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MIGRATION OF THIOLTHIOCARBONYL GROUPS OF METHYL α-D-GLUCOPYRANOSIDE XANTHATES*

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INTRODUCTION

Previously, we showed the effect of such reaction variables as solids content, temperature, and time upon the distribution of xanthate groups in starch xanthate[1]. We found that significant migration of the thiolthiocarbonyl groups from the secondary positions to the primary position occurred.

To verify these migrations and to provide guidelines for interpreting the mechanisms of these changes, xanthation of a model compound, methyl α-D-glucopyranoside, has now been studied. In addition, the isomeric monosubstituted 2-, 3-, and 6-(sodium xanthate) salts of the model compound have been prepared, and their behavior under alkaline conditions typical of xanthation media have been investigated.

RESULTS AND DISCUSSION

Xanthation of methyl α-D-glucopyranoside

Methyl α-D-glucopyranoside was treated with sodium hydroxide and carbon disulfide in the 2:2:1 ratios used for starch[1]. Portions of the reaction mixture were neutralized and benzylated at intervals up to 5 h. The yield of xanthate ester at each time was estimated from the u.v. absorption maximum at 355 nm. The results, presented in Table I, indicate that the increase in degree of substitution (D. S.) is almost

TABLE I

CHANGE IN DEGREE OF SUBSTITUTION (D.S.) DURING XANTHATION OF METHYL α-D-GLUCOPYRANOSIDE

Time (min)	15	30	45	60	120	180	240	300
D.S.	0.06	0.13	0.23	0.33	0.35	0.33	0.34	0.31

linear during the first h, and that the D.S. thereafter remains nearly constant. These results are closely parallel to data reported for the xanthation of starch[2].

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The xanthate esters were resolved by t.l.c., and were determined quantitatively by developing the t.l.c. plates with iodine vapor, sectioning the individual zones, evaporating the iodine, eluting the sections with methanol, and determining the u.v. absorption at λ_{max} 280–285 nm. To identify the components separated by this procedure, authentic samples of the 2-, 3-, and 6-(*S*-benzylxanthates) were prepared.

Table II shows the distributions of the various isomeric xanthates, in terms of molar contributions to the total D. S. values recorded in Table I.

TABLE II

DISTRIBUTION OF XANTHATE GROUPS DURING XANTHATION OF METHYL α-D-GLUCOPYRANOSIDE[a]

Glucoside Xanthate	*Time (min)* 15	30	45	60	120	180	240	300
2-Isomer	0.02	0.04	0.05	0.06	0.07	0.05	0.05	0.05
3-Isomer	0.01	0.01	0.02	0.03	0.03	0.02	0.02	0.02
6-Isomer	0.03	0.07	0.13	0.20	0.21	0.20	0.24	0.21
Polyxanthates	0.01	0.01	0.03	0.04	0.04	0.06	0.03	0.03

[a] Distributions of totals are presented in Table I.

Throughout the xanthation, the 6-isomer preponderates, and the 2-isomer is more abundant than the 3-isomer. Doane, Russell, and Rist[2] found similar orders of positional substitution for starch xanthated to D. S. values of 0.13 and 0.32. During the first few min of xanthation, the secondary substitution (sum of 2- and 3-isomers) and primary substitution (6-isomer) are almost the same. After several h, however, the primary substitution is about three times the secondary. In addition, there are as-yet-unidentified components having R_F values higher than those of the isomers identified. On the basis of u.v. analysis, these are believed to be polyxanthates of methyl α-D-glucopyranoside.

To permit study of the redistribution in more detail, the isomeric 2-, 3-, and 6-(sodium xanthate) salts were prepared, and each was treated with aqueous alkali under conditions typical of xanthation reactions. The resulting isomers were then benzylated, and the distributions of substituents in the products were determined.

The isomeric sodium xanthate salts were obtained from the respective *S*-benzylxanthates by treatment with sodium hydrosulfide in methyl sulfoxide:

$$ROC(=S)SCH_2Ph + NaSH \rightarrow ROC(=S)SNa + PhCH_2SH$$

Other useful solvents for the reaction were tetrahydrofuran and pyridine. A solution of the *S*-benzylxanthate was cooled to 0–5° and agitated with the theoretical amount of anhydrous sodium hydrosulfide. Some migration of substituent groups unavoidably took place during the cleavage reaction with sodium hydrosulfide. When the sodium xanthate salts were immediately dissolved in water and rebenzylated at 5°, the original

S-benzylxanthates were recoverable in yields of 70–80%. Small proportions of the other monosubstituted isomers and some polysubstituted products were also identified.

Table III gives the results obtained by incubating each of the 2-, 3-, and 6-xanthate salts in 18% sodium hydroxide for 30 min at 25° before neutralization and rebenzylation.

TABLE III

MIGRATION OF 2-, 3-, AND 6-SODIUM THIOLTHIOCARBONYL GROUPS OF METHYL α-D-GLUCOPYRANOSIDE XANTHATES[a]

Xanthate isomer treated	*Distribution of xanthate groups after treatment %*			
	2-	*3-*	*6-*	*Polyxanthates*[b]
2-	3	1	85	8
3-	11	8	77	4
6-	4	5	88	3

[a] Xanthates were treated with 18% sodium hydroxide for 30 min at 25°. [b] More than one xanthate group per molecule of methyl α-D-glucopyranoside.

With both the 2- and 3-isomers, extensive migration occurred, and gave 85 and 77%, respectively, of the 6-(sodium xanthate). The 6-isomer underwent little change, as 88% was recovered as the 6-(*S*-benzylxanthate).

To investigate the possibility of intramolecular migration of the sodium thiolthiocarbonyl group, a more detailed study was conducted with the 2-isomer. The treatment with 18% sodium hydroxide was performed at 0–5° in order to retard the rearrangement, and samples were neutralized and benzylated after 0, 30, 60, and 90 min (see Table IV). Since there was a relatively large proportion of the 3-isomer present

TABLE IV

MIGRATION OF THE 2-SODIUM THIOLTHIOCARBONYL GROUP OF METHYL α-D-GLUCOPYRANOSIDE XANTHATES[a]

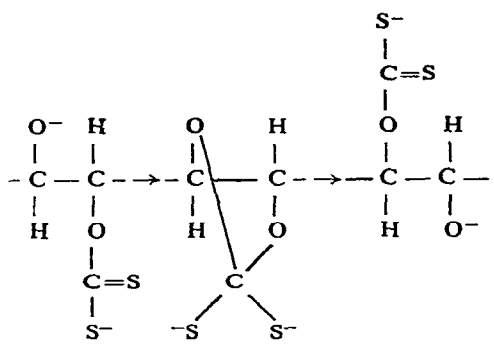
Length of treatment (min)	*Distribution of xanthate groups during treatment %*			
	2-	*3-*	*6-*	*Polyxanthates*
0	80	3	9	8
30	43	19	20[b]	18
60	13	14	62	11
90	7	12	56	25

[a] Xanthate was treated with 18% sodium hydroxide for 90 min at 5°. [b] Believed to contain some 4-isomer.

(30 min) before appreciable migration to the 6-position, transfer of substituent from the 2- to the 3- and 6-positions probably occurred intramolecularly. The presence of small proportions of polyxanthates indicates that some intermolecular transfer also occurs.

Further support for the intramolecular mechanism was obtained by use of a suitably protected derivative of methyl α-D-glucopyranoside. Methyl 3-*O*-methyl-α-D-glucopyranoside 2-(*S*-benzylxanthate) was synthesized, and cleaved to the xanthate salt; this was incubated with 18% sodium hydroxide for 2 h at 5°, the solution was neutralized, and the product was rebenzylated. A parallel experiment was performed with the unprotected 2-(*S*-benzylxanthate) of methyl α-D-glucopyranoside. T.l.c. of the rebenzylated products showed that, although extensive migration to the 6-position had taken place with the unprotected derivative, no migration was evident in the 3-*O*-methyl derivative, because only a single spot (that corresponded to the xanthate started with) was seen.

Migrations probably proceed through a series of ortho-ions as follows:



Efforts to trap and identify these ortho-ions through treatment of xanthates with alkoxide have so far been unsuccessful. Evidently, if such changes occur, they are so rapid that the intermediates are not isolable.

Other aspects of migration of substituents were examined. For example, if sodium thiolthiocarbonyl groups decompose to trithiocarbonate, xanthation might occur at a different position. Ingram and Toms[3] reported reactions between alcohols and trithiocarbonate in anhydrous media to form xanthates. However, treatment of ethanol or methyl α-D-glucopyranoside with sodium trithiocarbonate in 18% sodium hydroxide gave no evidence of formation of xanthate (u.v. spectra), even after several days. In view of these results and the rapidity of the migrations, the involvement of trithiocarbonate appeared unlikely. On the other hand, xanthate groups might decompose to carbon disulfide, which, in the presence of sodium hydroxide, could then re-xanthate the substrate at different positions. In control experiments, carbon disulfide was quantitatively and rapidly flushed with nitrogen from a medium of 18% sodium hydroxide into a solution of an amine in alcohol, and the carbon disulfide was determined spectrophotometrically as the dithiocarbamate salt (λ_{max} near 290 nm)[4]. Solutions of the 2-xanthate salt of methyl α-D-glucopyranoside in 18% sodium hydroxide contained small proportions of carbon disulfide, but benzylation of the nitrogen-flushed samples did not show significant differences in substituent distributions from those observed after benzylation of unflushed samples treated under similar conditions.

Apparently, the amounts of carbon disulfide involved were too low to influence the observed migrations appreciably.

Preparation of the isomeric 2-, 3-, and 6-(S-benzylxanthates) of methyl α-D-glucopyranoside

Methyl 4,6-*O*-benzylidene-α-D-glucopyranoside (**1**) was xanthated and *S*-benzylated, and the resultant mixture of xanthate esters was fractionally recrystallized

1 R^1 = H, R^2 = H
2 R^1 = CS_2CH_2Ph, R^2 = H
3 R^1 = H, R^2 = CS_2CH_2Ph
4 R^1 = CS_2CH_2Ph, R^2 = Bz
5 R^1 = Bz, R^2 = CS_2CH_2Ph
6 R^1 = $COSCH_2Ph$, R^2 = Bz
7 R^1 = Bz, R^2 = $COSCH_2Ph$
8 R^1 = CS_2CH_2Ph, R^2 = Me
9 R^1 = CS_2CH_2Ph, R^2 = H, R^3 = H
10 R^1 = H, R^2 = CS_2CH_2Ph, R^3 = H
11 R^1 = H, R^2 = H, R^3 = CS_2CH_2Ph
12 R^1 = CS_2CH_2Ph, R^2 = Me, R^3 = H
13 R^1 = CS_2Na, R^2 = Me, R^3 = H

to give methyl 4,6-*O*-benzylidene-α-D-glucopyranoside 2-(*S*-benzylxanthate) (**2**) and methyl 4,6-*O*-benzylidene-α-D-glucopyranoside 3-(*S*-benzylxanthate) (**3**). Mild, acid hydrolysis selectively removed the *O*-benzylidene groups to give methyl α-D-glucopyranoside 2-(*S*-benzylxanthate) (**9**) and methyl α-D-glucopyranoside 3-(*S*-benzylxanthate) (**10**). The identities of **2**, and **3**, were established by benzoylation to **4**, and **5**, and subsequent conversion to the known monothiolcarbonates, **6** and **7**. Methyl α-D-glucopyranoside 6-(*S*-benzylxanthate) (**11**) was prepared by direct xanthation and *S*-benzylation of methyl α-D-glucopyranoside. The 6-isomer preponderated, and could be crystallized preferentially from the ester mixture. Its identity was confirmed by comparison with the product obtained by the barium hydroxide procedure, and by preparation of the known[5] triacetate and tribenzoate.

Preparation and cleavage of methyl 3-O-methyl-α-D-glucopyranoside 2-(S-benzylxanthate)

Compound **2** was treated with diazomethane in the presence of boron trifluoride as a catalyst[6], to give methyl 4,6-*O*-benzylidene-3-*O*-methyl-α-D-glucopyranoside 2-(*S*-benzylxanthate) (**8**). Mild, acid hydrolysis removed the *O*-benzylidene group, to give methyl 3-*O*-methyl-α-D-glucopyranoside 2-(*S*-benzylxanthate) (**12**), which was cleaved with sodium hydrosulfide to yield the sodium xanthate salt **13**. Benzylation of **13** regenerated **12** exclusively.

EXPERIMENTAL

U. v. spectra between 210 and 400 nm were determined with a Perkin–Elmer*, Model 202, recording spectrophotometer equipped with 1-cm silica cuvettes. Appropriate blank corrections were made for all determinations of optical absorbance. Melting points were determined in sealed capillaries in an oil bath and are uncorrected. Optical rotations were measured with a Rudolph polarimeter.

Xanthation of methyl α-D-glucopyranoside. — A solution of methyl α-D-glucopyranoside (19.4 g) in water (20 ml) was mixed with carbon disulfide (3 ml) and sodium hydroxide solution (4 g in 5 ml of water) at room temperature, with rapid agitation. Portions (5 ml) were withdrawn at 15, 30, 45, 60, 120, 180, 240, and 300 min, neutralized with 10 ml of N acetic acid at 0–5°, and treated with 1 ml of benzyl bromide for 2–3 h. The mixtures were extracted with chloroform, dried over sodium sulfate, and diluted to 500 ml; the u.v. spectra were determined at 355 nm (the average extinction coefficient is 87 for the 2-, 3-, and 6-isomers at this wavelength).

The chloroform extracts were spotted on microscope slides coated with Silica Gel B (Brinkmann Instruments, Inc.) and developed with ethyl acetate. In later experiments, I.T.L.C. (Gelman Instrument Co.) was used and developed with 10:7:3 cyclohexane–ethyl acetate–chloroform. Charring, or staining with iodine, revealed four components, three of which corresponded to the known 2-, 3-, and 6-isomers when the latter were developed under similar conditions. For quantitative determinations, the components were revealed by the nondestructive, iodine-stain technique. The zones were sectioned, the iodine was evaporated, and the adsorbate was placed in a filter cone and eluted directly into a cuvette for determination of the u.v. absorbance at 280–285 nm. The extinction coefficients of each isomer were similar (near 12,500) in this region, and the proportion of each isomer was taken as the ratio of its absorbance to the total absorbance. To establish the validity of this method, known mixtures of the 2-, 3-, and 6-isomers were chromatographed under similar conditions, and the absorbances determined. The isomer ratios thus found agreed within 5–10% with the ratios taken by weight. It was necessary in each case to correct for absorption in the 280–285-nm region, since washing the absorbent from unspotted slides revealed slight interference in this region.

Methyl 4,6-O-benzylidene-α-D-glucopyranoside 2- and 3-(S-benzylxanthates) (**2** *and* **3**). — Compound **1** was prepared by known methods from methyl α-D-glucopyranoside[7–9]. Twenty g of **1** was xanthated by dissolving it in *p*-dioxane (50 ml) and adding carbon disulfide (50 ml) followed by 5N sodium hydroxide (12 ml). The mixture was stirred for 15 min, cooled to 5° with ice, and rendered neutral with acetic acid. The mixture was treated with benzyl bromide (7.2 ml), stirred for 4 h at 5°, and evaporated to a solid, which was extracted with several 50-ml portions of hot (75°) 0.5% sodium hydrogen carbonate solution, to give 4.23 g of **1**. The residue was dried,

*The mention of firm names or trade products does not imply that they are endorsed or recommended by the Department of Agriculture over other firms or similar products not mentioned.

and extracted with 1 liter of hexane, and the extract was cooled to give a solid, which was combined with the residue from this extraction; yield 17.61 g (57%). T.l.c. on Silica Gel G with 1:19 (v/v) acetone–chloroform showed two components, R_F 0.75 (85–90%), and R_F 0.61 (10–15%). These were resolved by fractional recrystallization from isopropyl alcohol. The less-soluble, minor isomer was **3**, yield 1.22 g (4%, based on **1**), m.p. 176–177°, $[\alpha]_D^{24.5}$ +38.8° (*c* 0.31, chloroform).

Anal. Calc. for $C_{22}H_{24}O_6S_2$: C, 58.9; H, 5.4; S, 14.3. Found: C, 58.9; H, 5.2; S, 14.3.

The more-soluble, major isomer was **2**, yield 10.40 g (34%, based on **1**), m.p. 132–133°, $[\alpha]_D^{24.5}$ +80.7° (*c* 0.87, chloroform).

Anal. Found: C, 59.0; H, 5.2; S, 14.4.

Methyl 2-O-benzoyl-4,6-O-benzylidene-α-D-glucopyranoside 3-(S-benzylxanthate) (**5**). — A solution of **3** (0.45 g) in pyridine (10 ml) was treated with benzoyl chloride (2 ml), and kept overnight. The mixture was processed in the usual way, to give 0.39 g (71%) of product. Recrystallization from ethanol gave **5**, m.p. 138°, $[\alpha]_D^{25}$ +95.9° (*c* 0.37, chloroform).

Anal. Calc. for $C_{29}H_{28}O_7S_2$: C, 63.0; H, 5.1; S, 11.6. Found: C, 63.1; H, 5.3; S, 11.9.

Methyl 3-O-benzoyl-4,6-O-benzylidene-α-D-glucopyranoside 2-(S-benzylxanthate) (**4**). — A solution of **2** (0.45 g) was benzoylated as above to give **4**, yield 0.39 g (71%). Recrystallization from ethanol gave pure **4**, m.p. 127°, $[\alpha]_D^{25}$ +68.4° (*c* 0.64, chloroform).

Anal. Found: C, 63.0; H, 5.2; S, 11.6.

Methyl 2-O-benzoyl-4,6-O-benzylidene-α-D-glucopyranoside 3-(S-benzylmonothiolcarbonate) (**7**). — A solution of **5** (0.28 g) in 90% aqueous *p*-dioxane (10 ml) was treated with mercuric acetate solution[5] (10 ml), and kept for 5 h at 40°. Colorless crystals were obtained from ethanol, yield 0.08 g (30%), which, on recrystallization, had m.p. 132–133°, $[\alpha]_D^{24.5}$ +109.6° (*c* 0.68, chloroform); lit.[9] m.p. 133–135°, $[\alpha]_D^{25}$ +107° (*c* 2, chloroform).

Methyl 3-O-benzoyl-4,6-O-benzylidene-α-D-glucopyranoside 2-(S-benzylmonothiolcarbonate) (**6**). — A sample of **4** (0.34 g) was treated as above to give the corresponding monothiolcarbonate (**6**), yield 0.10 g (30%), m.p. 136–137° on recrystallization from ethanol, $[\alpha]_D^{25}$ +44.5° (*c* 0.99, chloroform); lit.[9] m.p. 138–139°, $[\alpha]_D^{25}$ + 44.5° (*c* 2, chloroform).

Methyl α-D-glucopyranoside 2-(S-benzylxanthate) (**9**). — The *O*-benzylidene group was removed from **2** by an adaptation of the method of Capon, Overend, and Sobell[10] as follows: a solution of **2** (3.60 g) in methanol (190 ml), to which had been added concentrated hydrochloric acid (0.6 ml) and water (2 ml), was kept for 5 h at 40°. The solution was evaporated, the residue was dissolved in chloroform, and the solution was neutralized with sodium hydrogen carbonate solution, shaken with sodium hydrogen sulfite solution (to remove benzaldehyde), dried (sodium sulfate), evaporated, and the residue extracted with hot hexane, to give a colorless solid, yield 2.42 g (83.5%), m.p. 116–129°. Recrystallization from ether–hexane gave needles, m.p. 130–131°, $[\alpha]_D^{26.5}$ +97.8° (*c* 0.49, chloroform).

Anal. Calc. for $C_{15}H_{20}O_6S_2$: C, 50.0; H, 5.6; S, 17.8. Found: C, 49.9; H, 5.4; S, 17.6.

Methyl α-D-glucopyranoside 3-(S-benzylxanthate) (**10**). — A sample of **3** (1.07 g) was treated as above to remove the *O*-benzylidene group. Trituration of the final syrup with benzene gave 0.52 g of a solid (60.5%), that crystallized as needles from ether–hexane, m.p. 100–103°, $[\alpha]_D^{23}$ +150.9° (*c* 0.82, chloroform).

Anal. Found: C, 50.1; H, 5.8; S, 17.8.

Methyl α-D-glucopyranoside 6-(S-benzylxanthate) (**11**). — (*a*) *Sodium hydroxide method.* Methyl α-D-glucopyranoside (97 g) was dissolved in water (100 ml), and the solution was mixed with carbon disulfide (15 ml). The mixture was stirred rapidly, and a solution of sodium hydroxide (20 g) in water (25 ml) was added dropwise during 0.5 h, while the temperature was kept near 25°. The mixture was stirred for 5 h at 25°, rendered neutral with N acetic acid (500 ml), and cooled to 10°. Benzyl bromide (30 ml) was then added dropwise during 0.5 h, the mixture was stirred for 2 h at 10°, refrigerated overnight, extracted with chloroform, and the extract dried (sodium sulfate) and evaporated, to give 85.6 g of syrup (95% yield, based on carbon disulfide taken). The syrup was treated with warm benzene (500 ml), the suspension was filtered, and the filtrate was refrigerated overnight, to give 36.2 g of product, m.p. 77–83°, which, on repeated extraction with boiling hexane, was raised to 90–93°, yield 33.7 g (37.4%, based on carbon disulfide). The specific rotation varied somewhat with the concentration: $[\alpha]_D^{26.5}$ +69.6° (*c* 1.35, chloroform) and $[\alpha]_D^{26.5}$ +79.0° (*c* 4.82, chloroform). For this compound, $[\alpha]_D^{20}$ +79.4°, +79.8° (chloroform) have been reported[5].

(*b*) *Barium hydroxide method.* The method of Lieser, as adapted by Willard and Pacsu[5], was repeated to provide a reference for the preparation of this compound by the sodium hydroxide method. Benzylation of the xanthate solution gave a solid product, yield 14.22 g (30.6%). The yield varied according to the amount of carbon dioxide passed through the barium hydroxide solution. Crystallization of the ester from benzene, followed by boiling it with hexane, gave 11.7 g (25.2%), m.p. 91–93°, $[\alpha]_D^{26.5}$ +68.2° (*c* 1.17, chloroform) and $[\alpha]_D^{26.5}$ +79.6° (*c* 5.01, chloroform).

Products prepared by each method gave identical triacetates (84% yield) and tribenzoates (80% yield), having m.p. 106–109° and 124–127°, respectively (reported[5] 105–107° and 123–124°, 127–129°, respectively).

Sodium salts of the isomeric xanthates of methyl α-D-glucopyranoside. — The *S*-benzylxanthate isomers of methyl α-D-glucopyranoside (200–250 mg) were dissolved in a mixture of methyl sulfoxide (5 ml) and tetrahydrofuran (4 ml), the solution cooled to 0–5°, and agitated rapidly for 30–60 min with 40 mg of anhydrous sodium hydrosulfide[11]. The mixtures were neutralized with acetic acid, and the xanthate salts were precipitated as syrups on addition of ether (100 ml). The ether was decanted to remove α-toluenethiol, and the sodium salts were precipitated as solids by mixing with acetone (10 ml) and adding ether (100 ml). The products were filtered off, washed with ether, and dried immediately under vacuum over phosphorus pentaoxide. The products were deliquescent, and difficult to obtain pure. U.v. maxima were near 305 nm for the 2- and 3-xanthate salts and 303 nm for the 6-xanthate salts, and the extinction coefficients

lay between 6,000 and 10,000. The yields of the crude salts were between 90 and 100% of the theoretical.

Rebenzylation of the sodium salts of the isomeric xanthates of methyl α-D-glucopyranoside. — Portions of the xanthate salts (25–40 mg) were dissolved in water at 0–5° and treated with an excess of benzyl bromide. T.l.c. showed that, under these control conditions, the esters from which the salts had been derived were again formed. Similar amounts of salts were incubated for various time-intervals in 1 ml of 18% sodium hydroxide, and the mixtures were neutralized with 0.5N acetic acid (15 ml) at 0–5°, and benzylated similarly. The reaction mixtures were extracted with chloroform, and the extracts were dried with sodium sulfate. The yields of the rebenzylated xanthates were determined by diluting the chloroform extracts and determining the absorbance at 280–285 nm. The yields, based on the amount of xanthate salt taken, were generally quantitative. If too great an excess of benzyl bromide was used, there was some interference at this wavelength. In such instances, most of the excess benzyl bromide could be removed by evaporating the chloroform extract to a syrup and extracting this with hexane before u.v. analysis.

Conversion of methyl α-D-glucopyranoside 2-(S-benzylxanthate) into methyl α-D-glucopyranoside 6-(S-benzylxanthate). — Cleavage of the 2-(*S*-benzylxanthate) with sodium hydrosulfide, followed by incubation of the xanthate salt for 90 min in 18% sodium hydroxide at 0–5°, neutralization, and rebenzylation, gave a mixture in which the 6-(*S*-benzylxanthate) ester preponderated. The product, precipitated from benzene and hexane, melted at 75–90°, and t.l.c. showed a single component, comparable in R_F to the known 6-isomer. When the xanthate salt, in 18% sodium hydroxide at 0–5°, was neutralized immediately and then rebenzylated, the 2-(*S*-benzylxanthate) ester, m.p. 105–115°, was recovered. T.l.c. showed mainly the 2-isomer, with traces of the other isomers.

Methyl 4,6-O-benzylidene-3-O-methyl-α-D-glucopyranoside 2-(S-benzylxanthate) (**8**). — A solution of **2** (4.5 g) in dichloromethane (50 ml) was placed in a 2-l. Erlenmeyer flask and cooled to −80° in Dry Ice–acetone. A solution of diazomethane was prepared by mixing 10 g of *N*-methyl-*N*-nitrosourea with a suspension of 30 ml of 40% potassium hydroxide in 100 ml of ether and drying the resulting ether solution of diazomethane for several hours over potassium hydroxide pellets. This solution was cautiously added to the dichloromethane solution while the latter was stirred magnetically with a Teflon-covered stirring-bar. Addition of several drops of boron trifluoride etherate under these conditions caused a controlled evolution of gas, and, after 2 h, t.l.c. showed that **8** preponderated. The mixture was permitted to warm to room temperature gradually, causing slow decomposition of the excess diazomethane. The solution was then flushed with nitrogen, filtered through Celite, rendered neutral with 50 ml of 5% aqueous potassium hydrogen carbonate, and dried with sodium sulfate. The product was obtained by chromatography on Adsorbosil (Applied Science Laboratories, Inc.) by gradient elution with chloroform–cyclohexane. The product was crystallized from alcohol–water, to give crude **11**, yield 4.30 g (92%),

m.p. 15–25°. Several recrystallizations gave pure **11**, m.p. 35–37°, $[\alpha]_D^{24}$ +81.5° (*c* 1.66, chloroform).

Anal. Calc. for $C_{23}H_{26}O_6S_2$: C, 59.7; H, 5.7; S, 13.9. Found: C, 59.6; H, 5.8; S, 13.9.

Methyl 3-O-methyl-α-D-glucopyranoside 2-(S-benzylxanthate) (**12**). — Compound **8** (2.00 g) was treated for 3 h at 40° with 200 ml of 0.05M hydrochloric acid in methanol to remove the *O*-benzylidene group[10]. The product was isolated as previously described for the preparation of methyl α-D-glucopyranoside 2- and 3-(*S*-benzylxanthates). The product was separated from starting material by chromatography on Adsorbosil by using gradient elution with acetone–chloroform. Pure **12** was obtained by crystallization from benzene–hexane, yield 0.92 g (57%), m.p. 77–79°, $[\alpha]_D^{24}$ +114.6° (*c* 0.74, chloroform).

Anal. Calc. for $C_{16}H_{22}O_6S_2$: C, 51.3; H, 5.92; S, 17.1. Found: C, 51.4; H, 6.16; S, 16.5.

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SUMMARY

If similar reactant ratios are used, the xanthation of methyl α-D-glucopyranoside parallels the xanthation of starch. Degrees of substitution in the range of 0.3–0.4 were achieved, and changes in distribution from secondary to primary positions were observed. Synthesis of the individual, isomeric, xanthate salts of methyl α-D-glucopyranoside, and treatment of each with 18% sodium hydroxide, showed that the 2-, 3-, and 6-xanthate salts rearranged to mixtures in each of which the 6-isomer preponderated. Evidence is presented suggesting that the 2-isomer migrates intramolecularly to the 6-isomer by way of the 3-isomer. However, observation of the presence of minor proportions of polyxanthates in these mixtures suggests that intermolecular migration of thiolthiocarbonyl groups also occurs.

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