13}$$C$ NMR spectra to the previously reported data.
2. **Preparation of substituted acetanilide substrates**

All the substituted acetanilides in Table 3 were prepared from their corresponding precursors with Ac₂O in CH₂Cl₂ according to the literature method without modifications.[²]

*N*-phenylbenzamide, *N*-phenylpivalamide and *N*-phenylisobutyramide in Scheme 2 were prepared from phenylamine with their corresponding acyl chlorides in pyridine according to the literature method without modifications.[³]

3. **General procedures for reaction condition screenings and coupling reactions**

*General procedures for screening*: Acetanilide (0.135 g, 1.0 mmol) and metal complex (10 mol% or as indicated in Table 1) were loaded into a Schlenk tube equipped with a Teflon-coated magnetic stir bar under air. 4-Chlorotoluene (2.0 mL) was added into the tube. The solution was stirred for about 1 to 2 minutes until all solid dissolved. TBHP (12.0 mmol or as indicated in Table 1) were loaded into the tube. The tube was stirred at room temperature for ~5 minutes and then placed into a preheated oil bath (40-120 °C) for 24 hours. After completion of reaction, the reaction tube was allowed to cool to room temperature. Ethyl acetate (~10 mL), dodecane (227 μL, internal standard) and water (~3 mL) were added. The organic layer was subjected to GC analysis. The GC yield obtained was previously calibrated by authentic sample/dodecane calibration curve.
General procedure for C-H bond coupling of acetanilides and substituted toluene:
Substituted acetanilide (1.0 mmol) and Pd(OAc)$_2$ (22.4 mg, 0.10 mmol) were loaded into a Schlenk tube equipped with a Teflon-coated magnetic stir bar under air. Substituted toluene (2.0 mL) was added into the tube (Substituted toluene in solid form was added in 80 equiv.). TBHP (12.0 mmol) were loaded into the tube. The tube was stirred at room temperature for ~5 minutes and then placed into a preheated oil bath at 80 °C for 24 hours. After completion of reaction as judged by GC analysis, the reaction tube was allowed to cool to room temperature and quenched with saturated K$_2$CO$_3$. The organic layer was separated and the aqueous layer was washed with EtOAc. The filtrate was concentrated under reduced pressure. The crude products were purified by flash column chromatography on silica gel (230-400 mesh) to afford the desired oxidatively coupled product.
Table 1  Screening of reaction conditions$^a$

$^{1a}$ Reaction conditions: Acetanilide $^{1a}$ (1.0 mmol), catalyst (10 mol%), oxidant (as indicated), 4-chlorotoluene $^{2l}$ (2 mL) were stirred at indicated reaction temperature for 24 h under air. $^b$Calibrated GC yields were reported using dodecane as the internal standard. Isolated yield in parenthesis. $^c$DCE as solvent ($^{2l}$, 10 equiv.). $^d$Dioxane as solvent ($^{2l}$, 10 equiv.). $^e$MeCN as solvent ($^{2l}$, 10 equiv.). $^f$5 mol% Pd(OAc)$_2$ was used.

<table>
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<tr>
<th>entry</th>
<th>catalyst</th>
<th>oxidant (equiv.)</th>
<th>temp. /°C</th>
<th>%yield$^b$</th>
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</tr>
<tr>
<td>2</td>
<td>PdCl$_2$</td>
<td>TBHP (6)</td>
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<td>6</td>
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<tr>
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<td>94 (90)</td>
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4. Characterization data of coupling products

*N-(2-(1-Naphthoyl)phenyl)acetamide (Table 2, product 3ab)*

\[
\text{Hexane: EtOAc = 1:5, } R_f = 0.4; \quad ^1H \text{ NMR (400 MHz, CDCl}_3) \delta 11.49 (s, 1H), 8.69 (d, J = 8.5 Hz, 1H), 7.91 (dd, J = 7.5, 1.5 Hz, 1H), 7.86-7.79 (m, 2H), 7.50-7.43 (m, 2H), 7.43-7.38 (m, 3H), 7.32 (dd, J = 8.0, 1.5 Hz, 1H), 6.92-6.79 (m, 1H), 2.20 (s, 3H); \quad ^{13}C \text{ NMR (101 MHz, CDCl}_3) \delta 202.16, 169.66, 141.54, 137.01, 135.39, 134.82, 133.63, 131.21, 130.63, 128.55, 127.41, 127.18, 126.62, 125.31, 124.43, 123.24, 122.19, 120.87, 25.56.
\]

*N-(2-(2-Naphthoyl)phenyl)acetamide (Table 2, product 3ac)*

\[
\text{Hexane: EtOAc = 1:5, } R_f = 0.4; \quad ^1H \text{ NMR (400 MHz, CDCl}_3) \delta 10.79 (s, 1H), 8.66 (d, J = 8.3 Hz, 1H), 8.18 (s, 1H), 7.94 (dd, J = 12.3, 8.7 Hz, 3H), 7.84 (dd, J = 8.5, 1.6 Hz, 1H), 7.68-7.54 (m, 4H), 7.15-7.07 (m, 1H), 2.24 (s, 3H); \quad ^{13}C \text{ NMR (101 MHz, CDCl}_3) \delta 199.38, 172.01, 140.29, 135.94, 135.23, 134.20, 133.49, 132.45, 131.84, 129.55, 128.64, 128.31, 127.83, 127.05, 126.77, 125.42, 122.28, 121.78, 25.25.
\]
**Supporting Information**

* N-(2-Benzoylphenyl)acetamide (Table 2, product 3ad)\(^{[5]}\)

![Chemical Structure](image)

Hexane: EtOAc = 1:5, \( R_f = 0.4 \); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 10.81 (s, 1H), 8.60 (d, \( J = 8.2 \) Hz, 1H), 7.71-7.67 (m, 2H), 7.56 (dd, \( J = 15.8, 7.8 \) Hz, 3H), 7.48 (t, \( J = 7.6 \) Hz, 2H), 7.35-7.33 (m, 1H), 7.08 (s, 1H), 2.21 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 199.75, 169.44, 140.35, 134.28, 133.53, 132.57, 129.92, 128.36, 126.97, 122.18, 121.60, 25.23.

* N-(2-(2-Methylbenzoyl)phenyl)acetamide (Table 2, product 3ae)\(^{[4]}\)

![Chemical Structure](image)

Hexane: EtOAc = 1:5, \( R_f = 0.4 \); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 11.56 (s, 1H), 8.75 (d, \( J = 8.5 \) Hz, 1H), 7.56 (dd, \( J = 11.4, 4.3 \) Hz, 1H), 7.39 (dd, \( J = 9.4, 2.6 \) Hz, 1H), 7.29 (d, \( J = 7.7 \) Hz, 1H), 7.25-7.22 (m, 1H), 7.00 (t, \( J = 7.6 \) Hz, 1H), 2.29 (s, 3H), 2.28 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 202.92, 169.57, 141.54, 139.29, 135.90, 135.32, 134.52, 130.94, 130.25, 127.87, 125.38, 122.46, 122.17, 120.74, 25.55, 19.73.

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**Supporting Information**

*N-(2-(2-Methoxybenzoyl)phenyl)acetamide (Table 2, product 3af)*[^6]

![N-(2-(2-Methoxybenzoyl)phenyl)acetamide](image)

Hexane: EtOAc = 1:5, R_f = 0.4; ^1H NMR (400 MHz, CDCl_3) δ 11.61 (s, 1H), 8.75 (d, J = 8.5 Hz, 1H), 7.58-7.53 (m, 1H), 7.52-7.44 (m, 2H), 7.32-7.28 (m, 1H), 7.06 (td, J = 7.5, 0.7 Hz, 1H), 7.04-6.97 (m, 2H), 3.77 (d, J = 3.4 Hz, 3H), 2.26 (d, J = 15.3 Hz, 3H); ^13C NMR (101 MHz, CDCl_3) δ 200.62, 169.64, 156.81, 141.29, 135.09, 134.55, 131.99, 129.09, 128.50, 126.95, 122.58, 120.49, 120.47, 111.44, 55.64, 25.55.

*N-(2-(4-Methoxybenzoyl)phenyl)acetamide (Table 2, product 3ag)*[^4]

![N-(2-(4-Methoxybenzoyl)phenyl)acetamide](image)

Hexane: EtOAc = 1:5, R_f = 0.4; ^1H NMR (400 MHz, CDCl_3) δ 10.44 (s, 1H), 8.47 (d, J = 8.6 Hz, 1H), 7.65 (d, J = 8.8 Hz, 2H), 7.45 (dd, J = 10.1, 3.9 Hz, 2H), 7.01 (dd, J = 11.3, 3.8 Hz, 1H), 6.88 (d, J = 8.8 Hz, 2H), 3.80 (s, 3H), 2.11 (s, 3H); ^13C NMR (101 MHz, CDCl_3) δ 197.89, 169.04, 163.45, 139.80, 133.51, 132.72, 132.61, 130.88, 124.27, 122.07, 121.72, 113.64, 55.52, 25.14.
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*N-(2-(3,5-Dimethoxybenzoyl)phenyl)acetamide (Table 2, product 3ah)*[^12]

![Chemical Structure](image)

Hexane: EtOAc = 1:5, R\textsubscript{f} = 0.4; \(^1\)H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 10.69 (s, 1H), 8.53 (d, \(J = 8.3\) Hz, 1H), 7.58-7.38 (m, 2H), 7.01 (t, \(J = 7.6\) Hz, 1H), 6.73 (d, \(J = 2.2\) Hz, 2H), 6.60 (t, \(J = 2.2\) Hz, 1H), 3.74 (s, 6H), 2.16 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta\) 199.40, 169.30, 160.55, 140.45, 140.38, 134.37, 133.51, 122.12, 121.54, 107.65, 104.81, 55.62, 25.26.

*N-(2-(2-Fluorobenzoyl)phenyl)acetamide (Table 2, product 3ai)*[^4]

![Chemical Structure](image)

Hexane: EtOAc = 1:5, R\textsubscript{f} = 0.4; \(^1\)H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 11.36 (s, 1H), 8.75 (d, \(J = 8.5\) Hz, 1H), 7.62-7.57 (m, 1H), 7.54 (dd, \(J = 6.7, 1.4\) Hz, 1H), 7.52-7.48 (m, 1H), 7.45 (d, \(J = 7.0\) Hz, 1H), 7.31 – 7.25 (m, 1H), 7.20 (d, \(J = 9.4\) Hz, 1H), 7.09-7.03 (m, 1H), 2.28 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\textsubscript{3}) \(\delta\) 197.09, 169.48, 158.4,141.32, 135.57, 134.16, 133.04 (d, \(J_{CF} = 8.3\) Hz), 130.19 (d, \(J_{CF} = 2.3\) Hz), 127.61 (d, \(J_{CF} = 16.8\) Hz), 124.28 (d, \(J_{CF} = 3.5\) Hz), 122.27, 120.79, 116.37 (d, \(J_{CF} = 21.4\) Hz), 25.52.
**Supporting Information**

*N-(2-(4-Fluorobenzoyl)phenyl)acetamide (Table 2, product 3aj)* \(^4\)

![Chemical Structure]

Hexane: EtOAc = 1:5, \( R_f = 0.4 \); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 10.65 (s, 1H), 8.61 (d, \( J = 8.4 \) Hz, 1H), 7.82-7.74 (m, 2H), 7.64-7.49 (m, 2H), 7.19 (t, \( J = 8.6 \) Hz, 2H), 7.11 (s, 1H), 2.24 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 197.81, 169.09, 166.53, 164.00, 140.06, 134.56 (d, \( J_{CF} = 3.1 \) Hz), 132.90, 132.49 (d, \( J_{CF} = 9.2 \) Hz), 127.57 (d, \( J_{CF} = 155.5 \) Hz), 123.30, 121.88 (d, \( J_{CF} = 43.1 \) Hz), 115.43 (d, \( J_{CF} = 22.0 \) Hz), 25.07.

*N-(2-(2-Chlorobenzoyl)phenyl)acetamide (Table 2, product 3ak)* \(^4\)

![Chemical Structure]

Hexane: EtOAc = 1:5, \( R_f = 0.4 \); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 11.56 (s, 1H), 8.86-8.74 (m, 1H), 7.60 (s, 1H), 7.51-7.45 (m, 2H), 7.38 (ddd, \( J = 5.5, 3.3, 1.7 \) Hz, 2H), 7.33 (dd, \( J = 7.5, 1.3 \) Hz, 1H), 7.06-6.99 (m, 1H), 2.31 (s, 3H); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 199.27, 169.65, 141.92, 138.74, 135.95, 134.60, 131.20, 130.94, 130.14, 128.65, 126.75, 122.28, 121.27, 120.64, 25.63.
**Supporting Information**

*N-(2-(4-Chlorobenzoyl)phenyl)acetamide (Table 2, product 3al)*[^4]

![Chemical Structure](image)

Hexane: EtOAc = 1:5, Rf = 0.4; \( ^1 \)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 10.70 (s, 1H), 8.62 (d, \( J = 8.4 \text{ Hz}, 1\text{H} \)), 7.66 (d, \( J = 8.2 \text{ Hz}, 2\text{H} \)), 7.59 (t, \( J = 7.9 \text{ Hz}, 1\text{H} \)), 7.49 (dd, \( J = 13.5, 8.1 \text{ Hz}, 3\text{H} \)), 7.10 (t, \( J = 7.6 \text{ Hz}, 1\text{H} \)), 2.23 (s, 3H); \( ^{13} \)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 195.92, 168.10, 138.62, 137.81, 135.07, 133.14, 131.21, 130.29, 127.94, 126.01, 123.24, 122.25, 23.99.

*N-(2-(2-Bromobenzoyl)phenyl)acetamide (Table 2, product 3am)*[^4]

![Chemical Structure](image)

Hexane: EtOAc = 1:5, Rf = 0.4; \( ^1 \)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 11.54 (s, 1H), 8.80 (d, \( J = 8.5 \text{ Hz}, 1\text{H} \)), 7.65 (dd, \( J = 7.9, 0.9 \text{ Hz}, 1\text{H} \)), 7.57 (dd, \( J = 11.4, 4.2 \text{ Hz}, 1\text{H} \)), 7.39-7.32 (m, 3H), 7.30-7.28 (m, 1H), 7.03-6.98 (m, 1H), 2.29 (s, 3H); \( ^{13} \)C NMR (101 MHz, CDCl\(_3\)) \( \delta \) 199.88, 169.63, 142.03, 140.83, 135.94, 134.68, 133.23, 131.23, 128.56, 127.28, 122.27, 120.98, 120.64, 119.25, 25.62.
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N-(2-(4-Acetylbenzoyl)phenyl)acetamide (Table 2, product 3an)

![Chemical structure of 3an]

Hexane: EtOAc = 1:4, R_f = 0.4; ¹H NMR (400 MHz, CDCl₃) δ 7.95-7.93 (d, J = 8.0 Hz, 1H), 7.82-7.80 (d, J = 8.0 Hz, 1H), 7.76-7.74 (d, J = 8.0 Hz, 1H), 7.39-7.37 (d, J = 8.0 Hz, 1H), 7.25-7.24 (m, 1H), 7.22-7.17 (s, 1H), 2.47 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 197.64, 197.45, 171.20, 143.99, 140.66, 139.78, 133.58, 130.40, 129.84, 125.91, 122.20, 121.62, 27.00, 24.85. HRMS(H⁺): calcd. for C₁₇H₁₆NO₃: 282.3218, found 282.3210.

N-(2-(benzo[d]oxazole-2-carbonyl)phenyl)acetamide (Table 2, product 3ao)

![Chemical structure of 3ao]

Hexane: EtOAc = 1:2.5, R_f = 0.4; ¹H NMR (400 MHz, CDCl₃) δ 8.56 (s, 1H), 8.42 (s, 1H), 7.87-7.85 (d, J = 8.0 Hz, 1H), 7.75-7.63 (m, 1H), 7.56-7.52 (t, J = 11.4, 4.2 Hz, 1H), 7.43 – 7.41 (m, 2H), 7.39-7.26 (m, 1H), 2.27 (s, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 179.91, 171.31, 169.39, 160.39, 149.33, 137.38, 132.12, 130.69, 125.91, 124.10, 119.54, 116.59, 114.20, 107.43, 104.17, 24.85. HRMS(H⁺): calcd. for C₁₆H₁₂N₂O₃: 281.2832, found 282.2829.
Supporting Information

*N-(5-Chloro-2-(4-chlorobenzoyl)phenyl)acetamide (Table 3, product 3bl)\[^{12}\]*

![Chemical structure of N-(5-Chloro-2-(4-chlorobenzoyl)phenyl)acetamide](image)

Hexane: EtOAc = 1:5, \( R_f = 0.4 \); \(^1^H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 10.87 (s, 1H), 8.75 (d, \( J = 2.0 \) Hz, 1H), 7.63 (d, \( J = 8.5 \) Hz, 2H), 7.50-7.44 (m, 3H), 7.07 (dd, \( J = 8.5, 2.0 \) Hz, 1H), 2.24 (s, 3H); \(^{13}C \) NMR (101 MHz, CDCl\(_3\)) \( \delta \) 197.62, 169.28, 141.63, 141.03, 139.23, 136.65, 134.29, 131.15, 128.83, 122.36, 121.42, 120.79, 25.31.

*N-(4-Chloro-2-(4-chlorobenzoyl)phenyl)acetamide (Table 3, product 3cl)\[^{9}\]*

![Chemical structure of N-(4-Chloro-2-(4-chlorobenzoyl)phenyl)acetamide](image)

Hexane: EtOAc = 1:3, \( R_f = 0.4 \); \(^1^H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 10.52 (s, 1H), 8.60 (d, \( J = 9.0 \) Hz, 1H), 7.67 (d, \( J = 8.5 \) Hz, 2H), 7.56-7.45 (m, 4H), 2.23 (s, 3H); \(^{13}C \) NMR (101 MHz, CDCl\(_3\)) \( \delta \) 195.92, 167.80, 139.06, 137.79, 135.35, 133.14, 131.21, 130.29, 127.94, 126.30, 123.31, 122.25, 24.19.

*N-(4-Bromo-2-(4-chlorobenzoyl)phenyl)acetamide (Table 3, product 3dl)\[^{10}\]*

![Chemical structure of N-(4-Bromo-2-(4-chlorobenzoyl)phenyl)acetamide](image)

Hexane: EtOAc = 1:3, \( R_f = 0.4 \); \(^1^H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 10.52 (s, 1H), 8.54 (d, \( J = 9.0 \) Hz, 1H), 7.69-7.63 (m, 3H), 7.61 (d, \( J = 2.3 \) Hz, 1H), 7.53-7.49 (m, 2H), 2.22 (s, 3H); \(^{13}C \) NMR (101 MHz, CDCl\(_3\)) \( \delta \) 196.94, 169.13, 139.65, 139.29, 137.06, 136.08, 135.12, 131.32, 128.97, 124.68, 123.51, 114.68, 25.24.
Supporting Information

\[ N-(2-(4-Chlorobenzoyl)-6-methylphenyl)acetamide (Table 3, product 3el) \]^{12}

\[
\begin{align*}
\text{Hexane: EtOAc = 1:3, } R_f &= 0.4; \quad ^1H \text{ NMR (400 MHz, CDCl}_3) \ \delta 7.98 (s, 1H), 7.89-7.82 (m, 2H), 7.44-7.37 (m, 2H), 7.16 (t, } J = 8.0 \text{ Hz, 1H), 6.99 (dd, } J = 8.3, 1.1 \text{ Hz, 1H), 6.90 (dd, } J = 7.7, 1.1 \text{ Hz, 1H), 3.84 (s, 3H), 2.03 (s, 3H); \quad ^{13}C \text{ NMR (101 MHz, CDCl}_3) \ \delta 193.87, 168.20, 151.78, 138.94, 135.41, 133.54, 131.76, 128.38, 124.91, 123.78, 120.92, 112.84, 55.93, 23.58.
\end{align*}
\]

\[ N-(2-(4-Chlorobenzoyl)-6-methoxyphenyl)acetamide (Table 3, product 3fl) \]^{12}

\[
\begin{align*}
\text{Hexane: EtOAc = 1:3, } R_f &= 0.4; \quad ^1H \text{ NMR (400 MHz, CDCl}_3) \ \delta 8.73 (s, 1H), 7.71 (d, } J = 8.5 \text{ Hz, 2H), 7.32 (d, } J = 8.5 \text{ Hz, 2H), 7.24-7.20 (m, 1H), 7.06 (d, } J = 5.0 \text{ Hz, 2H), 2.12 (s, 3H), 1.85 (s, 3H); \quad ^{13}C \text{ NMR (101 MHz, CDCl}_3) \ \delta 196.39, 168.96, 139.61, 135.52, 135.39, 134.02, 133.89, 131.94, 128.58, 127.34, 125.30, 77.46, 77.14, 76.82, 23.18, 18.47.
\end{align*}
\]
**Supporting Information**

**N-(2-(4-Chlorobenzoyl)-5-methylphenyl)acetamide (Table 3, product 3gl)**\[12\]

![Chemical Structure](attachment:chemical_structure_image)

Hexane: EtOAc = 1:2, R<sub>f</sub> = 0.3; \( ^1H \) NMR (400 MHz, CDCl<sub>3</sub>) \( \delta \) 10.90 (s, 1H), 8.49 (s, 1H), 7.64-7.58 (m, 2H), 7.51-7.43 (m, 2H), 7.40 (d, \( J = 8.1 \) Hz, 1H), 6.89 (dd, \( J = 8.0, 0.8 \) Hz, 1H), 2.43 (s, 3H), 2.23 (s, 3H); \( ^{13}C \) NMR (101 MHz, d-DMSO) \( \delta \) 194.06, 168.08, 142.33, 137.12, 136.27, 131.21, 131.10, 130.12, 128.71, 128.19, 124.67, 123.50, 23.13, 21.04.

**N-(2-(4-Chlorobenzoyl)-4-methylphenyl)acetamide (3hl)**\[12\]

![Chemical Structure](attachment:chemical_structure_image)

Hexane: EtOAc = 1:3, R<sub>f</sub> = 0.4; \( ^1H \) NMR (400 MHz, CDCl<sub>3</sub>) \( \delta \) 10.74 (s, 1H), 8.61 (d, \( J = 8.4 \) Hz, 1H), 7.63 (d, \( J = 8.1 \) Hz, 2H), 7.57 (t, \( J = 7.6 \) Hz, 2H), 7.31 (s, 1H), 7.09 (t, \( J = 7.6 \) Hz, 1H), 2.46 (s, 3H), 2.23 (s, 3H); \( ^{13}C \) NMR (101 MHz, d-DMSO) \( \delta \) 199.36, 169.22, 143.53, 140.19, 135.82, 133.97, 133.29, 130.23, 129.04, 123.68, 122.05, 121.58, 25.27, 21.67.
Supporting Information

\textit{N-(2-(4-Chlorobenzoyl)-5-methoxyphenyl)acetamide (Table 3, product 3il)}\textsuperscript{12}

\begin{center}
\includegraphics[width=0.2\textwidth]{amide3il}
\end{center}

Hexane: EtOAc = 1:3, \(R_f = 0.3\); \(^1\text{H NMR (400 MHz, CDCl}_3\) \(\delta \) 11.48 (s, 1H), 8.40 (d, \(J = 2.6\) Hz, 1H), 7.62-7.56 (m, 2H), 7.51-7.44 (m, 3H), 6.59 (dd, \(J = 8.9, 2.6\) Hz, 1H), 3.92 (s, 3H), 2.27 (s, 3H); \(^{13}\text{C NMR (101 MHz, CDCl}_3\) \(\delta \) 197.62, 169.66, 164.84, 143.91, 138.10, 137.75, 135.93, 130.78, 128.59, 115.21, 109.11, 104.88, 55.71, 25.57.

\textit{N-(2-(4-Chlorobenzoyl)-4-methoxyphenyl)acetamide (Table 3, product 3jl)}\textsuperscript{12}

\begin{center}
\includegraphics[width=0.2\textwidth]{amide3jl}
\end{center}

Hexane: EtOAc = 1:3, \(R_f = 0.3\); \(^1\text{H NMR (400 MHz, CDCl}_3\) \(\delta \) 10.20 (s, 1H), 8.46 (d, \(J = 9.1\) Hz, 1H), 7.70 (d, \(J = 8.5\) Hz, 2H), 7.48 (d, \(J = 8.5\) Hz, 2H), 7.15 (dd, \(J = 9.1, 3.0\) Hz, 1H), 6.99 (d, \(J = 3.0\) Hz, 1H), 3.77 (s, 3H), 2.20 (s, 3H); \(^{13}\text{C NMR (101 MHz, d-DMSO)}\) \(\delta \) 193.21, 167.89, 155.79, 137.38, 135.64, 132.73, 131.27, 131.10, 128.22, 125.77, 117.13, 113.84, 55.42, 22.57.
N-(2-(4-Chlorobenzoyl)naphthalen-1-yl)acetamide (Table 3, product 3kl)[12]

Hexane: EtOAc = 1:3, $R_f = 0.4$; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.91 (s, 1H), 7.95 (dd, $J = 17.6, 8.3$ Hz, 2H), 7.80 (d, $J = 8.3$ Hz, 3H), 7.59 (dd, $J = 18.0, 6.1$ Hz, 2H), 7.53 (s, 2H), 7.46-7.42 (m, 2H), 2.19 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 196.86, 169.80, 139.72, 135.35, 134.84, 131.92, 131.36, 130.38, 128.83, 128.65, 128.07, 127.77, 126.88, 125.70, 124.88, 124.18, 23.54.

(2-Aminopyridin-3-yl)(4-chlorophenyl)methanone (Table 3, product 3ll)[12]

Hexane: EtOAc = 1:5, $R_f = 0.4$; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.07 (s, 1H), 8.38 (d, $J = 8.4$ Hz, 1H), 8.19 (s, 1H), 7.91-7.84 (m, 2H), 7.81-7.70 (m, 1H), 7.45 (d, $J = 8.6$ Hz, 2H), 7.06 (dd, $J = 6.9, 5.3$ Hz, 1H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 164.84, 151.49, 147.82, 138.58, 132.71, 129.07, 128.75 120.09, 114.38.

Methyl 4-acetamido-3-(4-chlorobenzoyl)benzoate (Table 3, product 3ml)[12]

Hexane: EtOAc = 1:5, $R_f = 0.4$; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 10.86 (s, 1H), 8.69 (d, $J = 9.4$ Hz, 2H), 8.17 – 8.12 (m, 3H), 7.59 (d, $J = 8.5$ Hz, 2H), 7.43 (d, $J = 8.5$ Hz, 2H), 3.81 (s, 2H), 2.19 (s, 3H); $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$196.86, 168.40, 143.23, 138.54, 135.35, 134.41, 133.70, 130.31, 127.95, 127.65, 122.67, 121.09, 120.00, 51.30, 24.40.
**Supporting Information**

**Ethyl 4-acetamido-3-(4-chlorobenzoyl)benzoate (Table 3, product 3nl)**[12]

![Chemical Structure of Ethyl 4-acetamido-3-(4-chlorobenzoyl)benzoate](image)

Hexane: EtOAc = 1:5, R_f = 0.4; ¹H NMR (400 MHz, CDCl₃) δ 10.93 (s, 1H), 8.76 (d, J = 9.4 Hz, 1H), 8.23 (s, 2H), 7.67 (d, J = 8.5 Hz, 2H), 7.51 (d, J = 8.5 Hz, 2H), 7.38 (s, 1H), 4.36 (d, J = 7.1 Hz, 2H), 2.27 (s, 3H), 1.37 (t, J = 7.1 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) δ 196.85, 168.36, 143.13, 138.52, 135.36, 134.31, 133.69, 130.32, 127.91, 127.53, 123.05, 121.10, 119.93, 60.26, 24.38, 13.28.

**N-(2-(4-Chlorobenzoyl)phenyl)benzamide (Scheme 2, product 5)**[11]

![Chemical Structure of N-(2-(4-Chlorobenzoyl)phenyl)benzamide](image)

Hexane: EtOAc = 1:5, R_f = 0.4; ¹H NMR (400 MHz, CDCl₃) δ 11.83 (s, 1H), 8.68 (d, J = 8.4 Hz, 1H), 7.93 (d, J = 8.5 Hz, 2H), 7.65 (d, J = 8.5 Hz, 2H), 7.57-7.52 (m, 5H), 7.46 (d, J = 7.4 Hz, 1H), 7.36 (dd, J = 7.6, 1.2 Hz, 1H), 7.30 (d, J = 4.4 Hz, 1H), 7.26 (d, J = 7.3 Hz, 1H); ¹³C NMR (101 MHz, CDCl₃) δ 198.97, 190.95, 141.06, 138.99, 137.00, 134.87, 134.49, 133.70, 132.16, 130.92, 129.47, 128.88, 127.40, 122.86, 122.31, 121.64.
Supporting Information

\textit{N-}(2-(4-Chlorobenzoyl)phenyl)isobutyramide (Scheme 2, product 6)\textsuperscript{[12]}

\begin{center}
\includegraphics[width=0.3\textwidth]{n-(2-(4-chlorobenzoyl)phenyl)isobutyramide.png}
\end{center}

Hexane: EtOAc = 1:10, \( R_f = 0.3 \); \( ^1\text{H} \) NMR (400 MHz, CDCl\textsubscript{3}) \( \delta \) 10.87 (s, 1H), 8.69 (d, \( J = 8.4 \) Hz, 1H), 7.65 (d, \( J = 8.5 \) Hz, 2H), 7.58 (s, 1H), 7.55-7.53 (m, 1H), 7.47 (d, \( J = 8.5 \) Hz, 2H), 7.08 (s, 1H), 1.30 (s, 3H), 1.28 (s, 2H); \( ^{13}\text{C} \) NMR (101 MHz, CDCl\textsubscript{3}) \( \delta \) 198.54, 176.56, 141.19, 138.94, 137.03, 134.63, 133.39, 131.40, 128.99, 128.92, 121.98, 121.64, 37.09, 19.50.

\textit{N-}(2-(4-Chlorobenzoyl)phenyl)pivalamide (Scheme 2, product 7)\textsuperscript{[12]}

\begin{center}
\includegraphics[width=0.3\textwidth]{n-(2-(4-chlorobenzoyl)phenyl)pivalamide.png}
\end{center}

Hexane: EtOAc =1:10, \( R_f = 0.3 \); NMR (400 MHz, CDCl\textsubscript{3}) \( \delta \) 11.12 (s, 1H), 8.73 (s, 1H), 8.71 (d, \( J = 8.5 \) Hz, 2H), 7.65 (d, \( J = 8.5 \) Hz, 1H), 7.60-7.56 (m, 2H), 7.48 (s, 1H), 7.10 – 7.07 (m, 1H), 1.35 (s, 9H); \( ^{13}\text{C} \) NMR (101 MHz, CDCl\textsubscript{3}) \( \delta \) 198.50, 177.74, 141.19, 138.84, 137.09, 134.65, 133.51, 131.29, 128.90, 128.65, 121.92, 121.55, 40.18, 27.79.
5. $^1$H and $^{13}$C NMR and HRMS spectra
Supporting Information

![Chemical Structure](image)

3am

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[Spectral graph with molecular structure of compound 5]
6. References


