Supporting Information

Direct C-H Heteroarylation of Azoles with 1,2-Di(pyrimidin-2-yl)disulfides through C-S Cleavage of Disulfides

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1. General
$^{1}$H NMR and $^{13}$C NMR data analyses were performed with a Varian Mercury plus-400 instrument and plus-600 instrument unless otherwise specified. Dual-beam infrared spectrophotometer CDCl$_3$ as solvent and tetramethylsilane (TMS) as the internal standard were employed. Chemical shifts were reported in units (ppm) by assigning TMS resonance in the $^1$H NMR spectrum as 0.00 ppm. The data of $^1$H NMR was reported as follows: chemical shift, multiplicity ($s$ = singlet, $d$ = doublet, $t$ = triplet, $m$ = multiplet and $br$ = broad), coupling constant ($J$ values) in Hz and integration. Chemical shift for $^{13}$C NMR spectrawere recorded in ppm from TMS using the central peak of CDCl$_3$ (77.0ppm) as the internal standard. Flash chromatography was performed using 200-300 mesh silica gel with the indicated solvent system according to standard techniques. Analytical thin-layer chromatography (TLC) was performed on pre-coated, glass-backed silica gel plates. Melting points were measured with an XT-4 apparatus. High-resolution mass spectra (HRMS) (ESI) were obtained with a Bruker Daltonics APEX II 47e and Orbitrap Elite mass spectrometer. Column chromatography was generally performed on silica gel (200–300 mesh) and TLC analyses were conducted on silica gel GF254 plates.

2. Experimental details and characterization data for all compounds.
2.1 General procedure for the synthesis of 3aa. Under an atmosphere of nitrogen, disulfide 1a (1 mmol, 0.546g), benzoxazole 2a (3 mmol, 0.357g), Pd(OAc)$_2$ (0.05mmol, 0.011g), CuTC (2.0mmol, 0.382g) dppp (0.1mmol, 0.041) and Cs$_2$CO$_3$ (3mmol, 0.978g) were added to an oven-dried Schlenk tube. The tube was stoppered and degassed with nitrogen three times. Water-free dioxane (3 mL) was added by syringe and the mixture was stirred for 18 h at 120°C and the reaction was monitored by TLC analysis. Then, 2mL diluted hydrochloric acid were added to the mixture to quench the reaction and extracted with ethyl acetate (3× 100 mL). The combined organic layers were washed with aqueous NaHCO$_3$ and brine, dried over MgSO$_4$, filtered, and the volatiles were removed in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/ petroleum ether 1:30) to give the corresponding products.

2.2 General procedure for the synthesis of 5aa. Under an atmosphere of nitrogen, disulfide 1a (1 mmol, 0.546g), benzo[d]thiazole 4a (3 mmol, 0.456g), Pd(OAc)$_2$ (0.05mmol, 0.011g), CuTC (2.0mmol, 0.382g) PCy$_3$ (0.1mmol, 0.028) and tBuOK (3mmol, 0.337g) were added to an oven-dried Schlenk tube. The tube was stoppered and degassed with nitrogen three times. Water-free DMA (3 mL) was added by syringe and the mixture was stirred for 18 h at 140°C and the reaction was monitored by TLC analysis. Then, 2mL diluted hydrochloric acid were added to the mixture to quench the reaction and extracted with ethyl acetate (3× 100 mL). The combined organic layers were washed with aqueous NaHCO$_3$ and brine, dried over MgSO$_4$, filtered, and the volatiles were removed in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/ petroleum ether 1:30) to give the corresponding products.

2.2 Characterization Data for the Isolated Products.

**Ethyl 2-(benzo[d]oxazol-2-yl)-4-methyl-6-phenylpyrimidine-5-carboxylate (3aa).** Yellow solid, m.p. = 166-167°C. $^1$H NMR (600 MHz, CDCl$_3$): δ 7.94 (d, $J = 7.8$ Hz, 1H), 7.78-7.76 (m, 2H), 7.72 (d, $J = 7.8$ Hz, 1H), 7.51 – 7.46 (m, 4H), 7.43 (t, $J = 7.2$ Hz, 1H), 4.25 (q, $J = 7.2$ Hz, 2H), 2.80 (s, 3H), 1.10 (t, $J = 7.2$ Hz, 3H); $^{13}$C NMR (150 MHz, CDCl$_3$): δ 167.30, 166.59, 164.59, 159.40, 141.79, 136.98, 130.47, 128.69, 128.55, 126.99, 126.26, 125.25, 123.32, 121.65, 111.60, 109.99, 62.22, 22.83, 13.63; HRMS (ESI$^+$) m/z: Calcd for C$_{21}$H$_{18}$N$_3$O$_3$ [M+H]$^+$ 360.1343, Found 360.1347.

**Ethyl 2-(benzo[d]oxazol-2-yl)-4-methyl-6-(p-tolyl)pyrimidine-5-carboxylate (3ba).** Yellow solid, m.p. = 165-166°C. $^1$H NMR (600 MHz, CDCl$_3$): δ 7.91 (d, $J = 7.8$ Hz, 1H), 7.68 – 7.67 (m, 3H), 7.44 (t, $J = 7.8$ Hz, 1H), 7.39 (t, $J = 7.2$ Hz, 1H), 1.13 (t, $J = 7.2$ Hz, 1H); $^{13}$C NMR (150 MHz, CDCl$_3$): δ 167.51, 166.59, 164.59, 159.40, 141.79, 136.98, 130.47, 128.69, 128.55, 126.99, 126.26, 125.25, 123.32, 121.65, 111.60, 109.99, 62.22, 22.83, 13.63; HRMS (ESI$^+$) m/z: Calcd for C$_{22}$H$_{28}$N$_3$O$_3$ [M+H]$^+$ 374.1499, Found 374.1492.
Ethyl 2-(benzo[d]oxazol-2-yl)-4-(4-fluorophenyl)-6-methylpyrimidine-5-carboxylate (3ca). Yellow solid, m.p. = 179-180 °C. 1H NMR (600 MHz, CDCl3): δ 7.94 (d, J = 7.8 Hz, 1H), 7.81 – 7.79 (m, 2H), 7.72 (t, J = 7.2 Hz, 1H), 7.48 (t, J = 7.2 Hz, 1H), 7.43 (t, J = 7.2 Hz, 1H), 7.19 (t, J = 8.4 Hz, 2H), 4.28 (q, J = 7.2 Hz, 2H), 2.79 (s, 3H), 1.16 (t, J = 7.2 Hz, 3H); 13C NMR (150 MHz, CDCl3): δ 167.24, 166.71, 165.11, 163.44, 163.29, 159.34, 154.26, 151.31, 141.70, 130.82, 130.76, 127.07, 126.08, 125.31, 121.66, 115.97, 115.82, 111.59, 62.34, 22.84, 13.74; HRMS (ESI+) m/z: Calcd for C21H17FN3O3 [M+H]+ 378.1248, Found 378.1254.

Ethyl 2-(benzo[d]oxazol-2-yl)-4-(4-chlorophenyl)-6-methylpyrimidine-5-carboxylate (3da). Yellow solid, m.p. = 147-148 °C. 1H NMR (600 MHz, CDCl3): δ 7.92 (d, J = 7.2 Hz, 1H), 7.69 (m, 3H), 7.45 (t, J = 7.2 Hz, 1H), 7.40 (t, J = 7.2 Hz, 1H), 7.28 (d, J = 7.2 Hz, 2H), 2.77 (s, 3H), 1.14 (t, J = 7.2 Hz, 3H); 13C NMR (150 MHz, CDCl3): δ 167.52, 166.34, 164.35, 159.55, 154.20, 151.29, 141.73, 140.91, 134.04, 129.40, 128.55, 126.91, 126.00, 125.20, 121.60, 111.57, 62.18, 22.79, 13.71; HRMS (ESI+) m/z: Calcd for C21H17ClN3O3 [M+H]+ 394.0953, Found 394.0951.

Ethyl 2-(benzo[d]oxazol-2-yl)-4-(2-chlorophenyl)-6-methylpyrimidine-5-carboxylate (3ea). Yellow solid, m.p. = 195-197 °C. 1H NMR (600 MHz, CDCl3): δ 7.92 (d, J = 7.2 Hz, 1H), 7.07 (d, J = 8.4 Hz, 1H), 7.47-7.36 (m, 6H), 4.13 (q, J = 7.2 Hz, 2H), 1.43 (s, 3H), 0.97 (t, J = 7.2 Hz, 3H); 13C NMR (150 MHz, CDCl3): δ 167.64, 165.61, 164.50, 159.22, 154.31, 151.35, 141.71, 136.59, 132.36, 130.64, 130.24, 129.58, 128.65, 127.12, 126.76, 125.31, 121.68, 111.67, 61.98, 23.52, 13.44; HRMS (ESI+) m/z: Calcd for C21H17ClN3O3 [M+H]+ 394.0953, Found 394.0948.

Ethyl 2-(benzo[d]oxazol-2-yl)-4-methyl-6-(3-nitrophenyl)pyrimidine-5-carboxylate (3fa). Yellow solid, m.p. = 153-154 °C. 1H NMR (600 MHz, CDCl3): δ 8.65 (s, 1H), 8.39 (d, J = 8.4 Hz, 1H), 8.15 (d, J = 6.8 Hz, 1H), 7.65 (d, J = 8.4 Hz, 1H), 7.47 (t, J = 7.2 Hz, 1H), 7.38 (d, J = 8.4 Hz, 1H), 7.10 (t, J = 7.2 Hz, 1H), 4.13 (q, J = 7.2 Hz, 2H), 1.43 (s, 3H), 0.97 (t, J = 7.2 Hz, 3H); 13C NMR (150 MHz, CDCl3): δ 167.64, 165.61, 164.50, 159.22, 154.31, 151.35, 141.71, 136.59, 132.36, 130.64, 130.24, 129.58, 128.65, 127.12, 126.76, 125.31, 121.68, 111.67, 61.98, 23.52, 13.44; HRMS (ESI+) m/z: Calcd for C21H17ClN3O3 [M+H]+ 394.0953, Found 394.0948.
= 7.8 Hz, 1H), 7.95 (d, J = 7.8 Hz, 1H), 7.74-7.70 (m, 2H), 7.49 (t, J = 7.2 Hz, 1H), 7.44 (t, J = 7.2 Hz, 1H), 4.33 (q, J = 7.2 Hz, 2H), 2.84 (s, 3H), 1.21 (t, J = 7.2 Hz, 3H); 13C NMR (150 MHz, CDCl3): δ 167.41, 166.59, 161.92, 154.52, 148.36, 141.66, 138.43, 134.63, 129.95, 126.34, 125.44, 125.12, 123.64, 121.74, 111.64, 62.71, 23.02, 13.77; HRMS (ESI+) m/z: Calcd for C21H17N4O5 [M+H]+ 405.1193, Found 405.1191.

Ethyl 2-(benzo[d]oxazol-2-yl)-4-isopropyl-6-phenylpyrimidine-5-carboxylate (3ga). Yellow solid, m.p. = 150-152 °C. 1H NMR (600 MHz, CDCl3): δ 7.95 (d, J = 7.8 Hz, 1H), 7.77 (d, J = 5.4 Hz, 2H), 7.71 (d, J = 7.8 Hz, 1H), 7.50-7.44 (m, 4H), 7.41 (t, J = 7.8 Hz, 1H), 4.23 (q, J = 7.2 Hz, 2H), 3.33-3.30 (m, 1H), 1.47 (d, J = 6.6 Hz, 6H), 1.09 (t, J = 7.2 Hz, 3H); 13C NMR (150 MHz, CDCl3): δ 174.17, 167.49, 164.49, 159.81, 154.77, 141.85, 137.21, 130.28, 128.63, 128.56, 127.51, 126.76, 125.74, 125.06, 121.65, 121.49, 111.52, 62.15, 33.79, 21.72, 13.64; HRMS (ESI+) m/z: Calcd for C23H22N3O3 [M+H]+ 388.1656, Found 388.1652.

Methyl 2-(benzo[d]oxazol-2-yl)-4-methyl-6-phenylpyrimidine-5-carboxylate (3ha). White solid, m.p. = 167-168 °C. 1H NMR (600 MHz, CDCl3): δ 7.93 (d, J = 7.8 Hz, 1H), 7.77 (d, J = 8.4 Hz, 2H), 7.71 (d, J = 7.8 Hz, 1H), 7.50 - 7.40 (m, 5H), 3.75 (s, 3H), 2.78 (s, 3H); 13C NMR (150 MHz, CDCl3): δ 167.88, 166.67, 164.44, 159.43, 154.37, 151.32, 141.72, 136.85, 130.61, 128.79, 128.46, 127.01, 125.89, 125.26, 121.64, 111.59, 52.86, 22.87; HRMS (ESI+) m/z: Calcd for C20H16N3O3 [M+H]+ 346.1186, Found 346.1188.

Methyl 4-methyl-2-(4-methylbenzo[d]oxazol-2-yl)-6-phenylpyrimidine-5-carboxylate (3hb). Yellow solid, m.p. = 154-155 °C. 1H NMR (600 MHz, CDCl3): δ 7.77 (d, J = 4.8 Hz, 2H), 7.70 (s, 1H), 7.58 (d, J = 8.4 Hz, 1H), 7.51 (s, 3H), 7.27 (d, J = 8.4 Hz, 1H), 3.76 (s, 3H), 2.78 (s, 3H), 2.50 (s, 3H); 13C NMR (150 MHz, CDCl3) δ 167.92, 166.63, 164.43, 159.48, 154.45, 149.51, 141.95, 136.91, 135.24, 130.58, 128.78, 128.46, 128.38, 125.79, 121.29, 110.95, 52.85, 22.88, 21.54; HRMS (ESI+) m/z: Calcd for C21H18N3O3 [M+H]+ 360.1343, Found 360.1341.
Ethyl 4-methyl-2-(4-methylbenzo[d]oxazol-2-yl)-6-phenylpyrimidine-5-carboxylate (3ab). Light yellow oil. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.80 – 7.75 (m, 3H), 7.50-7.49 (m, 4H), 7.24 (d, $J = 8.4$ Hz, 1H), 4.24 (q, $J = 7.2$ Hz, 2H), 2.79 (s, 3H), 2.53 (s, 3H), 1.10 (t, $J = 7.2$ Hz, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 167.34, 166.51, 164.55, 159.02, 154.35, 151.66, 139.62, 137.79, 137.04, 130.42, 128.67, 128.55, 126.73, 126.07, 120.95, 111.55, 62.18, 22.82, 22.01, 13.62; HRMS (ESI$^+$) m/z: Calcd for C$_{22}$H$_{20}$N$_3$O$_3$ [M+H]$^+$ 374.1499, Found 374.1496.

Ethyl 4-methyl-2-(4-methylbenzo[d]oxazol-2-yl)-6-(p-tolyl)pyrimidine-5-carboxylate (3bb). Grey solid, m.p. = 154–156 °C. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.62 (d, $J = 8.0$ Hz, 3H), 7.51 (d, $J = 8.4$ Hz, 1H), 7.20 (d, $J = 9.2$ Hz, 3H), 4.21 (q, $J = 7.2$ Hz, 2H), 2.71 (s, 3H), 2.44 (s, 3H), 2.36 (s, 3H), 1.09 (t, $J = 7.2$ Hz, 3H); $^{13}$C NMR (600 MHz, CDCl$_3$): $\delta$ 167.81, 166.56, 164.55, 159.85, 154.53, 149.84, 142.21, 141.12, 135.41, 134.34, 129.64, 128.79, 128.52, 126.15, 121.51, 111.18, 62.41, 23.04, 21.78, 19.38, 13.96. HRMS (ESI$^+$) m/z: Calcd for C$_{23}$H$_{22}$N$_3$O$_3$ [M+H]$^+$ 388.1656, Found 388.1655.

Ethyl 4-(4-fluorophenyl)-6-methyl-2-(4-methylbenzo[d]oxazol-2-yl)pyrimidine-5-carboxylate (3cb). Grey solid, m.p. = 137-139 °C. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 7.79-7.77 (m, 2H), 7.69 (s, 1H), 7.57 (d, $J = 8.4$ Hz, 1H), 7.27 (d, $J = 9.0$ Hz, 1H), 7.18 (t, $J = 8.4$ Hz, 2H), 4.26 (q, $J = 6.6$ Hz, 2H), 2.78 (s, 3H), 2.50 (s, 3H), 1.15 (t, $J = 7.2$ Hz, 3H); $^{13}$C NMR (151 MHz, CDCl$_3$): $\delta$ 167.26, 166.65, 165.08, 163.42, 163.26, 159.38, 154.33, 149.59, 141.92, 135.28, 130.74, 128.43, 125.96, 121.30, 115.94, 110.94, 62.30, 22.83, 21.53, 13.73; HRMS (ESI$^+$) m/z: Calcd for C$_{22}$H$_{19}$FN$_3$O$_3$ [M+H]$^+$ 392.1405, Found 392.1407.
Ethyl 4-methyl-2-(5-methylbenzo[d]oxazol-2-yl)-6-phenylpyrimidine-5-carboxylate (3ac). Light yellow oil. \(^1\)H NMR (400 MHz, CDCl\(_3\)): δ 7.78 – 7.76 (m, 2H), 7.71 (s, 1H), 7.59 (d, \(J = 8.8\) Hz, 1H), 7.51–7.50 (m, 3H), 7.28 (d, \(J = 10.0\) Hz, 1H), 4.25 (q, \(J = 7.2\) Hz, 2H), 2.80 (s, 3H), 2.51 (s, 3H), 1.11 (t, \(J = 7.2\) Hz, 3H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)): δ 167.33, 166.54, 164.57, 159.52, 154.33, 149.61, 141.95, 137.02, 135.23, 130.43, 128.68, 128.55, 128.35, 126.15, 121.29, 110.96, 62.20, 22.82, 21.53, 13.63; HRMS (ESI\(^+\)) m/z: Calcd for C\(_{22}\)H\(_{20}\)N\(_3\)O\(_3\) [M+H\(^+\)] 374.1499, Found 374.1506.

Ethyl 4-methyl-2-(5-methylbenzo[d]oxazol-2-yl)-6-(p-tolyl)pyrimidine-5-carboxylate (3bc). Yellow solid, m.p. = 146–148 °C. \(^1\)H NMR (600 MHz, CDCl\(_3\)) δ 7.72 (d, \(J = 12\) Hz, 1H), 7.62 (d, \(J = 12\) Hz, 2H), 7.37 (m, 3H), 7.26–7.13 (m, 3H), 4.20 (q, \(J = 10.8\) Hz, 2H), 2.70 (s, 3H), 2.46 (s, 3H), 2.35 (s, 3H), 1.09 (t, \(J = 10.8\) Hz, 3H); \(^{13}\)C NMR (150 MHz, CDCl\(_3\)) δ 167.83 , 166.53 , 164.58, 159.35, 154.54, 151.89 , 141.10 , 139.87 , 137.95 , 134.35 , 129.63 , 128.79 , 126.93 , 126.07 , 121.16 , 111.78 , 62.40 , 23.04 , 22.25 , 21.67 , 13.96; HRMS (ESI\(^+\)) m/z: Calcd for C\(_{23}\)H\(_{22}\)N\(_3\)O\(_3\) [M+H\(^+\)] 388.1656, Found 388.1653.

Ethyl 4-(4-fluorophenyl)-6-methyl-2-(5-methylbenzo[d]oxazol-2-yl)pyrimidine-5-carboxylate (3cc). Yellow solid, m.p. = 153–155 °C. \(^1\)H NMR (600 MHz, CDCl\(_3\)) δ 7.79 – 7.77 (m, 3H), 7.53 – 7.49 (m, 2H), 7.18 (t, \(J = 8.4\) Hz, 2H), 4.26 (q, \(J = 7.2\) Hz, 2H), 2.78 (s, 3H), 2.52 (s, 3H), 1.15 (t, \(J = 7.2\) Hz, 3H); \(^{13}\)C NMR (150 MHz, CDCl\(_3\)) δ 167.28 , 166.63 , 163.25 , 158.90, 151.65 , 137.89 , 132.35, 130.87 , 130.74 , 126.79 , 120.97 , 115.93 , 111.53 , 62.30 , 22.02 , 19.13 , 13.73; HRMS (ESI\(^+\)) m/z: Calcd for C\(_{23}\)H\(_{20}\)FN\(_3\)O\(_3\) [M+H\(^+\)] 392.1405, Found 392.1407.

Ethyl 2-(5-(4-methoxyphenyl)-1,3,4-oxadiazol-2-yl)-4-methyl-6-phenylpyrimidine-5-carboxylate (3ad). Light yellow oil. \(^1\)H NMR (600 MHz, CDCl\(_3\)) δ 8.19 (d, \(J = 8.4\) Hz, 2H), 7.77 (d, \(J = 7.8\) Hz, 2H), 7.53 – 7.49 (m, 3H), 7.03 (d, \(J = 9.0\) Hz, 2H), 4.26 (q, \(J = 7.2\) Hz, 2H), 3.89 (s, 3H), 2.77 (s, 3H), 1.12 (t, \(J = 7.2\) Hz, 3H); \(^{13}\)C NMR (151 MHz, CDCl\(_3\)) δ 167.23, 166.71, 164.36, 162.78, 152.47, 136.75, 130.65, 129.43, 128.69, 128.61, 126.20, 115.89, 114.76, 114.49, 62.27, 55.48, 22.74, 13.64; HRMS (ESI\(^+\)) m/z: Calcd for C\(_{25}\)H\(_{21}\)N\(_4\)O\(_4\) [M+H\(^+\)] 417.1557, Found 417.1552.
Ethyl 4-methyl-6-phenyl-2-(5-(m-tolyl)-1,3,4-oxadiazol-2-yl)pyrimidine-5-carboxylate (3ae). Yellow solid, m.p. = 151-152 °C. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 8.08 (s, 1H), 8.04 (d, $J = 7.8$ Hz, 1H), 7.78 (d, $J = 7.2$ Hz, 2H), 7.54-7.50 (m, 3H), 7.43 (t, $J = 7.8$ Hz, 1H), 7.39 (d, $J = 7.2$ Hz, 1H), 4.26 (q, $J = 7.2$ Hz, 2H), 2.78 (s, 3H), 2.46 (s, 3H), 1.12 (t, $J = 7.2$ Hz, 3H); $^{13}$C NMR (151 MHz, CDCl$_3$): $\delta$ 167.14, 166.76, 166.32, 164.41, 152.39, 138.99, 136.72, 133.09, 130.68, 128.94, 128.71, 128.61, 128.05, 124.75, 123.10, 114.95, 62.30, 22.75, 21.28, 13.64; HRMS (ESI$^+$) m/z: Calcd for C$_{23}$H$_{21}$N$_4$O$_3$ [M+H]$^+$ 401.1608, Found 401.1611.

Ethyl 4-methyl-6-(p-tolyl)-2-(5-(m-tolyl)-1,3,4-oxadiazol-2-yl)pyrimidine-5-carboxylate (3be). $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 8.08 (s, 1H), 8.04 (d, $J = 7.2$ Hz, 1H), 7.70 (d, $J = 7.2$ Hz, 1H), 7.31 (d, $J = 7.8$ Hz, 2H), 4.29 (q, $J = 7.2$ Hz, 2H), 2.76 (s, 3H), 2.46 (s, 3H), 1.17 (t, $J = 7.8$ Hz, 3H); $^{13}$C NMR (150 MHz, CDCl$_3$): $\delta$ 167.10, 166.38, 164.33, 162.58, 152.38, 141.19, 139.09, 139.03, 133.05, 131.04, 129.44, 128.93, 128.62, 128.03, 124.73, 123.26, 62.26, 22.71, 21.45, 21.27, 13.72; HRMS (ESI$^+$) m/z: Calcd for C$_{24}$H$_{23}$N$_4$O$_3$ [M+H]$^+$ 415.1765, Found 415.1761.

Ethyl 4-(4-fluorophenyl)-6-methyl-2-(5-(m-tolyl)-1,3,4-oxadiazol-2-yl)pyrimidine-5-carboxylate (3ce). $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 8.07 (s, 1H), 8.03 (d, $J = 7.2$ Hz, 1H), 7.81-7.79 (m, 2H), 7.44-7.38 (m, 2H), 7.19 (t, $J = 8.4$ Hz, 2H), 4.29 (q, $J = 7.2$ Hz, 2H), 2.77 (s, 3H), 2.45 (s, 3H), 1.17 (t, $J = 7.8$ Hz, 3H); $^{13}$C NMR (151 MHz, CDCl$_3$): $\delta$ 167.64, 166.86, 166.40, 165.21, 163.54, 162.42, 152.40, 139.00, 133.13, 130.88, 130.83, 128.95, 128.02, 126.15, 124.73, 123.22, 62.40, 22.74, 21.27, 13.74. HRMS (ESI$^+$) m/z: Calcd for C$_{23}$H$_{20}$F$_3$N$_4$O$_3$ [M+H]$^+$ 415.1765, Found 419.1514.

Ethyl 4-(4-chlorophenyl)-6-methyl-2-(5-(m-tolyl)-1,3,4-oxadiazol-2-yl)pyrimidine-5-carboxylate (3de). Yellow solid, m.p. = 131-132 °C. $^1$H NMR (600 MHz, CDCl$_3$): $\delta$ 8.07 (s, 1H), 8.04 (d, $J = 7.2$ Hz, 1H), 7.74 (d, $J = 8.4$ Hz, 2H), 7.49 (d, $J = 8.4$ Hz, 2H), 7.45 - 7.39 (m, 2H), 4.30 (q, $J = 7.1$ Hz, 2H), 2.78 (s, 3H), 2.46 (s, 3H), 1.12 (t, $J = 7.2$ Hz, 3H); $^{13}$C NMR (151 MHz, CDCl$_3$): $\delta$ 167.14, 166.76, 166.32, 164.41, 152.39, 138.99, 136.72, 133.09, 130.68, 128.94, 128.71, 128.61, 128.05, 124.75, 123.10, 114.95, 62.30, 22.75, 21.28, 13.64; HRMS (ESI$^+$) m/z: Calcd for C$_{23}$H$_{21}$ClN$_4$O$_3$ [M+H]$^+$ 415.1608, Found 415.1611.
2.78 (s, 3H), 2.46 (s, 3H), 1.19 (t, J = 7.2 Hz, 3H); $^{13}$C NMR (150 MHz, CDCl$_3$): δ 166.99, 166.34, 163.06, 162.37, 152.47, 139.02, 137.21, 135.07, 133.15, 130.03, 129.02, 128.97, 128.03, 126.18, 124.74, 123.21, 62.47, 22.77, 21.28, 13.75; HRMS (ESI$^+$) m/z: Calcd for C$_{23}$H$_{20}$ClN$_4$O$_3$ [M+H]$^+$ 435.1218, Found 435.1213.

**Ethyl 4-methyl-6-phenyl-(thiazol-2-yl)pyrimidine-5-carboxylate (3af).** Yellow solid, m.p. = 126-128 °C. $^1$H NMR (600 MHz, CDCl$_3$): δ 8.90 (s, 1H), 8.79 (s, 1H), 7.70 (d, J = 6.6 Hz, 2H), 7.50 – 7.46 (m, 3H), 4.20 (q, J = 7.2 Hz, 2H), 2.65 (s, 3H), 1.07 (t, J = 7.2 Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$): δ 167.87, 165.88, 163.81, 159.31, 156.51, 145.41, 137.44, 130.26, 128.54, 128.39, 123.57, 61.91, 22.66, 13.62. HRMS (ESI$^+$) m/z: Calcd for C$_{17}$H$_{16}$N$_3$O$_2$S [M+H]$^+$ 326.0958, Found 326.0960.

**Ethyl 4-methyl-2-(thiazol-2-yl)6-(p-tolyl)pyrimidine-5-carboxylate (3bf).** Yellow solid, m.p. = 126-128 °C. $^1$H NMR (600 MHz, CDCl$_3$): δ 8.90 (s, 1H), 8.79 (s, 1H), 7.63 (d, J = 7.8 Hz, 2H), 7.28 (d, J = 8.4 Hz, 2H), 4.23 (q, J = 7.2 Hz, 2H), 2.63 (s, 3H), 2.42 (s, 3H), 1.13 (t, J = 7.2 Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$): δ 168.09, 165.66, 163.61, 159.31, 156.41, 145.31, 140.67, 138.68, 134.54, 129.27, 128.38, 123.38, 61.88, 22.62, 21.40, 13.71. HRMS (ESI$^+$) m/z: Calcd for C$_{18}$H$_{18}$N$_3$O$_2$S [M+H]$^+$ 340.1114, Found 340.1112.

**Ethyl 4-(4-fluorophenyl)-6-methyl-2-(thiazol-2-yl)pyrimidine-5-carboxylate (3cf).** Light yellow oil. $^1$H NMR (600 MHz, CDCl$_3$): δ 8.92 (s, 1H), 8.79 (s, 1H), 7.73 (t, J = 8.4 Hz, 2H), 7.17 (t, J = 6.6 Hz, 2H), 4.24 (q, J = 7.2 Hz, 2H), 2.65 (s, 3H), 1.14 (t, J = 7.2 Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$): δ 167.81, 166.01, 162.53, 159.29, 156.60, 145.39, 130.59, 130.53, 123.42, 115.77, 115.62, 109.99, 62.01, 22.66, 13.73. HRMS (ESI$^+$) m/z: Calcd for C$_{17}$H$_{15}$FN$_3$O$_2$S [M+H]$^+$ 344.0864, Found 344.0864.

**Ethyl 2-(benzo[d]oxazol-2-yl)-4-(4-(benzo[d]oxazol-2-yl)phenyl)-6-methylpyrimidine-5-carboxylate (3ja).** Yellow solid, m.p. = 225-226 °C. $^1$H NMR (600 MHz, Chloroform-d) δ 8.40 (d, J =
$7.8 \text{ Hz, 2H}$, $7.96 \text{ (d, } J = 7.8 \text{ Hz, 3H})$, $7.82 \text{ (d, } J = 5.4 \text{ Hz, 1H})$, $7.74 \text{ (d, } J = 8.4 \text{ Hz, 1H})$, $7.63 \text{ (d, } J = 5.4 \text{ Hz, 1H})$, $7.50 - 7.39 \text{ (m, 4H)}$, $4.28 \text{ (q, } J = 6.6 \text{ Hz, 2H})$, $2.83 \text{ (s, 3H)}$, $1.15 \text{ (t, } J = 7.2 \text{ Hz, 3H})$.

$^{13}$C NMR (151 MHz, Chloroform-$_d$) $\delta$ 167.02, 163.52, 162.06, 159.29, 154.39, 151.34, 150.86, 142.03, 141.71, 139.68, 129.23, 128.99, 127.83, 127.14, 126.25, 125.60, 125.35, 124.81, 121.70, 120.24, 111.63, 110.72, 109.99, 62.46, 22.91, 13.73. HRMS (ESI$^+$) m/z: Calcd for C$_{28}$H$_{31}$N$_2$O$_4$ [M+H]$^+$ 477.1557, Found 477.1559.

Ethyl 2-(benzo[d]thiazol-2-yl)-4-methyl-6-phenylpyrimidine-5-carboxylate (5aa). Yellow solid, m.p. = 149-150$^\circ$C. $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ 8.29 (d, $J = 8.4$ Hz, 1H), 7.95 (d, $J = 7.8$ Hz, 1H), 7.78 (d, $J = 9.6$ Hz, 2H), 7.54 – 7.45 (m, 5H), 4.24 (q, $J = 7.2$ Hz, 2H), 2.78 (s, 3H), 1.10 (t, $J = 7.2$ Hz, 3H). $^{13}$C NMR (150 MHz, CDCl$_3$) $\delta$ 167.56, 166.63, 164.01, 158.77, 154.43, 136.98, 136.86, 130.48, 128.61, 128.58, 126.54, 126.53, 125.60, 125.08, 121.82, 62.12, 22.83, 13.64. HRMS (ESI$^+$) m/z: Calcd for C$_{27}$H$_{29}$FN$_2$N$_2$O$_4$S [M+H]$^+$ 454.0219, Found 454.0218.

Ethyl 2-(benzo[d]thiazol-2-yl)-4-methyl-6-(p-tolyl)pyrimidine-5-carboxylate (5ba). Light yellow oil. $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ 8.29 (d, $J = 8.4$ Hz, 1H), 7.96 (d, $J = 7.8$ Hz, 1H), 7.71 (d, $J = 7.8$ Hz, 2H), 7.53 (t, $J = 7.2$ Hz, 1H), 7.47 (t, $J = 7.8$ Hz, 1H), 7.30 (d, $J = 8.4$ Hz, 2H), 4.27 (q, $J = 6.6$ Hz, 2H), 2.77 (s, 3H), 2.43 (s, 3H), 1.17 (t, $J = 7.2$ Hz, 3H). $^{13}$C NMR (151 MHz, CDCl$_3$) $\delta$ 167.81, 166.80, 166.46, 163.77, 158.70, 154.44, 140.96, 136.86, 134.04, 129.36, 128.57, 126.51, 126.48, 125.35, 125.06, 121.82, 62.12, 22.82, 21.45, 13.73. HRMS (ESI$^+$) m/z: Calcd for C$_{27}$H$_{29}$FN$_2$N$_2$O$_4$S $^{[M+H]}$ 343.0791, Found 343.0794. HRMS (ESI$^+$) m/z: Calcd for C$_{27}$H$_{31}$N$_2$O$_4$S [M+H]$^+$ 376.1114, Found 376.112.

Ethyl 2-(benzo[d]thiazol-2-yl)-4-(4-bromophenyl)-6-methylpyrimidine-5-carboxylate (5da). Yellow solid, m.p. = 129-131$^\circ$C. $^1$H NMR (600 MHz, CDCl$_3$) $\delta$ 8.29 (d, $J = 8.4$ Hz, 1H), 7.97 (d, $J = 7.8$ Hz, 1H), 7.67 (d, $J = 8.4$ Hz, 2H), 7.64 (d, $J = 9.0$ Hz, 2H), 7.54 (t, $J = 7.2$ Hz, 1H), 7.48 (t, $J = 6.6$ Hz, 1H), 4.28 (q, $J = 7.2$ Hz, 2H), 2.78 (s, 3H), 1.18 (t, $J = 7.2$ Hz, 3H). $^{13}$C NMR (151 MHz, CDCl$_3$) $\delta$ 167.36, 166.91, 166.35, 162.79, 158.85, 154.42, 136.84, 135.83, 131.89, 130.18, 126.64, 126.62, 125.41, 125.33, 125.12, 121.84, 62.32, 22.87, 13.75. HRMS (ESI$^+$) m/z: Calcd for C$_{27}$H$_{29}$BN$_2$O$_4$S $^{[M+H]}$ 454.0219, Found 454.0218.
3 Copies of the NMR Spectra for All Products.

$^1$H and $^{13}$C Spectra of compound 3aa (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ba (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ca (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3da (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ea (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3a (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ga (CDCl$_3$, 600 MHz)
$^{1}$H and $^{13}$C Spectra of compound 3ha (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3hb (CDCl$_3$, 600 MHz)
$^{1}$H and $^{13}$C Spectra of compound 3ab (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3bb (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3cb (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ac (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3bc (CDCl$_3$, 600 MHz)
$^1\text{H}$ and $^{13}\text{C}$ Spectra of compound 3cc (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ad (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ae (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3be (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3ce (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3de (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3af (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3bf (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 3cf (CDCl$_3$, 600 MHz)

![Spectra Image]

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$^1$H and $^{13}$C Spectra of compound 3ja (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 5aa (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 5ba (CDCl$_3$, 600 MHz)
$^1$H and $^{13}$C Spectra of compound 5da (CDCl$_3$, 600 MHz)