AMINO SUGARS. XXVII.*

THE SYNTHESIS OF DERIVATIVES OF 3-AMINO-3,4,6-TRIDEOXY-D- OR L-*xylo*-HEXOPYRANOSE

K.KEFURT, K.ČAPEK, J.ČAPKOVÁ, Z.KEFURTOVÁ and J.JARÝ

Laboratory of Monosaccharides,
Institute of Chemical Technology, Prague 6

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On reduction of 3-acetamido-2-O-acetyl-3,4,6-trideoxy-L-*xylo*-hexonic acid lactone (*II*) with sodium bis(2-methoxyethoxy)aluminum hydride 3-acetamido-3,4,6-trideoxy-L-*xylo*-hexose (*III*) has been prepared, which on reduction with sodium borohydride gave 3-acetamido-3,4,6-trideoxy-L-*xylo*-hexitol (*IX*). Its oxidation with sodium periodate afforded 2-acetamido-2,3,5-trideoxy-L-*threo*-pentofuranose (*X*). From hexose *III* a mixture of methyl 3-acetamido-3,4,6-trideoxy-α- and β-L-*xylo*-hexopyranosides (*IVa,b*) is formed under the effect of methanol and a cation exchanger. By alkaline deacetylation of glycosides *IVa,b*, methylation, and acid hydrolysis hydrochloride of 3,4,6-trideoxy-3-dimethylamino-L-*xylo*-hexose (L-desosamine, *VII*) has been prepared. The same substance is also formed on reduction of dimethylamide of 3-acetamido-2,5-di-O-acetyl-3,4,6-trideoxy-L-*xylo*-hexonic acid (*VIII*). Amonolysis of methyl 2,3-anhydro-4,6-dideoxy-α-D-*ribo*-hexopyranoside (*XI*) led to a mixture of products substituted in the position 2 or 3 in a 1 : 2 ratio, which were separated to give methyl 2-acetamido-2,4,6-trideoxy-α-D-*arabino*-hexopyranoside (*XV*) and methyl 3-acetamido-3,4,6-trideoxy-α-D-*xylo*-hexopyranoside (*XIII*). From derivative *XIII* methyl 3-acetamido-3,4,6-trideoxy-α-D-*lyxo*-hexopyranoside (*XVIII*) has been prepared. On hydrolysis of glycosides *XIII* and *XVIII* 3-acetamido-3,4,6-trideoxyhexoses *XVI* and *XX* have been obtained.

In a previous paper[1] we described the stereoselective cleavage of the oxiran ring of the lactone of 2,3-anhydro-4,6-dideoxy-L-*ribo*-hexonic acid (*I*) with ammonia or dimethylamine, giving rise to amide of 3-amino-3,4,6-trideoxy-L-*xylo*-hexonic, or dimethylamide of 3,4,6-trideoxy-3-dimethylamino-L-*xylo*-hexonic acid. In the same paper we also described the preparation of 3-acetamido-2-O-acetyl-3,4,6-trideoxy-L-*xylo*-hexonic acid lactone (*II*), carried out by acetylation of the corresponding amino acid, formed on hydrolysis of the above mentioned amide. In the present paper we describe the synthesis of optical antipode of natural desosamine, *i.e.* 3,4,6-trideoxy-3-dimethylamino-L-*xylo*-hexose (*VII*), making use of lactone *II* as the starting material. Some intermediates of this synthesis were correlated with analogous substances of the D-series, obtained from the simultaneously investigated amonolysis of methyl 2,3-anhydro-4,6-dideoxy-α-D-*ribo*-hexopyranoside (*XI*). On reduction

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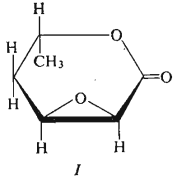
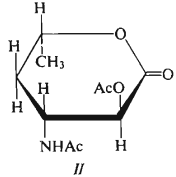
of lactone *II* with sodium bis(2-methoxyethoxy)aluminum hydride we obtained 3-acetamido-3,4,6-trideoxy-L-*xylo*-hexose (*III*) in 65–70% yield. (Hexose *III* was obtained in a 35% yield also by reduction of lactone *II* with lithium aluminum hydride in tetrahydrofuran.) Its structure was proved by reduction to the described 3-acetamido-3,4,6-trideoxy-L-*xylo*-hexitol[1] (*IX*) which on oxidation with sodium periodate gave 2-acetamido-2,3,5-trideoxy-L-*threo*-pentofuranose (*X*) the D-*erythro* isomer of which was prepared by a similar route earlier[2]. Hexose *III* has similar physical constants and IR spectra as an analogous substance of D-configuration prepared in a different manner.

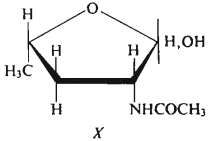
According to its PMR spectrum hexose *III* exists in a mixture of hexadeuteriodimethyl sulfoxide and deuteriochloroform in the form of its α-anomer of 1 C conformation, with an axial anomeric hydroxy group, as evidenced mainly by the low value of its coupling constant $J_{1,2} = 3$ Hz and a lower value of the chemical shift of acetamide group protons at 1·90 p.p.m., characteristic of its equatorial position. After acidification of the measured solution with deuterioacetic acid mutarotation takes place under formation of an equilibrium mixture of α- and β-anomers. In this mixture the proton at $C_{(1)}$ of the α-anomer gives a doublet at 5·09 p.p.m., $J_{1,2} = 3$ Hz, while the β-anomer gives it at 4·47 p.p.m., $J_{1,2} = 7{\cdot}5$ Hz. The double doublet of H_2 of the α-anomer is located at 3·37 p.p.m., $J_{2,1} = 3$ Hz, $J_{2,3} = 10{\cdot}5$ Hz; in the case of β-anomer the values are 3·13 p.p.m., $J_{2,1} = 7{\cdot}5$ Hz, $J_{2,3} = 10{\cdot}5$ Hz. The singlets of protons of acetamide groups of both



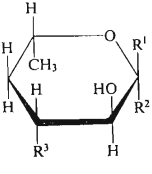
I

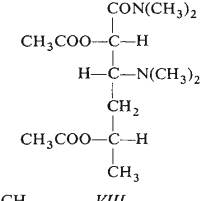


II

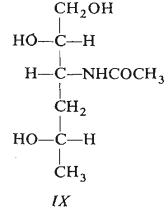


X





VIII

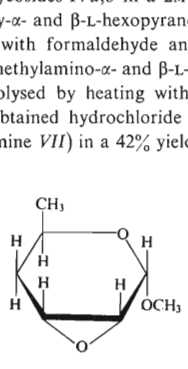


IX

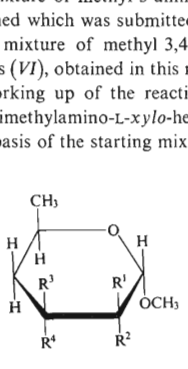
III, R^1, R^2 = H, OH, R^3 = NHCOCH$_3$
IVa, R^1 = OCH$_3$, R^2 = H, R^3 = NHCOCH$_3$
IVb, R^1 = H, R^2 = OCH$_3$, R^3 = NHCOCH$_3$
V, $R^1(R^2)$ = OCH$_3$, $R^2(R^1)$ = H, R^3 = NH$_2$
VI, $R^1(R^2)$ = OCH$_3$, $R^2(R^1)$ = H, R^3 = N(CH$_3$)$_2$
VII, R^1, R^2 = H, OH, R^3 = N(CH$_3$)$_2$.HCl

anomers are at 1·93 p.p.m. The multiplets of protons H_3 and H_5 of α-anomer are at 1·09 p.p.m., $J_{5,6}$ = 6·3 Hz, of β-anomer at 1·16 p.p.m., $J_{5,6}$ = 6·3 Hz. The determined values of the coupling constants $J_{2,3}$, as well as the value of the chemical shift of acetamido group protons also corroborated the 1 C conformation of both anomers.

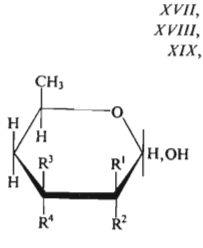
Heating of hexose *III* in methanol in the presence of a strong cation exchanger gave a mixture of methyl 3-acetamido-3,4,6-trideoxy-α-, and β-L-*xylo*-hexopyranoside *IVa* or *IVb* which we separated by preparative chromatography on alumina. The quantitative ratio of the anomers *IVa* : *IVb* was in good agreement with the value calculated for the original mixture on the basis of its optical rotation (57 : 43 in favour of anomer *IVa*). The configuration at the first carbon was assigned to both anomers on the basis of the comparison of substance *IVa* with the D-enantiomer *XIII* prepared in a different manner, and also by applying Hudson's rules. By heating the mixture of glycosides *IVa,b* in a 2M-NaOH solution a mixture of methyl 3-amino-3,4,6-trideoxy-α- and β-L-hexopyranosides (*V*) was obtained which was submitted to a reaction with formaldehyde and formic acid. The mixture of methyl 3,4,6-trideoxy-3-dimethylamino-α- and β-L-*xylo*-hexopyranosides (*VI*), obtained in this manner was hydrolysed by heating with 20% HCl. After working up of the reaction mixture we obtained hydrochloride of 3,4,6-trideoxy-3-dimethylamino-L-*xylo*-hexose (L-desosamine *VII*) in a 42% yield (calculated on the basis of the starting mixture *IVa,b*).



XI



XII, $R^1 = R^4 = H$, $R^2 = OH$, $R^3 = NH_2$
XIII, $R^1 = R^4 = H$, $R^2 = OH$, $R^3 = NHCOCH_3$
XIV, $R^1 = NH_2$, $R^2 = R^3 = H$, $R^4 = OH$
XV, $R^1 = NHCOCH_3$, $R^2 = R^3 = H$, $R^4 = OH$
XVII, $R^1 = R^4 = H$, $R^2 = OSO_2CH_3$, $R^3 = NHCOCH_3$
XVIII, $R^1 = OH$, $R^2 = R^4 = H$, $R^3 = NHCOCH_3$
XIX, $R^1 = OSO_2CH_3$, $R^2 = R^4 = H$, $R^3 = NHCOCH_3$



XVI, $R^1 = R^4 = H$, $R^2 = OH$, $R^3 = NHCOCH_3$
XX, $R^1 = OH$, $R^2 = R^4 = H$, $R^3 = NHCOCH_3$

Melting point and the absolute value of optical rotation corresponded to literature data[3,4]. In a lower yield we also obtained the same product by partial reduction of dimethylamide of 3-acetamido-2,5-di-O-acetyl-3,4,6-trideoxy-L-*xylo*-hexonic acid[1] (*VIII*), with sodium bis(2-methoxyethoxy)aluminum hydride.

For the corroboration of the structure of some intermediates from the above synthesis we carried out the amonolysis of methyl-2,3-anhydro-4,6-dideoxy-α-D-*ribo*-hexopyranoside (*XI*). In this reaction two basic products were formed in 2 : 1 ratio, of which the dominant methyl 3-amino-3,4,6-trideoxy-α-D-*xylo*-hexopyranoside (*XII*) was isolated from the reaction mixture either as such, or, by preparative chromatography, in the form of its N-acetyl derivative *XIII*. The second product which must be methyl 2-amino-2,4,6-trideoxy-α-D-*arabino*-hexopyranoside (*XIV*) (with respect to the structure of the starting anhydro derivative) was isolated in the form of N-acetyl derivative *XV*. Hydrolysis of derivative *XIII* with aqueous acetic acid gave 3-acetamido-3,4,6-trideoxy-D-*xylo*-hexose (*XVI*), which according to its melting point, absolute value of optical rotation, and IR spectrum, was identical with the enantiomeric substance prepared by reduction of lactone *II*. The same identity was observed also for the glycosides *XIII* and *IVa*. Reaction of derivative *XIII* with methanesulfonyl chloride in pyridine gave mesyl derivative *XVII*, which after reaction with sodium acetate in aqueous 2-methoxyethanol gave methyl 3-acetamido-3,4,6-trideoxy-α-D-*lyxo*-hexopyranoside (*XVIII*). According to its melting point mesyl derivative *XIX* obtained from substance *XVIII* under the effect of methanesulfonyl chloride in pyridine was identical with the substance described by Richardson[4]. Hydrolysis of acetamido derivative *XVIII* in aqueous acetic acid gave crystalline 3-acetamido-3,4,6-trideoxy-D-*lyxo*-hexose (*XX*).

In contrast to the described[2] amonolysis of the isomeric anhydro derivative of *lyxo*-configuration the cleavage of the oxiran ring did not take place in the case of methyl 2,3-anhydro-4,6-dideoxy-α-D-*ribo*-hexopyranoside (*XI*) selectively. A similar observation was also made by Newman[5], and recently by Benaszek and Zamojski[6], who reacted these anhydro derivatives (or their racemic modification) with dimethylamine. Supposing that both anhydro derivatives exist in half-chair conformation C 1, this fact may be explained as the consequence of two effects: first, the tendency for a diaxial opening of the oxiran ring in the sense of the Fürst–Plattner rule[7], and, second, the inductive effect of the semi-acetal group, which is especially evident in epoxides with the vicinal deoxy group[8] and which furthers the attack of the nucleophilic reagent on the third carbon atom. While in the case of the above mentioned isomer of *lyxo*-configuration[2] both effects synergistically support the cleavage of the anhydro ring at the third carbon, in the case of anhydro derivative *XI* the first of the mentioned effects (diaxial cleavage) competes with the second and gives rise to a substitution at the second carbon. This explanation is also supported by the result of the amonolysis of 2,3-anhydro-4,6-dideoxy-L-*ribo*-hexonic acid lactone (*I*), taking place in two separable steps[1]: epoxy lactone → epoxy amide → product of cleavage

of the epoxide ring. After the disappearance of the six-membered lactone ring only the inductive effect of the amide group could play a role here, and the cleavage of the oxiran ring of epoxy amide took place selectively under formation of a product substituted on the third carbon.

EXPERIMENTAL

Melting points were measured on a Kofler block and they are not corrected. Optical rotations were measured on an Opton apparatus, with subjective determination of rotation angle, using $c = 1$ in water if not stated otherwise. The PMR spectra were measured on a Varian HA-100 instrument. Substances for analysis were dried in a vacuum of a rotatory pump at 20—40°C for 10 h. The solutions of substances were evaporated on rotatory evaporators at maximum 40°C bath temperature. Chromatographic analysis was carried out on micro-slides covered with a thin layer of silica gel G, developed in the systems chloroform–methanol 10 : 1 (S_1), or chloroform–methanol 5 : 1 (S_2). Substances were detected by spraying with a solution of cerium-(IV) sulfate in 10% H_2SO_4 and subsequent heating.

3-Acetamido-3,4,6-trideoxy-L-*xylo*-hexose (*III*)

To a solution of 670 mg (2·94 mmol) of lactone *II* in 7 ml of tetrahydrofuran a solution of 1·62 g (8 mmol) of sodium bis(2-methoxyethoxy)aluminum hydride* in 5 ml of tetrahydrofuran was added dropwise at −15°C over 10 min, while stirring. The reaction course was followed by thin-layer chromatography. The starting lactone had R_F 0·55 in S_2, the reaction product had R_F 0·29 in the same system. After 1 h stirring at −15°C to −10°C the presence of the starting material could no longer be detected. After a strong undercooling in a refrigerating mixture the reaction mixture was decomposed with 5 ml of 20% acetic acid. The suspension formed was transferred quantitatively onto a column of 100 ml of Dowex 50W (H^+), which was previously eluted with water. Evaporation of approximately 500 ml of the eluate gave 560 mg of a solid foam which after crystallisation from acetone afforded 361 mg (65%) of hexose *III* in the form of a semihydrate, m.p. 165—168°C, $[\alpha]_D^{20}$ −77·5° (5 min) → −38·6° ± 1° (const., 70 min). NMR spectrum (in a mixture of hexadeuteriodimethyl sulfoxide and deuteriochloroform, tetramethylsilane as internal standard): NH 7·47 p.p.m., $J_{NH,3} = 7{\cdot}5$ Hz, OH_1 6·00 p.p.m., $J_{OH_1,1} \approx 4$ Hz, OH_2 3·92 p.p.m., $J_{OH_2,2} = 8$ Hz, H_1 5·06 p.p.m., $J_{1,OH_1} = 4$ Hz, $J_{1,2} = 3$ Hz, H_2 approx. 3·30 p.p.m. (superposed by the HDO signal), H_3, H_5 approx. 4·10 p.p.m., $NHCOCH_3$ 1·88 p.p.m., H_6 1·06 p.p.m., $J_{5,6} = 6{\cdot}5$ Hz, H_4 approx. 1·88 p.p.m. (hidden under a signal of NAc), H_4, 0·95—1·30 p.p.m. (hidden by the H_6 signal). According to absolute values of its physical constants and its IR spectrum the substance is identical with the D-enantiomer *XVI*. For $C_8H_{15}NO_4 \cdot \frac{1}{2} H_2O$ (198·2) calculated: 48·47% C, 8·14% H, 7·07% N; found: 48·21% C, 8·47% H, 7·05% N. The mother liquors after crystallisation of hexose *III* contain also small amounts of hexitol *IX* (R_F in S_2 was 0·15) which may be separated by preparative chromatography on a silica gel column, using chloroform with an increasing amount of ethanol (0—10%) for elution.

Methyl 3-Acetamido-3,4,6-trideoxy-α-L-*xylo*-hexopyranoside (*IVa*) and Methyl 3-Acetamido-3,4,6-trideoxy-β-L-*xylo*-hexopyranoside (*IVb*)

A solution of 859·4 mg (4·55 mol) of hexose *III* in 30 ml of methanol was stirred with 900 mg of Dowex 50W (H^+) (200—400 mesh) under reflux for 1·5 h. After this period no presence of the starting material could by detected in the reaction mixture (with R_F 0·29 in S_2). The exchanger separated by filtration was extracted several times with hot methanol. Evaporation of the combined

* For the reduction commercially accessible 70% benzene solution produced by the Institute of Inorganic Syntheses, Czechoslovak Academy of Sciences, Prague-Řež, was employed.

filtrates gave 808 mg (87·5%) of a residue which was crystallised from dichloromethane–n-hexane. M.p. 160—174°C, $[\alpha]_D^{20}$ −81·7°; by its elemental analysis it corresponded to methyl glycoside of hexose *III*. Thin-layer chromatography of the product in S_1 disclosed two equally intensive spots, of R_F 0·29 and 0·24. The mixture of glycosides (357 mg) was separated by chromatography on 70 g of alumina (Reanal, Budapest, activity II—III according to Brockmann). Elution was carried out with benzene containing an increasing amount of ethanol (0—2%), giving first 154·5 mg (43%) of α-anomer *IVa*. After crystallisation from dichloromethane–n-hexane m.p. 195—196°C, $[\alpha]_D^{24}$ −168 ± 1° (*c* 0·57); for $C_9H_{17}NO_4$ (203·2) calculated: 53·20% C, 8·43% H, 6·89% N; found: 53·33% C, 8·65% H, 6·95% N. Further elution gave 133 mg (37%) of β-anomer *IVb*, which after crystallisation from dichloromethane–n-hexane had m.p. 196 to 198°C, $[\alpha]_D^{22}$ +28·3 ± 1·2° (*c* 0·58); for $C_9H_{17}NO_4$ (203·2) calculated: 53·20% C, 8·43% H, 6·89% N; found; 53·29% C, 8·64% H, 7·13% N. Absolute values of physical constants of anomer *IVa*, as well as its IR spectrum agree with those of the corresponding D-enantiomer *XIII*.

Hydrochloride of L-Desosamine (*VII*)

A) A solution of a mixture of glycosides *IVa,b* from the preceding experiment (370 mg, 1·8 mmol) in 5 ml of 2M-NaOH was heated at 80°C for 240 min, until no presence of the starting compound (R_F approx. 0·55 in S_2) could be detected in the reaction mixture (R_F of the product was 0·13 in S_2). After cooling the mixture was filtered through a column of 20 ml of Dowex 50W (H^+) which was then washed with 100 ml of water. The basic product was liberated from the cation exchanger by elution with 0·3% aqueous ammonia (approx. 300 ml). The residue after evaporation of the ammoniacal eluate gave on extraction with acetone 232 mg of a crude mixture of α and β-methyl glycosides of 3-amino-3,4,6-trideoxy-L-*xylo*-hexose (*V*) which was heated with a mixture of 2 ml of 24% formaldehyde and 2 ml of 98% formic acid at 100°C for 4 h. The reaction mixture was evaporated and the residue dissolved in ether, saturated with ammonia, and partitioned between ether and water. From the ethereal fraction 207 mg of a syrupy residue were obtained which was neutralised by titration with dilute hydrochloric acid, using Tashiro as indicator. The consumption of 1·04 meq. corresponds to 203 mg of base. After decoloration with charcoal the aqueous solution was evaporated to dryness. The residue (257 mg), representing a mixture of hydrochlorides of methyl-α- and β-L-desosaminide (*VI*), was heated with 4 ml of a solution of 20% HCl at 90°C. After 2 h the presence of the starting substance could no longer be detected. The reaction mixture was cooled and filtered through a column of 20 ml of Amberlite IR-4-B (OH^-). The basic eluate was neutralised by titration with 0·1M-HCl, decolorised with charcoal, and evaporated to dryness. Yield 218 mg of a product which after repeated crystallisation from 90% ethanol and ether gave 159 mg (42%) of L-desosamine (*VII*) hydrochloride, m.p. 184·5 to 185·5°C, $[\alpha]_D$ −30·5° (2 min) → −47·0 ± 0·7° (35 min, const.). Literature[3,4] gives for D-enantiomer m.p. 182°C, $[\alpha]_D$ +48.° For $C_8H_{18}ClNO_3.H_2O$ (229·7) calculated: 41·83% C, 8·78% H, 15·44% Cl, 6·10% N; found: 42·09% C, 9·11% H, 15·56% Cl, 5·93% N. The elemental analysis of our sample corresponds to monohydrate, although its melting point agrees with the value given for the anhydrous material. The authors[9] who also isolated desosamine hydrochloride by crystallisation from aqueous solvents in the form of monohydrate give, for this substance, m.p. about 130°C, then solidification, and eventually the m.p. "at higher temperature" probably 182°C. In our case we did not observe this transformation during the m.p. determination.

B) To a solution of 302·8 mg (1 mmol) of dimethylamide *VIII* in 10 ml of tetrahydrofuran a solution of 806 mg (4 mmol) of sodium bis(2-methoxyethoxy)aluminum hydride in 10 ml of tetrahydrofuran was added dropwise at −15°C over 12 min. The reaction mixture was stirred for 1 h and then decomposed under cooling and stirring with a suspension of 3 ml of Dowex 50W (H^+) in 10 ml of 50% aqueous methanol. It was then transferred to a column of 12 ml of the same

cation exchanger, which was previously washed with 100 ml of water and then 0·25% NH_3. After evaporation of the combined alkaline eluates (approx. 250 ml) and extraction of the residue with chloroform a syrupy basic product (122·2 mg) was obtained which reduced Fehling's solution. An aqueous solution of 106 mg of this product was neutralised by titration with 0·1M-HCl (Tashiro indicator). After decolorizing with charcoal and evaporation to dryness 102 mg of residue were obtained from which crystallisation from 90% ethanol and ether gave 50 mg (26·5%) of L-desosamine (*VII*) hydrochloride, identical in its physical constants and IR spectrum with the substance obtained under *A*.

3-Acetamido-3,4,6-trideoxy-L-*xylo*-hexitol (*IX*)

To a solution of 100 mg of hexose *III* in 15 ml of water 120 mg of sodium borohydride were added and the mixture allowed to stand at room temperature for 2 h. After filtration through a column of 14 ml of Dowex 50W (H^+) the eluate was evaporated to dryness, then dissolved in 50 ml of methanol and evaporated again. This was repeated and the residue (98·6 mg) was recrystallised from acetone–n-hexane 5 : 2, affording 70 mg (69%) of hexitol *IX*, m.p. 137·5—138·5°C, identical in its physical constants and its IR spectrum with the substance described earlier[1].

2-Acetamido-2,3,5-trideoxy-L-*threo*-pentofuranose (*X*)

To a solution of 554 mg (2·9 mmol) of hexitol *IX* in 15 ml of water solid sodium periodate (685 mg; 3·2 mmol) was added over 4 min under stirring at 7°C. The reaction course was followed chromatographically on thin-layer, using system S_1 for development. R_F of the starting compound was 0·03, R_F of the products was 0·19. After 20 minutes the presence of the starting material could no longer be detected in the reaction mixture. After evaporation to dryness and drying, the residue was transferred onto a column of 10 g of silica gel which was then eluted with benzene additioned with steadily increasing amounts of ethanol (0—10%). The residue from the combined chromatographically individual fractions (430 mg) was crystallised from acetone–ether–n-hexane mixture 3 : 2 : 2, or dichloromethane–tetrachloromethane 2 : 3. Yield 300 mg (65%) of pentose *X*, m.p. 106—109°C, $[\alpha]_D$ +71·8° (3 min) → +52·7 ± 0·6° (1 h, const.). For $C_7H_{13}NO_3$ (159·2) calculated: 52·81% C, 8·23% H, 8·80% N; found: 53·21% C, 8·35% H, 8·79% N.

Reaction of Epoxy Derivative *XI* with Ammonia

A) *Separation in the form of* N-*acetyl derivatives*: To a solution of 820 mg (5·7 mmol) of anhydro derivative *XI* in 20 ml of liquid ammonia were added and the mixture was heated in a stainless-steel autoclave at 100—120°C for 30 h. It was evaporated to dryness and the residue dissolved in 10 ml of methanol. After addition of 3 ml of acetic anhydride the mixture was allowed to stand at room temperature overnight and then evaporated to dryness. The residue was chromatographed on a column of 30 g of silica gel. From the column 220 mg of 2-N-acetyl derivative *XV* were eluted first with chloroform–ethanol 100 : 2, followed by 30 mg of a mixture of compounds *XV* and *XIII*, and 520 mg of 3-N-acetyl derivative *XIII* (by elution with chloroform–ethanol 100 : 2 to 100 : 5), as well as several tens of miligrams of substances having much higher R_F values than substance *XV*. The latter mixture was no further investigated. 2-N-Acetyl derivative *XV* was recrystallised from ethyl acetate–light petroleum mixture, m.p. 128—130°C, $[\alpha]_D^{21}$ +33·5° ± 1°. For $C_9H_{17}NO_4$ (203·2) calculated: 53·20% C, 8·43% H, 6·89% N; found: 52·99% C, 8·36% H, 6·84% N. 3-N-Acetyl derivative *XIII* was crystallised from ethyl acetate–light petroleum mixture, m.p. 198—200°C, $[\alpha]_D^{21}$ +167·0 ± 2°. For $C_9H_{17}NO_4$ (203·2) calculated: 53·20% C, 8·43% H, 6·89% N; found: 53·10% C, 8·50% H, 6·83% N.

B) *Isolation of amino derivative* XII: Anhydro derivative *XI* (2·49 g; 17·3 mmol) was ammonolysed in 25 ml of methanol and 25 ml of liquid ammonia under the same conditions as above. After evaporation to dryness the mixture was dissolved in 15 ml of water and poured onto a column of cation exchanger. The column was washed with water in order to eliminate non-basic components. Basic substances were eluted with 0·25% NH_3. Total eluted basic syrupy material weighed 1·71 g. After double crystallisation from ethyl acetate 753 mg (27%) of amino derivative *XII* were obtained, m.p. 131–136°C. For analysis derivative *XII* was repeatedly crystallised from the same solvent, until the m.p. was 134–137°C, $[\alpha]_D^{21} + 162{\cdot}0 \pm 2°$. Richardson[4] gives for amino derivative *XII* an unsharp melting point. For $C_7H_{15}NO_3$ (161·2) calculated: 52·16% C, 9·38% H, 8·69% N; found: 52·31% C, 9·50% H, 8·69% N. The mother liquors after separation by crystallisation of 753 mg of substance *XII* were evaporated to dryness and the residue was dissolved in 10 ml of methanol, additioned with 3 ml of acetic anhydride, and the mixture was worked up as under *A*). Yield 660 mg (3·25 mmol) of 2-N-acetyl derivative *XV*, and 394 mg (1·94 mmol) of 3-N-acetyl derivative *XIII*. Total yield was 57%. The ratio of derivatives *XV* : *XIII* was 33 : 67.

Methyl 3-Acetamido-3,4,6-trideoxy-2-O-methanesulfonyl-α-D-*xylo*-hexopyranoside (*XVII*)

To a mixture of 690 mg (3·43 mmol) of derivative *XII* in 15 ml of pyridine 0·5 ml of methanesulfonyl chloride was added at −70°C and the mixture was allowed to stand at −15°C for 2 days. After decomposition with water the mixture was evaporated twice to dryness, after previous addition of 5% sodium hydrogen carbonate. The residue was transferred onto a column of 30 g of silica gel which was eluted with a mixture of benzene–ethanol 100 : 1 to 100 : 3. Yield 932 mg (97%) of chromatographically pure mesyl derivative *XVII*, which after crystallisation from ethanol–light petroleum had m.p. 181–182°C, $[\alpha]_D^{20} +116{\cdot}0 \pm 1°$ (chloroform). For $C_{10}H_{19}NO_6S$ (281·3) calculated: 42·70% C, 6·81% H, 4·98% N, 11·40% S; found: 42·91% C, 6·88% H, 4·83% N, 11·68% S.

Methyl 3-Acetamido-3,4,6-trideoxy-α-D-*lyxo*-hexopyranoside (*XVIII*)

A solution of 502 mg (1·79 mmol) of mesyl derivative *XVII* in 25 ml of 2-methoxyethanol was heated with 1·6 g of sodium acetate trihydrate and 1·6 ml of water for 44 h, and evaporated. The residue was chromatographed on 20 g column of silica gel with benzene–ethanol 100 : 3. The eluate, derivative *XVIII*, weighed 326 mg (90%) and it was crystallised for analysis from a mixture of ethyl acetate and light petroleum until the melting point was constant, *i.e.* 152 to 153°C, $[\alpha]_D^{20} +39{\cdot}3°$. For $C_9H_{17}NO_4$ (203·2) calculated: 53·20% C, 8·43% H, 6·89% N; found: 53·07% C, 8·52% H, 6·96% N.

Methyl 3-Acetamido-3,4,6-trideoxy-2-O-methanesulfonyl-α-D-*lyxo*-hexopyranoside (*XIX*)

To a solution of 50 mg of derivative *XVIII* in 3 ml of pyridine cooled to −70°C 0·1 ml of methanesulfonyl chloride was added and the mixture allowed to stand at −15°C for 48 h. After decomposition with water the mixture was extracted with chloroform and worked up in the usual manner. The crude product was crystallised from ethanol–light petroleum; yield 44 mg (65%) of mesyl derivative *XIX*, m.p. 159–161°C, $[\alpha]_D^{20} +39{\cdot}3$ (*c* 0·53, chloroform). Richardson[4] gives m.p. 161–163°C, $[\alpha]_D +27°$ (chloroform).

3-Acetamido-3,4,6-trideoxy-D-*xylo*-hexopyranose (*XVI*)

A solution of 190 mg (0·94 mmol) of acetamido derivative *XIII* in 10 ml of 50% acetic acid was refluxed for 10 h. It was evaporated and the residue chromatographed on a column of silica gel

(7 g). A chloroform–ethanol mixture 100 : 5 eluted 151 mg (85%) of chromatographically pure compound *XVI* which was crystallised twice from acetone–light petroleum, m.p. 167—168°C, $[\alpha]_D$ +38·5° (final value). Its IR spectrum was identical with that of the L-enantiomer, *III*.

3-Acetamido-3,4,6-trideoxy-D-*lyxo*-hexopyranose (*XX*)

A solution of 150 mg (0·74 mmol) of derivative *XVIII* in 8 ml of 50% acetic acid was refluxed for 3 h. During this time the reaction was followed by thin-layer chromatography. The reaction mixture was evaporated to dryness and the chromatographically pure residue was crystallised from ethyl acetate–light petroleum to give a product melting at 147—148·5°C, $[\alpha]_D$ +46·50° (final value). For $C_8H_{15}NO_4$ (189·2) calculated: 50·79% C, 7·99% H, 7·40% N; found: 50·78% C, 8·12% H, 7·65% N.

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REFERENCES

1. Kefurt K., Kefurtová Z., Jarý J.: This Journal *37*, 1035 (1972).
2. Čapek K., Jarý J.: This Journal *37*, 484 (1972).
3. Richardson A. C.: Proc. Chem. Soc. *1963*, 131.
4. Richardson A. C.: J. Chem. Soc. *1964*, 5364.
5. Newman H.: J. Org. Chem. *29*, 1461 (1964).
6. Banaszek A., Zamojski A.: Roczniki Chem. *45*, 391 (1971).
7. Fürst A., Plattner P.: *Abstracts of Papers, 12th International Congress of Pure and Applied Chemistry*, p. 405.
8. Parker R. E., Isaacs N. S.: Chem. Rev. *59*, 737 (1959).
9. Flynn E. H., Sigal M. V. jr, Willey P. F., Gerzon K.: J. Am. Chem. Soc. *76*, 3121 (1954).

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