Journal of the Serbian Chemical Society
JSCS@tmf.bg.ac.rs • www.shd.org.rs/JSCS
J. Serb. Chem. Soc. *83* (4) S166–S179 (2018) *Supplementary material*

SUPPLEMENTARY MATERIAL TO

Synthesis, characterization and anthelmintic activity evaluation of pyrimidine derivatives bearing carboxamide and sulphonamide moieties

DAVID I. UGWU[1,2]*, UCHECHUKWU C. OKORO[1] and NARENDRA K. MISHRA[2]

[1]*Department of Pure and Industrial Chemistry, University of Nigeria, Nsukka, 410002, Nigeria and* [2]*Department of Chemistry, Indian Institute of Technology, Kanpur, 208016, India*

J. Serb. Chem. Soc. *83* (4) (2018) 401–409

*2-(4-Nitrobenzenesulphonamido)acetic acid (**17a**)*. The amino acid was glycine. Yield: 2.2152 g, 94.59 %; m.p.: 171.9–172.2 °C; FTIR (KBr, cm^{-1}): 3417 (OH of CO_2H), 3297 (NH), 3108, 3070 (C–H aromatic), 1732 (C=O), 1605, 1482 (C=C), 1529, 1424 (N–O), 1354, 1333 (2S=O), 1240, 1165 (SO_2NH), 1100, 1087, 1014 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.43 (1H, *t*, J = 4.0 Hz, NH), 8.36 (2H, *d*, J = 9.2 Hz, Ar-H), 8.02 (2H, *d*, J = 8.6 Hz, Ar-H), 3.67 (2H, *d*, J = 4.0 Hz, CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 170.71 (C=O), 150.04, 147.03, 128.73, 124.94 (aromatic carbons), 44.3 (aliphatic carbon); HRMS-ESI (*m*/*z*): Calcd.: 261.3112. Found: 261.3108 (M+H).

*(2S)-2-(4-Nitrobenzenesulphonamido)-3-phenylpropanoic acid (**17b**)*. The amino acid was L-phenylalanine. Yield: 3.1530 g, 99.99 %; m.p.: 100.1–100.5 °C; FTIR (KBr, cm^{-1}): 3417 (OH of CO_2H), 3253 (NH), 3182, 3111 (C–H aromatic), 1753 (C=O), 1607, 1456, 1435 (C=C), 1525, 1403 (N–O), 1347, 1311 (2S=O), 1164, 1124 (SO_2NH), 1103, 1093 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.68 (1H, *d*, J = 8.6 Hz, NH), 8.16 (2H, *d*, J = 9.15 Hz, Ar-H), 7.71 (2H, *d*, J = 8.6 Hz, Ar-H), 7.11–7.06 (5H, *m*, Ar-H), 3.93 (1H, *ddd*, J_1 = = 5.2, J_2 = 4.6 & J_3 = 5.2 Hz, C**H**–CH_2), 2.95 (1H, *dd*, J_1 = 5.2 & J_2 = 5.2 Hz, CH_a of CH_2), 2.68 (1H, *dd*, J_1 = 9.8 & J_2 = 9.8 Hz, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 172.72 (C=O), 149.64, 147.09, 137.22, 129.71, 128.64, 128.19, 126.92, 124.67 (aromatic carbons), 58.18, 38.09 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for $(M+NH_4)^+$: 368.2349. Found: 368.2347.

*(2S)-3-(1H-Indol-2-yl)-2-(4-nitrobenzenesulphonamido)propanoic acid (**17c**)*. The amino acid was L-tryptophan. Yield: 3.4253 g, 97.94 %; m.p.: 226.9––227.2 °C; FTIR (KBr, cm^{-1}): 3448 (OH of CO_2H), 3380, 3295 (2NH), 3108

* Corresponding author. E-mail: zuchukwu.ugwu@unn.edu.ng

(C–H of aromatic), 1710 (C=O), 1607, 1459 (C=C), 1525, 1424 (N–O), 1348, 1332 (2S=O), 1167, 1119 (SO_2NH), 1092, 1014 (C–N, C–O); ^{1}H-NMR (400 MHz DMSO-d_6,δ / ppm): 10.66 (1H, *s*, NH, indole), 8.61–8.59 (1H, *d*, *J* = 8.0 Hz, NH), 7.86—7.84 (2H, *m*, Ar-H), 7.50–7.46 (2H, *m*, Ar-H), 7.24 (1H, *d*, *J* = = 7.5 Hz, Ar-H), 7.05 (1H, *d*, *J* = 8.0 Hz, Ar-H), 6.99 (1H, *s*, Ar-H), 6.89–6.82 (2H, *m*, Ar-H), 3.90 (1H, *ddd*, *J* = 4.0, J_2 = 2.85 & J_3 = 4.6 Hz, C**H**–CO_2H), 3.04 (1H, *dd*, J_1 = 4.6 & J_2 = 4.6 Hz, CH_a of CH_2), 2.79 (1H, *dd*, J_1 = 10.3 & J_2 = 9.8 Hz, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.28 (C=O), 148.89, 146.43, 136.45, 127.43, 126.92, 124.89, 123.78, 121.22, 118.78, 118.21, 111.67, 109.18 (aromatic carbons), 57.04, 28.37 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd.: 390.3289 for $(M+H)^+$. Found: 390.3285.

*(2*S*)-4-Methyl-2-(4-nitrobenzenesulphonamido)pentanoic acid (**17d**)*. The amino acid was L-leucine. Yield: 2.8461 g, 99.98 %; m.p.: 142.9–143.2 °C; FTIR (KBr, cm^{-1}): 3272 (NH), 3113, 3097, 3074 (C–H aromatic), 2934, 2878 (C–H aliphatic), 1714 (C=O), 1658, 1606, 1469 (C=C), 1531, 1417 (N–O), 1356, 1307 (2S=O), 1168, 1156 (SO_2NH), 1108, 1091, 1010 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.55 (1H, *d*, *J* = 9.2 Hz, NH), 8.36 (2H, *d*, *J* = 8.6 Hz, Ar-H), 7.98 (2H, *d*, *J* = 8.6 Hz, Ar-H), 3.74–3.69 (1H, *m*, C**H**–CO_2H), 1.59–1.53 (1H, *m*, C**H**$(CH_3)_2$), 1.41–1.37 (2H, *m*, CH_2), 0.81–0.71 (6H, *m*, $2CH_3$); ^{13}C--NMR (100 MHz, DMSO-d_6, δ / ppm): 173.44 (C=O), 149.89, 147.26, 128.68, 124.75 (aromatic carbons), 54.69, 41.20, 24.52, 23.14, 21.37 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for $(M–H)^–$: 315.1268. Found: 315.1265.

*(2*S*,3*S*)-3-Methyl-2-(4-nitrobenzenesulphonamido)pentanoic acid (**17e**)*. The amino acid was L-isoleucine. Yield: (2.7894 g, 97.97 %); m.p.: 131.4–131.7 °C; FTIR (KBr, cm^{-1}): 3271 (NH), 3110, 2967 (C–H aromatic), 2879, 2858 (C–H aliphatic), 1705 (C=O), 1647, 1607, 1472 (C=C), 1528, 1428 (N–O), 1361, 1351 (2S=O), 1175, 1142 (SO_2NH), 1092, 1011 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.43 (1H, *d*, *J* = 9.2 Hz, NH), 8.35 (2H, *d*, *J* = 8.6 Hz, Ar-H), 7.99 (2H, *d*, *J* = 8.6 Hz, Ar-H), 3.61 (1H, *t*, *J* = 6.0 Hz, C**H**–CO_2H), 1.68––1.65 (1H, *m*, CH), 1.35–1.30 (1H, *m*, CH_a of CH_2), 1.12–1.03 (1H, *m*, CH_b of CH_2), 0.78–0.73 (6H, *m*, $2CH_3$); ^{13}C-NMR (126 MHz, DMSO-d_6, δ / ppm): 172.42 (C=O), 149.91, 147.16, 128.74, 124.80 (aromatic carbons), 60.93, 37.34, 24.84, 15.89, 11.45 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd for $(M+H)^+$: 317.2393. Found: 317.2387.

*(2*S*)-3-Methyl-2-(4-nitrobenzenesulphonamido)butanoic acid (**17f**)*. The amino acid was L-valine. Yield: 2.7200 g, 99.97 %, m.p.: 182.6–182.9 °C; FTIR (KBr, cm^{-1}): 3415 (OH CO_2H), 3278 (NH), 3113, 2969 (C–H aromatic), 2931, 2873 (C–H aliphatic), 1711 (C=O), 1638, 1607, 1411 (C=C), 1532, 1463 (N–O), 1356, 1312 (2S=O), 1169, 1146 (SO_2NH), 1107, 1091, 1062, 1013 (C–N, C–O); ^{1}H-NMR (500 MHz, DMSO-d_6, δ / ppm): 8.43 (1H, *d*, *J* = 9.2 Hz, NH), 8.35 (2H, *d*, *J* = 8.6 Hz, Ar-H), 7.99 (2H, *d*, *J* = 9.2 Hz, Ar-H), 3.57 (1H, *dd*, J_1 = 5.7

& J_2 = 12.3 Hz, C**H**–CO_2H), 1.98–1.91 (1H, *m*, C**H**$(CH_3)_2$), 0.81–0.76 (6H, *m*, $2CH_3$); ^{13}C-NMR (126 MHz, DMSO-d_6, δ / ppm): 172.38 (C=O), 149.85, 147.27, 128.66, 124.75 (aromatic carbons), 61.85, 30.78, 19.58, 18.31 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for (M+NH_4): 320.1987. Found: 320.1982.

*(2*S*,4*R*)-4-Hydroxy-1-[(4-nitrophenyl)sulphonyl]pyrrolidine-2-carboxylic acid (**17g**)*. The amino acid was L-hydroxyproline. Yield: 2.8459 g, 99.97 %; m.p.:199.8–200.2 °C; FTIR (KBr, cm^{-1}): 3491 (OH), 3416 (OH of CO_2H), 3117, 3024(C–H aromatic), 2966, 2767 (C–H aliphatic), 1750 (C=O), 1638, 1608, 1457 (C=C), 1527, 1427 (N–O), 1359, 1331 (2S=O), 1184, 1164 (SO_2N), 1136, 1112, 1090, 1015, 1005 (C–N, C–O); ^{1}H-NMR (500 MHz, DMSO-d_6, δ / ppm): 8.37 (2H, *d*, *J* = 9.2 Hz, Ar-H), 8.03 (2H, *d*, *J* = 8.6 Hz, Ar-H), 4.17 (1H, *s*, OH), 4.12 (1H, *t*, *J* = 8.6 Hz, C**H**–CO_2H), 3.46 (1H, *dd*, J_1 = 3.5 & J_2 = 8.4 Hz, C**H**OH), 3.20 (2H, *d*, *J* = 10.9 Hz, CH_2N), 2.04–2.00 (1H, *m*, CH_a of CH_2), 1.93–1.88 (1H, *m*, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.54, 150.27, 143.56, 129.53, 124.78 (aromatic carbons), 69.02, 60.38, 57.06 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for $(M+H)^+$: 303.2991. Found: 303.2987.

*(2*S*)-1-[(4-Nitrophenyl)sulphonyl]pyrrolidine-2-carboxylic acid (**17h**)*. The amino acid was L-proline. Yield: 2.6051 g, 96.39 %; m.p.: 149.9–150.3 °C; FTIR (KBr, cm^{-1}): 3415 (OH of CO_2H), 3111 (C–H aromatic), 2899, 2648 (C–H aliphatic), 1723 (C=O), 1641, 1604, (C=C), 1533, 1447 (N–O), 1353, 1305 (2S=O), 1199, 1165 (SO_2N), 1072, 1024, 1008 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.40–8.36 (2H, *m*, Ar-H), 8.07–8.05 (2H, *m*, Ar-H), 4.19–4.17 (1H, *m*, C**H**–CO_2H), 3.40–3.36 (1H, *m*, CH_a of CH_2N), 3.23–3.18 (1H, *m*, CH_b of CH_2N), 1.99–1.92 (1H, *m*, CH_a of C**H$_2$**–$CHCO_2H$), 1.87–1.76 (2H, *m*, C**H$_2$**–CH_2N), 1.65–1.60 (1H, *m*, C**H**–CO_2H); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.39 (C=O), 150.36, 143.77, 129.17, 125.08 (aromatic carbons), 61.11, 48.86, 30.88, 24.72 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for $(M+H)^+$: 301.3427. Found: 301.3421.

*(2*S*,4*R*)-4-Hydroxy-1-tosylpyrrolidine-2-carboxylic acid (**17i**)*. The amino acid was L-hydroxyproline. Yield: 3.564 g, 99.86%; m.p.: 98.4–98.6 °C; FTIR (KBr, cm^{-1}): 3524 (OH), 2931 (C–H aliphatic), 1708 (C=O), 1600, 1444 (C=C), 1347, 1332 (2S=O), 1200, 1158 (SO_2N), 1090, 1075 (C–N or C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 7.65 (2H, *d*, *J* = 8.0 Hz, Ar-H), 7.37 (2H, *d*, *J* = 8.1 Hz, Ar-H), 4.18 (1H, *s*, OH), 4.01 (1H, *t*, *J* = 8.1 Hz, C**H$_2$**–$CHCO_2H$ and CH_a of C**H**$_2CH_2N$), 3.43–3.40 (1H, *m*, C**H**–OH), 3.05 (2H, *d*, *J* =10.3 Hz, CH_2N), 2.36 (3H, *s*, CH_3), 1.91 (2H, *t*, *J* = 4.6 Hz, CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.79 (C=O), 143.67, 135.03, 130.14, 127.89 (aromatic carbons), 68.91, 60.23, 56.78, 21.55 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for $(M+H)^+$: 286.1099. Found: 286.1097.

*(2*S*)-1-Tosylpyrrolidine-2-carboxylic acid (**17j**)*. The amino acid was L-proline. Yield: 3.2989 g, 98.09 %); m.p.: 50.4–50.7 °C; FTIR (KBr, cm^{-1}): 3415 (OH

of COOH), 2957 (C–H aliphatic), 1737 (C=O), 1619, 1597, 1494, 1449 (C=C), 1345, 1306 (2S=O), 1199 (SO_2N), 1159, 1095, 1013 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 7.66 (2H, *d*, *J* = 8.6 Hz, Ar-H), 7.35 (2H, *d*, *J* = 8.0 Hz, Ar-H), 4.04 (1H, *dd*, J_1 = 4.6 & J_2 = 5.2 Hz, C**H**–COOH), 3.29 (1H, *dd*, J_1 = 5.2 & J_2 = 9.8 Hz, CH_a of CH_2–N), 3.09 (1H, *dd*, J_1 = 6.9 & J_2 = 10.5 Hz, CH_b of CH_2–N), 2.31 (3H, *s*, Ar-CH_3), 1.81–1.72 (3H, *m*, CH_b of C**H**$_2$C**H**$_2$N), 1.50–1.47 (1H, *t*, *J* = 5.2 Hz, C**H**OH); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.71 (C=O), 143.90, 135.14, 130.32, 127.63 (aromatic carbons), 66.89, 48.87, 30.91, 24.67, 21.44 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for $(M+H)^+$: 269.0731. Found: 269.0726.

*(2*S*,4*R*)-4-Hydroxy-1-(Phenylsulphonyl)-pyrrolidine-2-carboxylic acid (**17k**)*. The amino acid was L-4-hydroxyproline. Yield: 3.3815 g, 99.99 %; m.p.: 159.0–159.9 °C; FTIR (KBr, cm^{-1}): 3402 (OH), 2993, 2955 (C–H aliphatic), 1714 (C=O), 1589, 1484, 1450 (C=C), 1385, 1353 (2S=O), 1195, 1158 (SO_2NH), 1158, 1100, 1070 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 7.77 (2H, *d*, *J* = 7.3 Hz, Ar-H), 7.64 (1H, *t*, *J* = 7.4 Hz, Ar-H), 7.56 (2H, *t*, *J* = 7.8 Hz, Ar-H), 4.18 (1H, *s*, OH), 4.04 (1H, *t*, *J* = 7.8 Hz, C**H**–CO_2H), 3.45–3.41 (1H, *m*, C**H**OH), 3.09 (2H, *d*, *J* = 11.0 Hz, CH_2–N), 1.98–1.87 (2H, *m*, CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.86 (C=O), 137.82, 133.57, 129.61, 127.94 (aromatic carbons), 68.96, 60.27, 56.88, 31.23 (aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd for (M^+): 271.0514. Found: 271.0518.

*(2*S*)-1-(Phenylsulphonyl)pyrrolidine-2-carboxylic acid (**17l**)*. The amino acid was L-proline. Yield: 3.1911 g, 100 %; FTIR (KBr, cm^{-1}): 3066 (C–H aromatic), 2983, 2884 (C–H aliphatic), 1730 (C=O), 1627, 1447 (C=C), 1343, 1292 (2S=O), 1199, 1161 (SO_2NH), 1095, 1073, 1016 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / pm) 7.83–7.78 (2H, *m*, Ar-H), 7.67–7.63 (1H, *m*, Ar-H), 7.59–7.56 (2H, *m*, Ar-H), 4.07 (1H, *dd*, J_1 = 4.6 & J_2 = 8.4 Hz, C**H**–CO_2H), 3.34–3.28 (1H, *m*, CH_a of CH_2N), 3.14–3.08 (1H, *m*, CH_b of CH_2N), 1.86–1.71 (3H, *m*, C**H**$_2$–C**H**CO_2H and CH_a of C**H**$_2$C**H**$_2$N), 1.53–1.47 (1H, *m*, CH_b of C**H**$_2$C**H**$_2$N); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / pm): 173.78 (C=O), 137.71, 133.64, 129.92, 127.66 (aromatic carbons), 60.89, 48.94, 30.97, 24.70 (aliphatic carbons); HRMS--ESI (*m*/*z*): Calcd. for (M+H): 256.1682. Found: 256.1679.

*2-{*N*-[(4-Nitrophenyl)sulfonyl]benzamido}acetic acid (**19a**)*. Yield: 0.2126 g, 58.36 %; m/p.: 135.0–135.5 °C; FTIR (KBr, cm^{-1}): 3310 (OH of COOH), 3073, 3009 (C–H aromatic), 2839 (C–H aliphatic), 1703, 1688 (2C=O), 1604, 1584, 1422 (C=C), 1527, 1454 (N–O), 1327, 1290 (2S=O), 1181, 1163 (SO_2N), 1128, 1106, 1074 (C–N, C–O); ^{1}H-NMR (500 MHz, DMSO-d_6, δ / / ppm): 8.36 (2H, *d*, *J* = 8.6 Hz, Ar-H), 8.01 (2H, *d*, *J* = 8.6 Hz, Ar-H), 7.91 (2H, *d*, *J* = 6.9 Hz, Ar-H), 7.59 (1H, *t*, *J* = 7.5 Hz, Ar-H), 7.47 (2H, *t*, *J* = 8.1 Hz, Ar-H), 3.67 (2H, *s*, CH_2); ^{13}C-NMR (126 MHz, DMSO-d_6, δ / ppm): 170.72, 167.81 (2C=O), 150.04, 147.01, 133.38, 131.27, 129.79, 129.09, 128.65, 124.85

(aromatic carbons), 44.30 (CH_2); HRMS-ESI (*m*/*z*): Calcd. for (M–H): 363.0265. Found: 363.0254.

*(2*S*)-2-{*N*-[(4-Nitrophenyl)sulfonyl]benzamido}-3-phenylpropanoic acid (**19b**)*. Yield: 0.4545 g, 100 %; m.p.: 122.5–122.8 °C; FTIR (KBr, cm^{-1}): 3309 (OH of COOH), 3113, 3073, 3008 (C–H aromatic), 2840 (C–H aliphatic), 1703, 1685 (2C=O), 1604, 1584, 1454, 1421 (C=C), 1527 (N–O), 1327, 1289 (2S=O), 1181, 1163 (SO_2N), 1128, 1106 1074, 1027 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.17–8.15 (2H, *m*, Ar-H), 7.91 (2H, *t*, *J* = 7.4 Hz, Ar-H), 7.71–7.69 (2H, *m*, Ar-H), 7.60–7.56 (1H, *m*, Ar-H), 7.48–7.44 (2H, *m*, Ar-H), 7.11–7.04 (5H, *m*, Ar-H), 3.95–3.89 (1H, *m*, C**H**–CO_2H), 2.95 (1H, *dd*, J_1 = 4.6 & J_2 = 9.8 Hz, CH_a of CH_2), 2.67 (1H, *dd*, J_1 = 10.1 & J_2 = 14.2 Hz, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 172.68, 167.81 (2C=O), 149.63, 147.06, 137.20, 133.41, 131.25, 129.76, 129.69, 129.11, 128.62, 128.15, 126.89, 124.74 (twelve aromatic carbons), 58.21, 38.13 (two aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for (M+H): 455.1940. Found: 455.1936.

*(2*S*)-3-(1*H*-Indol-2-yl)-2-{*N*-[(4-Nitrophenyl)sulfonyl]benzamido}propanoic acid (**19c**)*. Yield: 0.4932 g, 99.64 %; m.p.: 153.3–153.9 °C; FTIR (KBr, cm^{-1}): 3448 (OH of COOH), 3294 (NH of indole), 3072 (C–H aromatic), 1705, 1688 (C=O), 1605, 1584, 1454, 1425 (C=C), 1525 (N–O), 1327, 1292 (2S=O),1179, 1167 (SO_2N), 1129, 1092, 1073, 1027 (C–N, C–O); ^{1}H-NMR (500 MHz, DMSO-d_6, δ / ppm): 10.68 (1H, *s*, NH of indole), 7.92–7.89 (3H, *m*, Ar-H), 7.86–7.84 (1H, *m*, Ar-H), 7.60–7.56 (2H, *m*, Ar-H), 7.48–7.44 (3H, *m*, Ar-H), 7.23 (1H, *d*, *J* = 7.8 Hz, Ar-H), 7.04 (1H, *d*, *J* = 7.8 Hz, Ar-H), 6.99 (1H, *d*, *J* = 2.3 Hz, Ar-H), 6.89–6.81 (2H, *m*, Ar-H), 3.90–3.86 (1H, *m*, C**H**COOH), 3.04 (1H, *dd*, J_1 = 4.1 & J_2 = 8.6 Hz, CH_a of CH_2), 2.78 (1H, *dd*, J_1 = 10.1 & J_2 = = 14.1 Hz, CH_b of CH_2); ^{13}C-NMR (126 MHz, DMSO-d_6, δ / pm); 173.33, 167.84 (2C=O), 148.91, 144.73, 138.89, 136.45, 133.38, 132.78, 131.33, 129.78, 129.14, 127.32, 124.89, 123.78, 122.42, 118.78, 118.20, 111.73 (sixteen aromatic carbons), 46.41, 36.78 (two aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for (M+H): 494.1042. Found: 494.1045.

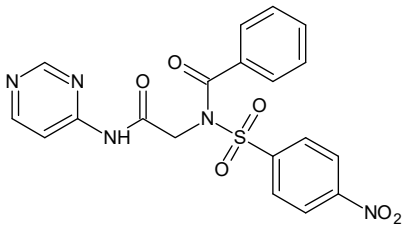
*(2*S*)-4-Methyl-2-{*N*-[(4-Nitrophenyl)sulfonyl]benzamido}pentanoic acid (**19d**)*. Yield: 0.4204 g, 100 %; m.p.: 116.3–116.7 °C; FTIR (KBr, cm^{-1}): 3412 (OH of COOH), 2960 (C–H aliphatic), 1721, 1689 (2C=O), 1603, 1584, 1454, 1410 (C=C), 1531 (N–O), 1348, 1323 (2S=O), 1177, 1149 (SO_2N), 1126, 1091, 1074, 1026 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.35 (2H, *d*, *J* = 8.7 Hz, Ar-H), 7.98 (2H, *d*, *J* = 9.2 Hz, Ar-H), 7.90 (2H, *t*, *J* = 6.9 Hz, Ar-H), 7.58 (1H, *t*, *J* = 7.4 Hz, Ar-H), 7.48–7.44 (2H, *m*, Ar-H), 3.73 (1H, *t*, *J* = 5.5 Hz, C**H**–COOH), 1.59–1.52 (1H, *m*, CH_a of CH_2), 1.43–1.34 (1H, *m*, CH_b of CH_2), 0.80 (3H, *d*, *J* = 6.4 Hz, CH_3), 0.71 (3H, *d*, *J* = 6.4 Hz, CH_3); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.33, 167.83 (2C=O), 149.92, 147.31, 133.40, 131.33, 129.78, 129.11, 128.67, 124.91 (eight aromatic carbons), 54.67, 41.22,

24.42, 23.16, 21.41 (five aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for (M^+): 420.0991. Found: 420.0999.

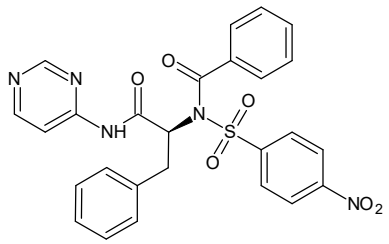
*(2*S*,3*S*)-3-Methyl-2-{*N*-[(4-Nitrophenyl)sulfonyl]benzamido}pentanoic acid (**19e**).* Yield: 0.4201 g, 99.93 %; m.p.: 110.4–110.6 °C; FTIR (KBr, cm^{-1}): 3293 (OH of COOH), 3117, 3072 (C–H aromatic), 2968, 2882 (C–H aliphatic), 1730, 1691 (2C=O), 1619, 1604, 1454, 1410 (C=C), 1531 (N–O), 1349, 1310 (2S=O), 1182, 1129 (SO_2N), 1105, 1073, 1027, 1012 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.35 (2H, *d*, *J* = 8.7 Hz, Ar-H), 7.98 (2H, *d*, *J* = = 8.7 Hz, Ar-H), 7.90 (2H, *t*, *J* = 7.3 Hz, Ar-H), 7.57 (1H, *t*, *J* = 7.3 Hz, Ar-H), 7.46 (2H, *t*, *J* = 7.7 Hz, Ar-H), 3.60 (1H, *d*, *J* = 2.3 Hz, C**H**–COOH), 1.70–1.64 (1H, *m*, CH), 1.34–1.28 (1H, *m*, CH_a of CH_2), 1.24–1.01 (1H, *m*, CH_b of CH_2), 0.78–0.72 (6H, *m*, $2CH_3$); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 172.36, 167.78 (2C=O), 149.89, 147.16, 133.35, 131.27, 129.78, 129.11, 128.68, 124.78 (eight aromatic carbons) 60.89, 37.31, 24.78, 15.87, 11.45 (five aliphatic carbons); HRMS-ESI (*m*/*z*): Calcd. for (M^+): 420.0991. Found: 420.0995.

*(2*S*)-3-Methyl-2-{*N*-[(4-Nitrophenyl)sulfonyl]benzamido}butanoic acid (**19f**).* Yield: 0.4063 g, 99.98 %; m.p.: 114.1–114.4 °C; FTIR (KBr, cm^{-1}): 3277 (OH of COOH), 3112, 3073 (C–H aromatic), 2969, 2874 (C–H aliphatic), 1710, 1687 (2C=O), 1606, 1584, 1454, 1424 (C=C), 1532 (N–O), 1356, 1327 (2S=O), 1169, 1146 (SO_2N), 1129, 1091, 1063, 1027, 1013, 1000 (C–N, C–O); ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.35 (2H, *d*, *J* = 9.2 Hz, Ar-H), 8.00 (2H, *d*, *J* = = 8.7 Hz, Ar-H), 7.90 (2H, *t*, *J* = 6.9 Hz, Ar-H), 7.58 (2H, *t*, *J* = 7.3 Hz, Ar-H), 7.48–7.44 (2H, *m*, Ar-H), 3.57 (1H, *d*, *J* = 2.8 Hz, C**H**–COOH), 1.98– –1.90 (1H, *m*, CH), 0.81–0.75 (6H, *m*, $2CH_3$); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 172.46, 167.85 (2C=O), 149.94, 147.37, 133.48, 131.36, 129.88, 129.12, 128.75, 124.86 (eight aromatic carbons), 61.96, 30.87, 19.65, 18.33 (four aliphatic carbons); HRMS-ESI (*m/z*): Calcd. for (M–H): 405.0736. Found: 405.0732.

*N-[(4-Nitrophenyl)sulfonyl]-N-[2-oxo-2-(pyrimidin-4-yl-amino)ethyl]benzamide (**21a**).* Yield: 0.4201 g, 95.17 %; m.p.: 164.7–164.9 °C; FTIR (KBr, cm^{-1}): 3411, 3105, 2858, 1700, 1669, 1623, 1606, 1524, 1456, 1353, 1304, 1162, 1093; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.69 (1H, *d*, *J* = 8.7 Hz, Ar-H), 8.30 (1H, *s*, Ar-H), 8.16 (2H, *d*, *J* = 8.7 Hz, Ar-H), 7.99 (1H, *d*, *J* = 6.0 Hz, Ar-H), 7.70 (2H, *d*, *J* = 9.2 Hz, Ar-H), 7.11–7.05 (5H, *m*, Ar-H), 6.87 (1H, *s*, Ar-H), 6.38–6.36 (1H, *m*, Ar-H), 3.92 (1H, *s*, CH–C=O); ^{13}C-NMR (100 MHz, DMSO- -d_6, δ / ppm): 172.68, 163.88, 158.44, 154.44, 149.62, 147.14, 137.19, 129.72, 129.10, 128.64, 128.17, 126.91, 124.68, 105.53, 58.16; ESI-HRMS (*m/z*): Calcd. for $[C_{19}H_{15}N_5O_6S]^+$: 441.0743. Found: 441.0751.

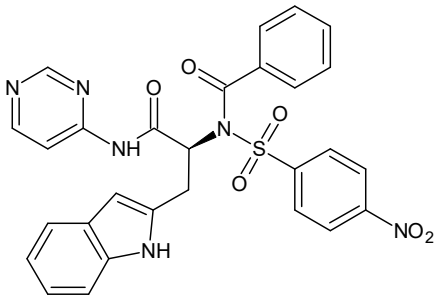


N-*[(1*S*)-1-Benzyl-2-oxo-2-(pyrimidin-4-yl-amino)ethyl]*-N-*[(4-nitrophenyl)-sulfonyl]benzamide* (***21b***). Yield: 0.5204 g, 97.99 %; m.p.: 97.6–98.1 °C; FTIR (KBr, cm^{-1}): 3410, 3010, 2965, 1686, 1671, 1622, 1601, 1530, 1487, 1441, 1353, 1304, 1163, 1123, 1094, 1023; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.68 (1H, *s*, Ar-H), 8.45 (1H, *s*, Ar-H), 8.36–8.32 (3H, *m*, Ar-H), 8.17–8.15 (3H, *m*, Ar-H), 8.02–7.99 (3H, *m*, Ar-H), 7.71 (2H, *d*, J = 8.7 Hz, Ar-H), 7.09–7.06 (3H, *m*, Ar-H), 6.39–6.38 (2H, *m*, Ar-H), 3.92 (1H, *dd*, J_1 = 6.0 & J_2 = 10.5 Hz, CH–C=O), 2.95 (1H, *dd*, J_1 = 5.0 & J_2 = 13.8 Hz, CH_a of CH_2), 2.67 (1H, *dd*, J_1 = 10.1 & J_2 = 13.8 Hz, CH_a of CH_2, CH_b of C**H**$_2$CH$_2$N); ^{13}C-NMR (101 MHz, DMSO-d_6, δ / ppm): 172.68, 170.67, 163.93, 158.24, 154.07, 149.99, 149.62, 147.13, 146.99, 137.19, 129.72, 129.10, 128.64, 128.17, 126.91, 124.91, 124.68, 105.53, 58.17, 38.07; ESI-HRMS (*m*/*z*): Calcd. for $[C_{26}H_{21}N_5O_6S+NH_4]^+$: 549.0457. Found: 549.0453.

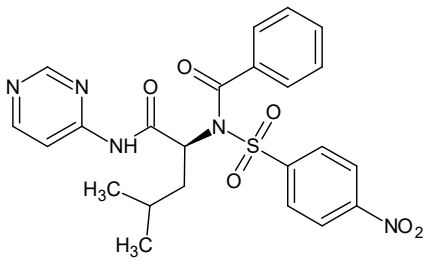


N-*[(1*S*)-(1*H*-Indol-2-ylmethyl)-2-oxo-2-[pyrimidin-4-yl-amino)ethyl]*-N-*[(4--nitrophenyl)sulfonyl]benzamide* (***21c***). Yield: 0.5001 g, 87.72 %; m.p.: 124.5––124.7 °C; FTIR (KBr, cm^{-1}): 3412, 3321, 3105, 2976, 1700, 1661, 1618, 1606, 1527, 1458, 1402, 1350, 1312, 1162, 1123, 1092, 1012; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 10.66 (1H, *s*, Ar-H), 8.28 (1H, *s*, Ar-H), 7.98 (2H, *d*, J = 6.0 Hz, Ar-H), 7.91–7.89 (1H, *m*, Ar-H), 7.84 (2H, *d*, J = 9.1 Hz, Ar-H), 7.47–7.43 (3H, *m*, Ar-H), 7.23–7.18 (1H, *m*, Ar-H), 7.04–6.98 (2H, *m*, Ar-H), 6.86–6.80 (5H, *m*, Ar-H), 6.37 (2H, *d*, J = 6.0 Hz, Ar-H), 3.87 (1H, *dd*, J_1 = 4.1 & J_2 = 10.0 Hz, CH–C=O), 3.03 (1H, *dd*, J_1 = 4.1 & J_2 = 14.2 Hz, CH_a of CH_2), 2.75 (1H, *dd*, J_1 = 10.6 & J_2 = 14.6 Hz, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / / ppm): 173.45, 163.80, 158.72, 155.00, 148.88, 146.41, 136.42, 134.67, 133.34, 131.31, 129.78, 129.08, 127.35, 126.96, 124.83, 123.78, 121.18, 118.76, 118.23,

111.68, 109.26, 105.58, 57.17, 28.41; ESI-HRMS (*m*/*z*): Calcd. for $[C_{28}H_{22}N_6O_6S–H]^-$: 569.1859. Found: 569.1855.

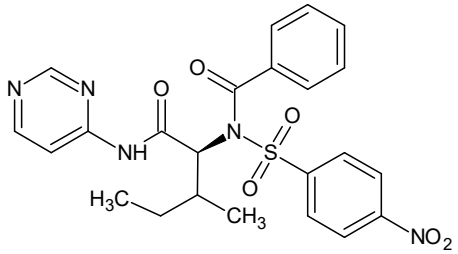


N-*{(1*S*)-3-Methyl-1-[(pyrimidin-4-ylamino)carbonyl]butyl}*-N-*[(4nitrophenyl)-sulfonyl]benzamide (**21d**).* Yield: 0.3862 g, 77.63 %; m.p.: 264.1–264.7 °C; FTIR (KBr, cm^{-1}): 3298 (NH), 3049, 2991, 2956, 2931, 2849, 2705, 1688, 1673, 1612, 1608, 1586, 1532, 1438, 1372, 1350, 1167, 1094, 999; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.61–8.55 (2H, *m*, Ar-H), 8.35 (2H, *d*, *J* = 8.7 Hz, Ar-H), 8.12 (2H, *d*, *J* = 6.9 Hz, Ar-H), 7.97 (2H, *d*, *J* = 9.2 Hz, Ar-H), 7.89 (1H, *d*, *J* = 7.4 Hz, Ar-H), 7.57 (1H, *t*, *J* = 8.7 Hz, Ar-H), 7.45 (1H, *t*, *J* = 7.6 Hz, Ar-H), 6.68 (1H, *d*, *J* = 6.8 Hz, Ar-H), 3.69 (1H, *t*, *J* = 6.0 Hz, CH–C=O), 1.56––1.51 (1H, *m*, CH), 1.40–1.35 (2H, *m*, CH_2), 0.78 (3H, *d*, *J* = 6.9 Hz, CH_3), 0.69 (3H, *d*, *J* = 6.4 Hz, CH_3); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.33, 165.06, 153.48, 152.02, 147.15, 145.29, 140.94, 136.33, 133.18, 129.78, 128.65, 126.32, 124.84, 118.96, 105.45, 54.69, 24.44, 23.14, 18.89; ESI-HRMS (*m*/*z*): Calcd. for $[C_{23}H_{23}N_5O_6S]^+$: 497.1369. Found: 497.1376.

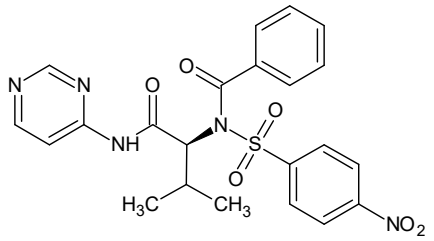


N-*{(1*S*,2*S*)-2-Methyl-1-[(pyrimidin-4-ylamino)carbonyl]butyl}-N-[(4--nitrophenyl)sulfonyl]benzamide (**21e**).* Yield: 0.3941 g, 79.28 %; m.p.: 176.5––176.6 °C; FTIR (KBr, cm^{-1}): 3217, 3011, 2966, 2877, 1681, 1664, 1607, 1598, 1530, 1461, 1373, 1311, 1166, 1121, 1092, 1013; ^{1}H-NMR (400 MHz, DMSO--d_6, δ / ppm): 8.33–8.30 (3H, *m*, Ar-H), 7.98 (3H, *d*, *J* = 8.7 Hz, Ar-H), 7.56 (1H, *t*, *J* = 7.8 Hz, Ar-H), 7.44 (1H, *t*, *J* = 7.8 Hz, Ar-H), 7.20–7.16 (1H, *m*, Ar-H), 7.11–7.07 (1H, *m*, Ar-H), 6.98 (1H, *s*, NH), 6.40 (2H, *d*, *J* = 5.5 Hz, Ar-H), 3.58 (1H, *d*, *J* = 5.8 Hz, CH–C=O), 1.70–1.65 (1H, *m*, CH), 1.33–1.27 (1H, *m*, CH_a of

CH_2),1.09–1.01 (1H, *m*, CH_b of CH_2), 0.76–0.70 (6H, *m*, $2CH_3$); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 172.50, 163.91, 158.17, 154.02, 149.88, 147.15, 133.34, 129.77, 129.40, 129.06, 128.71, 125.81, 124.73, 105.59, 61.01, 37.32, 24.81, 15.95, 11.4396; ESI-HRMS (*m*/*z*): Calcd. for $[C_{23}H_{23}N_5O_6S]^+$: 497.1369. Found: 497.1464.

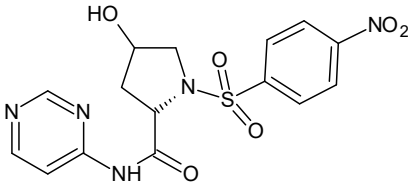


N-*{(1*S*)-2-Methyl-1-[(pyrimidin-4-ylamino)carbonyl]propyl}*-N-*[(4--nitrophenyl)sulfonyl]benzamide (**21f**)*. Yield: 0.3536 g, 73.13 %, m.p.: 97.6––97.9 °C; FTIR (KBr, cm^{-1}): 3214, 3021, 2967, 1682, 1664, 1611, 1606, 1530, 1351, 1312, 1166, 1141, 1092, 1041, 1013; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.40–8.24 (4H, *m*, Ar-H), 8.13–7.89 (4H, *m*, Ar-H), 7.21–7.04 (3H, *m*, Ar-H), 6.40 (1H, *d*, *J* = 6.0 Hz, Ar-H), 3.56 (1H, *d*, *J* = 4.60 Hz, CH–C=O), 1.98–1.91 (1H, *m*, CH), 0.80–0.75 (6H, *m*, $2CH_3$); ^{13}C-NMR (100MHz, DMSO--d_6, δ / ppm): 172.47, 167.96, 163.97, 158.02, 153.69, 149.89, 147.23, 133.38, 129.78, 129.41, 129.09, 128.71, 124.76, 105.55, 61.99, 30.81, 19.56, 18.24; ESI--HRMS (*m*/*z*): Calcd. for $[C_{22}H_{21}N_5O_6S]^+$: 483.1213. Found: 483.1943.

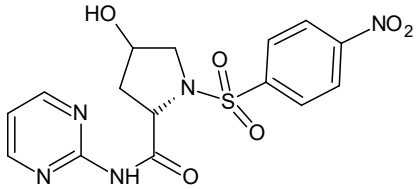


*(2*S*,4*R*)-4-Hydroxy-1-[(4-nitrophenyl)sulfonyl]*-N-*(pyrimidin-4-yl)pyrrolid-ine- -2-carboxamide (**21g**)*. Yield: 0.3929 g, 99.95 %; m.p.: 121.6–121.8 °C; FTIR (KBr, cm^{-1}): 3333, 3278, 3111, 2982, 2867, 1659, 1595, 1559, 1530, 1513, 1410, 1342, 1259, 1160, 1091, 1009; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.37–8.34 (2H, *m*, Ar-H), 8.28 (1H, *s*, Ar-H), 8.04–8.01 (2H, *m*, Ar-H), 7.98 (1H, *d*, *J* = 6.0 Hz, Ar-H), 6.79 (1H, *s*, NH), 6.36 (1H, *d*, *J* = 6.0 Hz, Ar-H), 4.17 (1H, *s*, OH), 4.10 (1H, *t*, *J* = 7.8 Hz, CH–C=O), 3.46–3.43 (1H, *m*, C**H**–OH), 3.19 (2H, *d*, *J* = 5.8 Hz, CH_2N), 2.04–1.99 (1H, *m*, CH_a of CH_2), 1.93–1.87 (1H, *m*, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.56, 163.80, 158.76,

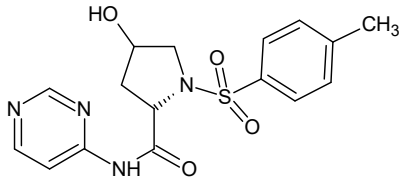
155.06, 150.31, 143.53, 129.52, 124.83, 105.55, 69.01, 60.42, 57.13; ESI-HRMS (*m*/*z*): Calcd. for $[C_{15}H_{15}N_5O_6S+H]^+$: 394.1439. Found: 394.1435.



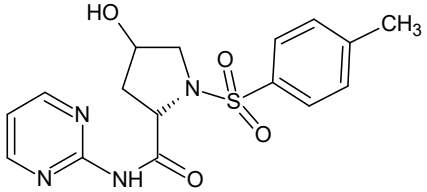
*(2*S*,4*R*)-4-Hydroxy-1-[(4-nitrophenyl)sulfonyl]*-N-*(pyrimidin-2-yl)pyrrolidine-2-carboxamide (**21h**)*. Yield: 0.3930 g, 99.97 %, m.p.: 172.3–172.6 °C; FTIR (KBr, cm^{-1}): 3519, 3209, 3080, 2987, 2897, 1749, 1627, 1608, 1528, 1453, 1359, 1331, 1185, 1137, 1090, 1069, 1016, 1004; ^{1}H-NMR (500 MHz, $CDOD_3$, δ / ppm): 8.38 (2H, *d*, *J* = 9.2 Hz, Ar-H), 8.24 (2H, *d*, *J* = 5.2 Hz, Ar-H), 8.09 (2H, *d*, *J* = 9.2 Hz, Ar-H), 6.64 (1H, *t*, *J* = 5.2 Hz, Ar-H), 4.30 (1H, *t*, *J* = 5.9 Hz, CH–C=O), 3.59–3.56 (1H, *m*, C**H**–OH), 3.40 (2H, *d*, *J* = 6.2 Hz, CH_2N), 2.20––2.15 (1H, *m*, CH of CH_2), 2.08–2.03 (1H, *m*, CH of CH_2); ^{13}C-NMR (126MHz, $CDOD_3$, δ / ppm): 174.42, 162.92, 158.11, 150.37, 143.59, 128.90, 128.60, 127.89, 124.98, 123.85, 110.48, 69.31, 60.13, 56.60, 39.13; ESI-HRMS (*m*/*z*): Calcd. for $[C_{15}H_{15}N_5O_6S+H_3O]^+$: 412.0927. Found: 412.0923.



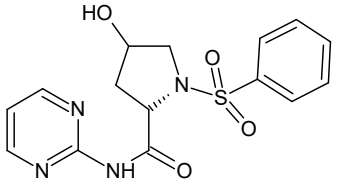
*(2*S*,4*R*)-4-Hydroxy-1-[(4-methylphenyl)sulfonyl]*-N-*(pyrimidin-4-yl)pyrrolidine-2-carboxamide (**21i**)*. Yield: 0.3620 g, 99.98 %; orange coloured oil; FTIR (KBr, cm^{-1}): 3346, 3203, 3008, 2950, 1663, 1598, 1517, 1403, 1334, 1291, 1195, 1156, 1090, 1033, 1011; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.28 (1H, *s*, Ar-H), 7.98 (1H, *d*, *J* = 6.0 Hz, Ar-H), 7.65–7.57 (2H, *m*, Ar-H), 6.79 (1H, *s*, NH), 6.36 (1H, *d*, *J* = 6.0 Hz, Ar-H), 4.17 (1H, *s*, OH), 3.99 (1H, *t*, *J* = 5.3 Hz, CH–C=O), 3.43–3.39 (1H, *m*, C**H**–OH), 3.04 (1H, *d*, *J* = 7.8 Hz, CH_a of CH_2N), 2.37–2.34 (3H, *m*, Ar-CH_3), 1.89 (2H, *t*, *J* = 2.3 Hz, CH_2), 0.82–0.76 (1H, *m*, CH_b of CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.83, 163.80, 158.79, 155.09, 143.74, 134.96, 130.10, 127.98, 105.56, 68.91, 60.20, 56.76, 31.48, 21.53; ESI-HRMS (*m*/*z*): Calcd. for $[C_{16}H_{18}N_4O_4S+H]^+$: 364.1579. Found: 364.1576.



*(2*S*,4*R*)-4-Hydroxy-1-[(4-methylphenyl)sulfonyl]*-N-*(pyrimidin-2-yl)pyrrolidine-2-carboxamide (**21j**).* Yield: 0.3621 g, 100 %; m.p.: 121.1–121.5 °C, FTIR (KBr, cm^{-1}): 3402, 3312, 2950, 1671, 1629, 1598, 1495, 1443, 1405, 1334, 1291, 1198, 1156, 1090, 1011; ^{1}H-NMR (400 MHz, $CDOD_3$, δ / ppm): 8.24 (2H, *d*, *J* = = 5.0 Hz, Ar-H), 7.72 (2H, *d*, *J* = 8.7 Hz, Ar-H), 7.34 (2H, *d*, *J* = 8.2 Hz, Ar-H), 6.64 (1H, *t*, *J* = 4.6 Hz, Ar-H), 4.31 (1H, *s*, OH), 4.20 (1H, *t*, *J* = 7.8 Hz, CH–C=O), 3.57–3.53 (1H, *m*, C**H**–OH), 3.24 (2H, *d*, *J* = 5.1 Hz, CH_2N), 2.32 (3H, *s*, CH_3), 2.10–2.00 (2H, *m*, CH_2); ^{13}C-NMR (100 MHz, $CDOD_3$, δ / ppm): 174.99, 162.45, 158.05, 143.94, 134.50, 129.38, 128.65, 127.94, 127.64, 125.02, 110.45, 69.22, 59.98, 56.29, 39.00, 20.25; ESI-HRMS (*m*/*z*): Calcd. for $[C_{16}H_{18}N_4O_4S+H_3O]^+$: 381.1237. Found: 381.1232.

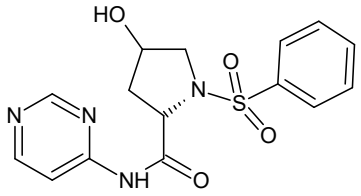


*(2*S*,4*R*)-4-Hydroxy-1-(phenylsulfonyl)*-N-*(pyrimidin-2-yl)pyrrolidine-2-carboxamide (**21k**).* Yield: 0.3480 g, 99.97 %; m.p.: 155.4–155.9 °C; FTIR (KBr, cm^{-1}): 3414, 3331, 2950, 1670, 1612, 1602, 1587, 1448, 1411, 1333, 1291, 1198, 1158, 1094, 1075, 1014; ^{1}H-NMR (400 MHz, $CDOD_3$, δ / ppm): 8.24 (2H, *d*, *J* = = 5.0 Hz, Ar-H), 7.85 (2H, *d*, *J* = 6.8 Hz, Ar-H), 7.63–7.59 (1H, *m*, Ar-H), 7.56–7.52 (2H, *m*, Ar-H), 6.63 (1H, *t*, *J* = 5.0 Hz, Ar-H), 4.31 (1H, *s*, OH), 4.24 (1H, *t*, *J* = 7.8 Hz, CH–C=O), 3.58–3.54 (1H, *m*, C**H**–OH), 3.29–3.28 (1H, *m*, CH_a of CH_2N), 3.27–3.26 (1H, *m*, CH_b of CH_2N), 2.12–2.01 (2H, *m*, CH_2); ^{13}C-NMR (100 MHz, $CDOD_3$, δ / ppm): 174.87, 162.70, 158.08, 137.62, 132.83, 128.84, 128.65, 127.94, 127.54, 125.02, 110.50 69.23, 60.02, 56.30, 39.04; ESI-HRMS (*m*/*z*): Calcd. for $[C_{15}H_{16}N_4O_4S+H_3O]^+$: 367.1069. Found: 367.1073.

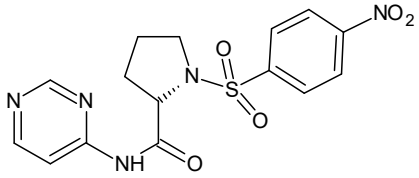


*(2*S*,4*R*)-4-Hydroxy-1-(phenylsulfonyl)*-N-*(pyrimidin-4-yl)pyrrolidine-2-carboxamide (**21l**).* Yield: 0.3479 g, 99.94 %; orange coloured oil; FTIR (KBr, cm^{-1}):

3392, 3225, 3011, 2948 1662, 1586, 1517, 1447, 1404, 1334, 1238, 1197, 1157, 1094, 1016; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.35 (1H, *s*, Ar-H), 8.00 (1H, *d*, *J* = 6.4 Hz, Ar-H), 7.76 (2H, *d*, *J* = 8.7 Hz, Ar-H), 7.63 (1H, *t*, *J* = = 7.3 Hz, Ar-H), 7.55 (2H, *t*, *J* = 7.8 Hz, Ar-H), 6.41 (1H, *d*, *J* = 6.4 Hz, Ar-H), 4.17 (1H, *s*, OH), 4.02 (1H, *t*, *J* = 5.3 Hz, CH–C=O), 3.44–3.40 (1H, *m*, C**H**–OH), 3.09–3.06 (2H, *d*, *J* = 5.2 Hz, CH_2N), 1.93–1.86 (2H, *m*, CH_2); ^{13}C-NMR (100 MHz, DMSO-d_6, δ / ppm): 173.77, 164.09, 157.59, 152.87, 137.83, 133.45, 129.64, 128.73, 127.89, 125.84, 105.51, 68.92, 60.21, 56.82; ESI-HRMS (*m*/*z*): Calcd. for $[C_{15}H_{16}N_4O_4S+H_3O]^+$: 367.1069. Found: 367.1084.

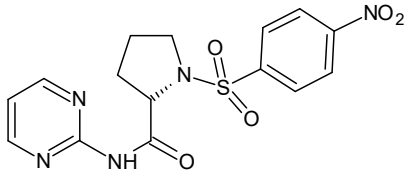


*(2*S*)-1-[(4-Nitrophenyl)sulfonyl]*-N-*(pyrimidin-4-yl)pyrrolidine-2-carboxamide* ***(21m)***. Yield: 0.3769 g, 99.95 %; m.p.: 153.9–154.2 °C; FTIR (KBr, cm^{-1}): 3340, 3047, 2984, 2871, 1647, 1616, 1527, 1346, 1313, 1199, 1163, 1088, 1013; ^{1}H-NMR (400 MHz, DMSO-d_6, δ / ppm): 8.39–8.35 (2H, *m*, Ar-H), 8.28 (1H, *s*, Ar-H), 8.07–8.04 (2H, *m*, Ar-H), 7.98 (1H, *d*, *J* = 5.5 Hz, Ar-H), 6.79 (1H, *s*, NH), 6.36 (1H, *d*, *J* = 4.6 Hz, Ar-H), 4.17 (1H, *dd*, J_1 = 3.7 & J_2 = 9.2 Hz, CH–C=O), 3.38–3.34 (1H, *m*, CH_a of CH_2N), 3.23–3.17 (1H, *m*, CH_b of CH_2N), 1.99–1.91 (1H, *m*, CH_a of C**H**$_2$–CH–C=O), 1.88–1.73 (2H, *m*, CH_2), 1.67–1.58 (1H, *m*, CH_b of C**H**$_2$–CHC=O); ^{13}C-NMR (100MHz, DMSO-d_6, δ / ppm): 173.43, 163.80, 158.78, 155.08, 150.40, 143.77, 129.22, 125.14, 105.54, 61.09, 48.94, 30.96, 24.74; ESI-HRMS (*m*/*z*): Calcd. for $[C_{15}H_{15}N_5O_5S+Na]^+$: 400.1339. Found: 400.1333.

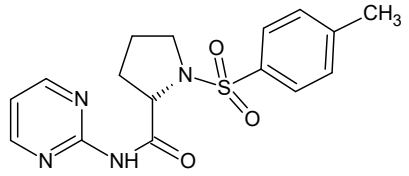


*(2*S*)-1-[(4-Nitrophenyl)sulfonyl]*-N-*(pyrimidin-2-yl)pyrrolidine-2-carbox-amide* ***(21n)***. Yield: 0.3771 g, 100 %; m.p.: 146.7–146.9 °C; FTIR (KBr, cm^{-1}): 3206, 3114, 2981, 2880, 1704, 1646, 1607, 1575, 1527, 1451, 1402, 1349, 1317, 1163, 1103, 1072, 1009; ^{1}H-NMR (400 MHz, CD_3OD, δ / ppm): 8.39 (2H, *d*, *J* = = 7.3 Hz, Ar-H), 8.23 (2H, *d*, *J* = 4.6 Hz, Ar-H), 8.09 (2H, *d*, *J* = 6.9 Hz, Ar-H), 6.62 (1H, *t*, *J* = 4.8 Hz, Ar-H), 4.30 (1H, *dd*, *J* = 3.7 & J_2 = 8.2 Hz, CH–C=O), 3.51–3.46 (1H, *m*, CH_a of CH_2N), 3.38–3.34 (1H, *m*, CH_b of CH_2N), 2.10–2.05 (1H, *m*, CH of CH_2, CH_a of C**H**CO_2H), 1.99–1.93 (2H, *m*, CH_2, C**H**$_2$–CH_2N),

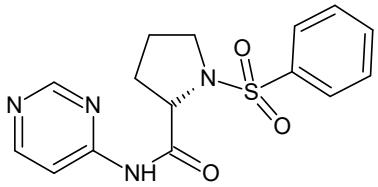
1.79–1.75 (1H, *m*, CH of CH_2, CH_b of C**H**$_2$$CH_2$N); ^{13}C-NMR (100 MHz, CD_3OD, δ / ppm): 174.08, 163.03, 158.11, 150.36, 143.99, 128.60, 124.06, 110.42, 60.79, 55.22, 30.72, 24.28; ESI-HRMS (*m*/*z*): Calcd. for $[C_{15}H_{15}N_5O_5S+H]^+$: 378.0879. Found: 378.0878.



*(2*S*)-1-[(4-Nitrophenyl)sulfonyl]*-N-*(pyrimidin-2-yl)pyrrolidine-2-carboxamide (**21o**)*. Yield: 0.3458 g, 99.91 %; yellowish oil, FTIR (KBr, cm^{-1}): 3364, 3021, 2980, 1701, 1656, 1596, 1570, 1450, 1361, 1345, 1196, 1161, 1096, 1010. ^{1}H-NMR (500 MHz, CD_3OD, δ / ppm): 8.24 (*d*, 2H, *J*= 3.5 Hz, Ar-H), 7.71 (*d*, 2H, *J*= 7.7 Hz, Ar-H), 7.35 (*d*, 2H, *J*= 8.6 Hz, Ar-H), 6.64 (*t*, 1H, *J*= 4.8 Hz, Ar-H), 4.17 (1H, *t*, *J* = 6.2 Hz, CH–C=O), 3.46–3.42 (1H, *m*, CH_a of CH_2N), 3.23––3.21 (1H, *m*, CH_b of CH_2N), 2.36–2.26 (3H, *m*, Ar-CH_3), 1.94–1.85 (3H, *m*, C**H**$_2$–$CHCO_2H$ and CH_a of C**H**$_2$$CH_2$N), 1.62–1.57 (1H, *m*, CH of CH_2, CH_b of C**H**$_2$$CH_2$N); ^{13}C-NMR (126 MHz, CD_3OD, δ / ppm): 174.99, 162.33, 158.03, 144.08, 134.79, 129.68, 127.98, 127.34, 125.71, 125.07, 110.53, 60.87, 30.77, 24.37, 20.34; ESI-HRMS (*m*/*z*): Calcd. for $[C_{16}H_{18}N_4O_3S+H]^+$: 347.1170. Found: 347.1172.



*(2*S*)-1-(Phenylsulfonyl)*-N-*(pyrimidin-4-yl)pyrrolidine-2-carboxamide (**21p**)*. Yield: 0.3321 g, 100 %; orange coloured oil; FTIR (KBr, cm^{-1}): 3319, 3049, 2993, 2956, 2930, 2862, 2813, 1683, 1617, 1601, 1582, 1446, 1410, 1373, 1336, 1174, 1138, 1096, 1071, 1020; ^{1}H-NMR (400 MHz, CD_3OD, δ / ppm): 8.46 (1H, *s*, Ar-H), 8.03 (1H, *d*, *J* = 6.4 Hz, Ar-H), 7.83 (2H, *d*, *J* = 6.9 Hz, Ar-H), 7.59––7.49 (2H, *m*, Ar-H), 7.14 (1H, *t*, *J* = 7.4 Hz, Ar-H), 7.05 (2H, *t*, *J* = 7.3 Hz, Ar-H), 6.65 (1H, *d*, *J* = 6.4 Hz, Ar-H), 4.12 (1H, *dd*, *J* = 4.2 & J_1 = 9.3 Hz, CH–C=O), 3.48–3.42 (1H, *m*, CH_a of CH_2N), 3.21–3.17 (1H, *m*, CH_b of CH_2), 1.93–1.81 (3H, *m*, C**H**$_2$–$CHCO_2H$ and CH_a of C**H**$_2$$CH_2$N), 1.47–1.46 (1H, *m*, CH); ^{13}C-NMR (100 MHz, CD_3OD, δ / ppm): 177.22, 164.57, 154.73, 148.45, 137.61, 132.90, 129.15, 128.74, 128.17, 125.11, 105.33, 62.37, 31.09, 24.47, 20.45; ESI-HRMS (*m*/*z*): Calcd. for $[C_{16}H_{18}N_4O_3S+H_3O]^+$: 351.1128. Found: 351.1125.



*(2*S*)-1-(Phenylsulfonyl)*-N-*(pyrimidin-2-yl)pyrrolidine-2-carboxamide (**21q**)*. Yield: 0.3318 g, 99.91 %; m.p.: 149.10–149.50 °C; FTIR (KBr, cm^{-1}): 3223, 3007, 2887, 2863, 1701, 1635, 1607, 1447, 1375, 1341, 1197, 1161, 1095, 1019; ^{1}H-NMR (400 MHz, CD_3OD, δ / ppm): 8.23 (2H, *d*, *J* = 4.6 Hz, Ar-H), 7.86 (2H, *d*, *J* = 6.9 Hz, Ar-H), 7.64 (1H, *t*, *J* = 7.6 Hz, Ar-H), 7.57 (2H, *t*, *J* = 7.6 Hz, Ar-H), 6.62 (1H, *t*, *J* = 5.0 Hz, Ar-H), 4.18 (1H, *t*, *J* = 5.5 Hz, CH–C=O), 3.48––3.43 (1H, *m*, CH_a of CH_2N), 3.26–3.22 (1H, *m*, CH_b of CH_2N), 1.98–1.83 (3H, *m*, C**H**$_2$–$CHCO_2H$ and CH_a of C**H**$_2CH_2N$), 1.55–1.48 (1H, *m*, CH of CH_2, CH_b of C**H**$_2CH_2N$); ^{13}C-NMR (100 MHz, CD_3OD, δ / ppm): 174.58, 158.10, 153.23, 137.84, 132.85, 129.03, 128.59, 127.88, 127.23, 124.98, 110.42, 60.71, 34.44, 31.42, 28.83. ESI-HRMS (*m*/*z*): Calcd. for $[C_{16}H_{18}N_4O_3S+H_3O]^+$: 351.1128. Found: 351.1128.