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n-Propyl 2,3,4,6-tetra-*O*-acetyl- β -D-glucopyranoside

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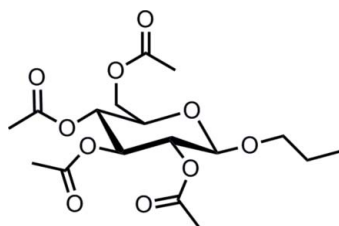
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Key indicators: single-crystal X-ray study; $T = 296$ K; mean $\sigma(\text{C}-\text{C}) = 0.006$ Å; R factor = 0.044; wR factor = 0.122; data-to-parameter ratio = 10.0.

The title compound [systematic name: (2*R*,3*R*,4*S*,5*R*,6*R*)-2-(acetoxymethyl)-6-propoxytetrahydro-2*H*-pyran-3,4,5-triyl triacetate], $\text{C}_{17}\text{H}_{26}\text{O}_{10}$, was formed by a Koenigs–Knorr reaction of 2,3,4,6-tetra-*O*-acetyl- α -D-glucopyranosyl bromide and *n*-propanol. The central ring adopts a chair conformation. The crystal does not contain any significant interactions such as hydrogen bonds.

Related literature

Metabolites of alcohol are important markers for previous alcohol consumption, see: Joya *et al.* (2012); Helander *et al.* (2012). For the investigation of the short-chain alkyl alcohol content in alcoholic beverages, see: Lachenmeier & Musshoff (2004). For the relevance of short-chain alkyl alcohol glucuronides as alcohol markers, see: Sticht & Käferstein (1999). For related synthesis, see: Baer & Abbas (1979).



Experimental

Crystal data

$\text{C}_{17}\text{H}_{26}\text{O}_{10}$
 $M_r = 390.38$
 Orthorhombic, $P2_12_12_1$
 $a = 7.0072$ (11) Å
 $b = 15.215$ (3) Å
 $c = 19.579$ (3) Å
 $V = 2087.4$ (6) Å³
 $Z = 4$
 Mo $K\alpha$ radiation
 $\mu = 0.10$ mm⁻¹
 $T = 296$ K
 $0.47 \times 0.41 \times 0.12$ mm

Data collection

Bruker APEXII CCD diffractometer
 Absorption correction: multi-scan (SADABS; Bruker, 2001)
 $T_{\min} = 0.152$, $T_{\max} = 0.326$
 12995 measured reflections
 2444 independent reflections
 1286 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.094$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.044$
 $wR(F^2) = 0.122$
 $S = 0.87$
 2444 reflections
 244 parameters
 H-atom parameters constrained
 $\Delta\rho_{\max} = 0.15$ e Å⁻³
 $\Delta\rho_{\min} = -0.13$ e Å⁻³

Data collection: APEX2 (Bruker, 2001); cell refinement: SAINT (Bruker, 2001); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: SHELXTL (Sheldrick, 2008) and ORTEPIII (Burnett & Johnson, 1996); software used to prepare material for publication: SHELXTL.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: BT6871).

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supporting information

Acta Cryst. (2013). E69, o158 [doi:10.1107/S1600536812051495]

n*-Propyl 2,3,4,6-tetra-*O*-acetyl- β -*D*-glucopyranoside*Bettina Mönch, Franziska Emmerling, Werner Kraus, Roland Becker and Irene Nehls****S1. Comment**

In recent years the determination of alcohol metabolites gained importance for screening previous alcohol consumption (Joya *et al.*, Helander *et al.*, 2012). Beside ethanol several short-chain alkyl alcohols, *e.g.* *n*-propanol, are found in alcoholic beverages as a result of fermentation process (Lachenmeier & Musshoff, 2004). The glucuronides of these so-called fusel alcohols are interesting markers for the consumption of alcohol (Sticht & Käferstein, 1999). So the analysis of these glucuronic metabolites, including their synthesis and full characterization is mandatory. The compound was formed by a Koenigs-Knorr-reaction of 2,3,4,6-tetra-*O*-acetyl- α -*D*-glucopyranosyl bromide and *n*-propanol (related synthesis Baer & Abbas, 1979) as an intermediate product towards synthesis of *n*-propyl-glucuronide.

The central ring has a chair conformation (Fig 1). One side chain of the molecule shows a small tendency to disorder, indicated in the *ORTEP* representation. This disorder leads to an unusual short contact C12—C13 (1.38 Å). The absolute configuration could not be defined confidently based on the single-crystal diffraction data. The isomeric purity of the title compound was confirmed by ¹H-NMR.

S2. Experimental

n-Propyl 2,3,4,6-tetra-*O*-acetyl- β -*D*-glucopyranoside was synthesized by a Koenigs-Knorr-reaction of 2,3,4,6-tetra-*O*-acetyl- α -*D*-glucopyranosyl bromide and *n*-propanol. In order to obtain crystals suitable for single-crystal analysis, about 10 mg were dissolved in 2 ml *i*-propanol. Colourless crystals of the title compound were formed after 4 days of slow solvent evaporation at room temperature.

S3. Refinement

All H-atoms were positioned geometrically and refined using a riding model with $d(\text{C—H}) = 0.93 \text{ \AA}$, $U_{\text{iso}} = 1.2U_{\text{eq}}(\text{C})$ for aromatic 0.98 \AA , $U_{\text{iso}} = 1.2U_{\text{eq}}(\text{C})$ for CH, 0.97 \AA , $U_{\text{iso}} = 1.2U_{\text{eq}}(\text{C})$ for CH₂, 0.96 \AA , $U_{\text{iso}} = 1.5U_{\text{eq}}(\text{C})$ for CH₃ hydrogen atoms. In the absence of significant anomalous dispersion effects 1815 Friedel pairs were merged. The absolute configuration has not been determined by anomalous-dispersion effects in diffraction measurements of the crystal. The conformation has been assigned due to an unchanging chiral centre in the synthetic procedure.

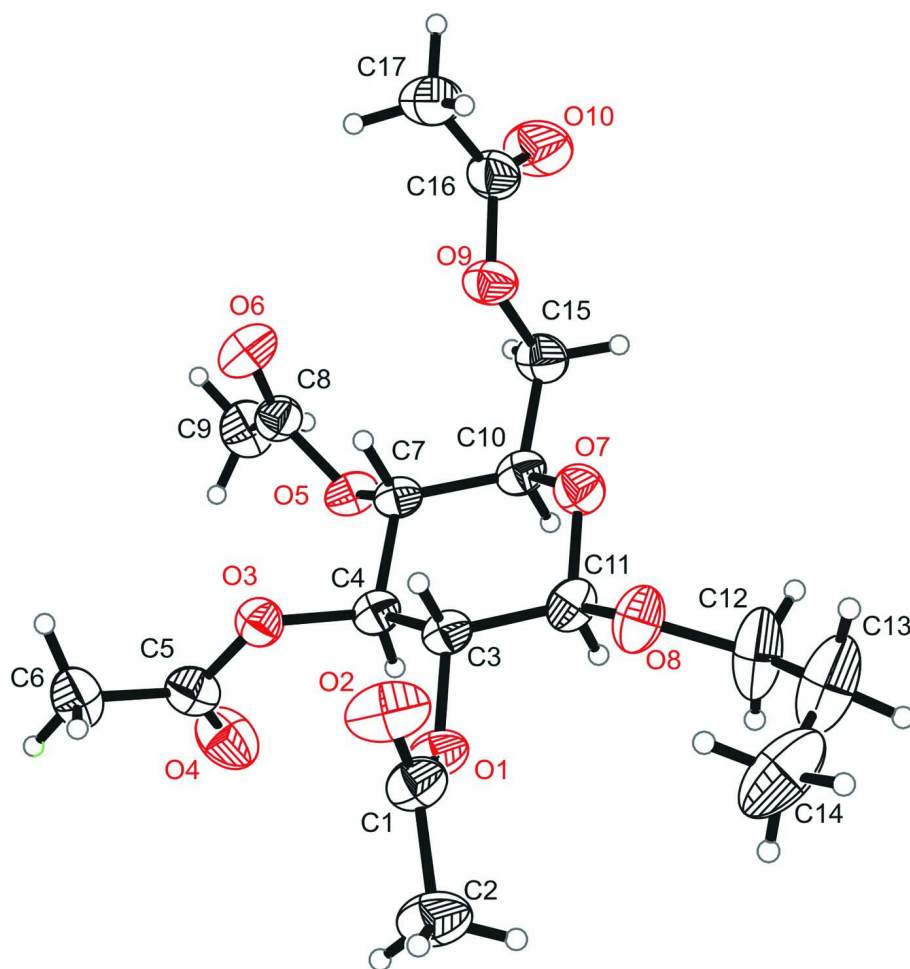
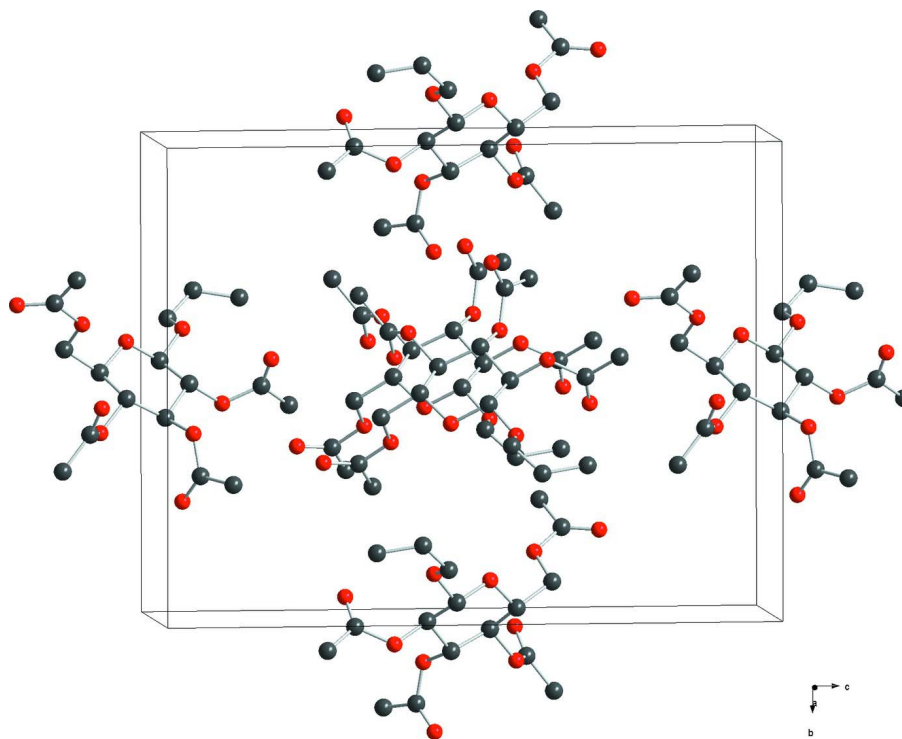


Figure 1

ORTEP representation of the title compound with atomic labeling shown with 30% probability displacement ellipsoids.

**Figure 2**View of the unit cell of the title compound along the *a* axis.**(2*R*,3*R*,4*S*,5*R*,6*R*)-2-(Acetoxymethyl)-6-propoxytetrahydro-2*H*-pyran-3,4,5-triyl triacetate***Crystal data* $C_{17}H_{26}O_{10}$ $M_r = 390.38$ Orthorhombic, $P2_12_12_1$

Hall symbol: P 2ac 2ab

 $a = 7.0072 (11) \text{ \AA}$ $b = 15.215 (3) \text{ \AA}$ $c = 19.579 (3) \text{ \AA}$ $V = 2087.4 (6) \text{ \AA}^3$ $Z = 4$ $F(000) = 832$ $D_x = 1.242 \text{ Mg m}^{-3}$ Mo $K\alpha$ radiation, $\lambda = 0.71073 \text{ \AA}$

Cell parameters from 1756 reflections

 $\theta = 2.5\text{--}20.6^\circ$ $\mu = 0.10 \text{ mm}^{-1}$ $T = 296 \text{ K}$

Block, colourless

 $0.47 \times 0.41 \times 0.12 \text{ mm}$ *Data collection*

Bruker APEXII CCD

diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

 φ and ω scans

Absorption correction: multi-scan

(SADABS; Bruker, 2001)

 $T_{\min} = 0.152$, $T_{\max} = 0.326$

12995 measured reflections

2444 independent reflections

1286 reflections with $I > 2\sigma(I)$ $R_{\text{int}} = 0.094$ $\theta_{\max} = 26.4^\circ$, $\theta_{\min} = 1.7^\circ$ $h = -8 \rightarrow 8$ $k = -14 \rightarrow 19$ $l = -22 \rightarrow 24$

Refinement

Refinement on F^2
 Least-squares matrix: full
 $R[F^2 > 2\sigma(F^2)] = 0.044$
 $wR(F^2) = 0.122$
 $S = 0.87$
 2444 reflections
 244 parameters
 0 restraints
 Primary atom site location: structure-invariant
 direct methods

Secondary atom site location: difference Fourier
 map
 Hydrogen site location: inferred from
 neighbouring sites
 H-atom parameters constrained
 $w = 1/[\sigma^2(F_o^2) + (0.0473P)^2]$
 where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\max} < 0.001$
 $\Delta\rho_{\max} = 0.15 \text{ e } \text{Å}^{-3}$
 $\Delta\rho_{\min} = -0.13 \text{ e } \text{Å}^{-3}$

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) etc. and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2)

	x	y	z	$U_{\text{iso}}^*/U_{\text{eq}}$
O1	-0.5821 (4)	-0.44666 (15)	0.11382 (11)	0.0723 (7)
O2	-0.4530 (6)	-0.5422 (2)	0.18823 (14)	0.1102 (11)
O3	-0.2268 (3)	-0.39673 (15)	0.05183 (11)	0.0658 (6)
O4	-0.2904 (6)	-0.25348 (18)	0.03622 (15)	0.1102 (11)
O5	-0.2593 (4)	-0.39896 (14)	-0.09808 (11)	0.0669 (7)
O6	0.0304 (4)	-0.4603 (2)	-0.10821 (15)	0.0957 (9)
O7	-0.5722 (4)	-0.57770 (15)	-0.04254 (12)	0.0729 (7)
O8	-0.7407 (4)	-0.59780 (17)	0.05611 (13)	0.0857 (8)
O9	-0.2672 (4)	-0.62575 (15)	-0.12723 (11)	0.0738 (7)
O10	-0.2239 (5)	-0.6686 (2)	-0.23468 (15)	0.1215 (12)
C1	-0.5591 (7)	-0.4835 (3)	0.17671 (19)	0.0767 (11)
C2	-0.6884 (7)	-0.4384 (3)	0.22700 (18)	0.1032 (15)
H2A	-0.6717	-0.4641	0.2714	0.155*
H2B	-0.8187	-0.4453	0.2128	0.155*
H2C	-0.6574	-0.3770	0.2289	0.155*
C3	-0.4973 (5)	-0.4916 (2)	0.05674 (16)	0.0597 (9)
H3A	-0.4081	-0.5364	0.0733	0.072*
C4	-0.3908 (5)	-0.4247 (2)	0.01340 (16)	0.0591 (9)
H4A	-0.4734	-0.3744	0.0034	0.071*
C5	-0.1930 (7)	-0.3094 (3)	0.06182 (19)	0.0737 (11)
C6	-0.0292 (7)	-0.2960 (3)	0.1081 (2)	0.0915 (14)
H6A	-0.0080	-0.2342	0.1143	0.137*
H6B	0.0827	-0.3224	0.0885	0.137*
H6C	-0.0558	-0.3228	0.1514	0.137*
C7	-0.3248 (5)	-0.4675 (2)	-0.05259 (15)	0.0560 (9)

H7A	-0.2198	-0.5082	-0.0429	0.067*
C8	-0.0781 (6)	-0.4022 (3)	-0.12245 (17)	0.0685 (10)
C9	-0.0396 (7)	-0.3275 (3)	-0.16879 (19)	0.0945 (14)
H9A	0.0885	-0.3317	-0.1859	0.142*
H9B	-0.0545	-0.2733	-0.1443	0.142*
H9C	-0.1277	-0.3290	-0.2063	0.142*
C10	-0.4873 (5)	-0.5170 (2)	-0.08911 (17)	0.0639 (10)
H10A	-0.5840	-0.4746	-0.1040	0.077*
C11	-0.6544 (6)	-0.5349 (3)	0.01541 (18)	0.0699 (10)
H11A	-0.7481	-0.4910	0.0007	0.084*
C12	-0.9385 (8)	-0.6126 (4)	0.0406 (3)	0.135 (2)
H12A	-1.0041	-0.5565	0.0400	0.162*
H12B	-0.9480	-0.6377	-0.0048	0.162*
C13	-1.0301 (9)	-0.6678 (5)	0.0862 (4)	0.162 (3)
H13A	-0.9848	-0.7270	0.0775	0.195*
H13B	-1.1649	-0.6670	0.0750	0.195*
C14	-1.0134 (8)	-0.6520 (4)	0.1606 (3)	0.163 (3)
H14A	-1.0800	-0.6974	0.1849	0.245*
H14B	-1.0682	-0.5960	0.1716	0.245*
H14C	-0.8812	-0.6525	0.1735	0.245*
C15	-0.4194 (6)	-0.5683 (3)	-0.14971 (17)	0.0765 (11)
H15A	-0.5234	-0.6027	-0.1686	0.092*
H15B	-0.3731	-0.5288	-0.1848	0.092*
C16	-0.1777 (7)	-0.6732 (3)	-0.1757 (2)	0.0798 (12)
C17	-0.0204 (7)	-0.7261 (3)	-0.1465 (2)	0.0987 (15)
H17A	0.0397	-0.7594	-0.1822	0.148*
H17B	-0.0704	-0.7654	-0.1126	0.148*
H17C	0.0718	-0.6877	-0.1258	0.148*

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1	0.0767 (17)	0.0846 (17)	0.0556 (14)	0.0178 (15)	0.0109 (13)	0.0092 (12)
O2	0.130 (3)	0.124 (3)	0.0759 (18)	0.050 (3)	0.0144 (18)	0.0268 (17)
O3	0.0678 (16)	0.0658 (15)	0.0638 (14)	0.0028 (14)	-0.0051 (13)	0.0010 (12)
O4	0.149 (3)	0.0707 (18)	0.110 (2)	0.010 (2)	-0.029 (2)	-0.0002 (18)
O5	0.0688 (17)	0.0688 (16)	0.0631 (14)	0.0136 (14)	0.0140 (13)	0.0154 (12)
O6	0.0701 (19)	0.115 (2)	0.102 (2)	0.0170 (19)	0.0162 (16)	0.0149 (18)
O7	0.0765 (17)	0.0740 (16)	0.0683 (15)	-0.0015 (15)	0.0013 (14)	-0.0006 (13)
O8	0.0682 (18)	0.101 (2)	0.0875 (18)	-0.0126 (16)	-0.0038 (15)	0.0267 (16)
O9	0.0829 (19)	0.0780 (16)	0.0605 (14)	0.0182 (15)	-0.0064 (14)	-0.0084 (13)
O10	0.137 (3)	0.159 (3)	0.0689 (18)	0.028 (3)	-0.001 (2)	-0.029 (2)
C1	0.076 (3)	0.096 (3)	0.058 (2)	0.013 (3)	0.006 (2)	0.011 (2)
C2	0.114 (4)	0.135 (4)	0.061 (2)	0.024 (4)	0.019 (3)	0.004 (2)
C3	0.057 (2)	0.066 (2)	0.0557 (19)	0.0087 (18)	0.0038 (19)	0.0036 (18)
C4	0.059 (2)	0.061 (2)	0.058 (2)	0.0083 (19)	0.0021 (18)	0.0073 (17)
C5	0.091 (3)	0.068 (3)	0.062 (2)	-0.003 (2)	0.009 (2)	0.005 (2)
C6	0.101 (4)	0.096 (3)	0.078 (3)	-0.021 (3)	-0.007 (3)	-0.001 (2)

C7	0.060 (2)	0.057 (2)	0.0511 (18)	0.0119 (18)	0.0043 (18)	0.0055 (17)
C8	0.067 (3)	0.084 (3)	0.054 (2)	0.001 (3)	0.005 (2)	-0.001 (2)
C9	0.107 (4)	0.103 (3)	0.073 (2)	-0.023 (3)	0.015 (3)	0.013 (2)
C10	0.063 (2)	0.073 (2)	0.0561 (19)	0.015 (2)	-0.0013 (19)	0.0080 (19)
C11	0.063 (2)	0.078 (3)	0.069 (2)	0.002 (2)	0.002 (2)	0.016 (2)
C12	0.094 (4)	0.177 (6)	0.134 (4)	-0.059 (4)	-0.025 (4)	0.040 (4)
C13	0.084 (4)	0.224 (7)	0.179 (6)	-0.038 (5)	-0.009 (4)	0.065 (6)
C14	0.100 (5)	0.213 (7)	0.176 (6)	0.017 (5)	0.048 (5)	0.083 (6)
C15	0.084 (3)	0.087 (3)	0.059 (2)	0.011 (3)	-0.011 (2)	-0.0033 (19)
C16	0.086 (3)	0.087 (3)	0.067 (3)	-0.002 (3)	0.006 (2)	-0.013 (2)
C17	0.105 (4)	0.094 (3)	0.097 (3)	0.024 (3)	0.004 (3)	-0.015 (3)

Geometric parameters (Å, °)

O1—C1	1.362 (4)	C6—H6B	0.9600
O1—C3	1.439 (4)	C6—H6C	0.9600
O2—C1	1.184 (5)	C7—C10	1.540 (5)
O3—C5	1.364 (4)	C7—H7A	0.9800
O3—C4	1.438 (4)	C8—C9	1.479 (5)
O4—C5	1.200 (5)	C9—H9A	0.9600
O5—C8	1.357 (5)	C9—H9B	0.9600
O5—C7	1.447 (3)	C9—H9C	0.9600
O6—C8	1.199 (4)	C10—C15	1.498 (5)
O7—C10	1.428 (4)	C10—H10A	0.9800
O7—C11	1.429 (4)	C11—H11A	0.9800
O8—C11	1.384 (4)	C12—C13	1.384 (7)
O8—C12	1.437 (5)	C12—H12A	0.9700
O9—C16	1.347 (4)	C12—H12B	0.9700
O9—C15	1.447 (4)	C13—C14	1.480 (7)
O10—C16	1.202 (4)	C13—H13A	0.9700
C1—C2	1.503 (6)	C13—H13B	0.9700
C2—H2A	0.9600	C14—H14A	0.9600
C2—H2B	0.9600	C14—H14B	0.9600
C2—H2C	0.9600	C14—H14C	0.9600
C3—C11	1.517 (5)	C15—H15A	0.9700
C3—C4	1.521 (5)	C15—H15B	0.9700
C3—H3A	0.9800	C16—C17	1.479 (6)
C4—C7	1.519 (4)	C17—H17A	0.9600
C4—H4A	0.9800	C17—H17B	0.9600
C5—C6	1.476 (6)	C17—H17C	0.9600
C6—H6A	0.9600		
C1—O1—C3	117.3 (3)	C8—C9—H9C	109.5
C5—O3—C4	120.2 (3)	H9A—C9—H9C	109.5
C8—O5—C7	119.2 (3)	H9B—C9—H9C	109.5
C10—O7—C11	112.3 (3)	O7—C10—C15	107.5 (3)
C11—O8—C12	114.1 (3)	O7—C10—C7	109.1 (3)
C16—O9—C15	116.9 (3)	C15—C10—C7	112.8 (3)

O2—C1—O1	123.8 (4)	O7—C10—H10A	109.1
O2—C1—C2	126.7 (4)	C15—C10—H10A	109.1
O1—C1—C2	109.5 (4)	C7—C10—H10A	109.1
C1—C2—H2A	109.5	O8—C11—O7	108.6 (3)
C1—C2—H2B	109.5	O8—C11—C3	108.1 (3)
H2A—C2—H2B	109.5	O7—C11—C3	109.2 (3)
C1—C2—H2C	109.5	O8—C11—H11A	110.3
H2A—C2—H2C	109.5	O7—C11—H11A	110.3
H2B—C2—H2C	109.5	C3—C11—H11A	110.3
O1—C3—C11	108.7 (3)	C13—C12—O8	114.0 (5)
O1—C3—C4	108.6 (3)	C13—C12—H12A	108.8
C11—C3—C4	110.4 (3)	O8—C12—H12A	108.8
O1—C3—H3A	109.7	C13—C12—H12B	108.8
C11—C3—H3A	109.7	O8—C12—H12B	108.8
C4—C3—H3A	109.7	H12A—C12—H12B	107.7
O3—C4—C7	109.2 (3)	C12—C13—C14	120.0 (6)
O3—C4—C3	107.3 (3)	C12—C13—H13A	107.3
C7—C4—C3	109.7 (3)	C14—C13—H13A	107.3
O3—C4—H4A	110.2	C12—C13—H13B	107.3
C7—C4—H4A	110.2	C14—C13—H13B	107.3
C3—C4—H4A	110.2	H13A—C13—H13B	106.9
O4—C5—O3	122.1 (4)	C13—C14—H14A	109.5
O4—C5—C6	126.9 (4)	C13—C14—H14B	109.5
O3—C5—C6	110.9 (4)	H14A—C14—H14B	109.5
C5—C6—H6A	109.5	C13—C14—H14C	109.5
C5—C6—H6B	109.5	H14A—C14—H14C	109.5
H6A—C6—H6B	109.5	H14B—C14—H14C	109.5
C5—C6—H6C	109.5	O9—C15—C10	107.9 (3)
H6A—C6—H6C	109.5	O9—C15—H15A	110.1
H6B—C6—H6C	109.5	C10—C15—H15A	110.1
O5—C7—C4	108.1 (2)	O9—C15—H15B	110.1
O5—C7—C10	107.5 (2)	C10—C15—H15B	110.1
C4—C7—C10	112.3 (3)	H15A—C15—H15B	108.4
O5—C7—H7A	109.6	O10—C16—O9	121.3 (4)
C4—C7—H7A	109.6	O10—C16—C17	127.1 (4)
C10—C7—H7A	109.6	O9—C16—C17	111.5 (3)
O6—C8—O5	122.5 (3)	C16—C17—H17A	109.5
O6—C8—C9	126.4 (4)	C16—C17—H17B	109.5
O5—C8—C9	111.0 (4)	H17A—C17—H17B	109.5
C8—C9—H9A	109.5	C16—C17—H17C	109.5
C8—C9—H9B	109.5	H17A—C17—H17C	109.5
H9A—C9—H9B	109.5	H17B—C17—H17C	109.5
