Benzimidazole Derivatives as New Serotonin 5-HT_6 Receptor Antagonists. Molecular Mechanisms of Receptor Inactivation

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Supporting Information

Experimental Section

Chemistry. Melting points (uncorrected) were determined on a Stuart Scientific electrothermal apparatus. Infrared (IR) spectra were measured on a Shimadzu-8300 or Bruker Tensor 27 instrument equipped with a Specac ATR accessory of 5200-650 cm^{-1} transmission range; frequencies (ν) are expressed in cm^{-1}. Nuclear Magnetic Resonance (NMR) spectra were recorded on a Bruker Avance 500 (^1H, 500 MHz; ^{13}C, 125 MHz), Bruker Avance 300-AM (^1H, 300 MHz; ^{13}C, 75 MHz) or Bruker 200-AC spectrometer (^1H, 200 MHz; ^{13}C, 50 MHz) at the UCM's NMR facilities. Chemical shifts (δ) are expressed in parts per million relative to internal tetramethylsilane; coupling constants (*J*) are in hertz (Hz). The following abbreviations are used to describe peak patterns when appropriate: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), br (broad), app (apparent). Mass spectrometry (MS) was carried out on a Bruker LC-Esquire in electrospray mode (ESI) or a HP 5989 A in electron impact mode (EI, 70 eV). Elemental analyses (C, H, N) were obtained on a LECO CHNS-932 apparatus at the UCM's analysis services and were within 0.5% of the theoretical values, confirming a purity of at least 95% for all tested compounds. Analytical thin-layer chromatography (TLC) was run on Merck silica gel plates (Kieselgel 60 F-254) with detection by UV light (254 nm), ninhydrin solution, or 10% phosphomolybdic acid solution in ethanol. Flash chromatography was performed on glass column using silica gel type 60 (Merck, particle 230-400 mesh) or on a Supelco VersaFlash station using silica gel cartridges (Supelco, particle size 20-45 μm). Unless stated otherwise, starting materials, reagents and solvents were purchased as high-grade commercial products from Sigma-Aldrich, Lancaster, Scharlab or Panreac, and were used without further purification. THF was distilled from sodium benzophenone ketyl and used immediately. Dichloromethane was distilled from calcium hydride.

Spectral characterization data of compounds 1-4, **7**, **10**, **13**, **14**, **16-18**, **20**, **25**, **27**, **29**, **33**, **34**, **36**, **37**, **40**, and **41**.

Phenyl(4-piperazin-1-yl-1*H*-benzimidazol-2-yl)methanone (1). IR (KBr) 3442, 1642, 1523, 1484, 1449. ^1H NMR (CD_3OD) δ 3.41 (br t, *J* = 3.2, 4H), 3.78 (m, 4H), 6.76 (d, *J* = 7.5, 1H), 7.24 (d, *J* = 7.8,

1H), 7.32 (t, *J* = 7.3, 1H), 7.57 (t, *J* = 7.4, 2H), 7.69 (t, *J* = 7.5, 1H), 8.55 (d, *J* = 8.3, 2H). ^{13}C NMR (CD_3OD) δ 44.1, 48.3, 104.3, 108.6, 126.8, 128.4, 131.1, 133.7, 135.0, 135.7, 136.4, 143.7, 146.4, 184.1. MS (ESI) 307.1 (M+H). Anal. ($C_{18}H_{18}N_4O$) C, H, N.

[4-(4-Methylpiperazin-1-yl)-1*H*-benzimidazol-2-yl](phenyl)methanone (2). IR (KBr) 3583, 1727, 1486. ^{1}H NMR ($CDCl_3$) δ 2.45 (s, 3H), 2.80 (br t, *J* = 4.5, 4H), 3.75 (m, 4H), 6.65 (d, *J* = 7.8, 1H), 7.09 (d, *J* = 8.1, 1H), 7.31 (t, *J* = 8.0, 1H), 7.55 (t, *J* = 7.4, 2H), 7.66 (t, *J* = 7.2, 1H), 8.76 (d, *J* = 7.3, 2H), 10.90 (br s, 1H). ^{13}C NMR ($CDCl_3$) δ 46.5, 49.9, 55.4, 104.3, 108.2, 127.9, 128.6, 131.8, 134.0, 135.2, 135.9, 136.6, 145.5, 145.6, 183.5. MS (ESI) 321.0 (M+H). Anal. ($C_{19}H_{20}N_4O$) C, H, N.

1-Naphthyl(4-piperazin-1-yl-1*H*-benzimidazol-2-yl)methanone (3). IR (KBr) 3442, 1644, 1590, 1510, 1439. ^{1}H NMR (CD_3OD) δ 3.29-3.33 (m, 4H), 3.64 (m, 4H), 6.77 (d, *J* = 7.4, 1H), 7.26-7.37 (m, 2H), 7.56-7.66 (m, 3H), 7.90-8.02 (m, 1H), 8.16 (d, *J* = 7.8, 1H), 8.28 (d, *J* = 7.2, 1H), 8.39-8.43 (m, 1H). ^{13}C NMR (CD_3OD) δ 44.0, 47.7, 103.9, 109.1, 124.4, 125.4, 126.5, 126.9, 127.7, 128.7, 131.4, 131.5, 133.0, 133.8, 134.3, 135.6, 145.2, 147.5, 187.1. MS (ESI) 357.2 (M+H). Anal. ($C_{22}H_{20}N_4O$) C, H, N.

[4-(4-Methylpiperazin-1-yl)-1*H*-benzimidazol-2-yl](1-naphthyl)methanone (4). IR (KBr) 3453, 1637, 1588, 1510, 1483, 1440. ^{1}H NMR (CD_3OD) δ 2.42 (s, 3H), 2.74 (m, 4H), 3.70 (m, 4H), 6.62 (d, *J* = 7.7, 1H), 7.10 (d, *J* = 7.7, 1H), 7.32 (t, *J* = 8.0, 1H), 7.50-7.63 (m, 3H), 7.91-7.96 (m, 1H), 8.09 (d, *J* = 8.0, 1H), 8.56-8.68 (m, 2H), 11.13 (br s, 1H). ^{13}C NMR (CD_3OD) δ 46.4, 49.9, 55.3, 104.3, 108.1, 124.5, 126.0, 126.7, 127.9, 128.2, 129.0, 131.7, 133.0, 133.3, 133.7, 134.2, 135.8, 136.7, 145.5, 146.4, 186.8. MS (ESI) 371.1 (M+H). Anal. ($C_{23}H_{22}N_4O$) C, H, N.

[5-(4-Methylpiperazin-1-yl)-1*H*-benzimidazol-2-yl](1-naphthyl)methanone (7). IR (KBr) 3442, 1642, 1629, 1577, 1514, 1484, 1454. ^{1}H NMR ($CDCl_3$) δ 2.40 (s, 3H), 2.64 (br t, *J* = 4.9, 4H), 3.30 (br t, *J* = 4.9, 4H), 6.94 (d, *J* = 2.0, 1H), 7.11 (dd, *J* = 9.2, 2.2, 1H), 7.53-7.66 (m, 3H), 7.78 (d, *J* = 9.2, 1H), 7.93 (d, *J* = 9.2, 1H), 8.08 (d, *J* = 9.2, 1H), 8.50-8.54 (m, 2H), 10.68 (br s, 1H). ^{13}C NMR ($CDCl_3$) δ 45.8, 49.4, 54.9, 96.5, 116.4, 122.6, 124.5, 125.4, 126.3, 127.7, 128.6, 131.2, 132.0, 132.8, 133.1, 133.9, 135.2, 138.5, 147.8, 150.9, 186.5. MS (ESI) 371.0 (M+H). Anal. ($C_{23}H_{22}N_4O$) C, H, N.

2-Benzyl-4-piperazin-1-yl-1*H*-benzimidazole (10). IR (KBr) 1593, 1532, 1496, 1456. ^{1}H NMR ($CDCl_3$) δ 2.10 (br s, 1H), 3.14 (br t, *J* = 5.0, 4H), 3.43 (m, 4H), 4.28 (s, 2H), 6.66 (d, *J* = 8.1, 1H), 7.00 (m, 1H), 7.11 (t, *J* = 7.5, 1H), 7.28-7.37 (m, 5H). ^{13}C NMR (CD_3OD) δ 35.8, 45.9, 51.3, 106.6, 110.0, 124.0, 127.8, 129.5, 129.7, 136.4, 138.0, 138.5, 143.0, 153.7. MS (EI) *m/z* (%) 292 (M, 50), 250 (100), 236 (28), 208 (20), 91 (34). Anal. ($C_{18}H_{20}N_4$) C, H, N.

4-(4-Methylpiperazin-1-yl)-2-(1-naphthylmethyl)-1*H*-benzimidazole (13). IR (KBr) 1663, 1593, 1449. ^{1}H NMR ($CDCl_3$) δ 2.54 (s, 3H), 2.90 (m, 4H), 3.57-3.59 (m, 4H), 4.72 (s, 2H), 6.64 (d, *J* = 7.8, 1H), 6.92 (d, *J* = 7.7, 1H), 7.07 (t, *J* = 7.9, 1H), 7.45-7.54 (m, 3H), 7.83-7.92 (m, 2H), 8.03 (d, *J* = 9.3, 2H). ^{13}C NMR ($CDCl_3$) δ 34.0, 46.0, 49.9, 55.5, 106.5, 108.8, 123.4, 124.3, 126.0, 126.4, 127.0, 128.1, 128.7, 129.1, 132.2, 133.5, 135.0, 136.0, 137.0, 142.2, 151.7. MS (ESI) 357.1 (M+H). Anal. ($C_{23}H_{24}N_4$) C, H, N.

4-(4-Methylpiperazin-1-yl)-2-(2-naphthylmethyl)-1*H*-benzimidazole (14). IR ($CHCl_3$) 1662, 1593, 1505, 1451. ^{1}H NMR ($CDCl_3$) δ 2.70 (s, 3H), 3.13 (br t, *J* = 4.7, 4H), 3.54-3.60 (m, 4H), 4.42 (s, 2H), 6.61 (d, *J* = 7.2, 1H), 7.02 (d, *J* = 7.9, 1H), 7.09 (t, *J* = 8.0, 1H), 7.40 (d, *J* = 8.4, 1H), 7.47-7.52 (m, 2H), 7.75-7.83 (m, 4H). ^{13}C NMR ($CDCl_3$) δ 35.8, 45.4, 48.6, 54.6, 106.7, 108.8, 123.3, 126.0, 126.4, 127.0, 127.6, 127.7, 128.7, 132.4, 133.5, 133.9, 136.0, 136.7, 140.8, 151.3. MS (ESI) 357.1 (M+H). Anal. ($C_{23}H_{24}N_4$) C, H, N.

2-Benzyl-5-(4-methylpiperazin-1-yl)-1*H*-benzimidazole (16). IR (KBr) 3449, 1630, 1603, 1493, 1456. ^{1}H NMR (CD_3OD) δ 2.57 (s, 3H), 2.93 (br t, *J* = 4.9, 4H), 3.25 (br t, *J* = 4.9, 4H), 4.19 (s, 2H), 7.00 (dd, *J* = 8.8, 2.1, 1H), 7.07 (d, *J* = 2.0, 1H), 7.22-7.31 (m, 5H), 7.41 (d, *J* = 8.7, 1H). ^{13}C NMR (CD_3OD) δ 35.1, 44.2, 50.1, 54.7, 102.2, 115.1, 115.4, 126.9, 128.7, 128.8, 135.6, 137.3, 138.5, 147.7, 153.9. MS (ESI) 307.0 (M+H). Anal. ($C_{19}H_{22}N_4$) C, H, N.

2-(1-Naphthylmethyl)-5-piperazin-1-yl-1*H*-benzimidazole (17). IR (KBr) 3481, 1624, 1508, 1491, 1458. ^{1}H NMR (CD_3OD) δ 3.19-3.23 (m, 8H), 4.54 (s, 2H), 6.88 (dd, *J* = 8.7, 2.1, 1H), 6.95 (m, 1H), 7.26-7.37 (m, 5H), 7.68-7.78 (m, 2H), 7.90-7.95 (m, 1H). ^{13}C NMR (CD_3OD) δ 45.0, 47.6, 50.2, 103.6,

116.4, 118.5, 124.5, 124.8, 126.6, 126.8, 127.3, 128.5, 129.1, 129.7, 133.1, 133.9, 135.4, 148.3, 155.0. MS (ESI) 343.1 (M+H). Anal. ($C_{22}H_{22}N_4$) C, H, N.

5-(4-Methylpiperazin-1-yl)-2-(1-naphthylmethyl)-1*H*-benzimidazole (18). IR (KBr) 3453, 1633, 1600, 1488, 1454. ^{1}H NMR (CD_3OD) δ 2.43 (s, 3H), 2.77 (br t, *J* = 4.9, 4H), 3.10 (br t, *J* = 4.9, 4H), 4.54 (s, 2H), 6.85 (dd, *J* = 8.7, 2.2, 1H), 6.91 (d, *J* = 1.9, 1H), 7.28 (d, *J* = 8.8, 1H), 7.31-7.38 (m, 4H), 7.68-7.78 (m, 2H), 7.93-7.97 (m, 1H). ^{13}C NMR (CD_3OD) δ 34.0, 45.3, 51.2, 55.8, 103.1, 116.1, 116.4, 124.8, 126.8, 127.0, 127.5, 128.6, 129.2, 129.9, 133.4, 133.9, 135.4, 135.6, 139.8, 148.8, 155.0. MS (ESI) 357.1 (M+H). Anal. ($C_{23}H_{24}N_4$) C, H, N.

5-(4-Methylpiperazin-1-yl)-2-(2-naphthylmethyl)-1*H*-benzimidazole (20). IR (KBr) 3454, 1632, 1497, 1455. ^{1}H NMR (CD_3OD) δ 2.53 (s, 3H), 2.90 (br t, *J* = 4.9, 4H), 3.17 (br t, *J* = 4.9, 4H), 4.27 (s, 2H), 6.90 (dd, *J* = 8.8, 2.2, 1H), 6.98 (d, *J* = 2.0, 1H), 7.30-7.36 (m, 4H), 7.67-7.73 (m, 4H). ^{13}C NMR (CD_3OD) δ 36.1, 44.8, 50.7, 55.5, 102.9, 116.0, 116.3, 126.7, 127.1, 127.7, 128.2, 128.5, 129.3, 133.7, 134.9, 135.2, 135.6, 139.6, 148.5, 154.7. MS (ESI) 357.1 (M+H). Anal. ($C_{23}H_{24}N_4$) C, H, N.

3-Piperazin-1-ylbenzene-1,2-diamine (25). IR ($CHCl_3$): 3325, 1601, 1477, 1455. ^{1}H NMR ($CDCl_3$) δ 2.86-2.89 (m, 4H), 3.04 (br t, *J* = 3.2, 4H), 6.54 (dd, *J* = 7.3, 1.7, 1H), 6.63 (dd, *J* = 7.5, 1.7, 1H), 6.69 (t, *J* = 7.2, 1H).

4-Piperazin-1-ylbenzene-1,2-diamine (27). ^{1}H NMR ($CDCl_3$) δ 2.93 (s, 8H), 3.40 (br s, 1H), 6.27 (dd, *J* = 8.2, 2.6, 1H), 6.30 (d, *J* = 2.4, 1H), 6.57 (d, *J* = 8.2, 1H). ^{13}C NMR ($CDCl_3$) δ 46.5, 52.2, 106.4, 108.8, 118.4, 127.7, 136.4, 147.1.

4-Chloro-1*H*-benzimidazole (29). IR (KBr) 3424, 1631, 1587, 1481, 1458. ^{1}H NMR ($CDCl_3$) δ 7.23 (t, *J* = 7.8, 1H), 7.33 (dd, *J* = 7.8, 1.5, 1H), 7.59 (dd, *J* = 7.8, 1.1, 1H), 8.23 (s, 1H). ^{13}C NMR ($CDCl_3$) δ 114.4, 120.3, 122.8, 123.6, 135.7, 138.8, 141.0. MS (ESI), 152.8 (M+H).

***tert*-Butyl 4-(2-benzoyl-1-{[2-(trimethylsilyl)ethoxy]methyl}-1*H*-benzimidazol-4-yl)piperazine-1-carboxylate (33).** ^{1}H NMR ($CDCl_3$) δ -0.08 (s, 9H), 0.89 (app t, *J* = 8.2, 2H), 1.50 (s, 9H), 3.56-3.66 (m, 10H), 6.05 (s, 2H) 6.69 (d, *J* = 9.1, 1H), 7.19 (d, *J* = 8.2, 1H), 7.35 (t, *J* = 8.4, 1H), 7.47-7.54 (m, 2H),

7.64 (t, *J* = 9.0, 1H), 8.40 (d, *J* = 7.3, 2H). ^{13}C NMR ($CDCl_3$) δ -1.7, 17.6, 28.3, 49.5, 66.1, 73.7, 79.7, 103.7, 108.1, 127.1, 127.9, 131.2, 133.1, 133.9, 136.9, 137.5, 143.7, 144.8, 154.7, 188.7.

[4-(4-Methylpiperazin-1-yl)-1-{[2-(trimethylsilyl)ethoxy]methyl}-1*H*-benzimidazol-2-yl](phenyl)methanone (34). IR ($CHCl_3$) 1650, 1596, 1507, 1472. ^{1}H NMR ($CDCl_3$) δ -0.12 (s, 9H), 0.85 (app t, *J* = 8.3, 2H), 2.37 (s, 3H), 2.67 (br t, *J* = 5.0, 4H), 3.56 (app t, *J* = 8.3, 2H), 3.69 (br t, *J* = 4.8, 4H), 6.03 (s, 2H), 6.67 (d, *J* = 7.7, 1H), 7.15 (d, *J* = 7.9, 1H), 7.34 (t, *J* = 7.8, 1H), 7.46-7.65 (m, 3H), 8.38 (d, *J* = 8.6, 2H). ^{13}C NMR ($CDCl_3$) δ -1.5, 17.7, 46.0, 49.3, 54.9, 66.3, 73.9, 103.5, 108.0, 127.2, 127.9, 131.3, 133.3, 134.1, 137.2, 137.7, 143.8, 144.7, 185.8. MS (ESI) 451.3 (M+H).

[4-(4-Methylpiperazin-1-yl)-1-{[2-(trimethylsilyl)ethoxy]methyl}-1*H*-benzimidazol-2-yl](1-naphthyl)methanone (36). IR ($CHCl_3$) 1648, 1593, 1508, 1471. ^{1}H NMR ($CDCl_3$) δ 0.11 (s, 9H), 1.00 (app t, *J* = 8.3, 2H), 2.36 (s, 3H), 2.58 (br t, *J* = 4.9, 4H), 3.64 (br t, *J* = 4.9, 4H), 3.73 (app t, *J* = 8.3, 2H), 6.22 (s, 2H), 6.71 (d, *J* = 7.7, 1H), 7.24 (d, *J* = 8.0, 1H), 7.42 (t, *J* = 8.0, 1H), 7.55-7.64 (m, 3H), 7.92-7.95 (m, 1H), 8.15 (t, *J* = 8.6, 2H), 8.43-8.47 (m, 1H). ^{13}C NMR ($CDCl_3$) δ -1.0, 18.3, 46.6, 49.9, 55.3, 66.7, 74.3, 103.7, 108.4, 124.3, 126.0, 126.6, 127.9, 128.8, 131.8, 132.2, 133.2, 134.1, 134.5, 135.2, 138.3, 145.0, 145.4, 189.0. MS (ESI) 501.1 (M+H).

[4-(4-Methylpiperazin-1-yl)-1-{[2-(trimethylsilyl)ethoxy]methyl}-1*H*-benzimidazol-2-yl](2-naphthyl)methanone (37). IR ($CHCl_3$) 1645, 1595, 1507, 1474. ^{1}H NMR ($CDCl_3$) δ -0.01 (s, 9H), 1.01 (app t, *J* = 8.2, 2H), 2.48 (s, 3H), 2.79 (br t, *J* = 4.7, 4H), 3.72 (app t, *J* = 8.2, 2H), 3.87 (br t, *J* = 4.7, 4H), 6.19 (s, 2H), 6.81 (d, *J* = 7.6, 1H), 7.29 (d, *J* = 8.2, 1H), 7.48 (t, *J* = 7.9, 1H), 7.67-7.76 (m, 2H), 8.03-8.11 (m, 3H), 8.35 (dd, *J* = 8.7, 1.7, 1H), 9.30 (s, 1H). ^{13}C NMR ($CDCl_3$) δ -0.1, 19.3, 47.7, 51.1, 56.6, 67.7, 75.4, 104.8, 109.5, 127.6, 128.1, 128.9, 129.2, 130.2, 131.4, 133.9, 135.5, 135.8, 136.1, 137.1, 139.2, 145.2, 146.4, 186.7. MS (ESI) 500.9 (M+H).

[6-(4-Methylpiperazin-1-yl)-1-{[2-(trimethylsilyl)ethoxy]methyl}-1*H*-benzimidazol-2-yl](phenyl)methanone (40). ^{1}H NMR ($CDCl_3$) δ -0.11 (s, 9H), 1.02 (app t, *J* = 8.2, 2H), 2.49 (s, 3H), 2.77 (br t, *J* = 4.9, 4H), 3.42 (br t, *J* = 4.9, 4H), 3.76 (t, *J* = 8.2, 2H), 6.18 (s, 2H), 7.10 (d, *J* = 2.0, 1H), 7.21 (dd, *J* = 9.1, 2.2, 1H), 7.60-7.75 (m, 3H), 7.85 (d, *J* = 9.0, 1H), 8.29-8.38 (m, 2H). ^{13}C NMR

($CDCl_3$) δ -1.6, 17.7, 45.9, 49.5, 54.9, 66.2, 73.7, 96.1, 116.3, 122.4, 128.8, 131.2, 133.9, 134.5, 135.6, 137.3, 145.9, 150.7, 185.6. MS (ESI) 451.2 (M+H).

[6-(4-Methylpiperazin-1-yl)-1-{[2-(trimethylsilyl)ethoxy]methyl}-1*H*-benzimidazol-2-yl](1-naphthyl)methanone (41). IR ($CHCl_3$) 1674, 1619, 1577, 1508, 1497, 1460. ^{1}H NMR ($CDCl_3$) δ 0.07 (s, 9H), 1.01 (app t, *J* = 8.2, 2H), 2.44 (s, 3H), 2.69 (br t, *J* = 4.9, 4H), 3.40 (br t, *J* = 4.9, 4H), 3.77 (t, *J* = 8.2, 2H), 6.21 (s, 2H), 7.06 (d, *J* = 2.0, 1H), 7.16 (dd, *J* = 9.0, 2.0, 1H), 7.57-7.64 (m, 3H), 7.77 (d, *J* = 9.1, 1H), 7.94-8.12 (m, 3H), 8.41-8.50 (m, 1H). ^{13}C NMR ($CDCl_3$) δ -1.5, 17.8, 46.1, 49.6, 55.0, 66.2, 73.8, 95.9, 116.3, 122.5, 124.2, 125.4, 126.2, 127.5, 128.4, 130.9, 131.2, 132.6, 133.9, 135.0, 136.3, 137.7, 145.9, 151.0, 185.9. MS (EI) *m/z* (%) 500 (M, 71), 427 (35), 155 (40), 127 (45), 73 (100), 43 (66).

Combustion Analysis Data

compd	molecular formula	calculated			found		
		C	H	N	C	H	N
1	$C_{18}H_{18}N_4O$	70.57	5.92	18.29	70.13	5.90	18.39
2	$C_{19}H_{20}N_4O$	71.23	6.29	17.49	71.10	6.58	17.81
3	$C_{22}H_{20}N_4O$	74.14	5.66	15.72	74.27	5.22	16.10
4	$C_{23}H_{22}N_4O$	74.57	5.99	15.22	74.11	6.17	15.23
5	$C_{23}H_{22}N_4O$	74.57	5.99	15.12	74.19	5.81	14.72
6	$C_{19}H_{20}N_4O$	71.23	6.29	17.49	71.55	6.58	17.59
7	$C_{23}H_{22}N_4O$	74.57	5.99	15.12	74.83	6.37	15.19
8	$C_{23}H_{22}N_4O$	74.57	5.99	15.12	74.72	6.22	14.92
9	$C_{22}H_{20}N_4O$	74.14	5.66	15.72	73.75	6.03	16.02
10	$C_{18}H_{20}N_4$	73.94	8.69	19.16	73.57	8.26	19.03
11	$C_{19}H_{22}N_4$	74.48	7.24	18.29	74.69	7.67	18.55
12	$C_{22}H_{22}N_4$	77.16	6.48	16.36	77.34	6.05	15.96
13	$C_{23}H_{24}N_4$	77.50	6.79	15.72	77.79	6.89	15.37
14	$C_{23}H_{24}N_4$	77.50	6.79	15.72	77.28	6.98	15.61
15	$C_{18}H_{20}N_4$	73.94	8.69	19.16	74.22	8.31	19.47
16	$C_{19}H_{22}N_4$	74.48	7.24	18.29	74.87	6.85	17.96
17	$C_{22}H_{22}N_4$	77.16	6.48	16.36	77.36	6.77	16.59
18	$C_{23}H_{24}N_4$	77.50	6.79	15.72	77.32	6.30	15.57
19	$C_{22}H_{22}N_4$	77.16	6.48	16.36	76.88	5.99	15.94
20	$C_{23}H_{24}N_4$	77.50	6.79	15.72	77.87	6.81	15.59