SUPPORTING INFORMATION

N°-Arylation of 2'-Deoxyadenosine via Copper-Catalyzed Direct Coupling

with Aryl Halides

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Typical Procedure for $N^6$-Arylation of 2'-Deoxyadenosine: Preparation of $N^6$-(4-Methylphenyl)-2'-deoxyadenosine (1). To 5.0 mL DMSO were added 4-iodotoluene (0.11 g, 0.5 mmol) and 2'-deoxyadenosine monohydrate (0.14 g, 0.5 mmol) followed by $K_3$PO$_4$ (0.11 g, 0.5 mmol), Cul (0.1 g, 0.5 mmol), and DMEDA (44.0 mg, 0.5 mmol) under argon. The resulting mixture was heated to 100 ~ 110 °C and stirred for 2.5 h. The solution was cooled to rt and poured into cold water (50 mL), then 0.5 mL (28 ~ 30 %) aqueous NH$_4$OH was added. The product was extracted with EtOAc (3 x 30 mL), dried over Na$_2$SO$_4$, and purified by chromatography on a silica gel column eluted with CH$_2$Cl$_2$/EtOAc/CH$_3$OH (6:6:1) to afford 1 (0.143 g, 84.0 %): $^1$H NMR (DMSO): δ 2.27 (s, 3H), 2.31 (m, 1H), 2.75 (m, 1H), 3.53 (m, 1H), 3.63 (m, 1H), 3.89 (dd, 1H, $J$ = 4.0, 7.0 Hz), 4.43 (m, 1H), 5.13 (t, 1H, $J$ = 6.5 Hz), 5.32 (d, 1H, $J$ = 4.0 Hz), 6.40 (dd, 1H, $J$ = 6.0, 6.0 Hz), 7.11 (d, 2H, $J$ = 8.5 Hz), 7.80 (d, 2H, $J$ = 8.5 Hz), 8.35 (s, 1H), 8.49 (br, 1H), 9.78 (s, 1H); $^{13}$C NMR (DMSO): 22.4, 41.3, 63.7, 72.8, 85.8, 89.9, 122.1, 122.8, 130.7, 133.5, 138.8, 142.1, 150.9, 153.8, 154.0; m.p: 201-202 °C; HRMS (M+H$^+$): calc: 342.1566, found: 342.1575.

$N^6$-(1-Naphthyl)-2'-deoxyadenosine (2). $^1$H NMR (CD$_3$OD): δ 2.37 (m, 1H), 2.71 (m, 1H), 3.71 (dd, 1H, $J$ = 3.2, 12.0 Hz), 3.81 (dd, 1H, $J$ = 3.2, 12.0 Hz), 4.07 (d, 1H, $J$ = 2.8 Hz), 4.55 (dd, 1H, $J$ = 2.8, 2.8 Hz), 6.41 (t, 1H, $J$ = 7.2 Hz), 7.41 ~ 7.50 (m, 3H), 7.72 (d, 1H, $J$ = 6.5 Hz), 7.77 (d, 1H, $J$ = 8.0 Hz), 7.87 (d, 1H, $J$ = 8.0 Hz), 7.98 (d, 1H, $J$ = 8.0 Hz), 8.16 (s, 1H), 8.39 (s, 1H); $^{13}$C NMR (CD$_3$OD) _ 41.5, 63.6, 72.9, 87.1, 89.8, 121.5, 123.6, 124.1, 126.7, 127.2, 127.3, 127.6, 129.4, 130.6, 134.6, 135.8, 142.2, 150.1, 153.3, 155.2; m.p: 178-180 °C; HRMS (M+H$^+$): calc: 378.1566, found: 378.1585.
\(N^6\)-(1-4-Methoxyphenyl)-2'-deoxyadenosine (3). \(^1\)H NMR (CD\(_3\)OD): \(\delta\) 2.41 (m, 1H), 2.78 (m, 1H), 3.77 (s, 3H), 3.71 \~ 3.85 (m, 2H), 4.09 (m, 1H), 4.58 (m, 1H), 6.43 (dd, 1H, \(J = 6.0, 6.0\) Hz), 6.86 (dd, 2H, \(J = 2.0, 6.5\) Hz), 7.61 (dd, 2H, \(J = 2.0, 10.0\) Hz), 8.26 (s, 1H), 8.40 (s, 1H); \(^13\)C NMR (CD\(_3\)OD): 41.5, 55.9, 63.7, 73.0, 87.0, 89.9, 115.0, 121.2, 124.2, 132.7, 142.2, 149.6, 153.3, 153.7, 157.8; m.p: 180-181 °C; HRMS (M+H\(^+\)): calc: 358.1515, found: 358.1519.

\(N^6\)-(3,4-Dimethylenyl)-2'-deoxyadenosine (4). \(^1\)H NMR (CD\(_3\)OD): \(\delta\) 2.16 (s, 3H), 2.17 (s, 3H), 2.39 (m 1H), 2.73 (m, 1H), 3.73 (dd, 1H, \(J = 3.5, 12.5\) Hz), 3.82 (dd, 1H, \(J = 3.0, 12.0\) Hz), 4.08 (m, 1H), 4.57 (dd, 1H, \(J = 3.0, 3.0\) Hz), 6.41 (dd, 1H, \(J = 7.0, 7.0\) Hz), 6.98 (d, 1H, \(J = 7.0\) Hz), 7.48 (d, 1H, \(J = 8.5\) Hz), 7.50 (s, 1H), 8.31 (s, 1H), 8.47 (s, 1H); \(^13\)C NMR (CD\(_3\)OD): 18.8, 19.3, 41.4, 63.6, 72.9, 87.0, 89.7, 119.9, 120.9, 123.5, 130.6, 133.1, 137.3, 137.8, 142.6, 149.6, 153.3, 153.4; m.p: 186-187 °C; HRMS (M+H\(^+\)): calc: 356.1723, found: 356.1734.

\(N^6\)-(2,3-Dimethylenyl)-2'-deoxyadenosine (5). \(^1\)H NMR (CD\(_3\)OD): \(\delta\) 2.15 (s, 1H), 2.32 (s, 3H), 2.41 (m, 1H), 2.79 (m, 1H), 3.74 (dd, 1H, \(J = 3.0, 12.0\) Hz), 3.84 (dd, 1H, \(J = 3.0, 12.0\) Hz), 4.09 (m, 1H), 4.59 (t, 1H, \(J = 3.0\) Hz), 6.45 (dd, 1H, \(J = 6.0, 6.0\) Hz), 7.11 (m, 2H), 7.25 (dd, 1H, \(J = 2.0, 7.0\) Hz), 8.17 (s, 1H), 8.36 (s, 1H); \(^13\)C NMR (CD\(_3\)OD): 14.5, 20.6, 41.5, 63.6, 73.0, 87.2, 89.9, 121.5, 125.5, 126.9, 129.2, 134.2, 137.0, 139.0, 141.8, 149.9, 153.3, 155.1; m.p: 148-149 °C; HRMS (M+H\(^+\)): calc: 356.1723, found: 356.1736.
N6-(4-Chlorophenyl)-2'-deoxyadenosine (6). 1H NMR (DMSO): δ 2.31 (m, 1H), 2.76 (m, 1H), 3.53 (m, 1H), 3.63 (m, 1H), 3.89 (d, 1H, J = 3.0 Hz), 4.43 (m, 1H), 5.15 (t, 1H, J = 6.0 Hz), 5.35 (d, 1H, J = 4.0 Hz), 6.42 (dd, 1H, J = 7.0, 7.0 Hz), 7.37 (d, 2H, J = 9.0 Hz), 8.01 (d, 2H, J = 9.0 Hz), 8.42 (s, 1H), 8.55 (s, 1H), 10.11 (br, 1H); 13C NMR (DMSO): 39.7, 61.8, 70.9, 83.9, 88.0, 120.9, 121.2, 122.2, 126.2, 128.3, 128.4, 138.7, 151.8, 151.9; m.p: 239-240 °C; HRMS (M+H+): calc: 362.1020, found: 362.1013.

N6-(4-Nitrophenyl)-2'-deoxyadenosine (7). 1H NMR (DMSO): δ 2.33 (m, 1H), 2.76 (m, 1H), 3.53 (m, 1H), 3.63 (m, 1H), 3.89 (dd, 1H, J = 4.0, 7.0 Hz), 4.10 (d, 1H, J = 5.0 Hz), 4.43 (m, 1H), 5.07 (t, 1H, J = 5.5 Hz), 5.35 (d, 1H, J = 4.0 Hz), 6.43 (t, 1H, J = 6.5 Hz), 8.21 (d, 1H, J = 9.0 Hz), 8.28 (d, 1H, J = 9.0 Hz), 8.54 (s, 1H), 8.63 (s, 1H), 10.69 (s, 1H); 13C NMR (DMSO): 39.7, 62.1, 71.1, 84.3, 88.4, 119.9, 121.4, 125.1, 141.6, 141.8, 146.8, 150.2, 151.5, 152.0; m.p: >260 °C; HRMS (M+H+): calc: 373.1260, found: 373.1275.

N6-(2,6-Dimethylphenyl)-2'-deoxyadenosine (8). 1H NMR (CD3OD): δ 2.14 (s, 6H), 2.35 (m, 1H), 2.76 (m, 1H), 3.66 (dd, 1H, J = 3.0, 12.5 Hz), 3.79 (dd, 1H, J = 3.0, 12.5 Hz), 4.01 (d, 1H, J = 2.0 Hz), 4.52 (t, 1H, J = 2.5 Hz), 6.39 (dd, 1H, J = 7.0 Hz), 7.07 ~ 7.10 (m, 3H), 8.04 (s, 1H), 8.30 (s, 1H); 13C NMR (CD3OD): 18.5, 41.5, 63.6, 73.0, 87.2, 89.9, 121.4, 128.6, 129.4, 136.0, 137.8, 141.7, 149.9, 153.5, 155.4; colorless oil; HRMS (M+H+): calc: 356.1723, found: 356.1721.
$N^6$-(6-Methoxynaphthyl-2-yl)-2'-deoxyadenosine (9). $^1$H NMR (DMSO-D$_2$O): $\delta$ 2.33 (m, 1H), 2.75 (m, 1H), 3.54 (dd, 1H, $J$ = 4.0, 12.0 Hz), 3.63 (s, 3H), 3.66 (dd, 1H, $J$ = 4.0, 12.0 Hz), 3.92 (dd, 1H, $J$ = 4.0, 6.5 Hz), 4.44 (dd, 1H, $J$ = 3.0, 3.0 Hz), 6.42 (dd, 1H, $J$ = 7.0 Hz), 7.10 (dd, 1H, $J$ = 2.5, 8.5 Hz), 7.23 (d, 1H, $J$ = 2.0 Hz), 7.70 (d, 1H, $J$ = 9.0 Hz), 7.74 (d, 1H, $J$ = 9.0 Hz), 7.89 (dd, 1H, $J$ = 2.0, 9.0 Hz), 8.41 (s, 1H), 8.44 (s, 1H); $^{13}$C NMR (DMSO): 39.9, 54.6, 61.3, 70.4, 83.4, 87.6, 105.4, 116.7, 118.3, 119.9, 121.9, 126.2, 128.2, 128.3, 130.2, 134.8, 139.9, 148.6, 151.5, 151.7, 155.8; m.p: 218-220 °C; HRMS (M+H$^+$): calc: 408.1672, found: 408.1682.

$N^6$-(Phenanithren-9-yl)-2'-deoxyadenosine (10). $^1$H NMR (DMSO): $\delta$ 2.34 (m, 1H), 2.79 (m, 1H), 3.57 (m, 1H), 3.66 (m, 1H), 3.92 (m, 1H), 4.46 (m, 1H), 5.20 (dd, 1H, $J$ = 5.5, 5.5Hz), 5.35 (d, 1H, $J$ = 4.0 Hz), 6.44 (dd, 1H, $J$ = 7.5, 7.5 Hz), 7.57-7.72 (m, 4H), 7.91 (s, 1H), 7.98 (dd, 2H, $J$ = 7.5, 8.0 Hz), 8.16 (s, 1H), 8.49 (s, 1H), 8.84 (d, 1H, $J$ = 10.0 Hz), 8.89 (d, 1H, $J$ = 5.0 Hz), 10.07 (s, 1H); $^{13}$C NMR (DMSO): $\delta$ 40.8, 62.3, 71.3, 84.4, 88.4, 120.3, 123.2, 123.5, 124.5, 124.7, 127.0, 127.1, 127.2, 127.4, 128.7, 129.2, 130.1, 131.0, 131.9, 133.6, 140.7, 149.8, 152.6, 154.9; m.p: 153-155 °C; HRMS (M+H$^+$): calc: 428.1723, found: 428.1732.

$N^6$-(Pyren-1-yl)-2'-deoxyadenosine (11). $^1$H NMR (DMSO): $\delta$ 2.34 (m, 1H), 2.81 (m, 1H), 3.56-3.68 (m, 2H), 3.94 (m, 1H), 4.46 (dd, 1H, $J$ = 3.0, 3.0 Hz), 5.21 (dd, 1H, $J$ = 7.0, 7.0 Hz), 5.37 (d, 1H, $J$ = 4.0 Hz), 6.45 (dd, 1H, $J$ = 7.0, 7.0 Hz), 8.04-8.32 (m, 10 H), 8.53 (s, 1H), 10.4 (s, 1H); $^{13}$C NMR (DMSO): $\delta$ 40.8, 62.2, 71.3, 84.4, 88.4, 120.5, 123.6, 124.3, 125.0, 125.3, 125.4, 125.6, 125.9, 126.7, 126.8, 127.2, 127.4, 127.7, 129.3, 130.8, 130.9,
131.2, 133.0, 140.9, 149.9, 152.6, 154.5; m.p: 178-179 °C; HRMS (M+H⁺): calc: 452.1723, found: 452.1729.

\(N^{2'}-(4\text{-Methoxyphenyl})\text{-O}^{6}\text{-benzyl-2'}\text{-deoxyguanosine (12).}\) Colorless oil (78 % yield): \(^1\text{H} NMR (CD}_3\text{OD): \delta 2.41 (m, 1H), 2.81 (m, 1H), 3.69-3.73 (m, 2H), 4.02 (m, 1H), 4.54 (m, 1H), 5.53 (s, 2H), 6.39 (dd, 1H, \(J = 6.5, 6.5\) Hz), 6.87 (m, 2H), 7.27-7.35 (m, 3H), 7.46 (d, 2H, \(J = 8.2, 8.2\) Hz), 7.54 (d, 2H, \(J = 8.2, 8.2\) Hz), 8.14 (s, 1H); \(^{13}\text{C} NMR (CD}3\text{OD): \delta 40.8, 55.9, 63.4, 69.1, 72.7, 85.8, 89.2, 114.8, 116.2, 122.6, 129.0, 129.2, 129.5, 137.9, 139.6, 140.1, 154.4, 156.6, 158.0, 161.5; HRMS (M+Na⁺): calc: 486.1753, found: 486.1750.