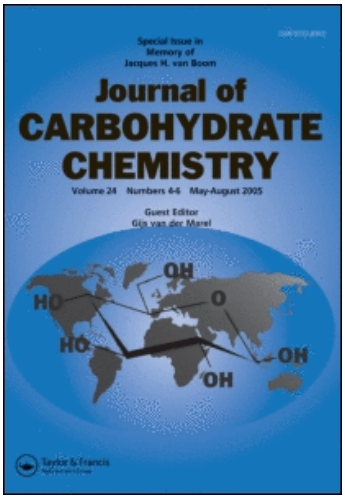


Journal of Carbohydrate Chemistry

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713617200

Synthesis of Push-Pull Derivatives of Levoglucosenone as Precursors of Annellated Pyranosides

Mario Gómez; José Quincoces; Björn Kuhla; Klaus Peseke; Helmut Reinke

To cite this Article Gómez, Mario , Quincoces, José , Kuhla, Björn , Peseke, Klaus and Reinke, Helmut(1999) 'Synthesis of Push-Pull Derivatives of Levoglucosenone as Precursors of Annellated Pyranosides', Journal of Carbohydrate Chemistry, 18: 1, 57 — 68

To link to this Article: DOI: 10.1080/07328309908543979

URL: http://dx.doi.org/10.1080/07328309908543979

J. CARBOHYDRATE CHEMISTRY, 18(1), 57-68 (1999)

SYNTHESIS OF PUSH-PULL DERIVATIVES OF LEVOGLUCOSENONE AS PRECURSORS OF ANNELLATED PYRANOSIDES

Mario Gómez,[a,c] José Quincoces,[a,b] Björn Kuhla,[c] Klaus Peseke*[c] and Helmut Reinke[c]

[a]Centro de Bioactivos Químicos, Universidad Central de Las Villas, Carretera a Camajuaní, km 5.5. Santa Clara, Cuba

[b]Universidade Bandeirante de São Paulo, Brazil

[c]Fachbereich Chemie, Universität Rostock, D-18051 Rostock, Germany

Received April 14, 1998 - Final Form September 22, 1998

ABSTRACT

1,6-Anhydro-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**2**) reacted with carbon disulphide and iodomethane to furnish 1,6-anhydro-3-[bis(methylthio)methylene]-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**3**). Treatment of **2** with dimethylformamide dimethyl acetal yielded 1,6-anhydro-3-deoxy-3-(dimethylaminomethylene)-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**4**). The reactions of **3** with malononitrile and hydrazine hydrate furnished 1,6-anhydro-3-[bis-(methylthio)methylene]-2-(dicyanomethylene)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranose (**7**) and (1*R*,7*R*,8*R*)-2,3,5,6(2,4,5,6)-tetradehydro-7-ethylthio-5-methylthio-3,4-diaza-10,11-dioxatricyclo[6.2.1.$0^{2,6}$]undecane (**8a,b**), respectively.

INTRODUCTION

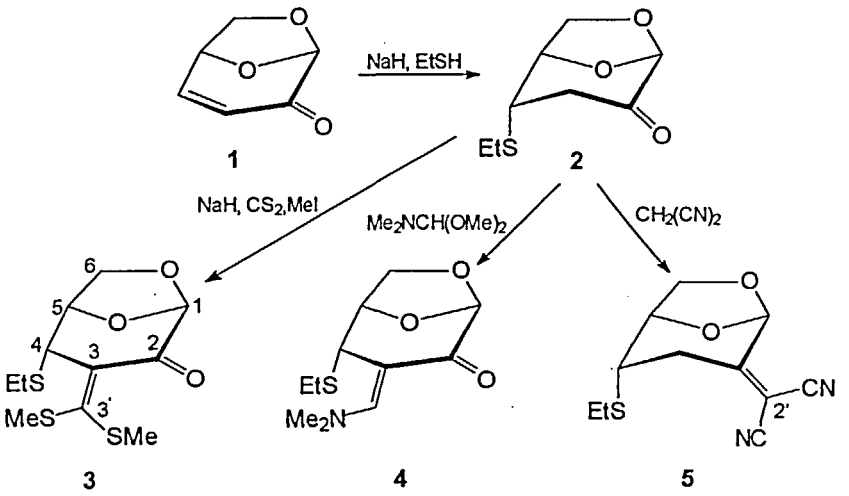
1,6-Anhydro-3,4-dideoxy-β-D-*glycero*-hex-3-enopyranos-2-ulose (levoglucosenone, **1**) is an α,β-unsaturated bicyclic ketone that can be obtained from pyrolysis of cellulose.[1-3] In recent years, this compound and its respective derivatives have attracted great interest as chiral precursors for the synthesis of both carbohydrate and non-carbohydrate derivatives.[4-8] The synthetic utility of levoglucosenone derives from the high stereoselectivity of its 1,4-Michael addition reactions,[9,10] which should allow the preparation of branched chain monosaccharides found in antibiotics,[11] and fused ring pyranose structures relevant to kalafungin.[12]

In recent years we have reported the preparation of several monosaccharides with push-pull functionality[13-16] by reaction of carbanions generated from sugar uloses with carbon disulphide, iminium salts, etc. These compounds can be used in annellation reactions or may serve as precursors for the synthesis of C-nucleoside analogues as well as monosaccharides bearing an amino group in the side chain.

As reported for other thiols by Essig,[9] the reaction of 1,6-anhydro-3,4-dideoxy-β-D-*glycero*-hex-3-enopyranos-2-ulose (**1**) with ethanethiol gave the 1,6-anhydro-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**2**) in good yields. This compound was used as a starting material for the synthesis of several push-pull derivatives. We have also explored the ability of these compounds to form pyrazole annellated pyranosides.

RESULTS AND DISCUSSION

As it is known, α-oxoketene dithioacetals can be obtained by reaction of cyclic or acyclic ketones with carbon disulphide in the presence of a base and an alkylating agent.[17,18] In earlier works we investigated the preparation of such classes of compounds containing an integrated monosaccharide unit.[14] In order to prepare the corresponding sodium salt of the 1,6-anhydro-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**2**) we used sodium hydride in tetrahydrofuran as solvent. When carbon disulphide and iodomethane were added, the 1,6-anhydro-3-[bis(methylthio)methylene]-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**3**) could be isolated in 65% yield.



Scheme 1

The ^{13}C spectrum of compound **3** showed an upfield shift for the C-3 signal (129.5 ppm) whereas the C-3' signal was shifted downfield (160.0 ppm) which is typical for push-pull alkenes.[19,20] The signals from the methylthio groups appeared in the regions of 2.40-2.45 ppm and 18-20 ppm in ^{1}H and ^{13}C NMR spectra, respectively.

Bredereck and co-workers reported the reaction of acidic methylene compounds with acetals of amides.[21] Similarly, compound **2** reacted with *N,N*-dimethylformamide dimethyl acetal in boiling toluene or tetrahydrofuran to furnish the branched chain anhydroulose **4** (Scheme 1).

The signals from the carbon atoms C-3 (128.1 ppm) and C-3' (158.1 ppm) were shifted upfield and downfield, respectively. This behaviour indicated the push-pull character of the exocyclic double bond. NOE experiments showed that compound **4** had a *Z*-configuration in chloroform solution.

We reported that arylalkylidenemalonitrile as well as cyclohexylidene-malononitrile react with carbon disulphide and alkylating agents to yield butadienes with push-pull functionality.[22,23] These compounds could be used as precursors for the synthesis of several heterocycles.[24,25] Currently, only two push-pull butadienes with a sugar moiety are known. These were obtained by reaction of 4,6-*O*-benzylidene-2-(dicyanomethylene)-2,3-dideoxy-α-D-*erythro*-hexopyranoside with thiazinium and

thiazolinium salts.[16] However, no example of a push-pull butadiene with a bis(alkylthio)methylene group that integrates the pyranose ring of a monosaccharide is known.

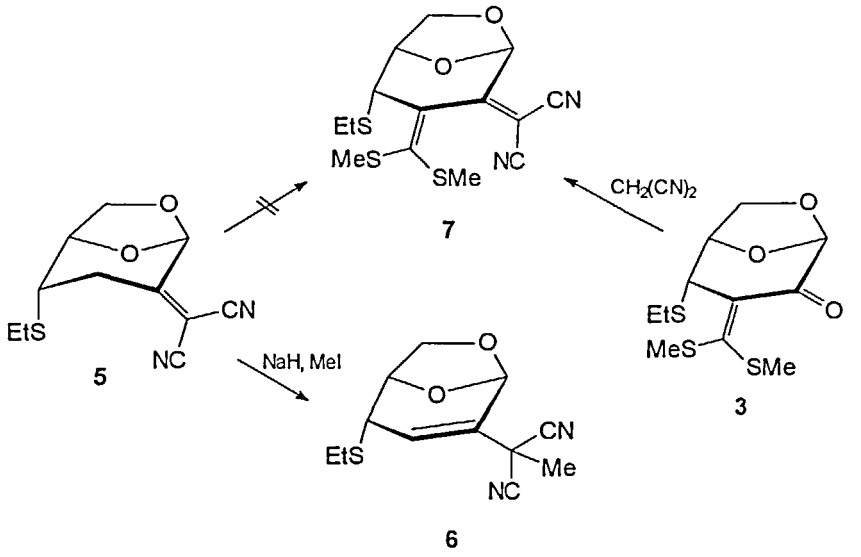
In order to obtain such a sugar push-pull butadiene with good leaving groups 1,6-anhydro-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**2**) was reacted with malononitrile in dichloromethane using aluminium oxide as catalyst. The expected 1,6-anhydro-2-(dicyanomethylene)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranose (**5**) was obtained in 62% yield. The NMR, IR and mass spectra are in agreement with the proposed structure.

Following our efforts to prepare a push-pull butadiene compound, **5** was reacted with carbon disulphide, iodomethane and sodium hydride. However, instead of the expected push-pull butadiene **7**, only the 1,6-anhydro-2-(1,1-dicyanoethyl)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hex-2-enopyranose (**6**) was isolated.

The mass spectrum of **6** contained a signal for M^+ at *m/z* 252. The ^{13}C NMR spectrum showed a signal at 25.9 which was in agreement with a methyl group attached to a carbon atom bearing two electron-withdrawing cyano groups. Two signals at 125.3 (C-3) and 132.3 (C-2) corresponded to a double bond without push-pull properties.

On the other hand, the 1,6-anhydro-3-[bis(methylthio)methylene]-2-(dicyanomethylene)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranose (**7**) could be obtained as crystals in 67% yield by the reaction of the branched chain ulose **3** with malononitrile in the presence of aluminium oxide. In the ^{13}C NMR spectrum of compound **7**, signals from the carbon atoms C-2 (167.9), C-3' (149.3), C-3 (131.1), C-2' (84.5) exhibited the alternating upfield and downfield shifts which are typical of push-pull butadienes (Scheme 2).

Furthermore, compound **7** was subjected to X-ray analysis at 293 K. The crystallographic data are given in Table 1. The structure was solved by direct methods with the program XS, version 4.0 for MS-DOS, copyright Siemens Analytical Xray Inst. Inc. and refined with the full-matrix least-squares method of SHELXL93. All non-hydrogen atoms were refined anisotropically (hydrogens introduced into theoretical positions). The weighting scheme was calculated according to $w = 1/[\sigma^2(Fo^2)+(0.0627P)^2 +0.0000P]$, where $P = (Fo^2+2Fc^2)/3$. An ORTEP drawing of **7** is shown in Figure 1,



Scheme 2

which displays the numbering scheme of the atoms. From a crystallographic point of view it is of interest that the cell is made up of four symmetry independent molecules. While bond lengths and angles are almost identical, there are some differences within the torsional angles.

The crystallographic data were in agreement with the proposed structure of 7. The bis(methylthio)methylene group was out of plane with the torsional angles [θ (C-2, C-3)-(C-10, S-2): between -172 and -174 degrees]. It is known, that in this class of compounds the bond distances of the double bonds participating in the push-pull system are increased, whereas the length of the central single bond is exceptionally reduced. However, in compound 7 this effect is not as strong as expected. The bond distances C2-C7 (~1.35) and C3-C10 (~1.34) are longer than in normal double bonds and the interatomic distance C2-C3 is smaller than for single bonds, but the difference is not exceptionally large. This can be explained by the fact that the four atoms forming the push-pull systems are not located in one plane [θ (C-7, C-2)-(C-3, C-10): between 50 and 57 degrees]. Therefore, the conjugation is decreased and the push-pull character is not as strong as expected.

Table 1. Crystallographic data for 1,6-anhydro-3-[bis(methylthio)methylene]-2-(dicyanomethylene)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranose (7). [a]

Compound	7
Crystal size (mm)	0.68 x 0.3 x 0.08
Space group	P1
Cell parameters (Å, degrees)	
a	8.792 (2)[a]
b	9.373 (2)[a]
c	21.220 (4)[a]
α	98.66
β	98.36
γ	93.28
Volume ($Å^3$)	1704 (6)[a]
Z	4
F(000)	712
Density D_x ($Mg\ m^{-3}$)	1.327
λ (Mo K_α) (Å)	0.71073
μ (cm^{-1})	0.44
2Θ range (degrees)	3.94-44
Measured reflections	7529
Symmetry independent reflections	7527
Observed reflections with $I > 2\ \sigma(I)$	5229
Number of refined parameters	757 (3 restraints)
R1 ($2\sigma(I)$)	0.0565
R1 (all data)	0.0885
wR2 (all data)	0.1505
GooF	0.990
Diffractometer	Siemens P4

a. Standard deviations in parenthesis.

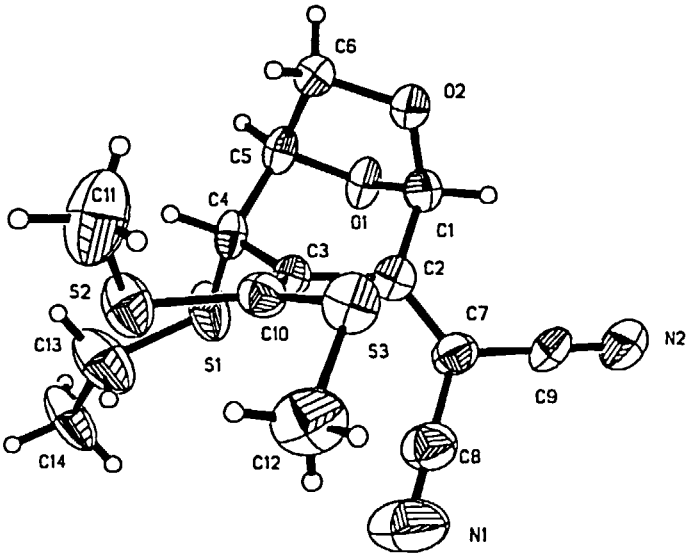
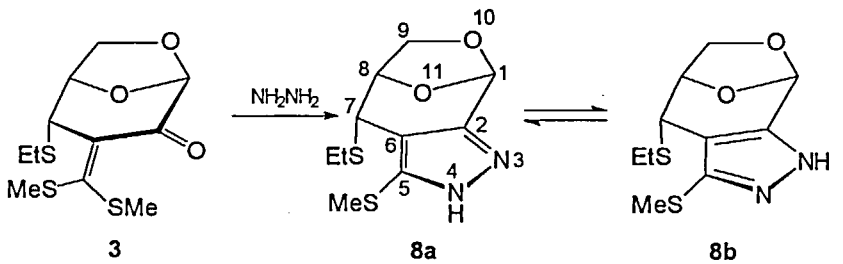


Figure 1 ORTEP drawing of 7



Scheme 3

Finally, in order to prove the versatility of the obtained compounds for the synthesis of heterocycles, we studied the reaction of the 1,6-anhydro-3-[bis(methylthio)-methylene]-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**3**) with hydrazine hydrate in boiling ethanol. The tricyclic compound **8** was obtained in 69% yield. The spectroscopic data confirmed the proposed structure but it was not possible to determine which of the two tautomers had been formed. It is assumed that there is an equilibrium between the two tautomeric forms **8a** and **8b** in solution (Scheme 3). This is typical for pyrazole derivatives.

EXPERIMENTAL

General procedures. Melting points were determined with a BOËTIUS apparatus and are corrected. IR spectra were recorded with a Nicolet 205 FT-IR spectrometer. Specific optical rotations were measured with a Gyromat HP (Dr. Kernchen). ^{1}H NMR (300 MHz) and ^{13}C NMR (75 MHz) spectra were obtained on a Bruker instrument AC 300 with $CDCl_3$ as solvent. ^{1}H and ^{13}C chemical shifts (δ) are given in ppm relative to the chloroform signal. The signals in the ^{13}C spectra were assigned by DEPT and/or ^{1}H, ^{13}C COSY experiments. 2D and NOE experiments were performed by means of a Brucker program AC 300. The mass spectra were recorded on an AMB 402/3 spectrometer AMD (Intectra GmbH). For chromatography Merck Silica gel 60 (230-400 mesh) was used. TLC was performed on silica gel 60 GF_{254} (Merck) with detection by charring with sulphuric acid. Elemental analysis was performed on a Leco CHNS-932 instrument. For compound 7 the tables of atomic coordinates, bond lengths, and bond angles have been deposited with the Cambridge Crystallographic Data Centre. These tables may be obtained on request from the Director, Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK. Data Deposition Forms can be obtained directly from the Center-Tel No. +44-223-336408, Fax No. +44-223-336033, e-mail: DEPOSIT@CCDC.CAM.AC.UK

1,6-Anhydro-3-[bis(methylthio)methylene]-3-deoxy-4-*S*-ethyl-4-thio-β-D-*e*-*rythro*-hexopyranos-2-ulose (3). Sodium hydride (90 mg of a 55%-60% dispersion in oil, ~ 2 mmol), carbon disulphide (0.06 mL, 1 mmol) and methyl iodide (0.2 mL, 3.2 mmol) were added to a stirred solution of 1,6-anhydro-3-deoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (**2**, 188 mg, 1 mmol) in anhydrous THF (15 mL) at 0 °C. The mixture was stirred for 1.5 h, then poured into ice-water (50 mL) and extracted with chloroform (3 x 20 mL). The combined extracts were washed with water (3 x 20 mL), dried (Na_2SO_4) and concentrated to a syrup. The product was chromatographed on a column of silica gel with 8:1 toluene/ethyl acetate to furnish, after recrystallization from ethanol, yellow needles of **3** (190 mg, 65 %): mp 69-71 °C; $[\alpha]^{25}_D$ -184° (*c* 0.5, chloroform); IR (KBr) 1674 (C=O), 1477 (C=C); ^{1}H NMR δ 1.26 (t, 3H, J = 7.2 Hz,

SCH_2CH_3), 2.42 (s, 3H, SCH_3), 2.43 (s, 3H, SCH_3), 2.67 (q, 2H, SCH_2CH_3), 3.50 (dd, 1H, $J_{5\text{-}6e}$ = 1.1 Hz, H-6e), 3.90 (dd, 1H, $J_{6a\text{-}6e}$ = 7.6 Hz, $J_{5\text{-}6a}$ = 5.3 Hz, H-6a), 4.35 (d, 1H, $J_{4\text{-}5}$ = 1.5 Hz, H-4), 4.80 (dd, 1H, H-5), 5.20 (s, 1H, H-1); ^{13}C NMR δ 186.1 (C-2), 160.1 (C-3'), 129.5 (C-3), 101.2 (C-1), 78.3 (C-5), 68.1 (C-6), 51.9 (C-4), 25.9 (SCH_2CH_3), 19.7 (SCH_3), 18.2 (SCH_3), 14.9 (SCH_2CH_3). Mass spectrum: *m/z*(%) 291.8 (5, M^+), 231 (100).

Anal. Calcd for $C_{11}H_{16}O_3S_3$: C, 45.18; H, 5.51; S, 32.89. Found: C, 45.58; H, 5.45; S, 33.11.

1,6-Anhydro-3-deoxy-3-(dimethylaminomethylene)-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranos-2-ulose (4). Dimethylformamide dimethyl acetal (0.13 mL, 1 mmol) was added to a stirred solution of **2** (188 mg, 1 mmol) in anhydrous toluene or THF (15 mL). The mixture was boiled under reflux for 1 h. The solvent was evaporated. Column chromatography of the obtained syrup with 1:2 toluene/ethyl acetate gave, after recrystallization from ethanol, white crystals of **4** (40 mg, 22%): mp 125-127 °C; $[\alpha]^{24}_D$ -60° (*c* 1.0, chloroform); IR (KBr) 1654 (C=O), 1562 (C=C); ^{1}H NMR δ 1.24 (t, 3H, J = 7.6 Hz, SCH_2CH_3), 2.68 (q, 2H, SCH_2CH_3), 3.25 (s, 6H , $N(CH_3)_2$), 3.77 (dd, 1H, $J_{5\text{-}6e}$ = 1.5 Hz, H-6e), 3.78 (d, 1H, $J_{4\text{-}5}$ = 1.5 Hz, H-4, NOE: enhancement of the intensity during irradiation at δ = 7.57), 3.94 (dd, 1H, $J_{6a\text{-}6e}$ = 7.2 Hz, $J_{5\text{-}6a}$ = 5.7 Hz, H-6a), 4.79 (dt, 1H, H-5), 5.19 (s, 1H, H-1), 7.57 (s, 1H, H-3'); ^{13}C NMR δ 186.9 (C-2), 152.1 (C-3'), 128.1 (C-3), 101.7 (C-1), 77.6 (C-5), 67.8 (C-6), 45.8 (C-4), 24.9 (SCH_2CH_3), 14.9 (SCH_2CH_3). Mass spectrum: *m/z*(%) 243.1 (7, M^+), 182.1 (100).

Anal. Calcd for $C_{11}H_{17}NO_3S$: C, 54.30; H, 7.04; N, 5.76; S, 13.18. Found: C, 54.91; H, 7.24; N, 5.49; S, 12.93.

1,6-Anhydro-2-(dicyanomethylene)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranose (5). Malononitrile (66 mg, 1 mmol) and alumina (300 mg, type T, Merck) were added to a stirred solution of **2** (188 mg, 1 mmol) in anhydrous dichloromethane (10 mL). The mixture was stirred for 1 h, filtered and the residue washed with dichloromethane. The solvent was evaporated. The residue was chromatographed on a silica gel column with 8:1 toluene/ethyl acetate to give a yellowish syrup **5** (77 mg, 62%); $[\alpha]^{25}_D$ -171° (*c* 0.5, chloroform); IR (capillary) 2235

(CN), 1616 (C=C); ^{1}H NMR δ 1.27 (t, 3H, J = 7.2 Hz, SCH_2CH_3), 2.62 (dq, 2H, SCH_2CH_3), 2.97 (d, 1H, J_{3a-3e} = 15.4 Hz, H-3e), 3.09-3.16 (m, 2H, H-3a, H-4), 4.00 (d, 2H, J_{6a-6e} = 2.7 Hz, H-6_a, H-6_e), 4.72 (broad s, 1H, H-5), 6.03 (s, 1H, H-1); ^{13}C NMR δ 170.0 (C-2), 110.4 (CN), 109.6 (CN), 101.5 (C-1), 84.7 (C-2'), 77.2 (C-5), 68.9 (C-6), 46.3 (C-4), 32.3 (C-3), 26.2 (SCH_2CH_3), 15.0 (SCH_2CH_3). Mass spectrum: *m/z*(%) 236.0 (85, $M^{+\cdot}$), 117 (100).

Anal. Calcd for $C_{11}H_{12}N_2O_2S$: C, 55.92; H, 5.12; N, 11.86; S, 13.57. Found: C, 55.22; H, 5.35; N, 11.30; S, 13.30.

1,6-Anhydro-2-(1,1-dicyanoethyl)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hex-2-enopyranose (6). Sodium hydride (90 mg of a 55%-60% dispersion in oil, ~ 2 mmol), carbon disulphide (0.06 mL, 1 mmol) and iodomethane(0.2 mL, 3.2 mmol) were added a stirred solution of **5** (236 mg, 1 mmol) in anhydrous THF (15 mL) at 0 °C. The mixture was stirred for 1.5 h, then poured into ice (50 mL) and extracted with chloroform (3 x 20 mL). The combined extracts were washed with water (3 x 20 mL), dried (Na_2SO_4) and concentrated. The resulting syrup chromatographed on a silica gel column with 8:1 toluene/ethyl acetate to give, after recrystallization from ethanol, white crystals of **6** (70 mg, 60%): mp 89-91 °C; $[\alpha]^{24}_D$ +176° (*c* 0.5, chloroform); IR (KBr) 2251 (CN), 1653 (C=C); ^{1}H NMR δ 1.26 (t, 3H, J = 7.2 Hz, SCH_2CH_3), 1.92 (s, 3H, CH_3), 2.68 (q, 2H, SCH_2CH_3), 3.10 (dd, 1H, J_{4-5} = 1.0 Hz, J_{3-4} = 4.2 Hz, H-4), 3.59 (dd, 1H, J_{5-6e} = 1.9 Hz, H-6e), 3.82 (m, 1H, H-5), 4.00 (dd, 1H, J_{5-6a} = 7.3 Hz, J_{6a-6e} = 13.4 Hz, H-6a), 5.66 (d, 1H, J_{1-3} = 1.89 Hz, H-1), 6.13 (dt, 3H, J_{3-5} = 1.89 Hz); ^{13}C NMR δ 132.3 (C-2), 125.3 (C-3), 113.9 (CN), 113.5 (CN), 95.6 (C-1), 77.6 (C-5), 68.2 (C-6), 44.9 (C-4), 34.6 (C-2'), 25.9 (CH_3), 25.4 (SCH_2CH_3), 15.4 (CH_2CH_3) . Mass spectrum: *m/z*(%) 252.0 (12, $M^{+\cdot}$), 104.9 (100).

Anal. Calcd for $C_{12}H_{14}N_2O_2S$: C, 57.12; H, 6.39; N, 11.10; S, 12.71. Found: C, 57.60; H, 6.45; N, 10.80; S 12.85.

1,6-Anhydro-3-[bis(methylthio)methylene]-2-(dicyanomethylene)-2,3-dideoxy-4-*S*-ethyl-4-thio-β-D-*erythro*-hexopyranose (7). Malononitrile (66 mg, 1 mmol) and alumina (300 mg, type T, Merck) were added to a stirred solution of **3** (292 mg, 1 mmol) in anhydrous dichloromethane (10 mL). The mixture was stirred for 1 h, filtered

and the residue washed with dichloromethane. The solvent was evaporated and the residue chromatographed on a silica gel column with 8:1 toluene/ethyl acetate to give, after recrystallization from ethanol, yellow crystals of 7 (228 mg, 68%): mp 94-96 °C; $[\alpha]^{25}_D$ -966° (*c* 0.1, chloroform); IR (KBr) 2229 (CN), 1588 (C=C); ^{1}H NMR ($CHCl_3$) δ 1.29 (t, 3H, J = 7.6 Hz, SCH_2CH_3), 2.44 (s, 3H, SCH_3), 2.45 (s, 3H, SCH_3), 2.64 (q, 2H, SCH_2CH_3), 3.83 (dd, 1H, $J_{5\text{-}6e}$ = 0.8 Hz, H-6e), 3.94 (dd, 1H, $J_{6a\text{-}6e}$ = 7.6 Hz, $J_{5\text{-}6a}$ = 5.0, H-6a), 4.55 (d, 1H, $J_{4\text{-}5}$ = 1.9 Hz, H-4), 4.71 (dq, 1H, H-5), 6.09 (s, 1H, H-1); ^{13}C NMR δ 167.9 (C-2), 149.3 (C-3'), 131.3 (C-3), 112.0 (CN), 110.7 (CN), 99.7 (C-1), 84.5 (C-2'), 78.2 (C-5), 69.0 (C-6), 55.9 (C-4), 25.3 (SCH_2CH_3), 17.2 (SCH_3), 17.2 (SCH_3), 14.8 (SCH_2CH_3). Mass spectrum: *m/z*(%) 339.7 (34, M^+), 278.7 (100)

Anal. Calcd for $C_{14}H_{16}N_2O_2S_3$: C, 49.39; H, 4.74; N, 8.23; S, 28.25. Found: C, 49.74; H, 5.04; N, 7.90; S, 27.70.

(1*R*,7*R*,8*R*)-2,3,5,6(2,4,5,6)-Tetradehydro-7-ethylthio-5-methylthio-3,4-diaza-10,11-dioxa-tricyclo[6.2.1.0^{2,6}]undecane (8). 80% Hydrazine hydrate (200 mg, 3.2 mmol) was added to a solution of **3** (292 mg, 1 mmol) in anhydrous ethanol (15 mL). The mixture was boiled under reflux for 1.5 h. The solvent was evaporated. Column chromatography of the obtained syrup with 1:2 toluene/ethyl acetate gave **8** as a yellowish syrup (60 mg, 69%); $[\alpha]^{23}_D$ -216° (*c* 0.5, chloroform); IR (capillary) 2923 (NH), 1561 (C=C); ^{1}H NMR δ 1.27 (t, 3H, J = 7.7 Hz, SCH_2CH_3), 2.49 (s, 3H, SCH_3), 2.67 (dq, 2H, SCH_2CH_3), 3.56 (dd, 1H, $J_{8\text{-}9e}$ = 2.3 Hz, H-9e), 3.71 (s, 1H, H-7), 4.07 (dd, 1H, $J_{9a\text{-}9e}$ = 8.0 Hz, $J_{8\text{-}9a}$ = 6.1 Hz, H-9a), 4.91 (dt, 1H, H-8), 6.33 (s, 1H, H-1), 9.8 (broad signal, 1H, NH); ^{13}C NMR δ 148.2 (C-2), 137.7 (C-5), 113.1 (C-6), 95.9 (C-1), 78.4 (C-8), 67.2 (C-9), 41.8 (C-7), 24.9 (SCH_2CH_3), 18.2 (SCH_3), 14.6 (SCH_2CH_3). Mass spectrum: *m/z*(%) 258 (15, M^+), 166.9 (100).

Anal. Calcd for $C_9H_{14}N_2O_3S_2$: C, 46.49; H, 5.46; N, 10.54; S, 24.82. Found: C, 46.22; H, 5.79; N, 10.19; S, 24.58.

ACKNOWLEDGEMENTS

The authors are very grateful to Dr. Regine Blattner, Industrial Research Limited, Lower Hutt, New Zealand, for supplying the levoglucosenone. The authors would like to

thank the Deutscher Akademischer Austauschdienst for a scholarship. We are grateful to the Deutsche Forschungsgemeinschaft and the Fonds der Chemischen Industrie for financial support.

REFERENCES

1. G. N. Richards, F. Shafizadeh and T. T. Stevenson, *Carbohydr. Res.*, **117**, 322 (1983).
2. R. Furneaux, J. M. Mason and I. J. Miller, *J. Chem. Soc., Perkin Trans. 1*, 1923 (1984).
3. M. Isobe, N. Yamamoto and T. Nishikawa in *Levoglucosenone and Levoglucosans Chemistry and Applications*, Z. J. Witczak, Ed.; ATL Press Inc. Science Publishers, Mount Prospect, Illinois, 1994, p 99.
4. Z. J. Witczak in *Studies in Natural Products Chemistry*, Vol. XIV; Atta-ur-Rahmann, Ed.; Elsevier, Amsterdam, 1994, p 267.
5. T. Goto, *Heterocycles*, **25**, 521 (1987).
6. Z. J.Witczak, R. Chhabra and J. Chojnacki, *Tetrahedron Lett.*, **38**, 2215 (1997).
7. M. Mori, T. Chuman and K. Kato, *Carbohydr. Res.*, **129**, 73 (1984).
8. M. Isobe, N. Fukami and T. Goto, *Chem. Lett.*, 71 (1985).
9. M. Essig, *Carbohydr. Res*, **156**, 225 (1986).
10. F. Shafizadeh, D. D. Ward and D. Pang, *Carbohydr. Res.*, **95**, 217 (1982).
11. J. Yoshimura, *Adv. Carbohydr. Chem. Biochem.*, **42**, 69 (1984).
12. J. N. Freskos and J. S. Swenton, *J. Chem. Soc., Chem. Commun.* 658 (1985).
13. K. Peseke and H.-D. Ambrosi, *Carbohydr. Res.*, **194**, 87 (1989).
14. K. Peseke, H. Feist and E. Cuny, *Carbohydr. Res.*, **230**, 319 (1992).
15. K. Peseke, H. Feist and P. Köll, *Carbohydr. Res.*, **247**, 315 (1993).
16. K. Peseke, H. Feist, W. Hanefeld, J. Kopf and H. Schulz, *J. Carbohydr. Chem.*, **14**, 317 (1995).
17. A. Thuillier and J. Vialle, *Bull. Soc. Chim. Fr.*, 2187 (1962).
18. R. K. Dieter, *Tetrahedron*, **42**, 3029 (1986).
19. M. Michalik, K. Peseke and R. Radeglia, *J. Prakt. Chem.*, **323**, 506 (1981).
20. M. Michalik and K. Peseke, *J. Prakt. Chem.*, **329**, 705 (1987).
21. H. Bredereck, F. Effenberger and H. Botsch, *Chem. Ber.*, **97**, 3397 (1964).
22. K. Peseke, *Z. Chem.*, **17**, 288 (1977).
23. K. Peseke, M. Michalik and G. Heide, *Z. Chem.*, **27**, 39 (1987).
24. K. Peseke, M. Michalik and U. Schönhusen, *J. Prakt. Chem.*, **328**, 856 (1986).
25. K. Peseke, G. Heide, H. Feist and M. Michalik, *J. Prakt. Chem.*, **333**, 119 (1991).