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Methyl 7-hydroxy-1,3-dimethyl-2,4-dioxo-1,2,3,4-tetrahydropteridine-6-carboxylate–dimethyl sulfoxide (1/1) forms chains containing O—H···O and C—H···O hydrogen bonds and aromatic π–π-stacking interactions

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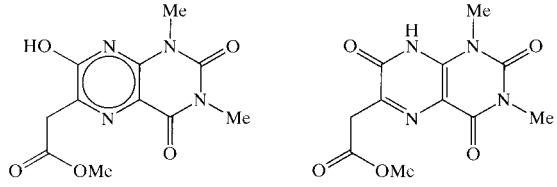
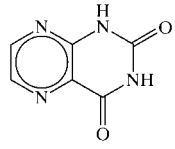
In the title compound, $C_{11}H_{12}N_4O_5\cdot C_2H_6OS$, the molecular components are linked by a short hydrogen bond with dimensions O···O 2.517 (2) Å and O—H···O 168°. Paired C—H···O hydrogen bonds [C···O 3.362 (2) and 3.382 (2) Å; C—H···O 157 and 140°] generate cyclic centrosymmetric four-component aggregates reinforced by aromatic π–π-stacking interactions, and further C—H···O hydrogen bonds [C···O 3.472 (3) and 3.521 (2) Å; C—H···O 156 and 157°] link these aggregates into chains.

Comment

Synthetic analogues of naturally occurring polyaza-hetero-aromatic compounds, such as pteridines, are of considerable interest because of their extensive pharmaceutical potential, for example, as inhibitors of folic acid biosynthesis (Lang *et al.*, 1995) and their action as antiallergic (Ferrand *et al.*, 1996), antihelminthic (Ochoa *et al.*, 1996), anti-inflammatory (Cottam *et al.*, 1996) and antiviral agents (Molina *et al.*, 1999). We report here the structure of one such synthetic pteridine, methyl 7-hydroxy-1,3-dimethyl-2,4-dioxo-1,2,3,4-tetrahydro-pteridine-6-carboxylate, (1), which is a useful intermediate for the synthesis of folic acid analogues (Molina *et al.*, 1999) and which crystallizes from dimethyl sulfoxide (DMSO) solution as the monosolvate, *i.e.* (1)·DMSO.

The bond lengths within the heteroaromatic portion of the molecule show clearly that form (1), carrying a hydroxyl group at position 7, is the correct representation, as opposed to the possible alternative tautomer (1*a*). In particular, the C7—O7 distance is very similar to the C62—O62 distance in the ester portion and much greater than the C2—O2 and C4—O4 distances; secondly, the bond lengths in the pyrazine portion of the heterocycle indicate considerable aromatic delocalization,





with C—N distances consistently shorter than those in the pyrimidinedione portion. Moreover, the hydroxyl group O7—H7 forms a rather short and strong O—H···O hydrogen bond with O1 of the DMSO component as hydrogen-bond acceptor (Table 2), which could favour tautomer (1) over (1*a*). The non-H atoms in (1) are virtually coplanar, apart from those in the methoxycarbonyl fragment (Table 1). Overall, the bond lengths in the heterocyclic ring are similar to those in the unsubstituted pteridine-2,4-dione (2) (Norrestam *et al.*, 1972) and in methylated pteridinediones in a variety of metal complexes retrieved from the Cambridge Structural Database

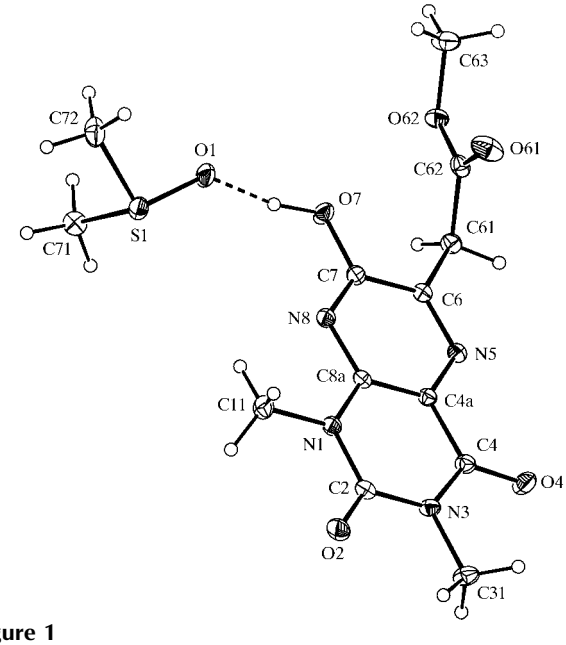


Figure 1
The asymmetric unit of (1)·DMSO showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 30% probability level.

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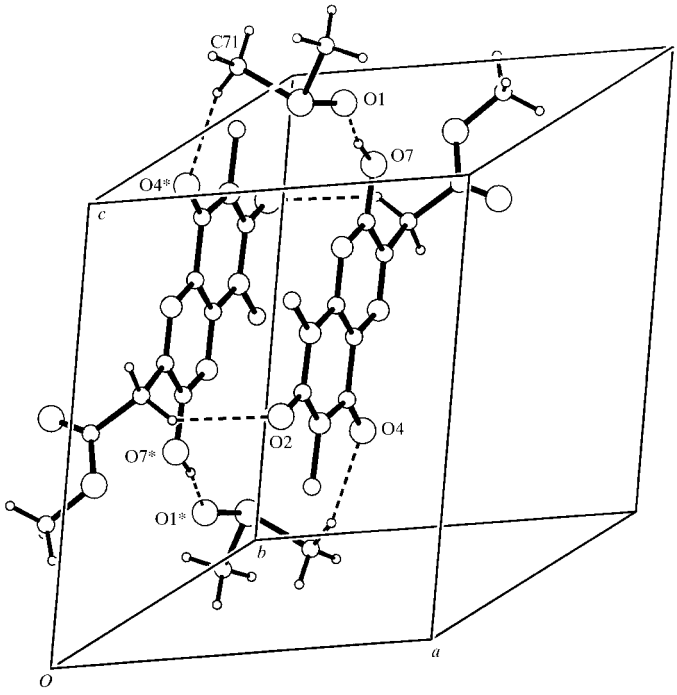

Figure 2
Part of the crystal structure of (1)·DMSO showing the formation of a cyclic centrosymmetric four-component aggregate. The atoms marked with an asterisk (*) are at the symmetry position $(-x, 2-y, 1-z)$. For clarity, the H atoms bonded to C11 and C31 have been omitted.

(CSD; Allen & Kennard, 1993), exemplified by PUSJUI (Hueso-Ureña *et al.*, 1998*a*), GAZTOQ, GAZZOW and GEBKUT (Hueso-Ureña *et al.*, 1998*b*), and LIVJIJ (Hueso-Ureña *et al.*, 1999).

The molecules of (1) and DMSO are linked by a series of hydrogen bonds (Table 2) into chains of fused centrosymmetric rings. In addition to the O—H···O hydrogen bond within the asymmetric unit (Fig. 1), there are C—H···O hydrogen bonds which link pairs of such units into centrosymmetric four-component aggregates; atoms C61 and C71 in the asymmetric unit at (x, y, z) act as donors, *via* H612 and H711, respectively, to O2 and O4, both at $(-x, 2-y, 1-z)$, so generating a centrosymmetric dimer in which the two individual hydrogen bonds generate $R_2^2(18)$ and $R_4^4(24)$ rings, respectively (Fig. 2). The effect of these mutually reinforcing C—H···O hydrogen bonds is further enhanced by aromatic π–π-stacking interactions between the two heteroaromatic rings within this cyclic aggregate; the perpendicular distance between the two ring planes is *ca* 3.41 Å, and the centroid offset between the pyrazine ring in one pteridine and the pyrimidine ring in the other is only *ca* 0.46 Å, giving almost perfect overlap.

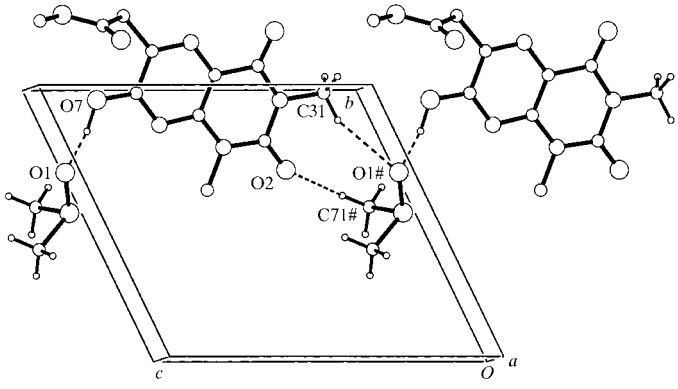

Figure 3
Part of the crystal structure of (1)·DMSO showing the formation of a [001] chain. For clarity, H atoms bonded to C11 and C61 have been omitted. Atoms marked with a hash (#) are at the symmetry position $(x, y, -1+z)$.

The four-component cyclic aggregates are linked into chains by a further pair of C—H···O hydrogen bonds; C31 at (x, y, z) acts as donor, *via* H311, to O1 at $(x, y, -1+z)$, while C71 at $(x, y, -1+z)$ acts as donor, *via* H712, to O2 at (x, y, z), so generating an $R_2^2(9)$ motif (Fig. 3). These interactions serve to link the cyclic aggregates (Fig. 2) into chains running parallel to the [001] direction, in which the cyclic aggregates are centred at $(0,1,\frac{1}{2}+n)$ (n = zero or integer) and the rings between them are centred at $(0,1,n)$ (n = zero or integer).

Experimental

A sample of (1) was prepared according to the published method of Molina *et al.* (1999). Crystals of (1)·DMSO suitable for single-crystal X-ray diffraction were grown from a solution of (1) in DMSO.

Crystal data

$C_{11}H_{12}N_4O_5\cdot C_2H_6OS$
M_r = 358.37
Triclinic, $P\overline{1}$
a = 8.8926 (2) Å
b = 10.2539 (2) Å
c = 10.8500 (4) Å
α = 62.2233 (10)°
β = 82.4797 (10)°
γ = 69.1050 (14)°
V = 817.03 (4) Å^3
Z = 2
D_x = 1.457 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 3282 reflections
θ = 2.9–27.1°
μ = 0.24 mm^{-1}
T = 150 (2) K
Lath, colourless
0.25 × 0.10 × 0.10 mm

Data collection

KappaCCD diffractometer
φ scans, and ω scans with κ offsets
Absorption correction: multi-scan (*DENZO–SMN*; Otwinowski & Minor, 1997)
T_{min} = 0.943, T_{max} = 0.977
7717 measured reflections
3528 independent reflections
2790 reflections with $I > 2\sigma(I)$
R_{int} = 0.037
θ_{max} = 27.0°
$h = -11 \rightarrow 11$
$k = -13 \rightarrow 13$
$l = -13 \rightarrow 13$
Intensity decay: negligible

Table 1
Selected geometric parameters (Å, °).

N1—C2	1.376 (2)	N1—C8a	1.381 (2)
C2—N3	1.386 (2)	N8—C8a	1.338 (2)
N3—C4	1.391 (2)	C4a—C8a	1.382 (2)
C4—C4a	1.452 (2)	C2—O2	1.220 (2)
N5—C4a	1.355 (2)	C4—O4	1.223 (2)
N5—C6	1.310 (2)	C62—O61	1.200 (2)
C6—C7	1.426 (2)	C62—O62	1.332 (2)
C7—N8	1.323 (2)	C7—O7	1.320 (2)
C6—C61—C62—O61	44.7 (2)	C7—C6—C61—C62	55.9 (2)
C6—C61—C62—O62	−137.11 (15)	N5—C6—C61—C62	−126.59 (17)

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0602P)^2 + 0.1126P]$ where $P = (F_o^2 + 2F_c^2)/3$
$R[F^2 > 2\sigma(F^2)] = 0.045$	$(\Delta/\sigma)_{max} = 0.001$
$wR(F^2) = 0.121$	$\Delta\rho_{max} = 0.26$ e Å^{-3}
$S = 1.05$	$\Delta\rho_{min} = -0.47$ e Å^{-3}
3528 reflections	
222 parameters	
H-atom parameters constrained	

Table 2
Hydrogen-bonding geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
O7—H7···O1	1.05	1.48	2.517 (2)	168
C31—H311···O1^{i}	0.98	2.56	3.472 (3)	156
C61—H612···O2^{ii}	0.98	2.57	3.382 (2)	140
C71—H711···O4^{ii}	0.98	2.44	3.362 (2)	157
C71—H712···O2^{iii}	0.98	2.60	3.521 (2)	157

Symmetry codes: (i) $x, y, z-1$; (ii) $-x, 2-y, 1-z$; (iii) $x, y, 1+z$.

The title compound crystallized in the triclinic system, and space group $P\overline{1}$ was assumed and confirmed by the analysis. H atoms were treated as riding atoms, with C—H distances of 0.98 (CH_3) or 0.99 Å (CH_2), except for H7, whose position was located on a difference map and thereafter kept fixed.

Data collection: *KappaCCD Server Software* (Nonius, 1997); cell refinement: *DENZO–SMN* (Otwinowski & Minor, 1997); data reduction: *DENZO–SMN*; program(s) used to solve structure: *SHELXS*97 (Sheldrick, 1997); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics: *PLATON* (Spek, 2001); software used to prepare material for publication: *SHELXL*97 (Sheldrick, 1997) and *PRPKAPPA* (Ferguson, 1999).

X-ray data were collected at the EPSRC X-ray Crystallographic Service, University of Southampton, using an Enraf–Nonius KappaCCD diffractometer. The authors thank the staff for all their help and advice.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: GG1046). Services for accessing these data are described at the back of the journal.

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