

The Structure of Ethyl 5,6,7,8,9-Pentaacetoxy-2-butylamino-4-nitromethyl-D-glycero-L-gluco-2-nonene-3-carboxylate

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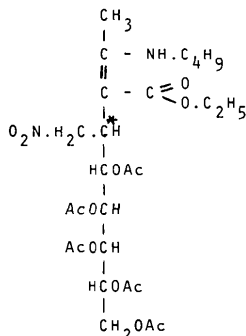
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Abstract

$C_{27}H_{42}N_2O_{14}$ is orthorhombic, space group $P2_12_12_1$, with $a = 11.147$ (1), $b = 37.350$ (2), $c = 7.705$ (1) Å, $V = 3207.9$ Å³, $Z = 4$, $D_c = 1.28$, $D_o = 1.29$ Mg m⁻³, $F(000) = 1420$, $\mu = 0.094$ mm⁻¹. The final $R = 0.069$ for 2135 observed reflections. The configuration around the chiral centres C(8), C(7), C(6), C(5) and C(4) of the sugar chain is *RSSRS*, that is D-glycero-L-gluco. The molecule has an intramolecular hydrogen bond between the N and O atoms of the butylamino and carbonyl groups respectively, showing a chelated structure. The packing of the molecules is governed by normal van der Waals contacts.

Introduction

The title compound was an intermediate in a synthesis of (3-pentaacetoxypropyl)pyrrole, a substance which has aroused interest as a precursor of C-glycosylpyrroles. It was obtained by a Michael-type addition of 3-(butylamino)crotonic ester to D-galacto-pentaacetoxy-1-nitroheptene (Gómez-Sánchez, Mancera, Rosado & Bellanato, 1980). In the assigned structure:



a new chiral centre is found (marked with an asterisk) and two diastereoisomers could result; however, only one product was isolated, and detected chromatographically. The configuration of this derivative could not be established from chemical and spectroscopic considerations. An X-ray analysis was undertaken to clarify

the problem and to determine conformational details of the molecule.

Experimental

Crystals were in the form of colourless prisms. Preliminary cell dimensions and space-group information were obtained from oscillation and Weissenberg photographs taken with Mo $K\alpha$ radiation. Accurate cell dimensions were obtained by least squares from the θ values of 50 reflections measured on a Philips PW1100 automated four-circle diffractometer. Intensities were collected with graphite-monochromated Mo $K\alpha$ radiation and the ω - 2θ step scanning mode. Intensities were collected over the range $2 < \theta < 30^\circ$ to give 4997 independent reflections of which 2862 were considered as observed [$I > 2\sigma(I)$].

Structure determination

The structure was solved with *MULTAN* (Main, Lessinger, Woolfson, Germain & Declercq, 1977). 330 reflections with $|E| > 1.50$ (approximately seven reflections for each non-hydrogen atom in the asymmetric unit) were used and a choice of phasing was possible based on FOM's; the highest combined figure of merit derived with unit weights for the components was 2.0. An *E* map computed with this phase set had distinguishable peaks for 40 of the 43 non-hydrogen atoms. The remaining atoms were located from a Fourier synthesis.

The structure was refined by full-matrix least squares. Scattering factors were taken from *International Tables for X-ray Crystallography* (1974). Refinement of the non-hydrogen atoms with isotropic temperature factors and unit weights gave $R = 0.12$. With anisotropic temperature factors and the weighting scheme $w = 1/\sigma^2(F)$, R was reduced to 0.071. The positions of the H atoms were calculated. A difference synthesis revealed most of the H atoms near their calculated positions. Further refinement with non-

hydrogen atoms treated anisotropically and H atoms isotropically produced convergence with $R = 0.069$.

In the last cycle the H atoms were kept fixed with isotropic temperature factors equal to 4.0 \AA^2 . The positional and isotropic thermal parameters for the non-hydrogen atoms are given in Table 1, those for the H atoms in Table 2.*

As can be seen from Table 1, the temperature factors for C(24), C(33), O(41) and O(42) atoms are higher than normal, possibly due to their location at the end of the chain.

* Lists of structure factors and anisotropic thermal parameters have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 35905 (23 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

Table 1. Atomic coordinates ($\times 10^4$) and isotropic temperature factors for non-hydrogen atoms

	x	y	z	B (\AA^2)
C(1)	2770 (7)	8113 (2)	4005 (11)	5.4
C(2)	3835 (6)	8124 (2)	2844 (9)	3.8
C(3)	4958 (6)	8270 (2)	3347 (9)	3.6
C(4)	5121 (6)	8416 (2)	5190 (8)	3.5
C(5)	5663 (6)	8793 (2)	5236 (8)	3.1
C(6)	4963 (5)	9069 (2)	4177 (8)	3.3
C(7)	5381 (6)	9449 (2)	4576 (9)	3.5
C(8)	4689 (6)	9753 (2)	3691 (8)	3.6
C(9)	5267 (8)	10102 (2)	4131 (10)	4.7
N(21)	3687 (6)	7988 (2)	1245 (8)	4.8
C(21)	2629 (7)	7791 (2)	0616 (12)	5.3
C(22)	1818 (7)	8024 (2)	-0499 (11)	5.2
C(23)	0756 (9)	7805 (3)	-1203 (14)	7.6
C(24)	-0086 (10)	8012 (3)	-2342 (15)	8.1
O(31)	7005 (4)	8338 (1)	2936 (6)	4.5
O(32)	5936 (4)	8140 (1)	0674 (6)	5.0
C(31)	5941 (6)	8234 (2)	2201 (10)	3.8
C(32)	8097 (7)	8277 (3)	1945 (13)	7.1
C(33)	9086 (8)	8396 (4)	2936 (16)	9.8
O(41)	4393 (7)	7779 (2)	7167 (11)	8.1
O(42)	5893 (8)	7561 (2)	5776 (11)	9.7
N(41)	5363 (8)	7801 (2)	6427 (10)	5.9
C(41)	5920 (7)	8169 (2)	6330 (10)	4.2
O(51)	5667 (4)	8912 (1)	7058 (5)	3.4
O(52)	7659 (4)	8839 (2)	7194 (7)	5.9
C(51)	6756 (6)	8934 (2)	7862 (10)	4.5
C(52)	6624 (8)	9071 (2)	9669 (10)	5.5
O(61)	3695 (4)	9060 (1)	4608 (6)	3.8
O(62)	3225 (5)	8962 (2)	1780 (7)	5.6
C(61)	2917 (6)	9021 (2)	3213 (11)	4.9
C(62)	1643 (7)	9084 (3)	3853 (15)	8.1
O(71)	6627 (4)	9456 (1)	4016 (6)	3.5
O(72)	7176 (5)	9718 (2)	6551 (8)	6.1
C(71)	7443 (6)	9589 (2)	5172 (11)	4.6
C(72)	8684 (7)	9550 (3)	4456 (13)	6.9
O(81)	4745 (4)	9699 (1)	1818 (5)	3.5
O(82)	2761 (5)	9811 (2)	1535 (8)	6.2
C(81)	3701 (6)	9735 (2)	0892 (10)	4.1
C(82)	3921 (8)	9673 (2)	-0994 (10)	5.4
O(91)	4520 (5)	10388 (1)	3468 (6)	5.0
O(91)	5284 (6)	10746 (2)	5485 (9)	7.3
C(91)	4625 (9)	10700 (2)	4268 (12)	5.9
C(92)	3846 (12)	10986 (2)	3516 (14)	7.8

Table 2. Fractional atomic coordinates ($\times 10^3$) for H atoms

	x	y	z	x	y	z	
H1(C1)	204	828	337	H2(C32)	808	840	063
H2(C1)	243	785	413	H1(C33)	901	868	327
H3(C1)	284	823	530	H2(C33)	914	825	419
H(C4)	426	841	589	H3(C33)	991	835	223
H(C5)	658	875	473	H1(C41)	610	828	760
H(C6)	513	899	281	H2(C41)	684	816	583
H(C7)	527	951	595	H1(C52)	622	933	963
H(C8)	376	974	418	H2(C52)	603	889	1041
H1(C9)	620	1012	361	H3(C52)	747	909	1034
H2(C9)	550	1013	550	H1(C62)	141	888	486
H(N21)	441	803	031	H2(C62)	155	935	441
H1(C21)	288	754	-008	H3(C62)	100	905	281
H2(C21)	213	767	166	H1(C72)	891	927	417
H1(C22)	153	826	018	H2(C72)	877	970	322
H2(C22)	232	815	-155	H3(C72)	937	965	533
H1(C23)	028	767	-012	H1(C82)	459	986	-147
H2(C23)	106	756	-188	H2(C82)	428	940	-120
H1(C24)	-046	825	-155	H3(C82)	312	970	-177
H2(C24)	037	813	-342	H1(C92)	403	1102	217
H3(C24)	-086	787	-279	H2(C92)	289	1089	363
H1(C32)	821	799	149	H3(C92)	386	1124	416

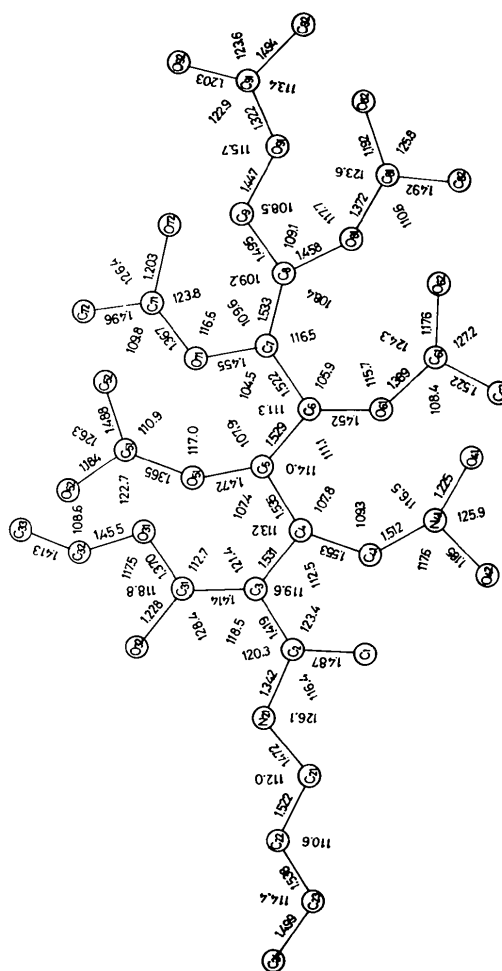


Fig. 1. Bond lengths (\AA) and angles ($^\circ$).

Results and discussion

The molecule consists of five acetoxy, a butylamino, an ethoxycarbonyl, and a nitromethyl group attached to a main nonene chain. Bond distances and angles not involving H atoms are shown in Fig. 1. The average e.s.d.'s in these bond lengths and angles are 0.009 Å (maximum 0.015 Å) and 0.6° (maximum 0.9°) respectively. Bond lengths and angles are quite close to those found in other compounds (Vloom, Hottentot, Overbeek & Stam, 1979). The only significant differences are in angles which are more responsive to differences in packing and conformation.

The main chain has an approximately planar zigzag part comprising C(4), C(5), C(6), C(7), C(8) and C(9) with deviations < 0.12 Å from their best plane and a second one, approximately planar too, involving C(1), C(2), C(3) and C(4) with a largest deviation of 0.009 Å. The two chain sections are joined by C(3)–C(4) (torsion angle 129.9°). The five acetoxy groups are planes with deviations < 0.016 Å. The butyl chain is planar and the N atom attached to it is at 0.07 Å. The nitromethyl group is also planar, maximum deviation from the best plane 0.002 Å. The ethoxycarbonyl group is not planar.

The acetoxy groups are markedly twisted out from the chain and the torsion angles are: C(9)–C(8)–O(81)–C(81) = –107.0 (7), C(8)–C(7)–O(71)–C(71) = 104.1 (6), C(7)–C(6)–O(61)–C(61) = 112.2 (6), C(6)–C(5)–O(51)–C(51) = –127.4 (6) and C(8)–C(9)–O(91)–C(91) = 155.1 (6)°. The butylamino, ethoxycarbonyl and nitromethyl groups are slightly twisted from the chain; the torsion angles are: C(3)–C(2)–N(21)–C(21) = 172.3 (6), C(4)–C(3)–C(31)–O(31) = 1.0 (9), C(4)–C(3)–C(31)–O(32) = –175.9 (7) and C(5)–C(4)–C(41)–N(41) = 175.8 (6)°. On the other hand, the torsion angle C(1)–C(2)–C(3)–C(4) = 2.0 (9)°.

The configuration around the chiral centres of the main chain can be deduced from Newman projections (Fig. 2). In the projection along C(2)=C(3), C(1) and N(21) are nearly eclipsed by C(4) and C(31) with C(4) synperiplanar to C(1) and C(4), antiperiplanar to N(21). With respect to C(3)–C(4), C(2) is eclipsed by HC(4) with C(5) synclinal to C(31) and C(5) anticlinal to C(2). These peculiarities are attributed to the double bond C(2)=C(3) which necessarily restricts the side-chain conformation. In the C(4)–C(5) bond, C(6) and C(3) assume synclinal conformations and C(6) is antiperiplanar to C(41). The conformation about C(5)–C(6) is such that for the two acetoxy groups O(51) and O(61) are in synclinal orientation and C(7), C(4) antiperiplanar. A similar situation is found around C(7)–C(8), with O(71) synclinal to O(81) and C(9) antiperiplanar to C(6). Also the conformation viewed down C(7)–C(6) has O(61) antiperiplanar to O(71) and C(5) antiperiplanar to C(8). In the last

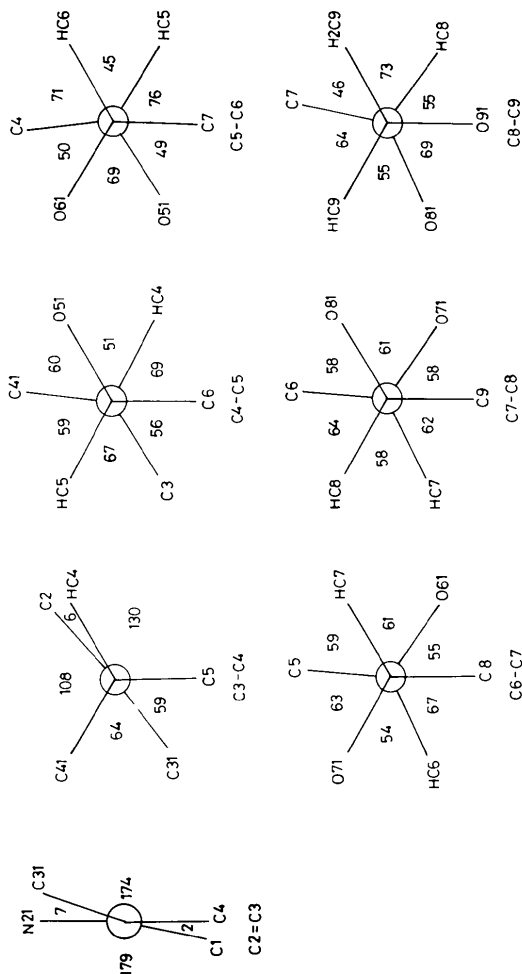


Fig. 2. Some Newman projections.

conformational situation observed C(7) adopts an antiperiplanar orientation to O(91), and O(81) is synclinal to O(91). Thus the configuration around the chiral centres C(8), C(7), C(6), C(5) and C(4) of the sugar chain is *RSSRS* in accord with the *D-glycero-L-gluco* distribution.

The structure viewed down *c* is given in Fig. 3. The molecule has an intramolecular hydrogen bond between the N and O atoms of the butylamino and carbonyl groups respectively: N(21)···O(32) = 2.607, N(21)–HN(21) = 1.094, HN(21)···O(32) = 1.768 Å, HN(21)–O(32)–N(21) = 31°. This confirms the chelated structure previously observed by IR spectroscopy (Gómez-Sánchez *et al.*, 1980). The packing of the molecules is governed by normal van der Waals contacts.

All calculations were carried out on a DCT 2000 terminal of the Centro de Calculo of this University, connected to a Univac 1108 computer, with XRAY (1970).

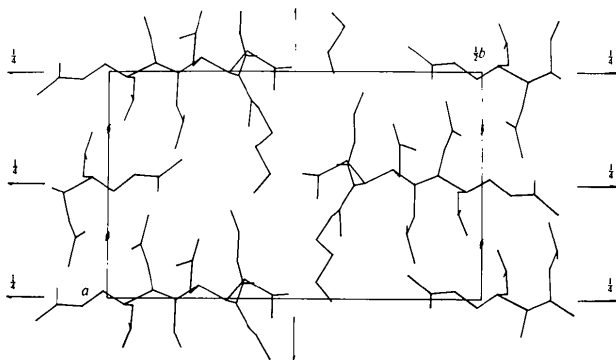


Fig. 3. The crystal structure.

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The Structure of the Antibiotic Amicetin Consisting of Nucleobase, Disaccharide and Amino Acid Moieties

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Abstract

Amicetin ($C_{29}H_{42}N_6O_9$), 1-[4-*O*-(4,6-dideoxy-4-dimethylamino- α -D-glucopyranosyl)-2,3,6-trideoxy- β -D-erythro-hexopyranosyl]-*N*⁴-[4-(2-methyl-L-serylamino)-benzoyl]cytosine, is one of a group of cytosine nucleoside antibiotics which inhibit peptide bond formation during protein biosynthesis. It contains a nucleobase, a disaccharide and an amino acid moiety. The compound crystallizes in the orthorhombic space group $P2_12_12_1$ with $a = 25.793$ (5), $b = 11.897$ (2), $c = 10.185$ (2) Å, $Z = 4$; $D_m = 1.293$, $D_c = 1.315$ Mg m⁻³ and $V_c = 3125.4$ (1.7) Å³. The crystal structure was solved by direct methods and refined to an R value of 0.06. The molecule is in a highly extended conformation with an end-to-end

distance of 25 Å. The terminal hydroxyl group O(17)–H of the α -methyl-L-serine moiety exhibits a twofold conformational disorder (occupancy factors of 0.62 and 0.38) and both hydroxyl positions participate in intermolecular hydrogen bonds. Concomitant with this disorder, the C(17) atom attached to the hydroxyl group also appears to be disordered. The cytosine base is in the *anti* conformation [$\chi = 25.7$ (5)°] with respect to the trideoxyglucose ring. The amide group C(4)–N(4)–C(7)–O(7) is markedly distorted from planarity [$\omega = -159.2$ (7)°]. The disaccharide component possesses a C(1) axial–C(4) equatorial bridge, with the *trans* conformation for the bridge torsions C(2*)–C(1*)–O(1*)–C(4') [–163.8 (5)°] and C(1*)–O(1*)–C(4')–C(5') [–162.8 (5)°], and a *+gauche* conformation for the bridge torsions O(5*)–C(1*)–O(1*)–C(4') [72.6 (5)°] and C(1*)–O(1*)–C(4')–C(3') [76.4 (5)°]. An unusual feature of the crystal structure is that only four of the eight available protons take part

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