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Reaction of Monosaccharide Derivatives with Stabilized Sulfur Ylides. A Highly Stereoselective Synthesis for C-Glycofuranosides

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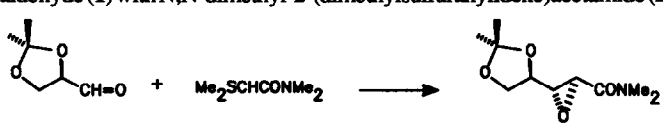
Abstract: Stereoselectivity in the formation of glycidic amides by reaction of various aldehydo- and keto-sugars [**(1)**, **(4)**, **(6)**, **(8)**, **(10)** and **(12)**] with N,N-dimethyl-2-(dimethylsulfuranylidene)acetamide **(2)** was studied. The reaction with derivatives of reducing cyclohemiacetalic monosaccharides **(14)** and **(21)**, gives to α-C-glycofuranosyl-2(S)-hydroxyacetamides with a higher yield and stereoselectivity.

INTRODUCTION

We recently developed a highly stereoselective synthesis for glycidic amides **(3)** by reaction of 2,3-O-isopropylidene-D-glyceraldehyde **(1)** with N,N-dimethyl-2-(dimethylsulfuranylidene)acetamide **(2)**, which is virtually quantitative[1]



(1) **(2)** **(3)** 96:4 (2S,3R,4R):(2R,3S,4R)

This provides a new, ready procedure for incorporating two new chiral carbons into an acyclic carbon chain. In addition, the resulting epoxide function is one of the most useful in organic synthesis, on account of the high synthetic versatility of epoxides and the regioselectivity that may arise from the presence of the amide group in subsequent reactions.

The results led us to study the versatility and potential uses of the process. Thus, in a first step we extended the reaction to other *aldehydo*-sugar derivatives and one ketose (Scheme 1). Next, we studied the reaction with two derivatives of reducing cyclohemiacetalic sugars (Scheme 2 and 3).

RESULTS AND DISCUSSION

The reaction of 2,3-O-isopropylidene-D-glyceraldehyde with ylide **2** in chloroform yields *trans*-2,3-epoxyamides **3a** and **3b** (86:14 at r. t., 96:4 at -5 to 0°C) with high diastereoselectivity. In order to examine the solvent effect on the stereoselectivity, we implemented the reaction in various solvents (CH_3CN, EtOH, THF, benzene) and also in their absence (by simply mixing the reactants); the ratio of the two stereoisomers,

Scheme 1

Reaction of sugar derivatives **1, 4, 6, 8, 10** and **12** with ylide **2** at room temperature

Sugar derivative	2,3-epoxyamide	stereoisomer *ratio*[a]	solvent	yield[b]
		86:14	$CHCl_3$	92%
		96:4*	$CHCl_3$	*c.a.*100%[c]
		86:14	CH_3CN	"
		87:13	EtOH	"
1	**3a,b**	83:17	THF	"
		85:15	Benzene	"
		87:13	without	95%
4	**5a,b**	86:14	without	95%
6	**7a,b**	3:2	$CHCl_3$	94%
8	**9a,b**	3:2	$CHCl_3$	86%
10	**11a,b**	*c.a.*3:1	$CHCl_3$	11%
12	**13a,b**	*cis*-isomer *ratio* 4.5:20	$CHCl_3$	95%
	13c,d	*trans*-isomer *ratio* 22:53.5		

[a] Determined by NMR and GC/MS; [b] Yield of pure isolated products; [c] Yield determined by GC/MS; * at -5 to 0°C

as determined by ^{1}H MNR and GC/MS was nearly always the same. We obtained identical results for the reaction between 2,3-O-isopropylidene-L-glyceraldehyde (**4**) and ylide **2**, which yielded the corresponding *trans*-2,3-epoxyamides **5a,b** (L-*arabino*:L-*xylono*, 86:14).

The reaction of 2,4-O-ethylidene-D-threose (**6**) with ylide **2** in chloroform at room temperature, was completed in a few minutes and a mixture of the two *trans*-2,3-epoxyamides **7a,b** in a 3:2 ratio was obtained with a virtually quantitative yield. The isomers were isolated by flash chromatography and recrystallized.

The 2,3:4,5-di-O-isopropylidene-D-arabinose (**8**) was also reacted with ylide **2** under similar conditions to give a 3:2 mixture of the *trans*-2,3-epoxyamides, **9a,b** with an overall yield of 86% (the more polar isomer was predominant). The individual isomers were isolated by flash chromatography and the minor isomer was obtained in crystalline form.

Only the *trans*-isomers were formed in both cases ($J_{2,3}$ = 2.1-2.2 Hz), but not the desired stereoselectivity. The ratio of stereoisomeric products was nearly always the same, but their absolute configuration could not be established.

As shown in previous work[1], the high stereoselectivity observed in the reaction of 2,3-O-isopropylidene-D-glyceraldehyde (**1**) can be ascribed to the ylide approaching the less hindered face (the *si* face) of the carbonyl group according to the preferred Felkin-Anh model. As can be readly seen with the aid of molecular models, the presence of a second dioxolane group in **8**, introduces additional hindrance over the *si* carbonyl face, leading to a lesser preference for this approach, which results in a change in the above mentioned proportion for **1** to 3:2 for **7** and **9**.

The poor stereoselectivity achieved with compound **6**, may arise from the occurrence of an intra or intermolecular hydrogen bond between the 3-OH function and the carbonyl group that alters the reaction course.

The reaction of 2,3,4,5-tetra-O-acetyl-D-xylose (**10**) with ylide **2** was seemingly quite fast, but the clear initial solution turned dark and fairly small amounts (11 %) of the desired epoxides were obtained. ^{1}H NMR showed both epoxides **11a,b** to have a *trans* configuration about the oxirane ring ($J_{2,3}$ = 2 Hz).

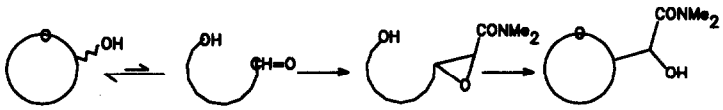
The reaction of 1-deoxy-3,4-O-isopropylidene-D-*glycero*-2-tetrulose (**12**) with the ylide **2** completed in *c.a* 1 h. GC/MS analysis of crude reaction products showed a clean mixture of the four possible diastereoisomeric epoxides **13a-d**, with an essentially quantitative yield, and in a ratio, in order of increasing retention time, of 4.5: 20:22: 53.5, respectively. No stereochemical assignment of these compounds was attempted. Partial chromatographic separation of isomers **13a** and **13b** was possible. Isomers **13c** and **13d** were isolated in analytically pure form, but not on the preparative scale. By comparison of NMR spectra, we believe isomers **13a** and **13b** are both *cis*, while isomers **13c** and **13d**, are *trans*. The main differences between the **13a,b** and **13c,d** pair, lie in the chemical shift of H-2, C-2 and C-3:

TABLE 1.- Major chemical shifts of the isomers of compound 13

	13a	**13b**	**13c**	**13d**
H-2	3.41	3.41	3.68	3.57
C-2	60.1	61.3	56.9	58.3
C-3	60.2	61.5	61.2	61.3

The mass spectra of isomers **13a** and **13b** also showed an intense *m/z* 157 fragment (M- $CONMe_2$). Interestingly, this fragment was not observed in the tentatively assigned **E** isomers **13c** and **13d**.

The high reactivity observed in free carbonyl groups prompted us to extend the reaction to other, less reactive sugar derivatives, such as some of reducing cyclohemiacetalic sugars [2,3-O-isopropylidene-D-ribofuranose (**14**)(Scheme 2) and 2,3:5,6-di-O-isopropylidene-D-manofuranose (**21**) (Scheme 3)], in the hope that the minor aldehyde form present in the equilibrium mixture would suffice for the reaction works. Subsequent cyclization by intramolecular opening of the oxirane ring might provide a new, regio- and stereoselective approach to C-glycofuranosides.



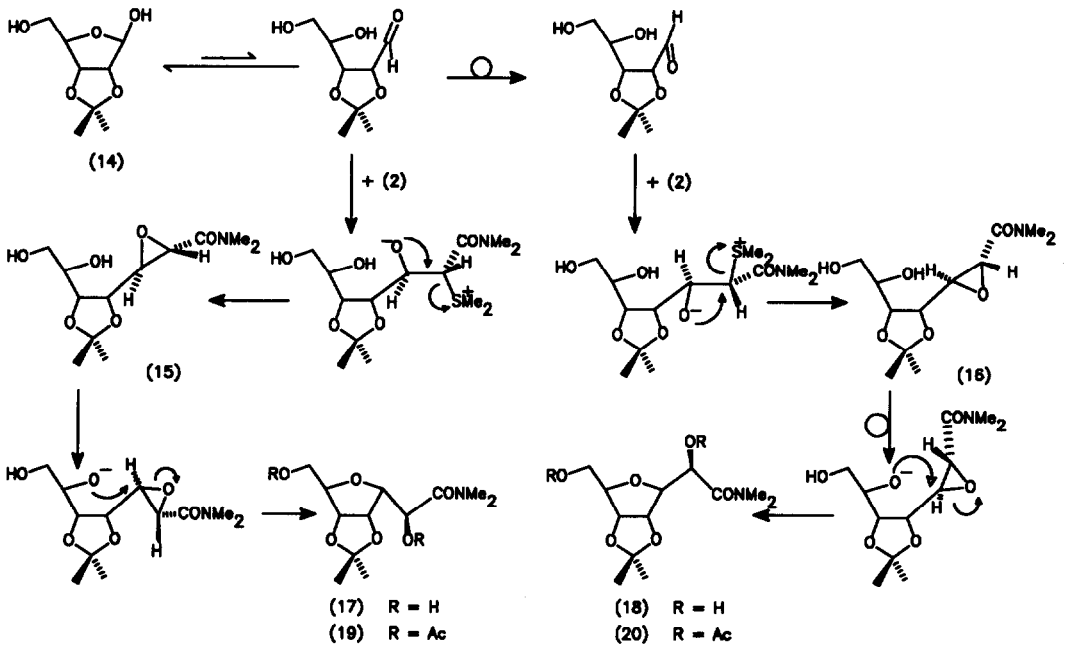
Ribose derivative **14** was reacted with the ylide **2** in chloroform. After 2h at 60º, TLC analysis revealed the absence of ylide and the presence of residual starting sugar and a sole new product in a *c.a.* 1:1 ratio. Examination of the ^1H and ^{13}C NMR spectra of the crude mixture, revealed the absence of epoxides. Thus, we assumed that the initial reaction product had undergone intramolecular cyclization *via* oxirane ring opening to give a C-glycoside. The same product was obtained by reaction at room temperature, when excess ylide was added sequentially until TLC confirmed depletion of the starting sugar. Only one glycoside was isolated (85 % yield) which was characterized spectroscopically and by comparison with similar compounds[2,3], such as α-C-glycoside **17**. The ring size was determined from the ^{13}C-chemical shifts of C-6 and C-7[4], and the "anomeric" configuration from the $J_{5,6}$ ^1H-NMR coupling constants of the tetrahydrofurane ring protons and the ^{13}C-chemical shifts of the isopropylidene carbons[2]. The ^{13}C chemical shifts of the isopropylidene groups in the C-glycosides derived from 2,3-O-isopropylidene-D-ribose, are correlated with their anomeric configuration (Table 2). The β-anomer (**18**) was not directly detected; however, acetylation of the crude reaction mixture gave a minor acetylated product (<10%), which was characterized as a β-anomer (**20**) by ^1H- and ^{13}C NMR spectroscopy, in addition to the major derivative (**19**). On thorough examination of the NMR spectra of the crude recorded in several runs, however, it became apparent that β-C-glycoside **18** was produced, although in much lesser amounts; we could not isolate the pure product, though.

TABLE 2. Relevant spectroscopic data for C-glycosides obtained from 2,3-O-isopropylidene-D-ribose

	α-anomer		β-anomer	α-anomer	β-anomer	
	17	**19**	**20**	lit.[2]	lit.[2]	lit.[3]
$J_{5,6}$	1 Hz	0 Hz	3.5 Hz	0-1 Hz	4.5 Hz	3.5 Hz
O-C-O	112.1	112.8	114.1	112.7±0.6	114.5±0.6	113.6-114.0
C-Me_2	26.5	26.4	27.4	26.3±0.2	27.5±0.2	27.4-27.7
	24.5	24.9	25.5	24.9±0.2	25.5±0.2	25.6-26.0

Also, the ^{13}C NMR spectra showed C-2, C-3 and C-4 in the α-anomer (**19**) (with the aglycon and its C4-hydroxyl in *cis*) to appear upfield from those in the β-anomer (**20**) (with a *trans* arrangement)[2]. The configuration at C-2 was assigned on the basis of the assumed reaction mechanism, via the initial formation of the α-*trans*-epoxide and subsequent stereospecific intramolecular opening of the oxirane ring with simultaneous formation of the tetrahydrofurane ring, in accordance with the previous reaction sequence. The intermediate epoxides **15** and **16** were not detected in this reaction; rather one *trans*-epoxide was the main product in the analogous reaction of the mannose derivative **21**.

Scheme 2



Thus, the reaction of D-mannose derivative **21** with ylide **2** in chloroform at room temperature, gave a mixture of one *trans*-epoxide and the two anomeric C-glycosides (3.1:1.0 α/β *ratio*), in essentially quantitative yield; the α/β *ratio* depends on the reaction time; as is showed later, **22** cyclise to **24**, increasing the α/β *ratio* to 6.5:1.0; the products were characterized as **22**, **24** and **25**. The *trans* configuration of the oxirane ring and that of the anomeric centre, were assigned on the basis of the NMR data for these compounds, as were those of the acetylated derivatives, which were prepared not only to provide more data for comparison, but also to achieve a higher ^1H NMR resolution in the protons.

Scheme 3

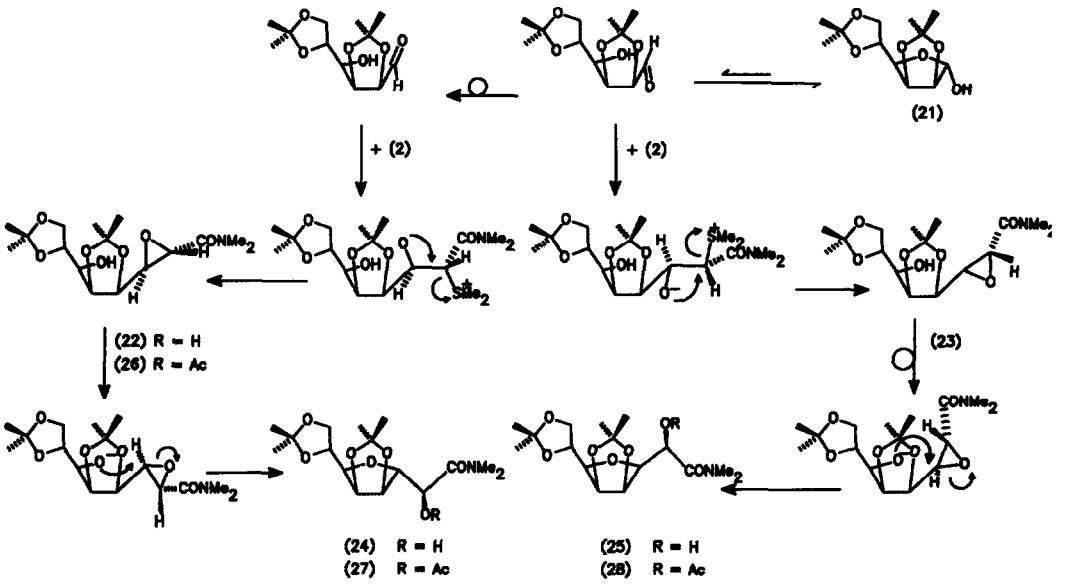
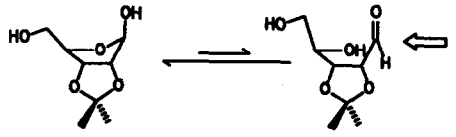


TABLE 3.- Relevant spectroscopic data for Epoxides and C-glycosides obtained from 2,3:5,6-di-O-isopropylidene-D-mannose

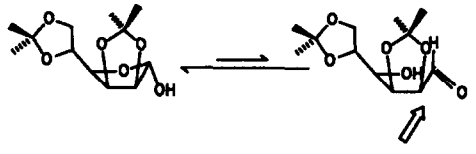
	trans-epoxides		α-anomers		β-anomers	
	22	**26**	**24**	**27**	**25**	**28**
$J_{2,3}$	2.0 Hz	2.1 Hz				
$J_{3,4}$			<1 Hz	0 Hz	3.5 Hz	1.2 Hz
C_2	51.5	49.3	70.7	72.3	64.6	66.2
C_3	57.6	55.6	85.1	83.2	83.7	80.5
C_4			81.4	81.1	80.8	80.2

The α-anomer of C-glycosides obtained from 2,3:5,6-di-O-isopropylidene-D-mannose, appears with a $J_{3,4}$ 0 Hz; this value is consistent with a *trans* arrangement of H-3 and H-4[2]. These compounds do not allow a goc correlation between the ^{13}C chemical shifts of the isopropylidene groups and the anomeric configuratio Nevertheless, the β-anomers showed chemical shifts for C-2, C-3 and C-4 that were upfield of those of the c anomers[2].

The involvement of epoxide **22** in the formation of the final C-glycosides was confirmed by the cyclizatic of **22** to the major α-C-glycoside **24**, which confirms the mechanistic basis for the configurational assignments C-2 in these products.

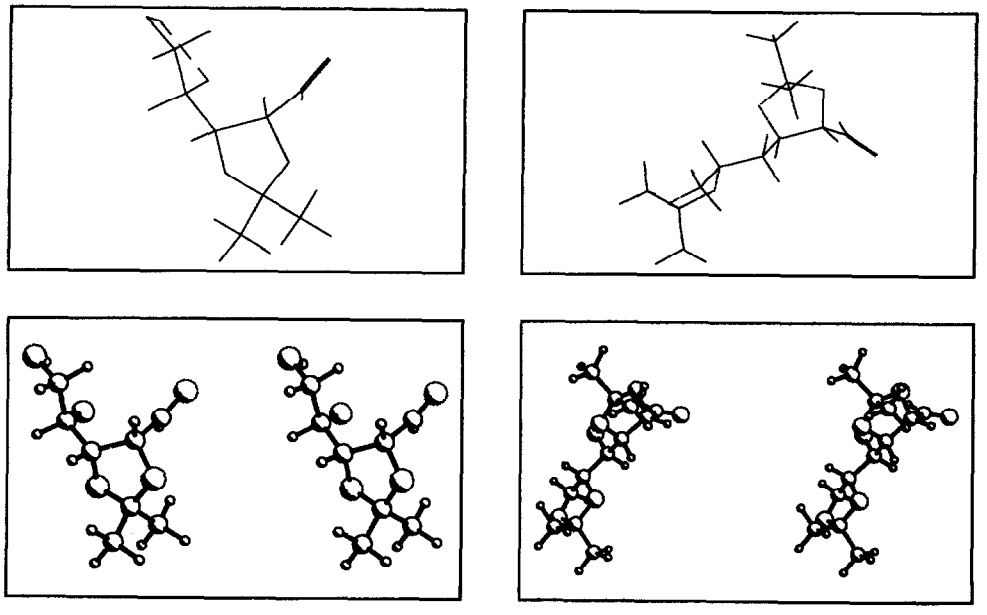


14A



21A

The high stereoselectivity observed in these reactions may be the result of rapid trapping of the open form of the sugar by ylide **2**. Thus, it appears that the incipient carbonyl group retains the conformation of the preceeding hemiacetalic form of the sugar, as shown in structures **14A** and **21A**. One other explanation can be provided by using Molecular Mechanics (InsightII program) to minimize the anionic form of the open initial sugar derivatives, which must result from the basic reaction medium. Thus, starting from structures like **14A** and **21A**, interactive minimization shows the repulsive interaction between the oxi-anion and the oxo-(carbonyl) group until the corresponding conformational minimum is reached. These minimum energy conformations are also obtained from many other different intial conformations, appearing as the absolute minimum conformations. As can be seen from the stereographs, the less hindered face is the α-face (*si*-face), in both cases.



14A 21A

EXPERIMENTAL

All mp values are uncorrected. Optical rotations were measured at 20-22°C with a Perkin-Elmer mod. 241 polarimeter. Low resolution mass spectra in the electron impact (EIMS) mode were recorded on a HP-5988; GC/MS analyser using HP-1 Crosslinked Methyl Silicone Gum strips of 12m x 0.2mm x 0.33mm; the temperature program was 80 ºC : 0.80 min, 30ºC/min, 250 ºC : 10 min. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker WP 200 SY spectrometer; Proton chemical shifts are referred to the residual chloroform (7.24 ppm), and carbon chemical shifts to the solvent ($^{13}CDCl_3$= 77 ppm). ^{1}H- and ^{13}C NMR signals were assigned from 2D COSY, 2D-NOESY, HCCORR and DEPT experiments. TLC was carried out on 60 F 254 silica gel plates and column chromatography was done on silica gel 60 (70-230 mesh or 230-400 mesh).

N,N-Dimethyl-2,3-anhydro-4,5-O-isopropylidene-L-*arabino*- and L-*xylono*- pentonamides (5a and 5b).

N,N-Dimethyl-2-(dimethylsulfuranylidene)acetamide (**2**, 0.62 g, 4.23 mmol) was added to 2,3-O-isopropylidene-L-glyceraldehyde[5] (**4**, 0.5 g, 3.85 mmol) at room temperature. The reaction was complete in a few minutes. ^{1}H NMR and GC/MS analysis of reaction crude showed a clean mixture of two isomers in essentially quantitative yield. (**5a**, T_R = 4.73 min, 86%; **5b**, T_R = 4.83 min. 14%). Analytical and spectroscopic data for **5a** and **5b** were identical to those for the previously reported[1] enantiomers **3a** (D-*arabino-)* and **3b** (D-*xylono*-).

Isomer **5a** was isolated by column chromatography on silica gel, using 1:1 hexane-ethyl acetate as eluent. [α]= +2.8° (c 0.93, $CHCl_3$); ^{13}C NMR ($CDCl_3$) δ: 166.3 (CO), 110.1 (OCO), 75.0 (C_4), 66.9 (C_5), 57.6* (C_3), 52.0* (C_2), 36.3 and 35.6 (NMe_2), 26.4 and 25.0 (CMe_2).

* These assignations were erroneously exchanged for the reported[1] D-isomer.

Anal. calcd. for $C_{10}H_{17}NO_4$: C, 55.80; H, 7.96; N, 6.51. Found: C, 55.84; H, 8.24; N. 6.87.

N,N-Dimethyl-2,3-anhydro-4,6-O-(S)-ethylidene-D-*ido*- and D-*galacto*-hexonamides (7a and 7b).

N,N-Dimethyl-2-(dimethylsulfuranylidene)acetamide (**2**, 1.14 g, 7.7 mmol) was added to a solution of 2,4-O-ethylidene-D-threose[6] (**6**, 1.02 g, 7 mmol) in $CHCl_3$ (20 ml) at room temperature. The reaction was monitored by TLC and was complete in a few minutes. The solvent was evaporated to an amorphous white solid, which was showns by ^{1}H NMR to consist of two *trans*-epoxides in a 3:2 ratio. The isomers were separated by flash chromatography on silica gel using 10:1 ethyl acetate-methanol as eluent, followed by crystallization from methanol.

Major isomer (less polar): 905 mg (56 % yield); m.p. 93-96°C; [α]= - 19° (c 0.2, MeOH). ^{1}H NMR ($CDCl_3$) δ: 4.72 (q, 1H, J= 5.1 Hz, $\underline{CH}CH_3$), 4.05 (dd, 1H, $J_{6',5}$= 2.0 and $J_{6',6}$= 12.0 Hz, H_6), 3.85 (dd, 1H, $J_{6,6'}$= 12.0 and $J_{6,5}$= 1.4, H_6), 3.81 (dd, 1H, $J_{4,5}$= 1.2 and $J_{4,3}$= 3.5 Hz, H_4), 3.75 (d, 1H, $J_{2,3}$= 2.1 Hz, H_2), 3.65 (ddd, 1H, $J_{5,4}$= 1.2, $J_{5,6'}$= 1.4 and $J_{5,6}$= 2.0 Hz, H_5), 3.34 (dd, 1H, $J_{3,2}$= 2.1 and $J_{3,4}$= 3.5 Hz, H_3), 2.00 (sb, 1H, -OH), 3.15 and 2.96 (2s, 6H, NMe_2), 1.33 (d, 3H, J= 5.1 Hz, $\underline{CH_3}CH$). ^{13}C NMR ($CDCl_3$) δ: 166.8 (CO), 99.5 (OCO), 77.3 and 64.1 (C_4 and C_5), 71.7 (C_6), 56.6 (C_3), 51.3 (C_2) 36.3 and 35.7 (NMe_2), 20.8 (CH_3). EIMS *m/z* (%): 230 (M^+-1, 1%), 159 (6), 144 (60), 114 (45), 87 (29), 72 (100), 45 (57), 44 (55), 43 (48).

Anal. calcd. for $C_{10}H_{17}NO_5$: C, 51.94; H, 7.41; N, 6.06. Found: C, 51.68; H, 7.53; N, 6.01.

Minor isomer (more polar) : 610 mg (38 % yield); m.p. 213-215°C (MeOH); [α]= - 35° (c 0.2, MeOH). ^{1}H NMR ($CDCl_3$) δ: 4.75 (q, 1H, J= 5.1 Hz, $CH_3\underline{CH}$), 4.03 (dd, 1H, $J_{6,5}$= 2.0 and $J_{6,6}$= 12.0 Hz, H_6), 3.81 (dd, 1H, $J_{6,6}$= 12.0 and $J_{6,5}$= 1.4 Hz, H_6), 3.75 (dd, 1H, $J_{4,3}$= 4.2 and $J_{4,5}$= 1.4 Hz, H_4), 3.73 (d, 1H, $J_{2,3}$= 2.2 Hz, H_2), 3.58 (ddd, 1H, $J_{5,4}$= 1.4, $J_{5,6}$= 1.4 and $J_{5,6}$=2.0 Hz, H_5), 3.37 (dd, 1H, $J_{3,2}$=2.2 and $J_{3,4}$=4.2 Hz, H_3), 3.14 and 2.96 (2s, 6H, NMe_2), 1.68 (sb, 1H, OH), 1.36 (d, 3H, J= 5.1 Hz, $\underline{CH_3}CH$). ^{13}C NMR ($CDCl_3$) δ: 166.6 (CO), 99.9 (OCO), 74.9 and 64.6 (C_4 and C_5), 71.9 (C_6), 57.2 (C_3), 50.3 (C_2), 36.3 and 35.7 (NMe_2), 20.8 (CH_3). EIMS *m/z* (%): 230 (M^+-1, 1.5%), 159 (5), 144 (48), 114 (42), 87 (37), 72 (100), 45 (49), 44 (54), 43 (50).
Anal. calcd. for $C_{10}H_{17}NO_5$: C, 51.94; H, 7.41; N, 6.06. Found: C, 51.60; H, 7.52; N. 6.05.

N,N-Dimethyl-2,3-anhydro-4,5:6,7-di-O-isopropylidene-D-*glycero*-D-*ido*- and D-*glycero*-D-*galacto*-heptonamides (9a and 9b).

N,N-Dimethyl-2-(dimethylsulfuranylidene)acetamide (**2**, 0.8 g, 5.4 mmol) was added to a solution of 2,3:4,5-di-O-isopropylidene-D-arabinose[7] (**8**, 1.15 g, 5 mmol) in $CHCl_3$ (20 ml) at room temperature. The reaction was monitored by TLC and was complete in a few minutes. The solvent was evaporated and the residue purified by chromatography on silica gel using 1:1 ethyl acetate-hexane as eluent. A white solid (1.35 g, 86 %) was isolated, which was shown by ^{1}H NMR and GC/MS analysis (R_T= 6.28 min and R_T= 6.19 min) to be a mixture of two *trans*-epoxides in a 3:2 ratio.

Anal. calcd. for $C_{15}H_{25}NO_6$: C, 57.12; H, 7.99; N, 4.44. Found: C, 57.07; H, 8.19; N, 4.29.
Flash chromatography provided enriched mixtures of each isomer. The minor isomer (less polar) was isolated as white crystals by crystallization with ethyl acetate-hexane. The major isomer (more polar) was obtained by preparative TLC as a colorless syrup which crystallized spontaneously.

The major isomer (more polar) had: [α]= - 4.17° (c 0.34, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ: 4.13 (dd, 1H, $J_{4,5}$= 7.0 and $J_{4,3}$= 3.1 Hz, H_4), 4.1-3.9 (m, 3H, H_5, H_6 and H_7), 3.82 (dd, 1H, J= 7.7 and 7.0 Hz, H_7), 3.74 (d, 1H, $J_{2,3}$= 2.2 Hz, H_2), 3.42 (dd, 1H, $J_{3,2}$= 2.2 and $J_{3,4}$= 3.1 Hz, H_3), 3.13 and 2.96 (2s, 6H, NMe_2), 1.39, 1.38, 1.37 and 1.32 (4s, 12H, 2 x CMe_2). ^{13}C-NMR ($CDCl_3$) δ: 166.7 (CO), 110.3 and 109.9 (2 x OCO), 78.6, 78.3 and 76.8 (C_4, C_5 and C_6), 67.6 (C_7), 57.5 (C_3), 51.1 (C_2), 36.3 and 35.7 (NMe_2), 29.7, 27.0, 26.7 and 25.2 (2 x $C\underline{Me_2}$). EIMS, *m/z* (%): 300 (M^+-15, 92), 214 (14), 128 (29), 101 (31), 72 (100).

The minor isomer (less polar) had: m.p. 92-94 °C; [α]= + 16.0° (c 0.2, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ: 4.15-4.00 and 3.95-3.85 (2m, 4H, H_5, H_6, H_7 and H_7), 4.03 (dd, 1H, $J_{4,5}$= 7.2 and $J_{4,3}$= 3.4 Hz, H_4), 3.70 (d, 1H, $J_{2,3}$= 2.1 Hz, H_2), 3.36 (dd, 1H, $J_{3,4}$= 3.4 and $J_{3,2}$= 2.1 Hz, H_3), 3.14 and 2.96 (2s, 6H, NMe_2), 1.37, 1.34, 1.33 and 1.30 (4s, 12H, 2 x CMe_2). ^{13}C NMR ($CDCl_3$) δ: 166.8 (CO), 110.4 and 109.9 (2 x OCO), 78.8, 78.4 and 77.2 (C_4, C_5 and C_6), 67.8 (C_7), 57.1 (C_3), 51.3 (C_2), 36.5 and 35.6 (NMe_2), 27.1, 26.7, 26.3 and 25.3 (2 x $C\underline{Me_2}$). EIMS *m/z* (%): 300 (M^+-15, 92), 214 (3), 128 (40), 101 (32), 72 (100).

N,N-Dimethyl-4,5,6,7-tetra-O-acetyl-2,3-anhydro-D-*glycero*-L-*galo*- and D-*glycero*-L-*ido*-heptonamides (11a and 11b)

N,N-Dimethyl-2-(dimethylsulfuranylidene)acetamide (**2**, 0.5 g, 3.4 mmol) was added to a solution of 2,3,4,5-tetra-O-acetyl-D-xylose[8] (**10**, 1 g, 3.14 mmol) in $CHCl_3$ (40 ml) at room temperature. The reaction seemed to proced

quickly, but the clear initial solution turned dark. A dark gum was obtained on evaporating the solvent. Silica gel chromatography of an aliquot (600 mg) yielded only 70 mg (11 %) of the two *trans*-epoxides isomers (in a ratio of *c.a.* 3:1). Further preparative TLC (1:2 hexane-ethyl acetate) allowed the major isomer to be isolated to some extent.

Major isomer: yellowish oil; ^{1}H NMR ($CDCl_3$) δ: 5.43 (dd, 1H, $J_{5,4}$= 4.3 and $J_{5,6}$= 5.9 Hz, H_5), 5.30 (ddd, 1H, $J_{6,5}$= 5.9, $J_{6,7}$= 4.5 and $J_{6,7'}$= 5.7 Hz, H_6), 4.85 (dd, 1H, $J_{4,5}$= 4.3 and $J_{4,3}$= 6.3 Hz, H_4), 4.30 (dd, 1H, $J_{7,6}$= 4.5 and $J_{7,7}$= 12.0 Hz, H_7), 3.95 (dd, 1H $J_{7',6}$= 5.7 and $J_{7,7}$= 12.0 Hz, $H_{7'}$), 3.69 (d, 1H, $J_{2,3}$= 2.0 Hz, H_2), 3.23 (dd, 1H, $J_{3,2}$= 2.0 and $J_{3,4}$= 6.3 Hz, H_3), 3.09 and 2.93 (2s, 6H, NMe_2), 2.10 (s, 6H, 2 x CH_3CO), 2.03 and 2.02 (2s, 6H, 2 x CH_3CO). ^{13}C NMR ($CDCl_3$) δ: 170.2, 169.7, 169.6, 165.7 and 165.6 (4 x $\underline{C}OCH_3$ and $\underline{C}ONMe_2$), 70.3, 69.4 and 69.2 (C_4, C_5 and C_6), 61.7 (C_7), 54.4 (C_3), 52.4 (C_2), 36.3 and 35.7 (NMe_2), 20.6 and 20.5 (4 x $\underline{C}H_3CO$). EIMS *m/z* (%): 403 (M^+, 0.1), 360 (M^+-43, 0.5), 331 (0.7), 114 (44), 72 (51), 43 (100).

Minor isomer: spectral data for a mixture with the major isomer. ^{1}H NMR ($CDCl_3$) δ: 5.4-5.28 (m, 2H, H_5 and H_6), 5.1 (dd, 1H, $J_{4,5}$= 4.6 and $J_{4,3}$= 4.5 Hz, H_4), 4.28 (dd, 1H, $J_{7,6}$= 4.7 and $J_{7,7}$= 12.0 Hz, H_7), 4.02 (dd, 1H, $J_{7',6}$= 5.4 and $J_{7,7}$= 12.0 Hz, $H_{7'}$), 3.49 (dd, 1H, $J_{2,3}$= 2.0 Hz, H_2), 3.37 (dd, 1H, $J_{3,2}$= 2.0 and $J_{3,4}$= 4.5 Hz, H_3), 3.09 and 2.95 (2s, 6H, NMe_2), 2.09, 2.07, 2.03 and 2.02 (4s, 12H, 4 x CH_3CO).

N,N-Dimethyl-2,3-annydro-4,5-O-isopropylidene-3-methyl-D-pentonamides (13a, 13b, 13c and 13d)

1-Deoxy-3,4-O-isopropylidene-D-*glycero*-2-tetrulose[9] (**12**, 0.9 g, 6.3 mmol) was added to the N,N-dimethyl-2-(dimethylsulfuranylidene)acetamide (**2**, 1.2 g, 8.2 mmol) at room temperature. The reaction was monitored by ^{1}H NMR and was complete in *c.a* 1 h; at least three new compounds were among the products. GC/MS analysis of crude reaction showed a clean mixture of four isomers in essentially quantitative yield. (**13a**, T_R = 4.65 min, 4.5%; **13b**, T_R = 4.79 min, 20 %; **13c**, T_R = 4.91 min, 22 %; **13d**, T_R = 5.02 min, 53.5 %).
Column chromatography on silica gel (1:1 followed by 1:2 hexane-ethyl acetate) yielded enriched mixtures of isomers **13a** and **13b** first, followed by a mixture of isomers **13b**, **13c** and **13d**, and, finally, a mixture (*c.a.* 2:5) of isomers **13c** and **13d**. Further preparative TLC (1:1 hexane-ethyl acetate) allowed isomers **13a** and **13b** to be isolated to some extent as colorless syrups. Attempts at isolating isomers **13c** and **13d** failed; spectral data were taken from a 2:5 mixture of isomers **13c** and **13d**.

13a: ^{1}H NMR ($CDCl_3$) δ: 4.11 (dd, 1H, $J_{5',5}$= 8.9 and $J_{5',4}$= 7.3 Hz, $H_{5'}$), 3.89 (dd, 1H, $J_{5,5'}$= 8.9 and $J_{5,4}$= 6.1 Hz, H_5), 3.76 (dd, 1H, $J_{4,5'}$= 7.3 and $J_{4,5}$= 6.1 Hz, H_4), 3.41 (s, 1H, H_2), 3.12 and 2.92 (2s, 6H, NMe_2), 1.46, 1.39 and 1.30 (3s, 9H, CMe_2 and Me). ^{13}C NMR ($CDCl_3$) δ: 166.0 (CO), 109.9 (OCO), 77.2 (C_4), 66.4 (C_5), 60.2 (C_3), 60.1 (C_2), 36.5 and 35.1 (NMe_2), 25.9 and 24.6 ($C\underline{Me}_2$), 15.6 (Me). EIMS *m/z* (%): 214 (M^+-15, 48), 157 (38), 128 (6), 112 (15), 102 (23), 99 (23), 85 (38), 72 (100), 43 (95).

13b: ^{1}H NMR ($CDCl_3$) δ: 4.05-3.95 (m, 2H, $H_{5'}$ and H_5), 3.74 (dd, 1H, $J_{4,5'}$= 5.4 and $J_{4,5}$= 6.5 Hz, H_4), 3.41 (s, 1H, H_2), 3.07 and 2.97 (2s, 6H, NMe_2), 1.43, 1.42 and 1.25 (3s, 9H, CMe_2 and Me). ^{13}C NMR ($CDCl_3$) δ: 166.1 (CO), 109.9 (OCO), 74.8 (C_4), 66.0 (C_5), 61.5 (C_3), 61.3 (C_2), 36.2 and 35.2 (NMe_2), 26.1 and 24.5 ($C\underline{Me}_2$), 16.2 (Me). EIMS *m/z* (%): 214 (M^+-15, 46), 157 (55), 128 (8), 112 (6), 102 (20), 99 (29), 85 (20), 72 (100), 43 (82).

13c: ^{1}H NMR ($CDCl_3$) δ: 4.13-3.95 (m, 2H, $H_{5'}$ and H_5), 3.85 (dd, 1H, $J_{4,5'}$= 4.7 and $J_{4,5}$= 6.3 Hz, H_4), 3.68 (s, 1H, H_2), 3.07 and 2.96 (2s, 6H, NMe_2), 1.38, 1.33 and 1.23 (3s, 9H, CMe_2 and Me). ^{13}C NMR ($CDCl_3$) δ: 166.2

(CO), 110.0 (OCO), 76.6 (C_4), 65.6 (C_5), 61.2 (C_3), 56.9 (C_2), 36.1 and 35.2 (NMe_2), 25.7 and 25.4 ($C\underline{Me}_2$), 14.5 (Me). EIMS *m/z* (%): 214 (M^+-15, 65), 172 (6), 128 (14), 112 (46), 102 (26), 85 (18), 72 (82), 43 (100).

13d: ^{1}H NMR ($CDCl_3$) δ: 4.10 (t, 1H, $J_{5,5'}=J_{5,4}=6.0$ Hz, H_5), 3.98 (t, 1H, $J_{5,5'}=J_{5',4}=6.0$ Hz, $H_{5'}$), 3.90 (t, 1H, $J_{4,5'}=J_{4,5}=6.0$ Hz, H_4), 3.57 (s, 1H, H_2), 3.08 and 2.96 (2s, 6H, NMe_2), 1.42, 1.32 and 1.24 (3s, 9H, CMe_2 and Me). ^{13}C NMR ($CDCl_3$) δ: 166.2 (CO), 110.0 (OCO), 77.6 (C_4), 65.9 (C_5), 61.3 (C_3), 58.3 (C_2), 36.1 and 35.2 (NMe_2), 26.1 and 24.7 ($C\underline{Me}_2$), 13.1 (Me). EIMS *m/z* (%): 214 (M^+-15, 66), 172 (6), 128 (14), 112 (38), 102 (19), 85 (18), 72 (92), 43 (100).

Anal. calcd. for $C_{11}H_{19}NO_4$: C, 57.62; H, 8.35; N, 6.11. Found: C, 57.43; H, 8.49; N, 6.14.

N,N-Dimethyl-3,6-anhydro-4,5-O-isopropylidene-D-*glycero*-D-*manno*-heptonamide (17)

A solution of 2,3-O-isopropylidene-D-ribofuranose[10] (**14**, 1g, 5.26 mmol) in $CHCl_3$ (50 ml) was stirred at room temperature while ylide (**2**, 1.63 g, 11 mmol) was added sequentially until TLC analysis revealed depletion of the starting sugar. When the reaction was complete (*c.a.* 24 h), the solvent was evaporated and the residue purified by flash chromatography on silica gel using ethyl acetate to obtain **17** (1.23 g, 85%) as a colorless syrup. [α]= + 33.4° (c 0.43, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ: 4.87 (dd, 1H, $J_{4,5}=6.2$ and $J_{4,3}=3.8$ Hz, H_4), 4.78 (t, 1H, $J_{2,3}=9.0$ and $J_{2,OH}=9.0$ Hz, H_2), 4.65 (dd, 1H, $J_{5,6}=1.2$ and $J_{5,4}=6.2$ Hz, H_5), 4.10 (dt, 1H, $J_{6,5}=1.2$ and $J_{6,7}=6.0$ Hz, H_6), 3.90 (dd, 1H, $J_{3,4}=3.8$ and $J_{3,2}=9.0$ Hz, H_3), 3.65 (d, 1H, $J_{OH,2}=9.0$ Hz, OH), 3.53 (d, 2H, $J_{7,6}=6.0$ Hz, $H_{7'}$ and H_7), 3.05 and 2.98 (2s, 6H, NMe_2), 1.49 and 1.33 (2s, 6H, CMe_2). ^{13}C NMR ($CDCl_3$) δ: 172.9 (CO), 112.1 (OCO), 85.0 (C_3), 83.1 (C_6), 82.0 (C_5), 81.2 (C_4), 65.2 (C_2), 61.8 (C_7), 36.8 and 35.7 (NMe_2), 26.5 and 24.5 (CMe_2). EIMS *m/z* (%): 260 (M^+-15, 6), 258 (M-17, 4), 257 (3), 213 (14), 203 (10), 168 (12), 152 (17), 124 (21), 114 (27), 103 (42), 102 (27), 72 (100), 59 (44).

Anal. calcd. for $C_{12}H_{21}NO_6$: C, 52.35; H, 7.69; N, 5.08. Found: C, 52.05; H, 7.96; N, 4.93

N,N-Dimethyl-2,7-di-O-acetyl-3,6-anhydro-4,5-O-isopropylidene-D-*glycero*-D-*manno*- and D-*glycero*-D-*allo*-heptonamides (19 and 20)

A portion of the above crude reaction mixture (100 mg) in anhydrous pyridine (3 ml) was treated with Ac_2O (1 ml) at room temperature overnight. After the usual treatment, the crude product was purified by flash chromatography on silica gel with ethyl acetate, to give **20** (10 mg, 7.7%) and the more polar derivative **19** (112 mg, 85.8%) as colorless syrups.

19: [α]= + 23.75 ° (c 0.4, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ: 5.50 (d, 1H, $J_{2,3}=9.5$ Hz, H_2), 4.80 (dd, 1H, $J_{4,3}=3.7$ and $J_{4,5}=6.0$ Hz, H_4), 4.71 (d, 1H, $J_{5,4}=6.0$ Hz, H_5), 4.31 (dd, 1H, $J_{3,2}=9.5$ and $J_{3,4}=3.7$ Hz, H_3), 4.26 (dd, 1H, $J_{6,7'}=5.0$ and $J_{6,7}=4.5$ Hz, H_6), 4.13 (dd, 1H, $J_{7,7'}=11.8$ and $J_{7,6}=4.5$ Hz, H_7), 3.98 (dd, 1H, $J_{7,7'}=11.8$ and $J_{7',6}=5.0$ Hz, $H_{7'}$), 3.15 and 2.98 (2s, 6H, NMe_2), 2.10 and 2.06 (2s, 6H, 2 x CH_3CO), 1.47 and 1.33 (2s, 6H, CMe_2). ^{13}C NMR ($CDCl_3$) δ: 170.4, 169.9 and 168.7 (3 x CO), 112.8 (OCO), 82.7 (C_5), 82.1 (C_6), 81.1 (C_3), 80.9 (C_4), 66.9 (C_2), 64.2 (C_7), 37.2 and 36.1 (NMe_2), 26.4 and 24.9 ($C\underline{Me}_2$), 20.9 and 20.6 (2 x $\underline{CH_3}CO$). EIMS *m/z* (%): 359 (M^+, 0.3), 344 (M^+-15, 2), 300 (M^+-59, 8), 197 (16), 181 (25), 137 (13), 81 (15), 72 (100), 43 (73).

20: [α]= + 11.2 ° (c 0.5, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ: 5.35 (d, 1H, $J_{2,3}=4.2$ Hz, H_2), 4.91 (dd, 1H, $J_{4,3}=2.8$ and $J_{4,5}=6.3$ Hz, H_4), 4.49 (dd, 1H, $J_{5,6}=3.5$ and $J_{5,4}=6.3$ Hz, H_5), 4.30 (dd, 1H, $J_{3,2}=4.2$ and $J_{3,4}=2.8$ Hz, H_3), 4.25-

4.04 (m, 3H, H_6, H_7 and H_7), 3.08 and 2.95 (2s, 6H, NMe_2), 2.13 and 2.07 (2s, 6H, 2 x CH_3CO), 1.50 and 1.3 6H, CMe_2). ^{13}C NMR ($CDCl_3$) δ: 170.6, 170.2 and 166.7 (3 x CO), 114.1 (OCO), 83.0 (C_6), 82.7 (C_3), 81.8 81.3 (C_4), 70.6 (C_2), 64.4 (C_7), 36.8 and 36.0 (NMe_2), 27.4 and 25.5 (CMe_2), 20.8 and 20.7 (2 x CH_3CO). I *m/z* (%): 344 (M^+-15, 2), 300 (M^+-59, 1), 197 (4), 181 (8), 137 (4), 81 (4), 72 (57), 43 (100).

Anal. calcd. for $C_{16}H_{25}NO_8$: C, 53.47; H, 7.01; N, 3.89. Found: C, 53.67; H, 7.28; N, 3.87.

In a separate experiment the pure isomer **17** (30 mg) was acetylated by the same procedure mentioned a to give **19** (38 mg, 97%).

N,N-Dimethyl-2,3-anhydro-4,5:7,8-di-O-isopropylidene-D-*erithro*-L-*gluco*-octonamide (22), Dimethyl-3,6-anhydro-4,5:7,8-di-O-isopropylidene-D-*erithro*-L-*allo*-octonamide (24) and N,N-Dime 3,6-anhydro-4,5:7,8-di-O-isopropylidene-D-*erithro*-L-*manno*-octonamide (25).

A solution of 2,3:5,6-di-O-isopropylidene-D-mannofuranose[11] (**21**, 1g, 3.84 mmol) in $CHCl_3$ (90 ml stirred at room temperature while ylide (**2**, 1.5 g, 10.2 mmol) was added sequentially until TLC analysis rev depletion of the starting sugar. When the reaction was complete (*c.a.* 40 h), the solvent was evaporated amorphous white solid, which was shown by ^1H NMR to consist of three new compounds. Preliminary chromatography (1:2 hexane-ethyl acetate) provided an enriched mixture of each compound. The isomers isolated by further flash chromatography, followed by crystallization.

22: White solid (530 mg, 40%); m.p. 126-128°C (benzene); [α]= + 13.95° (c 0.29, $CHCl_3$). ^1H NMR (Cl δ: 4.47 (dd, 1H, $J_{5,6}$= 1.4 and $J_{5,4}$= 7.0 Hz, H_5), 4.17 (dd, 1H, $J_{8',8}$= 9.0 and $J_{8',7}$= 6.5 Hz, $H_{8'}$), 4.15 (ddd, 1H, 6.5, $J_{7,8}$= 5.5 and $J_{7,6}$= 6.4 Hz, H_7), 4.04 (dd, 1H, $J_{8,8'}$= 9.0 and $J_{8,7}$= 5.5 Hz, H_8), 4.00 (dd, 1H, $J_{4,5}$= 7.0 and $J_{3,4}$ Hz, H_4), 3.70 (dt, 1H, $J_{6,7}$= 6.4, $J_{6,5}$= 1.4 and $J_{6,OH}$= 6.4 Hz, H_6), 3.55 (d, 1H, $J_{2,3}$= 2.0 Hz H_2), 3.53 (dd, 1H, $J_{3,2}$ and $J_{3,4}$= 4.0 Hz, H_3), 3.16 and 2.95 (2s, 6H, NMe_2), 1.52, 1.38, 1.37 and 1.34 (4s, 12H, 2 x CMe_2). ^{13}C NMR (Cl δ: 167.1 (CO), 109.52 and 109.46 (2 x OCO), 77.3 (C_4), 76.8 (C_5), 75.9 (C_7), 70.3 (C_6), 67.8 (C_8), 57.6 (C_3), (C_2), 36.6 and 35.5 (NMe_2), 26.9 and 26.8 (CMe_2), 25.34 and 25.29 (CMe_2). EIMS *m/z* (%): 330 (M^+-15, 5) (15), 244 (10), 186 (10), 185 (7), 128 (18), 103 (35), 102 (25), 101 (40), 85 (20), 72 (100).
Anal. calcd. for $C_{16}H_{27}NO_7$; C, 55.64; H, 7.88; N, 4.05. Found: C, 55.69; H, 8.13; N, 4.00.

24: white crystals (504 mg, 38%); m.p. 165-167°C (benzene); [α]= - 16.86° (c 0.5, $CHCl_3$). ^1H NMR (Cl δ: 4.84-4.75 (m, 2H, H_4 and H_5), 4.53 (dd, 1H, $J_{2,3}$= 2.8 and $J_{2,OH}$= 6.3 Hz, H_2), 4.40-4.26 (m, 2H, H_6 and H_7), 4.04 (m, 3H, H_3, H_8 and H_8), 3.02 (s, 6H, NMe_2), 1.46, 1.43, 1.36 and 1.30 (4s, 12H, 2 x CMe_2). ^{13}C NMR (Cl δ: 171.1 (CO), 112.3 and 109.0 (2 x OCO), 85.1 (C_3), 83.0 (C_6), 81.5 and 81.4 (C_4 and C_5), 73.8 (C_7), 70.7 66.6 (C_8), 36.6 and 36.2 (NMe_2), 26.7, 25.9, 25.1 and 24.3 (2 x CMe_2). EIMS *m/z* (%): 345 (M^+, 0.3), 33(272 (30), 103 (75), 102 (42), 101 (52), 85 (25), 72 (100).
Anal. calcd. for $C_{16}H_{27}NO_7$; C, 55.64; H, 7.88; N, 4.05. Found: C, 55.31; H, 8.11; N, 3.86.

25: white solid (159 mg, 12%); m.p. 121-123°C. [α]= -18.18° (c 0.1, $CHCl_3$). ^1H NMR ($CDCl_3$) δ: 4.8(1H, $J_{4,5}$= 6.1 and $J_{4,3}$= 3.5 Hz, H_4), 4.80 (d, 1H, $J_{2,3}$= 9.1 Hz, H_2), 4.71 (dd, 1H, $J_{5,6}$= 3.7 and $J_{5,4}$= 6.1 Hz, H_5), (ddd, 1H, $J_{7,6}$= 6.1, $J_{7,8}$= 5.3 and $J_{7,8'}$= 6.0 Hz, H_7), 4.01 (dd, 1H, $J_{8',7}$= 6.0 and $J_{8',8}$= 8.5 Hz, $H_{8'}$), 3.95 (dd, 1H,

5.3 and $J_{8,8'}$= 8.5 Hz, H_8), 3.51 (dd, 1H, $J_{6,5}$= 3.7 and $J_{6,7}$= 6.1 Hz, H_6), 3.42 (dd, 1H, $J_{3,2}$= 9.1 and $J_{3,4}$= 3.5 Hz, H_3), 3.00 and 2.99 (2s, 6H, NMe_2), 1.39, 1.35 and 1.34 (3s, 3H, 3H and 6H, 2 x CMe_2). ^{13}C NMR ($CDCl_3$) δ: 172.7 (CO), 112.4 and 108.9 (2 x OCO), 83.7 (C_3), 82.2 (C_6), 80.8 (C_4), 79.8 (C_5), 73.1 (C_7), 66.3 (C_8), 64.6 (C_2), 36.8 and 35.9 (NMe_2), 26.7, 25.7, 25.1 and 24.1 (2 x $C\underline{Me}_2$). EIMS *m/z* (%): 345 (M^+, 1), 330 (13), 272 (14), 186 (9), 185 (8), 115 (14), 103 (42), 102 (24), 101 (32), 85 (22), 72 (100).
Anal. calcd. for $C_{16}H_{27}NO_7$; C, 55.64; H, 7.88; N, 4.05. Found: C, 55.30; H, 8.18; N, 3.93

The following acetylated derivatives were prepared with a 92-95 % yield from **22**, **24** and **25** respectively, using the procedure above described, all were purified by preparative TLC.

N,N-Dimethyl-6-O-acetyl-2,3-anhydro-4,5:7,8-di-O-isopropylidene-D-*erithro*-L-*gluco*-octonamide (26)

Colorless syrup; [α]= +29.69° (c 0.32, $CHCl_3$). ^{1}HNMR ($CDCl_3$) δ: 5.25 (dd, 1H, $J_{6,5}$= 2.4 and $J_{6,7}$= 6.6 Hz, H_6), 4.45 (dd, 1H, $J_{5,4}$= 6.8 and $J_{5,6}$= 2.4 Hz, H_5), 4.21 (ddd, 1H, $J_{7,6}$= 6.6, $J_{7,8}$= 6.7 and $J_{7,8'}$= 6.0 Hz, H_7), 4.08 (dd, 1H, $J_{4,3}$= 4.6 and $J_{4,5}$= 6.8 Hz, H_4), 3.98 (dd, 1H, $J_{8',7}$= 6.0 and $J_{8',8}$= 8.8 Hz, $H_{8'}$), 3.87 (dd, 1H, $J_{8,7}$= 6.7 and $J_{8,8'}$= 8.8 Hz, H_8), 3.53 (d, 1H, $J_{2,3}$= 2.1 Hz, H_2), 3.21 (dd, 1H, $J_{3,2}$= 2.1 and $J_{3,4}$= 4.6 Hz, H_3), 3.11 and 2.94 (2s, 6H, NMe_2), 2.08 (CH_3CO), 1.48, 1.35 and 1.32 (3s, 3H, 3H and 6H, 2 x CMe_2). ^{13}C NMR ($CDCl_3$) δ: 170.4 and 166.4 ($CH_3\underline{CO}$ and $\underline{CO}NMe_2$), 109.7 and 109.5 (2 x OCO), 76.1 (C_4), 75.8 and 75.6 (C_5 and C_7), 69.6 (C_6), 66.4 (C_8), 55.6 (C_3), 49.3 (C_2), 36.5 and 35.9 (NMe_2), 26.4 and 25.5 (2 x $C\underline{Me}_2$), 21.1 ($\underline{CH}_3CO$). EIMS *m/z* (%): 372 (M^+-15, 9), 314 (3), 114 (20), 101 (30), 72 (100).

N,N-Dimethyl-2-O-acetyl-3,6-anhydro-4,5:7,8-di-O-isopropylidene-D-*erithro*-L-*allo*-octonamide (27)

Colorless syrup; [α]= -6.9° (c 0.36, $CHCl_3$); ^{1}H NMR ($CDCl_3$) δ: 5.29 (d, 1H, $J_{2,3}$= 3.6 Hz, H_2), 5.06 (d, 1H, $J_{4,5}$= 6.2, H_4), 4.81 (dd, 1H, $J_{5,4}$= 6.2 and $J_{5,6}$= 4.1 Hz, H_5), 4.32 (q, 1H, $J_{7,8'}$=$J_{7,8}$=$J_{7,6}$= 6.0 Hz, H_7), 4.24 (d, 1H, $J_{3,2}$= 3.6, H_3), 4.10-3.99 (m, 3H, H_6, H_8, $H_{8'}$), 3.08 and 2.93 (2s, 6H, NMe_2), 2.09 (s, 3H, CH_3CO), 1.44, 1.40, 1.32 and 1.30 (4s, 12H, 2 x CMe_2). ^{13}C NMR ($CDCl_3$) δ: 169.9 and 166.6 ($\underline{CO}NMe_2$ and $CH_3\underline{CO}$), 112.7 and 108.9 (2 OCO), 83.2 (C_3), 82.7 (C_6), 81.6 and 81.1 (C_4 and C_5), 73.7 (C_7), 72.3 (C_2), 66.2 (C_8), 36.9 and 36.0 (NMe_2), 26.8, 25.9, 25.0 and 24.4 (2 x $C\underline{Me}_2$), 20.8 ($\underline{CH}_3CO$). EIMS *m/z* (%): 372 (M^+-15, 9), 314 (45), 168 (45), 145 (91), 103 (46), 102 (14), 101 (49), 85 (12), 72 (100), 43 (75).

N,N-Dimethyl-2-O-acetyl-3,6-anhydro-4,5:7,8-di-O-isopropylidene-D-*erithro*-L-*manno*-octonamide (28)

White solid; m.p. 134-137°C; [α]= -27.7° (c 0.31, $CHCl_3$). ^{1}H NMR ($CDCl_3$) δ: 5.48 (d, 1H, $J_{2,3}$= 9.5 Hz, H_2), 4.75-4.73 (m, 2H, H_4 and H_5), 4.32 (ddd, 1H, $J_{7,8'}$= 6.0, $J_{7,8}$= 5.4 and $J_{7,6}$= 6.3 Hz, H_7), 4.0 (dd, 1H, $J_{8',7}$= 6.0 and $J_{8',8}$= 8.5 Hz, $H_{8'}$), 3.94 (dd, 1H, $J_{8,7}$= 5.4 and $J_{8,8'}$= 5.4 Hz, H_8), 3.86 (dd, 1H, $J_{3,2}$= 9.5 y $J_{3,4}$= 1.2 Hz, H_3), 3.52 (dd, 1H, $J_{6,7}$= 6.3 and $J_{6,5}$ <1 Hz, H_6), 3.10 and 2.94 (2s, 6H, NMe_2), 2.10 (CH_3CO), 1.46, 1.36, 1.33 and 1.30 (4s, 12H, 2 x $C\underline{Me}_2$). ^{13}C NMR ($CDCl_3$) δ: 169.9 and 168.7 ($\underline{CO}NMe_2$ and $CH_3\underline{CO}$), 112.6 and 109.0 (2 x OCO), 82.0

(C_6), 80.5, 80.2 and 80.1 (C_3, C_4 and C_5), 73.0 (C_7), 66.3 and 66.2 (C_2 and C_8), 36.9 and 36.0 (NMe_2), 26.6, 25.8, 25.2 and 24.2 (2 x CMe_2), 20.6 (CH_3CO). EIMS *m/z* (%): 387 (M^+, 2), 372 (M^+-15, 20), 330 (8), 314 (4), 229 (7), 194 (8), 168 (11), 152 (24), 145 (21), 103 (11), 102 (6), 101 (26), 72 (100), 43 (60).

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