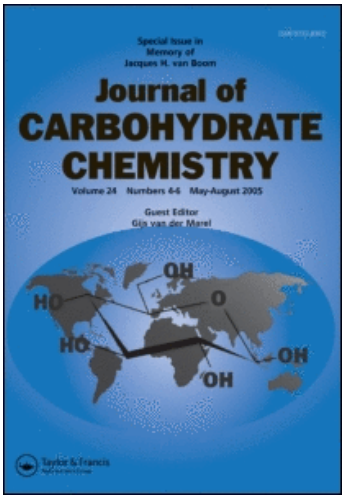

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REACTIONS OF 2-DEOXY-4,5-*O*-ISOPROPYLIDENE-D-*ERYTHRO*- AND D-*THREO*-PENT-1-ENOSE DERIVATIVES

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ABSTRACT

The reactivity of the title compounds has been studied toward different nucleophiles and electrophiles. Unlike other ketene dithioacetals, compounds 3-5 did not add nucleophiles to the double bond. Instead, in the presence of Lewis acids they underwent substitution reaction at position 3. If the nucleophile was not strong enough, formation of 6 and 7 were observed. With 2,3,4,6-tetra-*O*-acetyl-1-thio-β-D-glucopyranose (18), a 3:1 mixture of 11 and 12 was formed from 4. These observations may be interpreted in terms of easy formation of the allylic carbocation I which gives diastereomers with nucleophiles. However, this allylic ether-like behaviour was ruled out by the fact that compounds 9 and 10 did not undergo [2,3] sigmatropic rearrangement with lithium diisopropylamide. With *N*-bromosuccinimide compound 3 gave the 2-bromo derivative 8. Compounds 3 and 8 resisted common mercury salt assisted demercaptalization procedures.

INTRODUCTION

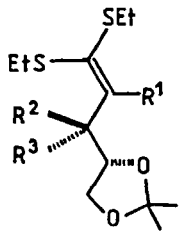
Sugar ketene dithioacetals are poorly investigated synthetic units.[1] Horton and Wander[1d] reported the unusually low reactivity of some carbohydrate ketene diphenyl dithioacetals, and Wong and Gray[1a,b] prepared 1 and 2 and demonstrated their synthetic utility in the prepa-

ration of 2-deoxyaldopentoses and their isotopically labelled derivatives. Later, they extended the synthetic methodology to 2-deoxyaldohexoses.[1c] Gurjar *et al.* synthesized 1,5-di-*O*-acetyl-3-azido-2,3-dideoxy-D-*erythro*-pentofuranose (containing the glycosyl moiety of AZT) starting from 1.[1e] Maehr *et al.* developed a synthetic strategy for the preparation of leukotriene B_4 analogues using 2-deoxy-4,5-*O*-isopropylidene-D-*erythro*-pent-1-enose diisopropyl dithioacetal.[1f]

Therefore, as a part of our ongoing program to obtain sugar α-ketoesters, which are valuable starting materials for the synthesis of many organic compounds, e.g. *C*-nucleosides[2], we have investigated the transformation of some pentose ketene dithioacetals. Here we wish to report on the behaviour of the title compounds toward different reagents.

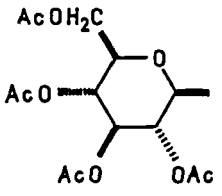
RESULTS AND DISCUSSION

Following the methodology developed by Wong and Gray[1b] we have obtained 1 from the potassium *tert*-butoxide induced elimination of 2,3:4,5-di-*O*-isopropylidene-D-arabinose diethyl dithioacetal. *In situ* alkylation with benzyl chloride or methyl iodide gave 3 and 4, respectively. Similarly, 5 was prepared from 2,3:4,5-di-*O*-isopropylidene-D-xylose diethyl dithioacetal *via* 2. Ketene dithioacetals are known to be able to add nucleophiles,[3] e.g. cyanide, alkylthiolate etc., often resulting in compounds of type 13, which can be transformed into protected α-ketoesters. Therefore, we have allowed 3 to react with trimethylsilyl cyanide in methanol, and, with ethanethiol in dichloromethane, in the presence of zinc iodide. To our surprise, both reactions afforded the same products (6 and 7 - albeit in 12 and 68 % yield, respectively), after 24 hours and 1 hour, respectively. In addition, in the first reaction after a few minutes two kinetic products were observed to be formed and, then slowly transformed into two thermodynamic products. After 30 minutes the kinetic products were isolated and determined to be 4 and 5. Treating 4 or 5 with trimethylsilyl cyanide in methanol resulted in the formation of two thermodynamic products, identical in all respects with compounds obtained in the reaction of 3 (TMSCN/MeOH or $EtSH/CH_2Cl_2/ZnI_2$). Pure samples of these products were obtained by column chromatography. Based upon the ^1H NMR spectrum of each compound, it was concluded that each contained one additional

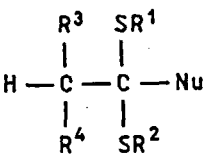


1 - 12

	R^1	R^2	R^3
1	H	OH	H
2	H	H	OH
3	H	OBn	H
4	H	OMe	H
5	H	H	OMe
6	H	SEt	H
7	H	H	SEt
8	Br	OBn	H
9	H	OCH_2CO_2Me	H
10	H	OCH_2CO_2H	H
11	H	SR^4	H
12	H	H	SR^4

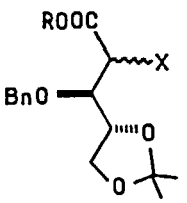


18 : R^4SH



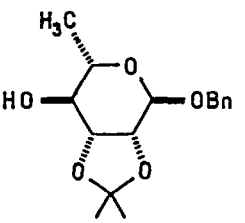
Nu = CN, SR etc.

13



15 X = H; R = alkyl

16 X = Br; R = alkyl



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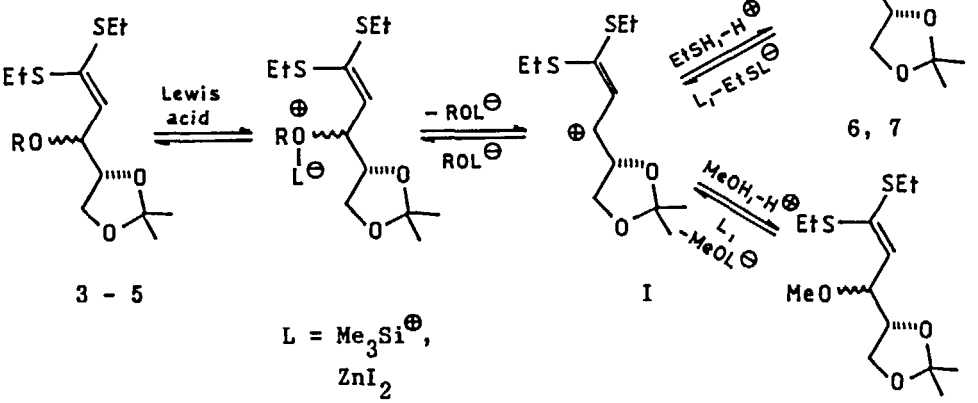


3 - 5

I

6, 7

4, 5

L = $Me_3Si^{\oplus}$, ZnI_2

SCHEME 1

ethylthio group in lieu of substituent at position 3. The assignment of stereochemistry at position 3, however, is tentative. We consider the more polar compound as the D-*erythro*, and the less polar one as the D-*threo* diastereomer (6 and 7, respectively).

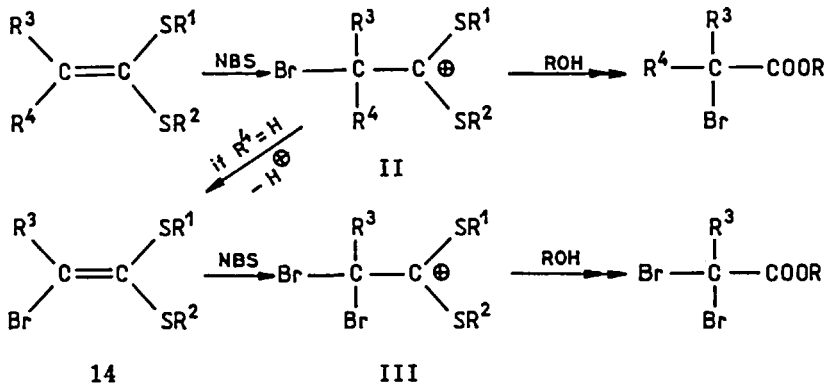
The formation of 6 and 7 can be interpreted in terms of carbocation formation (SCHEME 1). The formation of carbocation I is facilitated by Lewis acids (TMSCN or ZnI_2). This ion reacts with solvent methanol in the first reaction to afford 4 and 5 as kinetic products. These substances, however, are not stable and *via* I give 6 and 7 (in a ratio of 6:4). The source of ethanethiol needed for this reaction is rather mysterious, but may originate from the starting substance(s) or from the intermediate(s). It should be noted that we could not isolate any other product beside 4, 5, 6, and 7. The reaction of 3 with $EtSH/ZnI_2$ in CH_2Cl_2 proceeded very quickly to afford 6 and 7 without intermediate(s).

Sodium ethanethiolate (DMF, Δ), potassium cyanide (DMF, Δ), or tetrabutylammonium cyanide (benzene, Δ) additions to 3 were unsuccessful, and we recovered 3 without any change.

This behaviour of ketene dithioacetals 3 - 5 prompts us to believe that they prefer the Lewis acid-mediated replacement of the substituent at position 3 by nucleophiles, instead of addition to the double bond.

Seebach *et al.*[4] reported on the mono- and dibromination of ketene dithioacetals by *N*-bromosuccinimide to give α-bromo and α,α-dibromo carboxylic esters (SCHEME 2). These reactions proceed *via* the intermediates II and III. Since α,α-dibromo carboxylic esters are precursors of α-ketoesters, we treated 3 with one equivalent of NBS (THF--MeCN, 0 °C) and compound 8 was formed. With two or more equivalents of NBS the course of the reaction did not change and further introduction of bromine was not possible, even with heating. Since the yield of 8 was not very high using NBS we turned our attention to pyridine dibromide[5] as a brominating agent. Indeed, the reaction takes place smoothly to give 8 in 83 % yield. Seebach *et al.*[4] assumed the formation of a similar monobrominated substance (14) and Carey *et al.*[6] indeed isolated compounds of this type. The reason why the introduction of second bromine was unsuccessful in the case of 3 remains to be clarified.

As could be expected from the previous reactions of 3, it tends to behave as an allyl ether rather than a ketene dithioacetal. In order to check this hypothesis we prepared 9 and 10, because carboxymethyl allyl



SCHEME 2

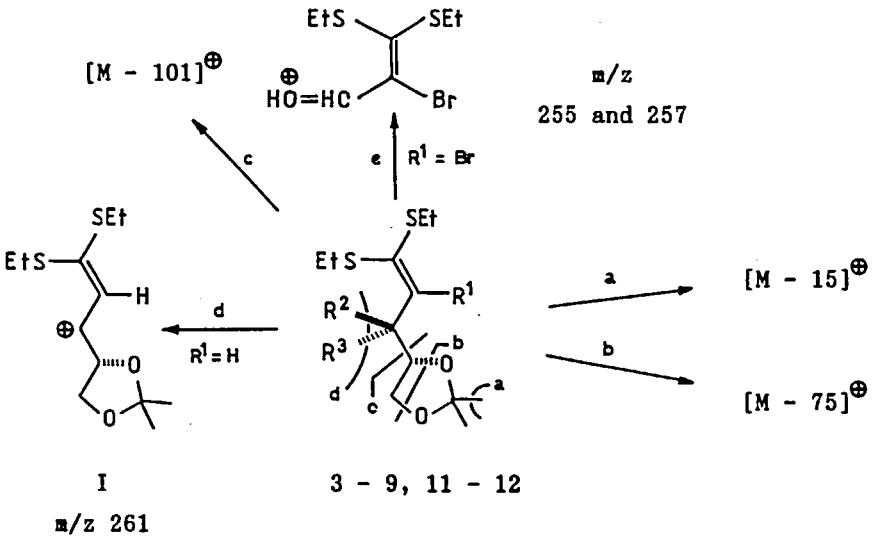
ethers are known to undergo smooth [2,3] sigmatropic rearrangement with strong bases.[7] Compound 9 was prepared from crude 1 by *in situ* alkylation with methyl bromoacetate. The yield was low (28 % + 25 % 1) and alterations in the reaction conditions or reagents did not improve the yield. Attempted alkylation with ethyl diazoacetate (benzene, $RhCl_3$, Δ)[8] failed to give any etherified product. Compound 9 was hydrolysed to 10 (KOH/THF-water, r.t., then acid) and not isolated. Compounds 9 and 10 were treated with lithium diisopropylamide (1.2 and 2.2 eq. in THF, respectively), but no change was observed even at room temperature; thus, these substances do not undergo [2,3] sigmatropic rearrangement to give the expected masked α-hydroxy β-keto carboxylic acid derivatives.

Compounds 3 and 8 resisted the common mercury salt assisted demercaptalisation procedures to give esters 15 and 16, respectively, which might be elaborated into protected α-ketoesters. Carbohydrate ketene diphenyl dithioacetals proved to be similarly unreactive towards hydrolysis.[1d]

The facile exchangeability of a substituent at position 3 observed in the reactions of compounds 3-5 has stimulated us to attempt to introduce nucleophiles in the presence of Lewis acids. First we have allowed 5 to react with benzyl 2,3-di-*O*-isopropylidene-α-L-rhamnopyranoside (17)[9] in CH_2Cl_2, in the presence of 0.1 eq of trimethylsilyl cyanide. This reaction was completed only after 12 days, and the products were 6 and 7 along with unchanged 17. Performing this reaction in nitromethane

in the presence of catalytic amounts of zinc iodide we have observed after 20 minutes the equilibration between 4 and 5 alongside with the concomitant formation of 6 and 7. The reaction was completed after 3 days and beside the compounds mentioned and unchanged 17 we could not detect any other product. Using trimethylsilyl triflate in CH_2Cl_2 in the same reaction, the formation of 6 and 7 was complete within 5 minutes and we isolated their mixture in 44 % yield. These results suggest that the sterically hindered *O*-nucleophile 17 probably cannot compete with ethanethiol which always forms in an unknown way from the carbocation I. Thus, we have tried 2,3,4,6-tetra-*O*-acetyl-1-thio-β-D-glucopyranose (R^4SH: 18)[10] as an *S*-nucleophile in reaction with 4 or 5 in nitromethane, in the presence of catalytic amounts of zinc iodide. The reaction was complete after 15 minutes: both starting materials have been consumed and a single new spot was detected by TLC with negligible formation of 6 and 7. The product was isolated and determined to be a 3 : 1 mixture of the expected products, 11 and 12 (stereochemistry again tentatively assigned). By several recrystallizations from ether and hexane this ratio was raised to ca. 5 : 1. Comparing the ^1H and ^{13}C NMR spectral parameters of the two mixtures we were able to assign all signals of the major (that we believe is 11) and nearly all signals of the minor diastereomer with extensive application of ^1H-^1H and ^1H-^{13}C correlation methods (*cf.*TABLEs).[11] The $J_{1',2'}$ coupling constants, both in 11 and 12, indicate that the relative 1', 2' *trans* stereochemistry has been preserved in the glucopyranosyl moiety during the course of reaction. This is in accordance with the fact that the anomerization of thioglycosides requires rather drastic conditions,[12] which were avoided in the above reaction. Compounds of type 11/12 were hitherto unknown. Dithioacetals of reducing disaccharides, which exhibit some resemblance to them, have been reported.[13]

Due to the flexibility of the open chain in substances 6, 7, 11, and 12, the conformation is uncertain. Therefore an exact configuration assignment is not possible. Although certain tendencies can be observed in the ^1H- and ^{13}C-NMR data of these compounds (see TABLEs), we do not consider them satisfactory for unambiguous configuration assignment. Thus, the attributed configuration of diastereomeric substances 6/7 and 11/12 is arbitrary and their configurations at C-3 may be reversed.



SCHEME 3

In the mass spectra of the title compounds some characteristic fragmentation patterns were observed (see SCHEME 3). The molecular peak in these substances is usually weak. The peaks belonging to M-15, M-75, and M-101 are the most characteristic ones, representing the splitting paths a, b, and c, respectively. In compounds 6, 7, 11, and 12 the formation of carbocation I (m/z 261) is facilitated (path d). The brominated substance 8, in addition, shows a more complicated fragmentation pattern (path e). In the mixture of 11 and 12 the presence of the glucopyranosylium ion $[R^4]^+$ (m/z 331) was also seen.

Our original objective, the transformation of carbohydrate ketene dithioacetals into the corresponding α-ketoesters, was not attained since the double bond in these compounds is very stable and they avoid reactions leading to the fission of π bond (addition of nucleophiles, dibromination, allylic ether-like rearrangement, hydrolysis). The observed positive reactions comprise (probably electrophilic) bromination at C-2 and Lewis acid mediated nucleophilic displacement at C-3.

EXPERIMENTAL

General Procedures. Melting points were determined in open capillary tubes or on a Kofler electric hot stage and are not corrected. The

dried (magnesium sulphate) solutions were concentrated on a rotary vacuum evaporator, usually below 40 °C. Optical rotations were determined with a Perkin-Elmer 241 polarimeter. The IR spectra were recorded on a Perkin-Elmer 283 B spectrometer in potassium bromide pellets. NMR spectra were obtained with a Bruker WP 200 SY instrument in C_6D_6 solutions with tetramethylsilane as internal standard (δ, ppm). The NMR parameters of individual compounds are listed in TABLEs. The electron ionization MS spectra were recorded on a VG 7035 instrument. Elemental analyses were performed by the Analytical Division of our Institute. TLC : Kieselgel 60 F_{254}, Merck. The chromatograms were rendered visible under a UV lamp and by heating on an electric hot plate. Flash chromatography was performed on silica gel. Eluents were used as follows: hexane - ethyl acetate 99 : 1 (A); 98 : 2 (B); 97 : 3 (C); 9 : 1 (D); 8 : 2 (E); 7 : 3 (F); chloroform - methanol 8 : 2 (G). Anhydrous tetrahydrofurane was distilled over lithium aluminium hydride. Anhydrous dimethyl sulphoxide was distilled over calcium hydride in a nitrogen atmosphere *in vacuo*. Anhydrous pyridine was distilled first over potassium hydroxide then over phosphorus pentoxide. Anhydrous dichloromethane, nitromethane, and acetonitrile were distilled over phosphorus pentoxide.

Generally, only successful experiments have been described.

3-*O*-Benzyl-2-deoxy-4,5-*O*-isopropylidene-D-*erythro*-pent-1-enose Diethyl Dithioacetal (3). To a suspension of 1.50 g (13.37 mmol) of *tert*-BuOK in 75 mL of THF and 25 mL of DMSO was added dropwise a solution of 2,3:4,5-di-*O*-isopropylidene-D-arabinose diethyl dithioacetal[1b] (3.00 g, 8.93 mmol) in 30 mL of THF at ambient temperature over 15 min. After stirring for 1 h, 1.13 mL (9.81 mmol) of benzyl chloride was added to the dark solution. After 2 h the reaction mixture was poured onto ice and extracted with chloroform (3 x 150 mL). The combined organic layers were washed with brine. Drying and evapn afforded a brownish syrup which was subjected to chromatography (eluent C) to yield 3 (2.36 g, 72 %) as a yellow oil: $[\alpha]_D^{25}$ +79.7° (*c* 1.8, chloroform); MS (m/z, I, %): 353 (1, M-15); 336 (10); 293 (1, M-75); 267 (24, M-101); 217 (25); 143 (90); 135 (85); 101 (30); 91 (92, $C_7H_7^+$); 43 (100, $^iPr^+$).

Anal. Calcd for $C_{19}H_{28}O_3S_2$: C, 61.92; H, 7.66; S, 17.40. Found: C, 62.01; H, 7.57; S, 17.19.

TABLE 1. ^{1}H NMR Spectral Parameters for Compounds 3-9, 11-12[a]

	3	4	5	6	7	8	9	11[b]	12[b]
Chemical Shifts (δ in ppm, relative to internal tetramethylsilane)									
H-2	6.13	6.05	6.03	6.30	6.17	-	6.07	6.320	6.245
H-3	4.84	4.58	4.73	4.36	4.55	5.31	4.98	4.535	4.835
H-4	4.17	4.10	4.24	4.10	4.20	4.48	4.45	4.725	-[c]
H-5a	3.90-	3.99-	3.81	3.91	3.79	4.03	4.08-	3.883	3.795
H-5b	-4.07	-4.01	3.94	3.94	3.94	4.13	-4.29	4.050	3.992
$C\underline{H}_3CH_2S$	1.06 1.08	1.06 1.08	1.02 1.05	1.09 1.10	1.05 1.07	0.99 1.12	1.08 1.10	1.050- -1.190	-[c]
$CH_3C\underline{H}_2S$	2.30- -2.85	2.31- -2.87	2.30- -2.83	2.30- -2.72	2.47[d] 2.49[d]	2.30- -2.80	2.32- -2.88	2.338- -2.850	-[c]
$(C\underline{H}_3)_2C$	1.28 1.49	1.27 1.50	1.31 1.50	1.24 1.43	1.26 1.47	1.21 1.50	1.32 1.53	1.260 1.413	1.213 1.450
Others	4.39 4.62 ($PhC\underline{H}_2$) 7.02- -7.33 ($C_6\underline{H}_5$)	3.20 ($C\underline{H}_3O$)	3.25 ($C\underline{H}_3O$)	1.13 (3-$C\underline{H}_3CH_2S$) 2.30- -2.72 (3-$CH_3C\underline{H}_2S$)	1.16 2.63[d]	4.22 4.59 ($PhC\underline{H}_2$) 7.03- -7.35 ($C_6\underline{H}_5$)	3.28 ($C\underline{H}_3O$) 3.98 4.07 ($C\underline{H}_2CO$)	4.717 (H-1') 5.233 (H-2') 5.395 (H-3')	4.668 (H-1') -[c] -[c]
H-4'								5.212	-[c]
H-5'								3.352	3.532
H-6'								4.204	-[c]
Coupling Constants (J in Hz)									
$J_{2,3}$	9.0	9.0	9.0	10.5	10.5	-	9.5	9.8	10.4
$J_{3,4}$	6.5	6.5	5.8	7.5	6.0	8.3	7.0	7.5	4.8
$J_{4,5a}$	6.0	5.0	6.5	7.5	6.0	6.0	-[e]	6.1	5.8
$J_{4,5b}$	6.0	-[e]	7.0	8.0	6.5	6.5	-[e]	6.1	6.5
$J_{5a,5b}$	-[e]	-[e]	8.5	-[e]	8.5	9.0	-[e]	8.5	8.5
$J_{1',2'}$								10.0	10.0
$J_{2',3'}$								9.0	-
$J_{3',4'}$								9.4	-
$J_{4',5'}$								10.2	10.2
$J_{5',6'a}$								2.5	2.5
$J_{5',6'b}$								4.8	4.8

a. In C_6D_6 b. Assignments based on COSY[11a,b] and ^{1}H-^{13}C one bond correlation[11c] experiments c. Signals indistinguishable from those of the major diastereomer d. Interchangeable assignments e. Coupling constant could not be determined due to the presence of an unanalysable multiplet

TABLE 2. ^{13}C NMR Chemical Shifts of Compounds 4-7, 9, 11, 12[a]

	4	5	6	7	9	11	12
C-1	137.02	137.19	133.08	133.89	138.46	134.70	-[b]
C-2	134.92	133.02	136.48	135.02	132.88	134.41	133.85
C-3	77.91[c]	78.28[d]	48.22	48.01	77.70[e]	48.03	47.57
C-4	79.89[c]	79.53[d]	78.19	78.54	78.47[e]	78.67	77.86
C-5	67.36	65.83	68.55	67.27	67.56[f]	68.28	66.95
$\underline{C}H_3CH_2S$	14.06 15.23	14.08 15.20	14.24 15.15	14.24 15.16	13.96 15.14	14.28 15.32	-[b] -[b]
$CH_3\underline{C}H_2S$	26.94 27.53	26.94 27.58	27.07 27.63	27.05 27.66	27.00 27.62	27.24 27.63	27.75 -[b]
$(CH_3)_2\underline{C}$	109.52	109.68	109.78	109.92	109.56	110.08	-[b]
$(\underline{C}H_3)_2C$	25.49 26.83	25.67 26.74	25.59 26.80	25.52 26.78	25.42 26.73	25.66 26.81	25.34 26.61
Others	56.32	56.61	15.45	15.40	65.17[f]	82.96	83.19
	($\underline{C}H_3O$)	($\underline{C}H_3O$)	(3-$\underline{C}H_3CH_2S$)		(3-$\underline{C}H_2O$)	(C-1')	(C-1')
			24.68 (3-$CH_3\underline{C}H_2S$)	25.13	170.46 ($\underline{C}OO$)	71.18 (C-2')	70.99 (C-2')
					51.09 ($\underline{C}H_3O$)	74.55 (C-3')	-[b] (C-3')
C-4'						68.71	68.96
C-5'						76.28	-[b]
C-6'						62.18	-[b]
$\underline{C}H_3CO$[g]						20.15 20.32	
$CH_3\underline{C}O$						168.75 168.97 169.75 169.92	

a. In C_6D_6 b. Shielded by other signals c., d., e., f. Interchangeable assignments g. Not all signals are distinguishable due to the feeble resolution.

2-Deoxy-4,5-*O*-isopropylidene-3-*O*-methyl-D-*erythro*- and -D-*threo*-pent-1-enose Diethyl Dithioacetal (4 and 5). Compound 4[1b] was prepared in 54 % yield in an analogous way as 3 using methyl iodide instead of benzyl chloride: $[\alpha]_D^{25}$ +72.2° (*c* 1.29, chloroform), lit.[1b] value +17.6° (*c* 0.4, chloroform); MS (m/z, I, %): 292 (1, M^+); 277 (2, M-15); 253 (1); 240 (1); 217 (2, M-75); 203 (1); 191 (100, M-101); 101 (20); 85 (5).

Anal. Calcd for $C_{13}H_{24}O_3S_2$: C, 53.39; H, 8.27; S, 21.93. Found: C, 53.20; H, 8.21; S, 21.85.

Similarly, 5 was prepared from 2,3:4,5-di-*O*-isopropylidene-D-xylose diethyl dithioacetal[1b] as above, in 61 % yield: $[\alpha]_D^{25}$ -68.9° (*c* 1.21, chloroform); MS (m/z, I, %): 292 (1, M^+); 277 (3, M-15); 217 (2, M-75); 191 (100, M-101); 101 (30); 85 (3).

Anal. Calcd for $C_{13}H_{24}O_3S_2$: C, 53.39; H, 8.27; S, 21.93. Found: C, 53.28, H, 8.19; S, 21.74.

Comparing the rotatory values of 4 and 5 with that of the reported value for 4 and taking into account the observed easy equilibration between the two diastereomers, we suspect that the reported optical rotation is not correct, and it refers to the mixture of 4 and 5, which might have formed from 4 during storage in the presence of a catalytic amount of an acid.

Reaction of 3 with Trimethylsilyl Cyanide. To a stirred solution of 3 (0.369 g, 1 mmol) in anhydrous methanol (2 mL) trimethylsilyl cyanide (0.138 mL, 1 mmol) was added in one portion at room temperature. TLC monitoring (solvent D) indicated the slow consumption of 3 together with the appearance of two slower-moving components, which, after 24 h, completely disappeared and only two faster-moving components were present in the reaction mixture. Aqueous work-up after 24 h afforded a syrup, which was chromatographed (eluent B) to yield 6 and 7 and their mixture (altogether 41.0 mg, 12 %).

2-Deoxy-3-*S*-ethyl-4,5-*O*-isopropylidene-3-thio-D-*erythro*-pent-1--enose Diethyl Dithioacetal (6): $[\alpha]_D^{25}$ -1.40° (*c* 1.29, chloroform); MS (m/z, I, %): 322 (1, M^+); 307 (2, M-15); 261 (25, I); 247 (8, M-75); 221 (95, M-101); 203 (10); 186 (10); 157 (18); 141 (20); 131 (13); 113 (19); 101 (23); 97 (20); 85 (27); 75 (88); 61 (13, EtS^+), 43 (100).

Anal. Calcd for $C_{14}H_{26}O_2S_3$: C, 52.13; H, 8.13; S, 29.82. Found C, 52.30; H, 8.24; S, 29.70.

2-Deoxy-3-*S*-ethyl-4,5-*O*-isopropylidene-3-thio-D-*threo*-pent-1-enose Diethyl Dithioacetal (7): $[\alpha]_D^{25}$ -14.40° (*c* 1.29, chloroform); MS: completely identical with that for 6.

Anal. Calcd for $C_{14}H_{26}O_2S_3$: C, 52.13; H, 8.13; S, 29.82. Found C, 52.10; H, 8.11; S, 29.55.

In another experiment 6 and 7 were isolated together from the crude product in order to establish their ratio by integrating the doublets of protons H-2 at δ 6.30 and 6.17 ppm, respectively. This ratio was invariably found to be 6:4, in favour of the more polar 6.

If the above reaction was interrupted after 30 min by pouring the reaction mixture into water, evaporating the methanol and extracting the solution several times with chloroform and purifying the resulting crude product as mentioned, the two slower-moving components could be isolated in variable and modest yields. The optical rotations, the spectral data and microanalyses have proved beyond doubt that these kinetic products are identical with authentically prepared 4 and 5.

Reaction of 3 with Ethanethiol/Zinc Iodide. To a stirred solution of compound 3 (0.369 g, 1.00 mmol) dissolved in dichloromethane (10 mL) were added ethanethiol (0.110 mL, 1.50 mmol) and a catalytic amount of zinc iodide. TLC monitoring indicated that the reaction was complete after ca. 1 h. The mixture was poured into a dilute sodium hydroxide solution, and the products were extracted with dichloromethane (3 x 10 mL). The organic layers were dried, evapd and the residue subjected to chromatography (eluent A). Eluted first was 6 (41 mg), then a mixture of 6 and 7 (155 mg), and finally pure 7 (23 mg; altogether 68 %). The physicochemical and spectral parameters of these products were completely identical with those of the previously prepared ones.

3-*O*-Benzyl-2-bromo-2-deoxy-4,5-*O*-isopropylidene-D-*erythro*-pent-1-enose Diethyl Dithioacetal (8). A. With N-Bromosuccinimide.
Compound 3 (0.368 g, 1.00 mmol) was dissolved in tetrahydrofuran (1 mL) and the solution stirred in an ice bath. *N*-Bromosuccinimide (0.178 g, 1.00 mmol) in acetonitrile (1 mL) was added to the solution which was then stirred for 20 min. The reaction mixture was poured onto a chromatographic column and eluted (solvent B) to afford 8 as a light yellow oil (0.226 g, 51 %): $[\alpha]_D^{25}$+6.2° (*c* 1.14, chloroform); MS (m/z, I, %): 431 and 433 (each 3, M-15); 345 and 347 (each 30, M-101); 255 and 257 (each 10); 101 (42); 91 (100, $C_7H_7^+$); 43 (13).

Anal. Calcd for $C_{19}H_{27}BrO_3S_2$: C, 51.00; H, 6.08; Br, 17.86; S, 14.33. Found: C, 51.07; H, 6.17; Br, 17.68; S, 14.20.

B. With Pyridine Dibromide. A carbon tetrachloride solution of bromine (3.00 mL of 1.00 M soln, 3.00 mmol) was added to stirred ice-cold anhydrous pyridine (5 ml). Pyridine dibromide immediately separated in the form of orange crystals. To this mixture the chilled soln of compd 3 (0.368 g, 1.00 mmol) in anhydrous pyridine (3 mL) was added and stirring was continued. The colour of the mixture turned into pale yellow. After 1 h the salts were filtered off and washed with carbon tetrachloride. The filtrate was diluted with carbon tetrachloride and washed with potassium hydrogen sulphate soln to remove pyridine and then with sodium hydrogen carbonate soln. Evapn and chromatography as above gave 8 (0.370 g, 83 %). This substance was identical in all respects with the previously obtained one.

2-Deoxy-4,5-*O*-isopropylidene-3-*O*-methoxycarbonylmethyl-D-*erythro*-pent-1-enose Diethyl Dithioacetal (9). From 2,3:4,5-di-*O*-isopropylidene-D-arabinose diethyl dithioacetal (3.00 g, 8.93 mmol) was prepared compd 1 as described in the preparation of 3. *In situ* reaction with methyl bromoacetate (1.24 g, 13.37 mmol) resulted in partial alkylation even after prolonged reaction times and a reagent surplus. Aqueous workup and chromatography (eluents D and E) yielded 9 (0.86 g, 28 %) and unreacted 1 (0.63 g, 25 %). Attempted alkylation of 1 (0.63 g, 2.26 mmol) with ethyl diazoacetate (0.24 mL, 2.26 mmol) in benzene (10 mL) in the presence of rhodium trichloride trihydrate (5.1 mg, 0.020 mmol) failed to give any 9, either at room temperature or at elevated temperatures.

9: $[\alpha]_D^{25}$ +63.4° (*c* 1.43, chloroform); MS (m/z, I, %): 350 (1, M^+); 335 (8, M-15); 275 (9, M-75); 261 (4, I); 249 (100, M-101); 203 (4); 159 (33); 145 (20); 141 (13); 113 (12); 101 (47); 97 (7); 85 (13); 75 (36); 61 (8); 43 (78).

Anal. Cald for $C_{15}H_{26}O_5S_2$: C, 51.40; H, 7.48; S, 18.30. Found: C, 51.28; H, 7.53; S, 18.13.

Acid 10 was prepared by hydrolysis of 9 (0.330 g, 0.94 mmol) in an aqueous tetrahydrofuran soln of potassium hydroxide. The solvents were removed *in vacuo*, the residue was acidified with hydrochloric acid and the compd extracted with chloroform. TLC (solvent G) indicated the presence of a single component. The evapd and carefully dried residue was pure enough to be used directly in the lithiation experiments.

Attempted Demercaptalisation of Compds 3 and 8. The following reagent systems were tried and invariably found to be unsuccessful in performing the desired transformation: A. $Hg(OAc)_2$, $CdCO_3$/MeOH - H_2O, Δ. B. $HgCl_2$, HgO/MeOH - H_2O, Δ. C. $Hg(OCOCF_3)_2$, $CdCO_3$/MeOH - H_2O, Δ. D. HgO, $BF_3.Et_2O$/85 % THF, rt. E. *m*-chloroperbenzoic acid/CH_2Cl_2, 0 °C, aqueous work-up. F. MeI/MeOH - H_2O, $NaHCO_3$, Δ.[14]

2-Deoxy-4,5-*O*-isopropylidene-3-*S*-(2',3',4',6'-Tetra-*O*-acetyl-β-D-glucopyranosyl)-3-thio-D-*erythro*- and -D-*threo*-pent-1-enose Diethyl Dithioacetals (11 and 12). Compounds 4 (0.628 g; 2.15 mmol) and 18 (0.782 g; 2.15 mmol) were dissolved in anhydrous nitromethane (15 mL) and a catalytic amount of anhydrous zinc iodide was added. After 10 min practically a single spot was detected by TLC (solvent F) with negligible formation of 6 and 7. Prolonged reaction times gave unidentified side products. The reaction mixture was poured into a satd soln of sodium hydrogen carbonate and extracted with chloroform. Column chromatography (eluent E) of the evapd residue afforded a yellowish syrup (0.903 g; 67 %) which crystallized on standing. Trituration with hexane gave a solid with a melting range of 68 - 78 °C. Integrating the pertinent doublets of H-2 in the ^1H NMR spectrum (at δ 6.320 and 6.245 ppm, respectively) it was evident that the sample was a 3 : 1 mixture of 11 and 12. Several recrystallizations from ether-hexane mixtures afforded a solid (mp 77 - 81 °C) which proved to be a 4.6 : 1 mixture, in favor of 11: $[\alpha]_D^{25}$-61.3° (*c* 1.15, chloroform; 11 : 12 = 4.6 : 1); MS (m/z; I; %; 11 : 12 = 3 : 1): 624 (2, M^+); 609 (1, M-15); 549 (2, M-75); 523 (33, M-101); 331 (48, $[R^4]^+$); 293 (10, $[I + S]^+$); 261 (100, I); 203 (52); 169 (100, $[R^4 - 2 \times AcOH - CH_2CO]^+$); 141 (50); 109 (86, $[R^4 - 3 \times AcOH - CH_2CO]^+$); 101 (56); 75 (100); 43 (100).

Anal. Calcd for $C_{26}H_{40}O_{11}S_3$: C, 49.98; H, 6.45; S, 15.40. Found C, 50.20; H, 6.52; S, 15.30.

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