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O—H···O-bridged dimers linked *via* C—H···O and C—H···π interactions in 4,6-di-*O*-benzyl-*myo*-inositol 1,3,5-orthoformate

K. Manoj,[a]* S. Devaraj,[b] R. G. Gonnade,[a] M. M. Bhadbhade[a] and M. S. Shashidhar[b]

[a]Centre for Materials Characterization, National Chemical Laboratory, Pune 411 008, India, and [b]Division of Organic Synthesis, National Chemical Laboratory, Pune 411 008, India
Correspondence e-mail: k.manoj@ncl.res.in

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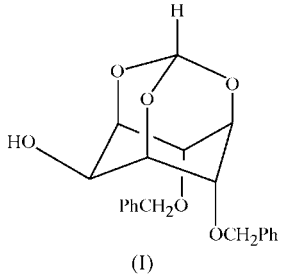
The centrosymmetric O—H···O-bonded head-to-head dimers of the title compound, $C_{21}H_{22}O_6$, are linked together *via* bifurcated C—H···O interactions along the *a* axis and *via* favourable C—H···π interactions along the *b* axis in the crystal structure.

Comment

Protected *myo*-inositol derivatives are important precursors for the synthesis of phosphorylated *myo*-inositol derivatives (Sureshan *et al.*, 2003), which play a significant role in cellular signal transduction (Potter & Lampe, 1995). *myo*-Inositol 1,3,5-orthoformate is a key intermediate for the synthesis of several *myo*-inositol phosphates and other cyclitols (Sarmah, Shashidhar *et al.*, 2005). Encouraged by the frequently encountered polymorphic (Gonnade *et al.*, 2004; Bhosekar *et al.*, 2005) and pseudo polymorphic (Manoj *et al.*, 2005) behaviour of *myo*-inositol derivatives, 4,6-di-*O*-benzyl-*myo*-



(I)

inositol 1,3,5-orthoformate, (I), was also screened for the same property by varying crystallization conditions. However, compound (I) yielded only solvent-free crystals of the triclinic form from most of the common organic solvents, such as dichloromethane, ethyl acetate, chloroform, dioxane and acetonitrile.

The three axial positions at C1, C3 and C5 constitute the orthoformate bridge (Fig. 1). The conformation of the molecule as observed in the crystal shows three rather weak intramolecular interactions. The equatorial hydroxy O2—H2*A* group makes bifurcated O—H···O contacts with the orthoformate bridge atoms O1 and O3. Another bifurcated contact of the C—H···O type is made by the C2—H2 group with ether atoms O4 and O6 (Table 1). An almost perpendicular orientation of the phenyl rings [the dihedral angle between the rings is 83.35 (15)°] facilitates the somewhat off-

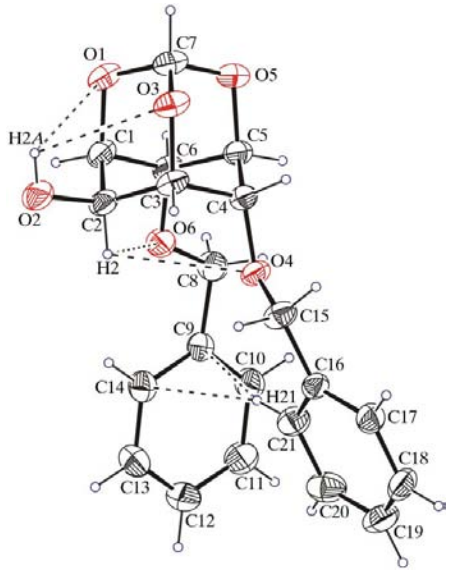


Figure 1
An *ORTEPIII* (Burnett & Johnson, 1996) diagram of (I), drawn with 30% probability displacement ellipsoids. The broken lines indicate O—H···O, C—H···O and C—H···π intramolecular interactions.

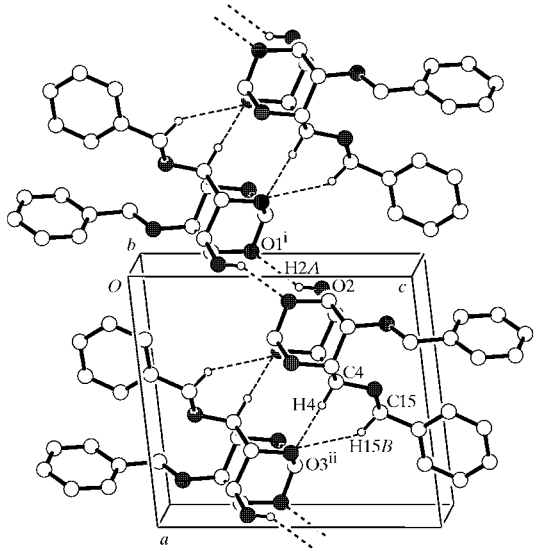


Figure 2
Dimers linked by bifurcated C—H···O interactions, viewed down the *b* axis. The broken lines indicate intermolecular O—H···O and C—H···O hydrogen bonds. [Symmetry codes: (i) $-x, -y+2, -z+1$; (ii) $-x+1, -y+2, -z+1$.]

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centred C21—H21···π interaction (H21···C9 = 2.85 Å and H21···C14 = 2.83 Å).

Molecules of (I) form centrosymmetric dimers through conventional intermolecular O2—H2*A*···O1 bonds, bringing the orthoformate bridgeheads closer but causing the two benzyloxy groups to point away (Fig. 2). These dimers also make centrosymmetric bifurcated C—H···O contacts with atom O3 [C15—H15*B*···O3^{ii} and C4—H4···O3^{ii}; symmetry code: (ii) $-x+1, -y+2, -z+1$], extending along the *a* axis, forming two-dimensional ribbon-like patterns with the hydrophilic groups clustered together and the hydrophobic phenyl rings protruding.

Both the phenyl rings make intermolecular C—H···π contacts; the C15—H15*A* group interacts with the C16–C21 aromatic ring (Table 1) to form layers normal to the [101] direction (Fig. 3) with a very favourable geometry, whereas the C9–C14 phenyl ring is held by C6—H6···C14^{v} and C1—H1···C10^{v} contacts [H6···C14^{v} = 2.99 Å and H1···C10^{v} = 2.94 Å; symmetry code: (v) $-x, -y+1, -z+2$] from one side and the above-mentioned intramolecular contact involving the C21—H21 group from the other side (Fig. 3). It is noteworthy that the phenyl rings are involved only in C—H···π contacts and not in any π–π stacking interactions in the structure. The significance of C—H···π interactions is well established in various fields of chemistry, including self-assembly (Xie *et al.*, 2005), crystal packing (Suezawa *et al.*, 2001), inclusion complexes (Kobayashi *et al.*, 1993) and solid-state reactions (Sarmah, Gonnade *et al.*, 2005). An extensive search (Takahashi *et al.*, 2000) of the Cambridge Structural Database (CSD; Allen, 2002) for the existence of C—H···π interactions strongly suggests the weak hydrogen-bond character of these interactions (Nishio *et al.*, 1998).

The packing of O—H···O-bonded dimers down the *c* axis is shown in Fig. 4. The organization of molecules shows some voids (~3.5 × 5.0 Å), marked as *A*, that are too small for the inclusion of any organic solvent or even a water molecule.

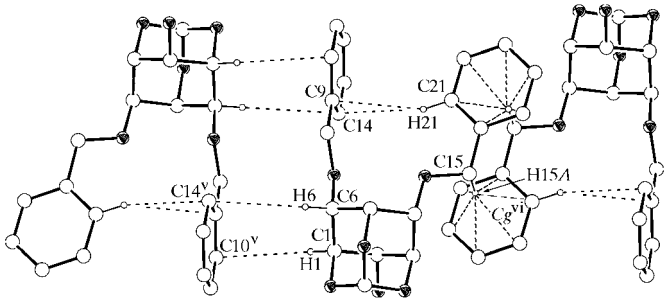

Figure 3
The involvement of C—H···π contacts of both the phenyl rings. [Symmetry codes: (v) $-x, -y+1, -z+2$; (vi) $-x+1, -y+2, -z+2$.]

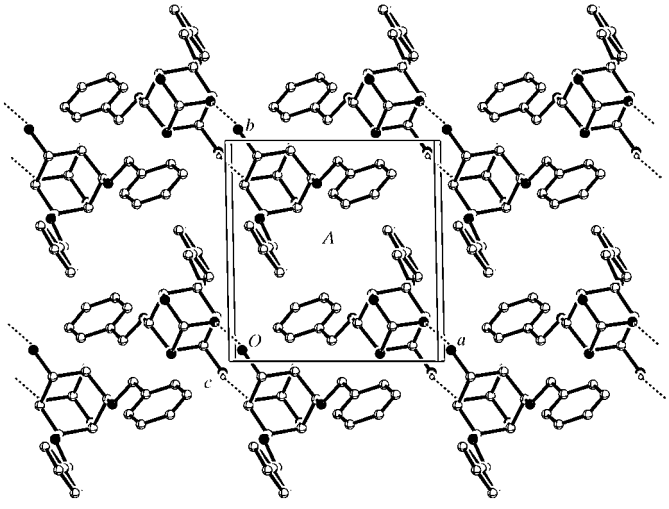

Figure 4
The molecular packing, viewed down the *c* axis, with voids marked as *A*.

Experimental

2-*O*-Tosyl-*myo*-inositol orthoformate (Sureshan *et al.*, 2002) (0.177 g, 0.5 mmol) was dissolved in dimethylformamide (4 ml) and stirred for 2 min after the addition of sodium hydride (0.024 g, 1 mmol). Benzyl bromide (0.15 ml, 1 mmol) was then added and the mixture was stirred at room temperature for 5 min. The solvents were evaporated under reduced pressure and the residue obtained was worked up with ethyl acetate to obtain 4,6-di-*O*-benzyl-2-*O*-tosyl-*myo*-inositol orthoformate. The tosyl group was cleaved by refluxing with sodium methoxide (0.270 g, 5 mmol) in methanol (5 ml) for 12 h. The reaction mixture was then quenched with ice and extracted with ethyl acetate. The extract was washed with dilute HCl, saturated Na_2CO_3 solution and brine, and dried over anhydrous Na_2SO_4. The solvent was evaporated under reduced pressure and the solid obtained was dissolved in dichloromethane, diluted with petroleum ether and stored at ambient temperature. Good quality colourless crystals were obtained after 4 h (yield 0.188 g, 99%); m.p. 401–403 K, *cf.* literature m.p. 393–396 K (Devaraj *et al.*, 2005).

Crystal data

$C_{21}H_{22}O_6$
M_r = 370.39
Triclinic, $P\overline{1}$
a = 9.0511 (11) Å
b = 10.0953 (12) Å
c = 10.6586 (13) Å
α = 68.849 (2)°
β = 81.453 (2)°
γ = 87.433 (2)°
V = 898.18 (19) Å^3
Z = 2
D_x = 1.370 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 4418 reflections
θ = 2.4–25.0°
μ = 0.10 mm^{-1}
T = 298 (2) K
Plate, colourless
0.29 × 0.22 × 0.13 mm

Data collection

Bruker SMART APEX CCD area-detector diffractometer
φ and ω scans
Absorption correction: multi-scan (*SADABS*; Bruker, 2000)
T_{min} = 0.972, T_{max} = 0.987
13398 measured reflections
3328 independent reflections
2911 reflections with $I > 2\sigma(I)$
R_{int} = 0.025
θ_{max} = 25.5°
$h = -10 \rightarrow 10$
$k = -12 \rightarrow 12$
$l = -12 \rightarrow 12$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.045
$wR(F^2)$ = 0.113
S = 1.09
3328 reflections
245 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0492P)^2 + 0.1889P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.19 e Å^{-3}
$\Delta\rho_{min}$ = −0.18 e Å^{-3}

Table 1
Hydrogen-bond and short-contact geometry (Å, °).

*Cg*1 is the centroid of the C16–C21 ring.

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
C2—H2···O6	0.98	2.47	2.8550 (19)	103
C2—H2···O4	0.98	2.69	3.0463 (18)	102
O2—H2*A*···O3	0.82	2.63	2.9385 (18)	104
O2—H2*A*···O1	0.82	2.66	2.9408 (18)	102
C10—H10···O4^{iii}	0.93	2.67	3.517 (2)	152
C15—H15*B*···O3^{ii}	0.97	2.64	3.514 (2)	150
C4—H4···O3^{ii}	0.98	2.62	3.466 (2)	145
O2—H2*A*···O1^{i}	0.82	2.15	2.8558 (16)	144
C15—H15*A*···*Cg*1^{iv}	0.97	2.69	3.602	158

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

The hydroxy H atom was constrained to an ideal geometry [O—H = 0.82 Å and U_{iso}(H) = 1.5U_{eq}(O)]. Other H atoms were placed in idealized positions (C—H = 0.98 Å for the cyclohexane ring H atoms and atom H7, C—H = 0.93 Å for the phenyl H atoms and C—H = 0.97 Å for the methylene H atoms) and constrained to ride on their parent atoms [U_{iso}(H) = 1.2U_{eq}(C)].

Data collection: *SMART* (Bruker, 2000); cell refinement: *SMART*; data reduction: *SAINT* (Bruker, 2000); program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *ORTEPIII* (Burnett & Johnson, 1996) and *PLATON* (Spek, 2003); software used to prepare material for publication: *SHELXL97* and *PLATON*.

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: AV1256). Services for accessing these data are described at the back of the journal.

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