SUPPORTING INFORMATION

Arylidene pyruvic acids motif in the synthesis of new *2H,5H*- chromeno[4',3':4,5]thiopyrano[2,3-*d*]thiazoles via tandem *hetero*-Diels-Alder- hemiacetal reaction

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Spectral and analytical data for compounds **3b-d/3b-d***

rel*-(5*S*,5*aR*,11*bR*)- and *rel*-(5*R*,5*aS*,11*bR*)-6-Hydroxy-2-oxo-5-(2-thienyl)-3,5*a*,6,11*b*-tetrahydro-2*H*,5*H*-chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (**3b/3b).** Yield 48%, mp 224-226°C (DMF:AcOH). ¹H NMR (400 MHz, DMSO-*d*₆): δ 4.12 (d, 1H, *J* = 6.4 Hz, 11*b*-H, **3b***), 4.48 (d, 1H, *J* = 6.0 Hz, 5-H, **3b***), 4.60-4.80 (m, 3H, 5*a*-H,11*b*-H), 4.93 (d, 1H, *J* = 11.8 Hz, 5-H, **3b**), 6.73 (d, 1H, *J* = 7.6 Hz, arom.), 6.80 (d, 2H, *J* = 8.4 Hz, arom.), 7.22-7.46 (m, 4H, arom., thiophen.), 8.47 (s, 1H, OH), 11.57 (s, 1H, NH). ¹³C NMR (100 MHz, DMSO-*d*₆): δ 31.36, 46.63, 46.96, 95.01, 109.11, 115.00, 115.22, 123.06, 125.22, 128.15, 130.79, 130.88, 133.13, 138.45, 150.32, 163.25, 169.28, 170.35. Anal. Calcd for C₁₈H₁₃NO₅S₃: C, 51.54; H, 3.12; N, 3.34. Found: C, 51.53; H, 3.11; N, 3.35. ESI-MS *m/z* 419 (M+H)⁺.

rel*-(5*S*,5*aR*,11*bR*) and *rel*-(5*R*,5*aS*,11*bR*)-10-Bromo-6-hydroxy-2-oxo-5-phenyl-3,5*a*,6,11*b*-tetrahydro-2*H*,5*H*-chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (**3c/3c).** Yield 70%, mp 246-248°C (DMF:AcOH). ¹H NMR (400 MHz, DMSO-*d*₆): 4.19 (d, 1H, *J* = 6.2 Hz, 11*b*-H, **3c***), 4.29 (dd, 1H, *J* = 9.0, 11.7 Hz, 5*a*-H, **3c***), 4.37 (d, 1H, *J* = 6.2 Hz, 5-H, **3c***), 4.55 (d, 1H, *J* = 11.5 Hz, 5-H, **3c**), 4.74 (d, 1H, *J* = 4.2 Hz, 11*b*-H, **3c**), 4.89 (dd, *J* = 4.2, 11.5 Hz, 5*a*-H, **3c**), 6.95 (d, 2H, *J* = 8.6 Hz, arom.), 7.27-7.34 (m, 2H, arom.), 7.47-7.52 (m, 4H, arom.), 8.30 (s, 1H, OH), 10.97 (s, 1H, NH), 13.86 (br s, 1H, COOH). ¹³C NMR (100 MHz, DMSO-*d*₆): δ 35.07, 45.13, 47.84, 97.37,

108.22, 115.05, 120.14, 121.14, 125.94, 127.25, 129.52, 130.68, 132.70, 135.90, 148.85, 161.34, 170.47, 170.78. Anal. Calcd for C₂₀H₁₄BrNO₅S₂: C, 48.79; H, 2.87; N, 2.84. Found: C, 48.81; H, 2.85; N, 2.87. ESI-MS m/z 492 (M+H)⁺.

***rel*-(5*S*, 5*aR*, 11*bR*) and *rel*-(5*R*, 5*aS*, 11*bR*)-5-(4-Fluorophenyl)-6-hydroxy-2-oxo-5-phenyl-3,5*a*,6,11*b*-tetrahydro-2*H*,5*H*-chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (3*d*/3*d*^{*}).**

Yield 73%, mp 232-234°C (DMF:AcOH). ¹H NMR (400 MHz, DMSO-*d*₆): δ 4.15 (d, 1H, *J* = 6.4 Hz, 11*b*-H, 3*d*^{*}), 4.30 (d, 1H, *J* = 10.4 Hz, 5-H, 3*d*), 4.36 (d, 1H, *J* = 6.4 Hz, 5-H, 3*d*^{*}), 4.54 (dd, 1H, *J* = 10.7, 11.2 Hz, 5*a*-H, 3*d*^{*}), 4.78 (dd, 1H, *J* = 4.2, 10.4 Hz, 5*a*-H, 3*d*), 4.85 (d, 1H, *J* = 4.0 Hz, 11*b*-H, 3*d*), 6.73 (d, 1H, *J* = 8.0 Hz, arom.), 6.86 (t, 1H, *J* = 7.8 Hz, arom.), 7.06-7.18 (m, 2H, arom.), 7.36 (t, 2H, *J* = 8.5 Hz, arom.), 7.50 (dd, 2H, *J* = 5.5, 7.9 Hz, arom.), 7.97 (s, 1H, OH), 11.59 (s, 1H, NH). ¹³C NMR (100 MHz, DMSO-*d*₆): δ 31.74, 45.51, 47.33, 93.24, 108.43, 114.63, 114.85, 118.19, 128.59 (d, *J* = 23.0 Hz, C-F), 130.95, 131.05, 133.85, 133.88, 136.71, 149.65, 158.05, 159.44 (d, *J* = 278.0 Hz, C-F), 163.09, 169.36, 170.47. Anal. Calcd for C₂₀H₁₄FNO₅S₂: C, 55.68; H, 3.27; N, 3.25. Found: C, 55.65; H, 3.28; N, 3.27. ESI-MS m/z 431 (M+H)⁺.

Crystal structure determination of **3a/3a***.

Crystal data: $C_{20}H_{15}NO_5S_2$, $M_r = 413.45$, monoclinic, space group $P2_1/c$, $a = 10.13635(15)$, $b = 14.6995(2)$, $c = 11.8223(2)$ Å, $\beta = 102.4884(17)^\circ$, $V = 1719.84(5)$ Å³, $T = 130(2)$ K, $Z = 4$.

Data collection: A yellow block crystal of 0.18 x 0.08 x 0.06 mm was used to record 16358 ($CuK\alpha$ radiation, $\theta_{max} = 76.36^\circ$) intensities on a Super Nova Dual Atlas diffractometer [1]. The data were corrected for Lorentz and polarization effects. Multi-scan absorption correction has been applied too. The minimum and maximum transmissions were 0.74697 and 1.00000. The 3580 total unique reflections ($R(int) = 0.026$) were used for further calculations.

Structure solution and refinement: The crystal structure of **3a/3a*** was solved by direct methods using the SHELXS-97 program [2]. The positions of the H atoms were positioned geometrically and were refined within the riding model approximation, with C–H = 0.98 Å (CH), 0.93 Å ($C_{ar}H$), N–H = 0.86 Å, O–H = 0.82 Å and U_{iso} (H) values were constrained to be 1.2 times U_{eq} of the appropriate carrier atom. The structure was refined by the full-matrix least-squares method on F^2 s using the SHELXL-97 program [2]. The final refinement converged with $R = 0.0348$ (for 7017 data with $F^2 > 4\sigma(F^2)$), $wR = 0.1013$ (on F^2 for all data), and $S = 1.062$ (on F^2 for all data). The largest difference peak a hole were 0.320 and -0.340 eÅ⁻³. The molecular illustrations were drawn using ORTEP-3 for Windows [3]. Software used to prepare material for publication was OLEX2 [4], WINGX [3], PLATON [5].

The supplementary crystallographic data have been deposited at the Cambridge Crystallographic Data Centre (CCDC), 12 Union ROAD, Cambridge CB2 1EZ (UK), Tel.: (+44) 1223/336-408, Fax: (+44) 1223/336-033, E-mail: deposit@ccdc.cam.ac.uk, World Wide Web: <http://www.ccdc.cam.ac.uk> (deposition No. CCDC 1401842).

Copies of NMR spectra

6-hydroxy-2-oxo-5-phenyl-3,5a,6,11b-tetrahydro-2*H*,5*H*-chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (3a/3a*)

**6-Hydroxy-2-oxo-5-(2-thienyl)-3,5a,6,11b-tetrahydro-2*H*,5*H*-
chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (3b/3b*)**

**10-Bromo-6-hydroxy-2-oxo-5-phenyl-3,5a,6,11b-tetrahydro-2*H*,5*H*-
chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (3c/3c*)**

5-(4-Fluorophenyl)-6-hydroxy-2-oxo-5-phenyl-3,5a,6,11b-tetrahydro-2*H*,5*H*-chromeno[4',3':4,5]thiopyrano[2,3-*d*][1,3]thiazole-6-carboxylic acid (3d/3d*)

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