

The Synthesis of Methyl-2, 4, 6-Trideoxy- α -D-Glycero-3-Hexosulo Pyranoside and Methyl-3,4, 6-Trideoxy- α -D-Glycero-2-Hexosulo Pyranoside

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This paper dedicated to Professor W.A.Szarek for his retirement and his 80th birthday.

ABSTRACT

Two trideoxy keto sugars namely methyl-2,4,6-trideoxy- α -D-glycero-3-hexasulo pyranoside (7a) and methyl-3,4,6-trideoxy- α -D-glycero-2-hexasulo pyranoside (10) have been prepared from-D-glucose. The synthesis of 7a was achieved by irradiation of methyl -4,6-dideoxy-2-O-tosyl- α -D-erythro hexosulo pyranoside (6a). The another ketone 10 was prepared by an oxidation of methyl-3,4,6-trideoxy- α -D-erythro and threo hexapyranosides (9a and 9b). Intermediates and final products characterized by IR, ¹H-NMR spectroscopy and elemental analysis.

Key wards: Glucose, methyl-2,4,6-trideoxy- α -D-glycero-3-hexasulo pyranoside, methyl-3,4,6-trideoxy- α -D-glycero-2-hexasulo pyranoside, photochemical reactions, synthesis.

INTRODUCTION

Deoxy sugars had attracted researchers in chemistry, biochemistry and biology since the discovery of DNA (deoxy nucleic acid) structure.^{1,2} Quite a number of good books³ reviews,⁴ and research articles ⁵ have been published in this field. Mono deoxy sugars form an important class of carbohydrates represented by the most famous 2-deoxy furanose and its other analogues 1,3,4,5- and 6- monodeoxy sugars.⁶ The dideoxy sugars of different deoxy positions including a large class of sugars represented by methyl 4,6-dideoxy- α -D-xylo hexopyranoside which is part of Azitromycine antibiotic-the supplementary medicine to hydroxyl chloroquine- which was used as antimalarial and recently recommended as anti covid 19 virus.⁷ The trideoxy sugars form a large class of carbohydrate which varies according to their deoxy positions in their monosaccharide unit. Some of those are the 2,3,6-trideoxy hexoses which form an important naturally occurring sugars such as 2,3,6-trideoxy-D-erythro-hexose (D-amictose) and its L-enantiomer 2,3,6-trideoxy-D-threo-hexose (L-rhodinose) found in antibiotics.^{2,8}

Synthesis of 2,3,6-trideoxy hexoses implies diversity approaches, firstly by selective functionalizing OH group(s), and secondly by eliminating the protective groups.⁸⁻¹¹

Some 2,3,6-trideoxy sugars had been found to be promising with broad-spectrum activity against both bacterial and fungal strains.^{12,13}

RESULTS AND DISCUSSION

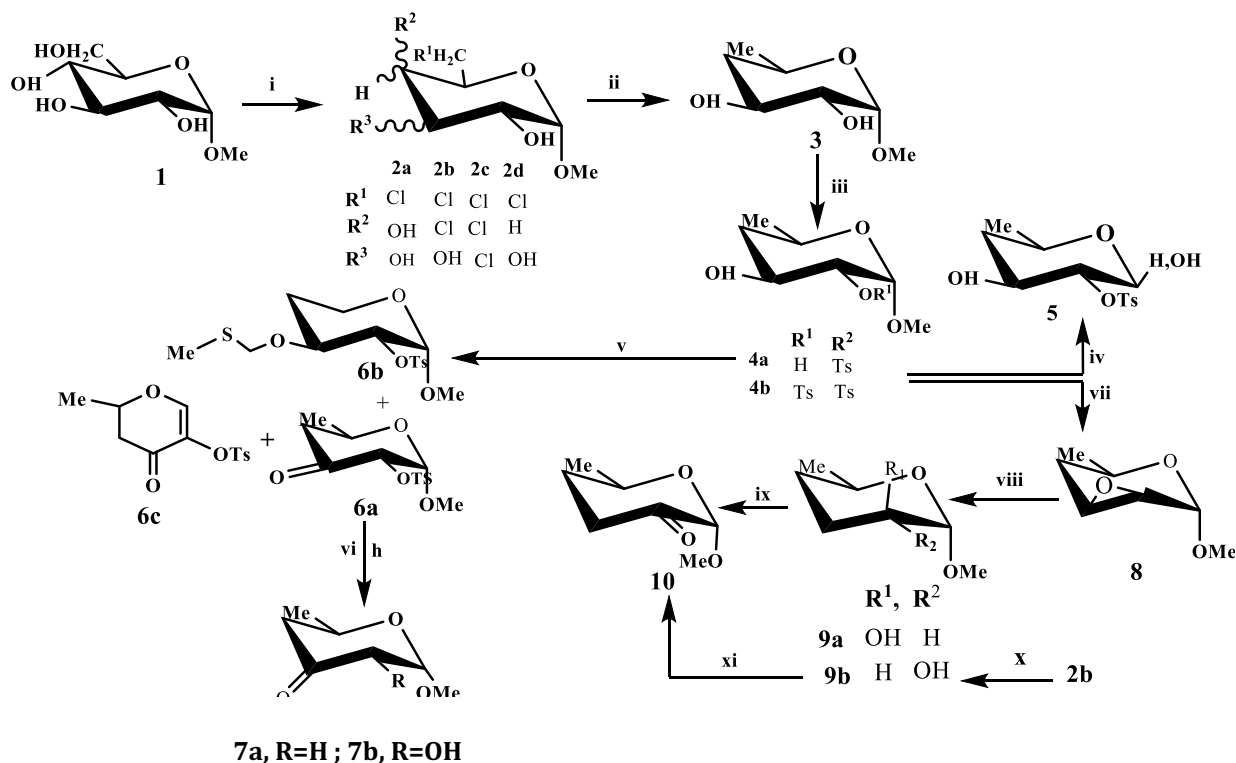
The trideoxy keto sugars methyl-2,4,6-trideoxy- α -D-glycero-3-hexosulo pyranoside (**7a**) and methyl-3,4,6-trideoxy- α -D-glycero-2-hexosulo pyranoside (**10**) have been prepared from-D-glucose via different routes as illustrated in Scheme 1.

A mixture of methyl-6-chloro-6-deoxy- α -D-galucopyranoside (**2a**), methyl-4,6-dichloro-4, 6-dideoxy- α -D-galacto pyranoside [**2b**] and methyl-3,4,6-trichloro-3,4, 6-trideoxy- α -D-galacto pyranoside [**2c**] has been obtained by means of the reported procedure¹⁴⁻¹⁵ in 80% yield and separated by column chromatography. Catalytic hydrogenation of (**2b**) using active Raney Nickel in presence of triethylamine resulted into methyl 6-chloro-4,6-dideoxy- α -D-xylo-hexopyranoside [**2d**]. But when the hydrogenation of (**2b**) was carried out under similar conditions but using potassium hydroxide instead of triethylamine it gave a quantitative yield of methyl 4,6-dideoxy- α -D-xylo hexopyranoside (**3**).

The 2-O-tosylate (**4a**) and its isomer 3-O-tosylate (**4b**) were considered as key compounds for the synthesis of the deoxy ketones (**7a** and **10** respectively).

Tosylation of **3** resulted into two products as shown in tlc. The rapid moving spot was shown to be belonging to the 2,3-ditosylate **4b** and the slower moving spot was proved to be the 2-tosylate (**4a**) in 48% yield. The structure of 2-tosylate (**4a**) was concluded from its resistance to acid hydrolysis in aqueous HOAc or in 1:1 methanolic HCl.¹⁶ The mono-detosylation of **4b** achieved with sulphuric acid 25% to give the 4, 6-dideoxy-2-O-tosyl-xylose (**5**) which failed to be oxidized with periodate. Oxidation of the tosylate (**4a**) with dimethyl sulphoxide gave a mixture of the 3-keto tosylate (**6a**), 3-O-thioethyl -2-O-tosylate (**6b**) and the α , β - unsaturated keto-tosylate compound (**6c**). The latter was isolated as a crystalline by silica gel column chromatography. However, the other two compounds **6a** and **6b** failed to separate neither by thick layer chromatography nor by silica gel or alumina column chromatography. Oxidation better achieved with ruthenium tetroxide and the pure keto-tosylate **6a** was isolated from silica gel column.

Irradiation of methyl 4,6-dideoxy-2-O-tosyl- α -D-erythro-3-hexosulopyranoside (**6a**) by immersion Hanovia high pressure mercury vapour lamp (110W) using corex filter was employed in aqueous acetone in presence of catalytic amount of triethyl amine resulted into a mixture of compounds **7(a,b)**.



Scheme 1, Synthetic scheme for 2,4,6-trideoxy hexaloses 7a and 3,4,6-trideoxy hexaloses 10 from methyl α -D-glucopyranoside (1).

[i) SO_2Cl_2 , ii) H_2/Ni , iii) TsCl , iv) $\text{H}^+/\text{H}_2\text{SO}_4$, v) RuO_4 , vi) UV, vii) NaOMe , viii) LiAlH_4 , ix) NaIO_4]

TLC showed four spots of R_f , 0.87, 0.64, 0.51 and 0.32. Column chromatography revealed the faster moving compound was unidentified substance, the second compound of R_f , 0.64, was found to be methyl-2,4,6-trideoxy- α -D-glycero-3-hexosulopyranoside (**7a**) resulted from photocatalyzed detoluensulphonation of **6a**. The lesser moving compound of R_f 0.51, identified to be the unchanged keto-tosylate **6a**. Whereas the slower moving component (R_f , 0.32) was found to be 4,6-dideoxy-3-keto sugar (**7b**) which resulted by means of photocatalyzed detosylation of **6a**. Structure elucidations based on IR, ^1H -NMR spectroscopic measurements and their elemental analysis (see experimental section).

The synthesis of the another 3-deoxy ketone **10**, namely methyl 3,4,6-trideoxy- α -D-glycero-2-hexosulopyranoside was achieved via two routes. The first route involved the preparation of the 2,3-anhydro compound **8** from the monotosylate **4a**, followed by ring opening of the epoxide with lithium aluminum hydride to give methyl 3,4,6-trideoxy- α -D-threo hexosulopyranoside (**9a**). Oxidation of the latter with ruthenium tetroxide in methanol-free chloroform gave the ketone **10** in 77% yield. The second route, which started from catalytic reduction of methyl 3,4,6-trichlore-3,4, 6-trideoxy- α -D-galactopyranoside (**2c**) with Raney nickel, yielded methyl 3,4, 6-trideoxy- α -D-erythre hexopyranoside (**9b**) in quantitative yield. Oxidation of **9b** with sodium periodate gave ketone **10** in 60% yield.

EXPERIMENTAL

General

Experimental with ultra violet light conducted in quartz apparatus with an immersion Hanovia high-pressure mercury vapor lamp (110W). Corex filter employed, unless otherwise stated. The lamp cooled internally by running water. ^1H -NMR spectra were recorded in CDCl_3 solution in a Varian A-60 spectrometer using TMS as internal standard. The following symbols were used to describe the corresponding signals: *s* = singlet, *ds* = double singlets, *d* = double, *dd* = double doublets, *t* = triplet, *dt* = double triplets, *q*=quartet, *dq*=double quartets, *m*=multiplet.

IR spectra were measured as Nujol mulls for solid samples or neat for syrup in Pye Unicam SP3-100 spectrophotometer and recorded as IR ν_{max} , cm^{-1} .

Thin layer chromatography (TLC) was carried out on DC-Alufeliar Kiesel gel 60; Ohme Fluoreszindikator.

Adsorption column chromatography were carried out using silica gel, (Keisel gel, 0.040 - 0.063mm; 230-400 ASTM-Merek), Columns were manually packet.

Melting points in centigrade recorded by means of Buchi 510 melting point apparatus and they are uncorrected.

Evaporation of the solutions performed in rotatory evaporator and under reduced pressure.

The term "the reaction mixture was worked up as usual": means that after stopping the reaction in the appropriate way, water added, the aqueous layer extracted once or several times with chloroform. The chloroform layer then washed with brine to neutrality, dried over anhydrous MgSO_4 . The solid filtered off and the filtrate evaporated to dryness under reduced pressure on a steam bath unless otherwise stated.

Synthesis

Methyl 4,6-dichloro-4,6-dideoxy- α -D-galactopyranoside(2a) and methyl 3,4,6-trichloro-3,4,6-trideoxy- α -D-galacto-Pyranoside (2b)

Methyl D-glucopyranoside(**1**) was treated with sulphuryl chloride by the method of Jennings and Jones.^{14,15} Column chromatography could separated three chloro derivatives of 1, namely: methyl-6-chloro-6-deoxy-D-glucopyranoside(**2a**),methyl-4,6-dichloro-4,6-dideoxy- α -D galactopyranoside(**2b**) and methyl 3,4,6-trichloro-3, 4,6-trideoxy- α -D-galacto-Pyranoside (**2c**).

Methyl-4, 6-dideoxy- α -D-xylopyranoside (2a)

Methyl 4,6-dichloro-4,6-dideoxy- α -D-galactopyranoside (**2a**, 1.65g), dissolved in ethanol (150 ml). Potassium hydroxide (lg) and catalytic amount of activated Raney Nickel added. The mixture was shaken under an atmosphere of hydrogen at 50 psi at room temperature for 1hr. the catalyst filtered off and the filtrate evaporated down to dryness under vacuum. Chloroform was added and washed with diluted HCL then with brine to neutrality and worked up as usual to give a colourless light syrup of methyl 4,6-dideoxy- α -D-xylo hexopyranoside (**3**, 0.96g). NMR = $^{TMS}_{CDCl_3}$ δ , 4.65, *d* (1H, H1) 4.35-3.7 *m*, (2H, H2 & H5). 3.05, *s* (1H, OH); 2.1-1.1, *m* (4H, H3, H3, H4, H4) unassigned), 1.25, *d* (3H, CH_3).

Tosylation of methyl-4, 6-dideoxy- α -D-xylopyranoside to give 4(a, b)

The deoxy sugar (**3**; 6g) dissolved in dry chloroform (50ml) and cooled down into an ice bath; dry pyridine (3.5ml) and *p*-toluene sulphonyl chloride (7.5g, 1 mole) added gradually. The reaction mixture was set aside for overnight at room temperature in dark. The reaction monitored by TLC (C_6H_6 -EtOAc; 3:1) which showed the formation of two products **4a** and **4b**. Iced water added and the contents extracted with chloroform. The organic layer was worked as usual to give a heavy syrup which was transferred to silica gel chromatography column eluted with C_6H_6 -Et OAc, 3:1 to give methyl-4, 6-dideoxy -2,3-O-di-tosyl- α -D-xylopyranoside (**4b**; 0.25g., as a colorless crystalline which recrystallized from EtOE-light petroleum ether:m.p 107-108°. IR 1600, 1500 (aromatic). NMR = $\frac{TMS}{CDCl_3}$ δ 4.5, *t* (8 H aromatic), 4.7, *d* (1H, H1, J= 4.5 Hz); 4.43-3.3, *m* (2H, H₂ & H₃); 3.2, *s* (3H.OCH₃); 2.4, *ds* (6H, 2CH₃ aromatic); 1.05, *d* (3H; CH₃).

Calculated for C₂₁ H₃₂ O₈ S₂ :

C, 52.94 % ; H, 6.71% ; S, 13.4%

Found: C, 53.05% ; H, 6.46% ; S, 13.46%

The second fraction methyl-4,6-dideoxy-2-O-tosyl)- α -D-xylopyranoside (**4a**, 2.5g) was collected as a heavy syrup. IR, 3500 (OH), 1600 , 1500 (Aromatic);). NMR = $\frac{TMS}{CDCl_3}$, 7.8, *t* (2H, Aromatic); 4.61, *d* (1H; HL, J₁₂4Hz); 4.15, *s* (1H; OH); 4.1 $\rightarrow$ 3.2, *m* (3H; H₂, H₃ & H₅); 3.2, *s* (3H; OCH₃); 2.4, *s* (3H; CH₃ aromatic).

Calculated for C₁₄H₂₀O₆S ; C, 53.16%; H, 6.32% S, 10.12%

Found: C, 52.92%; H, 6.45%; S, 9.93%

The aqueous layer was extracted continuously with chloroform for three days to give the starting deoxy sugar (**3**; 3.3g) recrystallized from EtOAc-petroleum ether 60-80°.

Methyl 4,6-dideoxy-2,3-di-O-*p*-toluene sulphonyl- α -D-xylopyranoside (4b)

Methyl 4,6-dideoxy sugar (**3**; 2.1 g.) was dissolved in dry pyridine (20ml). P-Toluene sulphonyl-chloride (5.5g; in 2.3 ml. pyridine) was added with an aid of stirring. The contents allowed standing at room temperature for 20 hours. The pyridinium salt filtered off. Chloroform (50 ml) added and the chloroform layer washed down many times with cold water/NaCl, then with cold diluted H₂SO₄, followed by bicarbonate then with water. The chloroform layer worked up as usual to give a heavy syrup (**4b**; 2.68g) IR showed no OH absorption. The syrup crystallized from EtOH-light petroleum to give colourless crystals, m.p 107-108°.

Calculated for C₂₁H₃₂O₈S₂ : C, 52.44%; H, 6.71% ; S, 13.4%

Found: C, 53.08%; H, 6.46%; S, 13.46%

4,6-Dideoxy-2-O-tosylate-D-xylose(5) by hydrolysis of methyl 4,6-dideoxy-2-O-tosyl- α -D-Xylo pyranoside with diluted H₂SO₄

Aqueous sulphuric acid (25%; 10ml) was added to the mono tosylate sugar (**4a**; 0.25g), and the contents were heated under reflux for 10 hrs. Hydrolysis monitored by TLC, which showed development of a new more polar spot. The contents were cooled down, neutralized with aqueous saturated solution of sodium bicarbonate and extracted with chloroform (250 ml). The extract worked up as usual to give a colorless syrup (0.2g). Transformed into a silica gel column eluted with ether- Pet ether 30-60°, 5:1) to give the starting tosylate (**4a**, 0.12 g) and 4,6-dideoxy

-2-O-tosylate -D-xylose (**5**, 0.06 g) which solidified by standing and recrystallized from petroleum ether 60-80°-chloroform into colorless cubes m.p 113°-114°.

The methyl glycoside (**4a**, 0.12g) which was recovered from the chromatography column was hydrolyzed again with aqueous H₂SO₄ as above to give another quantity of 4,6-dideoxy-2-O-tosylate-D-xylose to make the total yield (**5**, 0.14 g). IR max 3440 cm⁻¹ (broad, OH), 1375 cm⁻¹ (C=O), 1600-1500 cm⁻¹ (aromatic).

Calculated for C₁₃H₁₈O₆S; C, 51.65% ; H, 5.96% ; S, 10.6M

Found: C, 51.61% ; H, 6.09% ; S, 10.6%

Attempted periodate Cleavage of 5

4,6-Dideoxy-2-O-tosylate-D-xylose (**5**, 0.12 g) was dissolved in a small amount of ethanol. Aqueous- ethanolic solution of NaIO₄ (50 ml containing NaIO₄, 360 mg, 2 mole) and one drop of 2N-HCL was added to the sugar. The reaction mixture was set aside at room temperature for 12 hrs. The reaction mixture monitored by TLC, which indicated that no product produced. More sodium periodate was added and the contents were allowed to stand for further 6 hours at room temperature. TLC showed no change in the starting material. The reaction mixture was extracted with chloroform and the organic layer was worked up as usual to give the unchanged tosylate (**5**, 0.1g), mp 113-114°.

Oxidation of methyl-4,6-dideoxy-2-O-tosyl)- α -D-xylopyranoside (4a) to give Methyl 4,6-dideoxy-2-O-tosyl-D-erythro-3- α -hexosulo-Pyranoside (6a)

I) With DMSO: The monotosylate (**4a**, 7.5g) dissolved in dry acetic anhydride (20 ml) and dry dimethyl sulphoxide (65 ml). The mixture was set a side at room temperature for 14hrs. the bulk of solvents were removed under vacuum to a steam bath to give a crude syrup (7.6 g) which was transferred to a silica gel column, eluted with light petroleum ether- ether, 5:1 to give compound (**6c**, 1.2 g) as a colourless crystalline which recrystallized from petroleum ether 60-80°- methanol, m.p 103-104°. IR, 1690 cm⁻¹ (un sat, CO); 1620 cm⁻¹ (C=C); NMR, δ 7.7 dd (4H, aromatic); 7.5 s (1H, H1); 2.5 s (3H, CH₃ tosylate); 1.5 d (3H, CH₃).

Calculated for C₁₃H₁₄O₅S : C, 55.32% ; H, 4.96%; S, 11.34%

Found: C, 55.43%; H, 5.14% ; S, 11.26%

The second fraction (**6b**; 0.51 g) as a colourless syrup IR^{max} 1600, 1500 cm⁻¹ (aromatic). NO OH or C=O absorptions. NMR = δ 7.6, dd (4H, aromatic); 4.9, d (1H, H1, J 4.5), 4.6, s (2H, -S-CH₂-O-); 4.4-3.7, m (3H; 2H4, 1H5) ; 3.65, d (1H, H2), 4.45, s (3H, OCH₃), 2.55, s (3H, CH₃ aromatic); 2.2, s (3H, S-CH₃), 1.65, d (3H, H6). The third fraction was the starting tosylate (**4a**, 4.5 g).

II) With RuO₄: The tosylate (**4a**, 4.64g) dissolved in chloroform methanol free (50ml). Activated ruthenium dioxide (0.1g) added and the suspension was stirred vigorously. Aqueous solution of sodium hypochlorite 61% (100 ml) added and stirring continued at room temperature. After 20min, the black coloration changed into yellow. TLC eluted with benzene-Et OAC 3:1 showed the development of less polar compound than the starting material. Stirring continued at room temperature for further 2hrs. Additional solution of sodium hypochlorite (25 ml) added from

time to time to maintain the yellow coloration of the reaction mixture. After 6hrs, all the tosylate converted into keto tosylate (**6a**).

The chloroform layer separated and the aqueous layer extracted twice with chloroform and combined with the previous layer. Washed with aqueous solution of $\text{Na}_2\text{S}_2\text{O}_3/\text{NaCl}$ to remove the black suspension. The chloroform layer worked up as usual to give colourless syrup (4.64 g.). the crude α -Keto tosylate (**6a**, 3.2g) was transferred to a silica gel column eluted with C_6H_6 -EtOAc 3:1 to give a heavy colourless syrup (**6a**, 2.05g). IR 1765 cm^{-1} (CO), $1600\text{--}1500\text{ cm}^{-1}$ (aromatic). NMR = $^{\text{TMS}}_{\text{CDCl}_3}$ δ : 7.6, *dd* (4H, aromatic), 5.35, *d* (1H, H2), 3.1, *d* (1H, H2), 3.9, *s* (3H, OCH₃), 3.65, *d* (1H, H5), 2.5, *s* (3H, CH₃ aromatic), 1.4 $\rightarrow$ 1.3, *m* (5H, -CH₂ - & CH₃).

Calculate for $\text{C}_{14}\text{H}_{18}\text{O}_6\text{S}$, C, 53.5%; H, 5.73%, S10.19%

Found C, 52.9%; H, 6.0%, S 10.2 %

Photolysis of α -ketotosylate (6a) in aqueous acetone

A solution of α -ketotosylate (**6a**, 0.3g) in acetone (300ml), water (60ml) and triethylamine (1ml) added and the mixture was irradiated under an atmosphere of nitrogen at -10°C for 45 min, using corex glass filter. Reaction monitored by TLC to give four spots: $R_f = 0.87; 0.64; 0.51$ and 0.32 . The bulk of the acetone removed at room temperature under reduced pressure. The remaining aqueous mixture extracted thoroughly with petroleum ether $30\text{--}60^\circ$ (500 ml). The extract worked up as usual to give a yellowish syrup, which transformed to a silica gel column eluted with C_6H_6 -EtOAc 3: 1 to give four fractions. First fraction as a syrup (0.3g). IR showed to be an unidentified substance since it showed neither OH nor C=O absorptions. The second fraction as a pale yellowish syrup (0.05g). IR, showed no OH absorption but a strong absorption at 1740 cm^{-1} attributed to the ketone (**7a**)

Calculated for $\text{C}_7\text{H}_{12}\text{O}_3$, C, 58.33 % ; H, 8.33%

Found: C, 58.21% ; H, 8.5 %

The third fraction was a syrup (0.03g). IR showed an OH absorption and a strong absorption at $1720, 1600$ and 1500 cm^{-1} regions attributed to C=O and to the aromatic C=C stretching's respectively. Thus the product was attributed to the starting ketotosylate **6a** in comparison on TLC. The four fraction was also a syrup (0.03g) showed an absorption at 3500 cm^{-1} for OH and a strong C=O at 1720 cm^{-1} . This product attributed to **7b**.

Calculated for $\text{C}_7\text{H}_{12}\text{O}_4$: C, 52.2% ; H, 7.5%

Found: C, 52.9%; H, 7.6%

Methyl 4,6 dideoxy-2,3-anhydro- α -D-Xylopyranoside (8)

The monotosylate (**4a**; 2.97g) dissolved in a dry methanol (125ml). Methanolic solution of sodium methoxide (2%; 2ml) added and the contents heated under reflux on a steam bath for 1hr. TLC eluted with C_6H_6 -EtOAc 3:1 showed only a little conversion to the epoxide. Another portion of sodium methoxide solution (2%; 15ml) added and the reflux was continued for further 1.5 hr. TLC showed that all of the starting material was converted into the product with the development of other three spots. The reaction mixture then chilled into an ice bath and neutralized very carefully with 2N HCL. Excess of chloroform was added (500 ml) and the small

aqueous layer separated and extracted many times with chloroform. The extracts combined and evaporated to dryness under reduced pressure at room temperature to give a semi solid material. Chloroform (500 ml) added and the solid filtered off. The organic layer worked up as usual to give a yellowish syrup, which was adsorped into a silica gel column eluted with C₆H₆-EtOAC 3:1 to give four fractions.

Fraction 1: Rf 0.88 as a syrup (0.06g). IR max showed 1745 cm⁻¹, no OTS, NMR = $^{TMS}_{CDCl_3}$ δ : 4, s, 3.75 s, 3, m, 2.3, *m*, 1.5 s and *l, d*. Substance unidentified.

Fraction 2: Rf 0.69 as syrup (0.21g). IR max 1745 cm⁻¹ no OH or OTS. NMR = $^{TMS}_{CDCl_3}$ δ : 7.6, m; 4.85, s, 4.0, s, 3.75, s, 3.0, *m*, 2.3, *m*, 1.5, *m*, 1.0 *d*. Substance unidentified.

Fraction 3: Rf 0.56 as syrup (**8**, 0.45g). IR showed no OH, no CO, no OTS absorptions. NMR = $^{TMS}_{CDCl_3}$ δ : 4.8, s (1H, H1); 3.85, *m* (1H, H5); 3.45, s (3H, OCH₃), 3.3, *m*, 2.95, d, 2.6 *m* (2H, H2 & H3 un signed); 1.8, *m* (1H, H4), 1.1, *d* (3H, CH₃).

Fraction 4: Rf 0.23 as a syrup (**3**, 0.69g) which crystallized by standing and recrystallized from peteroleum other 60°-80° / EtOAC into colourless needles m.p 73-75°C. IR max 3500 cm⁻¹ strong absorption for OH, but no tosylate indication.

Methyl 3,4,6-trideoxy- α -D-threohexopyranoside (9a)

The expoxide (**8**, 0.42g) dissolved in redistilled tetahydrofuran (THF) (100 ml) and cooled down into ice bath. Lithium aluminum hydride (0.5g) added slowly in batches. The reaction mixture allowed to warm up to soon temperature and stirred magnetically for 2hrs. TLC, C₆H₆; EtOAC 3:1 showed that most of the starting material was diminished to give a now itense more polar spot. Ordinary other added dropwise until no vigrrous reaction was absorved. The solid material filtered off and washed with ether. The solid material dissolved in water and extracted thoroughly with chloroform. The ether filtrate and the chloroform extract were combined and washed with brine and worked up as usual to give a light syrup (**9a**, 0.38 g) which adsorped into a silica gel column eluted with C₆H₆-EtOAC to give a light syrup (0.2g) which crystallized by cooling and melted at room temperature. NMR = $^{TMS}_{CDCl_3}$ δ : 4.6, *d* (1H, H1), 4.15-3.35, *m* (2H, H2 & H5), 3.5, s (3H, OCH₃), 2.8, s (1H, OH), 2.1 $\rightarrow$ 1.1, *m* (unassigned), 1.35, *d* (3H, CH₃).

Methyl -3, 4, 6-trideoxy- α -D-erythro hexapyranoside (9b)

Methyl 3, 4, 6-trichloro-3, 4, 6-trideoxy- α -D-galacto-Pyranoside (**2b**, 1.65g) dissolved in ethanol (150 ml). Potassium hydroxide (lg) and catalytic amount of activated Raney Nickel added. The mixture was shaker under an atmosphere of hydrogen at 50 psi at room temperature for 1hr. the catalyst filtered off and the filtrate evaporated down to dryness under vacuum. Chloroform added and washed with diluted HCL then with brine to neutrality and worked up as usual to give a colourless light syrup (**9b**, 0.96g). NMR = $^{TMS}_{CDCl_3}$ δ : 4.65, *d*(1H, H1) 4.35-3.7, *m* (2H, H2 & H5). 3.05, s (1H, OH); 2.1-1.1, *m* (4H, H3, H3, H4, H4) unassigned), 1.25, *d* (3H, CH₃).

Methyl -3,4, 6-trideoxy- α -D-glycero-hexopyran-2-ulose (10)

a) From (9a)

Methyl-3, 4, 6-trideoxy- α -D-threo hexapyranoside (**9a**, 0.04g) dissolved in a minimum quantity of chloroform – methanol free. Ruthenium tetroxide in chloroform-methanil free (prepared by

suspending the black RuO₂ into chloroform- methanol free and shaking it with aqueous saturated solution of NaIO₄ until the chloroform. The reaction mixture was set aside at room temperature for 2hr. The reaction mixture changed into black after the addition of the RuO₄. TLC eluted with C₆H₆-EtOAc 3:1 showed that all the compound **9a** was changed to the ketone **10**. The chloroform filtered off and worked up as usual to give a colourless syrup (**10**, 0.03g). IR and NMR were identical with that of the above reaction.

b) From (9b)

Methyl- 3, 4, 6-trideoxy- α -*D*-erythro hexopyranoside (**9b**; 0.23 g) dissolved in chloroform-methanol free (10 ml). Water (15C.C) added and anhydrous potassium carbonate (0.09g) and sodium periodate (0.95g) added. The heterogeneous mixture was stirred vigorously by magnetic stirrer for overnight at room temperature. TLC, C₆H₆-EtOAc 3:1 showed the development of one spot and no trace for the starting material **2b**. The two layers separated and the aqueous layer extracted twice with chloroform and the extracts combined with the chloroform layer. The organic extracts were worked up as usual to give a colourless syrup (**10**, 0.13g) IR max; 1745, 1730 cm⁻¹ CO stretching. NMR = ^{TMS}_{CDCl₃} δ : 4.65, s (1H, H1), 3.6, s (3H, OCH₃). 3.5, m (2H, H5 & H4 unassigned), 1.4, d (3H, CH₃).

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