Supporting Information
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A Mild and Efficient Route to 2-Azetidinones Using the Cyanuric Chloride-DMF Complex

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General
All required chemicals were purchased from Merck, Fluka and Acros chemical companies. IR spectra were run on a Shimadzu FT-IR 8300 spectrophotometer. 1H NMR and 13C NMR spectra were recorded in CDCl3 using a Bruker Avance DPX instrument (1H NMR 250 MHz, 13C NMR 62.9 MHz). Chemical shifts were reported in parts per million (δ) downfield from TMS. All of the coupling constants (J) are in hertz. Elemental analyses were run on a Thermo Finnigan Flash EA-1112 series. Melting points were determined in open capillaries with Buchi 510 melting point apparatus and are not corrected. Thin-layer chromatography was carried out on silicagel 254 analytical sheets obtained from Fluka. Column chromatography was performed on silicagel 60 (Merck, 70-230 mesh). Azidoacetic acid was synthesized via the reported procedures.

General procedure
DMF (0.30 mL, 4.0 mmol) was added to cyanuric chloride (TCT) (0.22 g, 1.2 mmol) and the resulting suspension was stirred at rt for 5 min. Schiff bases (1.0 mmol) and substituted acetic acids (1.2 mmol) in dry CH2Cl2 (7 mL) solution was added to the cyanuric chloride–DMF suspension followed by addition of dry Et3N (0.6 mL, 4.0 mmol). The reaction mixture was stirred at room temperature overnight. The solution was washed successively with saturated NaHCO3 (7 ml) and brine (7 ml), dried over Na2SO4 and then filtered. The solvent was evaporated under reduced pressure to give the crude product.

β-Lactams were purified by recrystallization from ethyl acetate and β-lactams by short column chromatography (hexane: EtOAc 9:1).

3-(4-chlorophenoxy)-1-(4-ethoxyphenyl)-4-p-tolyl-azetidin-2-one (3a)
White solid. mp: 178-180 °C; IR (KBr) cm-1: 1759 (CO, β-lactam); 1H NMR (250 MHz, CDCl3) δ 1.31 (Me, t, 3H, J = 7.0), 2.33 (Me, s, 3H), 4.02 (OCH2, q, 2H, J = 7.0), 5.18 (H-4, d, 1H, J = 5.1), 5.40 (H-3, d, 1H, J = 5.1), 6.84-7.61 (ArH, m, 12H); 13C NMR (CDCl3) δ 14.2 (Me), 22.5 (Me), 59.6 (OCH2), 61.6 (C-4), 63.0 (C-3), 117.4, 119.1, 122.9, 123.3, 124.0, 125.6, 128.9, 129.2, 141.8, 142.5, 152.7, 156.3 (aromatic carbons), 165.9 (CO, β-lactam); Anal. calcd. For C24H22ClNO3: C, 70.67; H, 5.44; N, 3.43. Found: C, 70.58; H, 5.53; N, 3.38.

4-(3,4-Dimethoxyphenyl)-1-(4-ethoxyphenyl)-3-phenoxyazetidin-2-one (3b)
White solid. mp: 186-188 °C; IR (KBr) cm-1: 1758 (CO, β-lactam); 1H NMR (CDCl3) δ 1.36 (Me, t, 3H), 3.75, 3.81 (2OMe, 2s, 6H), 3.95 (OCH2, q, 2H), 5.28 (H-4, d, 1H, J=4.2), 5.52 (H-3, d, 1H, J=4.2), 6.74-7.33 (ArH, m, 12H); 13C-NMR (CDCl3) δ 14.77 (Me), 55.76, 55.94 (2OMe), 62.05 (OCH2), 63.64 (C-4), 81.11 (C-3), 110.78-156.96 (aromatic carbons), 162.50 (CO, β-lactam); Anal. calcd. For C25H25NO5: C, 71.58; H, 6.01; N, 3.34. Found: C, 71.63; H, 5.98; N, 3.38.
2-(1-(4-Methoxyphenyl)-2-oxo-4-styrylazetidin-3-yl)isoindoline-1,3-dione (3c)

White solid. mp: 189–191 °C; IR (KBr) cm\(^{-1}\): 1732, 1753 (CO, phth), 1779 (CO, \(\beta\)-lactam); \(^1\)H NMR (250 MHz, CDCl\(_3\)) \(\delta\) 3.61 (OMe, s, 3H), 5.12 (H-4, dd, 1H, \(J = 5.4, 8.8\)), 5.61 (H-3, d, 1H, \(J = 5.4\)), 6.29 (H-5, dd, \(J = 8.8, 15.9\)), 6.87 (H-6, d, 1H, \(J = 15.9\)), 7.04–7.86 (ArH, m, 13H); \(^13\)C NMR (62.9 MHz, CDCl\(_3\)) \(\delta\) 55.6 (OMe), 61.5 (C-4), 64.1 (C-3), 113.7, 115.1, 119.4, 120.6, 122.5, 124.3, 128.8, 130.1, 132.5, 138.9, 143.0, 151.6, 158.6 (C=C, aromatic carbons), 163.8 (CO, phth), 166.5 (CO, \(\beta\)-lactam); Anal. Calcd for C\(_{26}\)H\(_{20}\)N\(_2\)O\(_4\): C, 73.57; H, 4.75; N, 6.60. Found: C, 73.66; H, 4.81; N, 6.53.

1-(4-Methoxyphenyl)-3-methoxy-4-p-tolylazetidin-2-one (3d)

White solid. mp: 151-153 °C; IR (KBr) cm\(^{-1}\): 1748 (CO, \(\beta\)-lactam). \(^1\)H NMR (250 MHz, CDCl\(_3\)) \(\delta\) 2.34 (Me, s, 3H), 3.25, 3.91 (2OMe, 2s, 6H), 4.63 (H-4, d, 1H, \(J = 5.1\)), 4.81 (H-3, d, 1H, \(J = 5.1\)), 6.68-8.26 (ArH, m, 8H).

3-(2,4-Dichlorophenoxy)-1-(4-ethoxyphenyl)-4-(4-nitrophenyl)-azetidin-2-one (3e)

Light-yellow crystalline solid. mp: 160–162 °C; IR (KBr) cm\(^{-1}\): 1335, 1524 (NO\(_2\)), 1748 (CO, \(\beta\)-lactam); \(^1\)H NMR (250 MHz, CDCl\(_3\)) \(\delta\) 1.37 (Me, t, 3H, \(J = 7.0\)), 3.96 (OCH\(_2\), q, 2H, \(J = 7.0\)), 5.52 (H-4, d, 1H, \(J = 5.1\)), 5.56 (H-3, d, 1H, \(J = 5.1\)), 6.78–8.22 (ArH, m, 11H); \(^13\)C NMR (62.9 MHz, CDCl\(_3\)) \(\delta\) 14.7 (Me), 60.4 (OCH\(_2\)), 63.7 (C-4), 81.8 (C-3), 115.2, 116.7, 118.7, 123.7, 124.0, 127.7, 128.0, 129.0, 129.5, 130.1, 140.2, 148.2, 151.2, 156.4 (aromatic carbons), 161.3 (CO, \(\beta\)-lactam); Anal. Calcd for C\(_{23}\)H\(_{18}\)Cl\(_2\)N\(_2\)O\(_5\): C, 58.37; H, 3.83; N, 5.92. Found: C, 58.32; H, 3.88; N, 5.89.

4-(4-Chlorophenyl)-1-(4-ethoxyphenyl)-3-(naphthalen-2-yloxy)-azetidin-2-one (3f)

Light-yellow solid. mp: 140–142 °C; IR (KBr) cm\(^{-1}\): 1748 (CO, \(\beta\)-lactam). \(^1\)H NMR (250 MHz, CDCl\(_3\)) \(\delta\) 1.35 (Me, t, 3H, \(J = 7.0\)), 3.90 (OCH\(_2\), q, 2H, \(J = 7.0\)), 5.35 (H-4, d, 1H, \(J = 4.5\)), 5.64 (H-3, d, 1H, \(J = 4.5\)), 6.67–8.08 (ArH, m, 15H); \(^13\)C NMR (62.9 MHz, CDCl\(_3\)) \(\delta\) 14.9 (Me), 61.4 (OCH\(_2\)), 64.6 (C-4), 81.0 (C-3), 109.1, 114.8, 115.1, 118.3, 118.9,123.9,124.3, 126.5, 126.9, 127.7, 128.7, 129.5, 130.9, 131.4, 133.9, 134.6, 154.7, 156.1 (aromatic carbons), 162.2 (CO, \(\beta\)-lactam); Anal. Calcd for C\(_{27}\)H\(_{22}\)ClNO\(_3\): C, 73.05; H, 5.00; N, 3.16. Found: C, 73.13; H, 5.09; N, 3.11.

1-Benzyl-4-(4-chlorophenyl)-3-phenoxyazetidin-2-one (3g)

White solid. mp: 104-106 °C; IR (KBr) cm\(^{-1}\): 1748 (CO, \(\beta\)-lactam). \(^1\)H NMR (250 MHz, CDCl\(_3\)) \(\delta\) 3.85, 4.83 (CH\(_2\)-benzyl, 2d, 2H, \(J = 14.7\)), 4.71(H-4, d, 1H, \(J = 4.3\)), 5.37 (H-3, d, 1H, \(J = 4.3\)), 6.88-7.76 (ArH, m, 14H); \(^13\)C NMR (62.9 MHz, CDCl\(_3\)) \(\delta\) 44.4 (CH\(_2\)), 60.8 (C-3), 82.0 (C-4), 115.4, 122.2, 128.1, 128.3, 128.5, 128.7, 129.0, 129.3, 130.1, 131.5, 134.6, 156.7 (aromatic carbons), 165.4 (CO, \(\beta\)-lactam). Anal. Calcd for C\(_{22}\)H\(_{18}\)ClNO\(_2\): C, 72.62; H, 4.99; N, 3.85. Found: C, 72.75; H, 5.10; N,3.78.

(1-Methyl-2-oxo-4-p-tolylazetidin-3-yl)isoindoline-1,3-dione (3h)

White solid. mp: 176-178 °C; IR (CHCl\(_3\)) cm\(^{-1}\): 1731, 1764 (CO, phth),1782 (CO, \(\beta\)-lactam). \(^1\)H NMR (250 MHz, CDCl\(_3\)) \(\delta\) 2.37 (Me, s, 3H), 2.90 (Me-N, s, 3H), 4.88(H-4, d, 1H, \(J = 4.4\)), 5.16
(H-3, d, 1H, J = 4.4), 7.22-7.86 (ArH, m, 8H). $^{13}$C NMR (62.9 MHz, CDCl$_3$) $\delta$ 21.2 (Me), 27.4 (Me-N), 62.1 (C-4), 62.9 (C-3), 123.6, 126.5, 129.9, 131.7, 132.5, 134.5, 139.0 (aromatic carbons), 164.9 (CO, phth), 166.9 (CO, $\beta$-lactam). Anal. Calcd for C$_{19}$H$_{16}$N$_2$O$_3$: C, 71.24; H, 5.03; N, 8.74. Found: C, 71.18; H, 5.16; N, 8.62.

3-(Naphthalen-2-yloxy)-4-(4-nitrophenyl)-1-(4-(phenyl-diazenyl)-phenyl)-azetidin-2-one (3i)

Orange solid. mp: 220-222 °C; IR (CHCl$_3$) cm$^{-1}$: 1755 (CO, $\beta$-lactam). $^1$H NMR (250 MHz, CDCl$_3$) $\delta$ 5.66 (H-4, d, 1H, J = 5.0), 5.85 (H-3, d, 1H, J = 5.0), 6.88-8.18 (ArH, m, 20H). $^{13}$C NMR (62.9 MHz, CDCl$_3$) $\delta$ 61.3 (C-4), 81.4 (C-3), 109.1, 110.5, 112.8, 115.3, 117.9, 118.0, 122.8, 123.8, 124.4, 124.7, 126.8, 126.9, 127.8, 129.0, 129.1, 129.8, 129.9, 131.1, 133.8, 146.3, 150.7, 154.3 (aromatic carbons), 162.9 (CO, $\beta$-lactam). Anal. Calcd for C$_{31}$H$_{22}$ClN$_3$O$_2$: C, 72.36; H, 4.31; N, 10.89. Found: C, 72.42; H, 4.43; N, 10.81.

3-Chloro-1-(4-methoxyphenyl)-4-phenylazetidin-2-one (3j)

White solid. mp: 116–118 °C; IR (KBr) cm$^{-1}$: 1751 (CO, $\beta$-lactam); $^1$H NMR (250 MHz, CDCl$_3$) $\delta$ 3.63 (OMe, s, 3H), 4.51 (H-4, d, 1H, J = 4.5), 4.98 (H-3, d, 1H, J = 4.5), 6.84-7.17 (ArH, m, 9H); $^{13}$C NMR (62.9 MHz, CDCl$_3$) $\delta$ 54.7 (OMe), 62.5 (C-4), 68.3 (C-3), 106.0, 113.3, 119.1, 125.8, 126.0, 134.1, 149.6, 151.8 (aromatic carbons), 163.7 (CO, $\beta$-lactam); Anal. Calcd for C$_{16}$H$_{14}$ClN$_2$O: C, 66.78; H, 4.87; N, 4.87. Found: C, 66.69; H, 4.96; N, 4.73.

3-Azido-1,4-diphenylazetidin-2-one (3k)

Pale-yellow solid. mp: 96-98 °C; IR (KBr) cm$^{-1}$: 2130 (N$_3$), 1745 (CO, $\beta$-lactam). $^1$H NMR (250 MHz, CDCl$_3$) $\delta$ 4.95 (H-4, d, 1H, J = 5.1), 5.39 (H-3, d, 1H, J = 5.1), 6.54-7.51 (ArH, m, 10H). $^{13}$C NMR (62.9 MHz, CDCl$_3$) $\delta$ 60.0 (C-3), 64.2 (C-4), 112.8, 115.1, 118.8, 120.9, 123.5, 127.3, 139.0, 151.1 (aromatic carbons), 160.4 (CO, $\beta$-lactam). Anal. Calcd for C$_{15}$H$_{12}$N$_4$O: C, 68.17; H, 4.58; N, 21.20. Found: C, 68.06; H, 4.69; N, 21.13.