Carbohydrate Research, 31 (1973) 331–338

GLYCOSYL* α-AMINO ACIDS

PART IV. SYNTHESIS OF D- AND L-2-(3-DEOXY-1,2:5,6-DI-*O*-ISOPROPYLIDENE-α-D-ALLOFURANOS-3-YL)GLYCINE, ANALOGS OF THE POLYOXIN SUGAR MOIETY

ALEX ROSENTHAL AND COLIN M. RICHARDS
Department of Chemistry, The University of British Columbia, Vancouver 8, B.C. (Canada)
(Received June 1st, 1973; accepted in revised form June 28th, 1973)

ABSTRACT

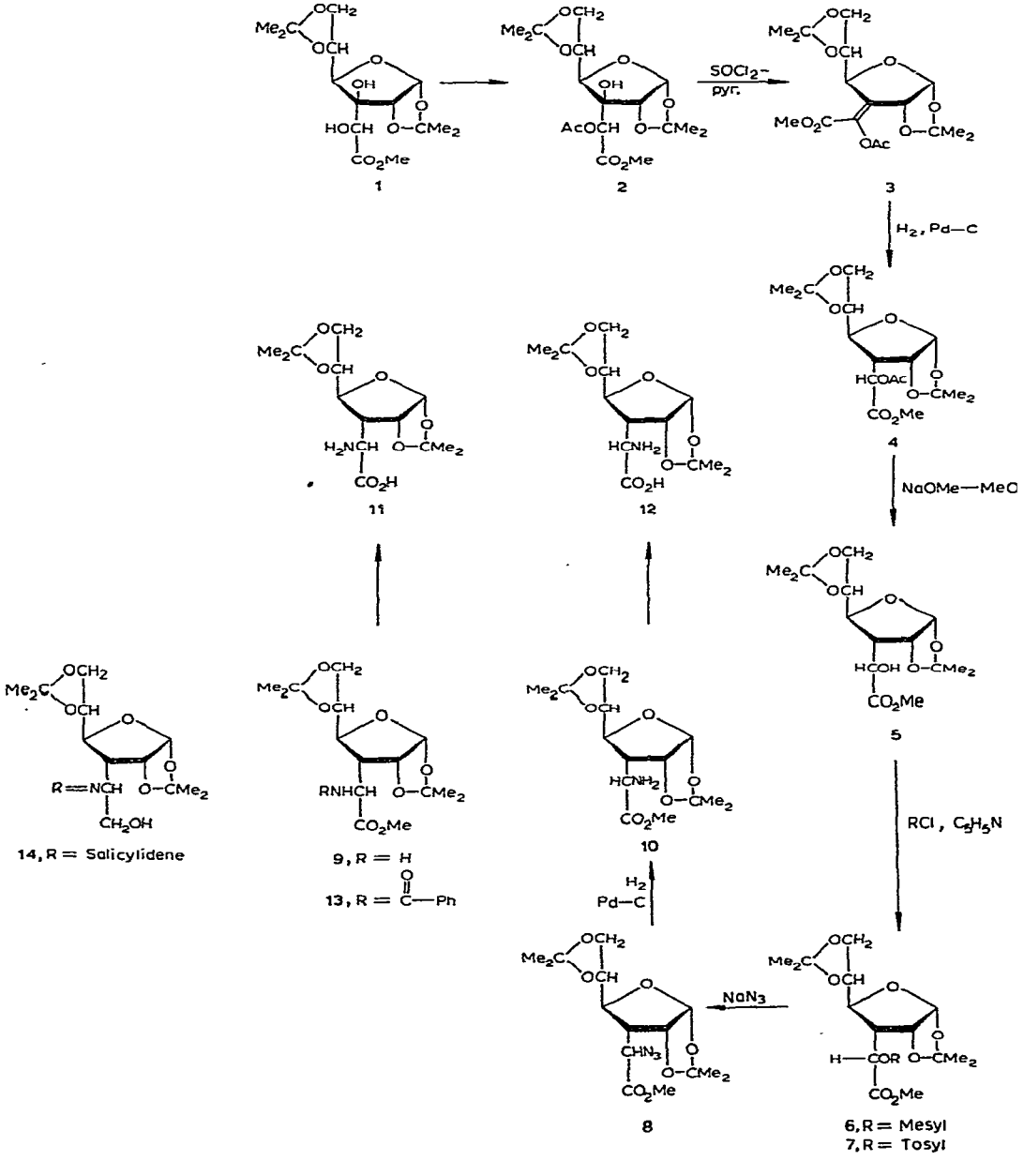
The synthesis of D-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycine (**11**) is described. Selective acetylation of the hitherto described diol, 3-*C*-[(*S*)-hydroxy(methoxycarbonyl)methyl]-1,2:5,6-di-*O*-isopropylidene-α-D-glucofuranose (**1**), with acetic anhydride and pyridine gave 83% of 3-*C*-[(*S*)-acetoxy(methoxycarbonyl)methyl]-1,2:5,6-di-*O*-isopropylidene-α-D-glucofuranose (**2**), which was stereoselectively dehydrated with thionyl chloride in pyridine to afford 3-*C*-[acetoxy(methoxycarbonyl)methylene]-(*Z*)-3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-*ribo*-hexofuranose (**3**) in 69% yield. Stereospecific catalytic reduction of **3** afforded 3-*C*-[(*S*)-acetoxy(methoxycarbonyl)methyl]-3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranose (**4**) in 97% yield. Mesylation and tosylation of deacetylated **4** yielded the monomethane- and -*p*-toluenesulfonates (**6** and **7**) in 92 and 68% yields, respectively. Treatment of **6** with sodium azide in *N*,*N*-dimethylformamide and reduction of the resultant α-azido ester afforded methyl D-(and L-)2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycinate (**9**) and **10**) in 34 and 22% yields, respectively. Similar treatment of the sulfonate **7** gave **9** and **10** in 10 and 27% yields, respectively. Basic hydrolysis of **9** and **10** yielded D- and L-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycine (**11**) and (**12**), respectively. The structure of **11** was correlated with that of L-alanine by circular dichroism and also with 5-*O*-(*p*-bromophenylsulfonyl)-3-deoxy-3-*C*-(*R*)-(ethoxycarbonylformamide)methyl-1,2-*O*-isopropylidene-α-D-ribofuranose. The structure of the latter compound has been determined by X-ray analysis.

DISCUSSION

The primary objective of this research was to prepare D-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycine (**11**), a diastereoisomer of the previously described L-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-D-allofuranos-3-yl)glycine[1] (**12**). This synthesis was designed to test the utility of optical rotary dispersion (o.r.d.) and circular dichroism (c.d.) for ascertaining the chirality of glycosyl-α-L- and D-amino

*Used in an extended sense, through the indicated, non-anomeric carbon atom.

acids having the amino acid moiety attached by a carbon–carbon linkage to C-3 of 3-deoxy and normal sugars. After our work had been completed there appeared a communication of an X-ray study of a compound that could be correlated with compound **11** by simple chemical transformations; publication of this paper thus



assumed cogency because the proof of the structures of all previously published glycos-3-yl α-amino acids[2,3] could now be determined unambiguously. Moreover, this research confirms the great utility of c.d. as a rapid physical means for determining the configuration of glycosyl α-amino acids and possibly of the sugar–amino acid moiety of the polyoxins[4].

The key intermediate in the synthesis of the glycosyl α-amino acid **11** was 3-*C*-[(*R*)-hydroxy(methoxycarbonyl)methyl]-1,2:5,6-di-*O*-isopropylidene-α-D-glucofuranose (**1**), previously described[2] and easily obtained pure from the readily available 1,2:5,6-di-*O*-isopropylidene-α-D-*ribo*-hexofuranos-3-ulose by application of a Wittig reaction followed by dihydroxylation of the resulting exocyclic unsaturated sugar[1,2]. Selective acetylation of the diol **1** with acetic anhydride in pyridine afforded the monoacetate **2** in 83% yield. Stereospecific dehydration[1,5,6] of **2** with thionyl chloride in pyridine yielded, after column chromatography on silica gel, crystalline 3-*C*-[acetoxy(methoxycarbonyl)methylene]-(*Z*)-3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-*ribo*-hexofuranose (**3**) in 69% yield. Catalytic hydrogenation of **3** in ethyl acetate over palladium on charcoal proceeded stereoselectively[1] to afford 3-*C*-[(*S*)-acetoxy (methoxycarbonyl)methyl]-3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranose (**4**) in 97% yield. Compound **4**, in contrast to the previously described (*R*)-diastereoisomer[1] was not contaminated with any product derived by hydrogenolysis of the acetoxyl group of **3**, thus indicating that the 1,2-*O*-isopropylidene group might inhibit the reactivity of the 1′-acetoxyl group if these groups are in the cisoid relationship. As in the previous work[1], the structure of the monoacetate **4** was assigned from its n.m.r. spectrum. In 1,2-*O*-isopropylidene sugars having the *allo* configuration, H-2 gives rise to either a triplet or a pair of doublets[1]. Thus, as H-2 of **4** resonated as a triplet at τ 5.19 with $J_{1,2} = J_{2,3} = 4$ Hz, and H-3 exhibited a doublet of triplets at τ 7.58 having $J_{3,4} = 9.5$ Hz, it was surmised that **4** must have the *allo* configuration[1,7]. Treatment of the α-acetate **4** with an approximately 0.05 molar equivalent of sodium methoxide for 4 h, followed by neutralization with ion-exchange resin, caused deacetylation without cleavage of the methyl ester to afford the ester **5** in 100% yield. In the previous synthesis of the *R*-diastereoisomer[1] by using aqueous base, remethylation was required because both protecting groups were removed by the hydroxide ion. Compound **5** exhibited a positive Cotton effect, in contrast to the negative Cotton effects exhibited by the starting diol **1** and the *R*-diastereoisomer, thus indicating that **5** must be 3-deoxy-3-*C*-[(*S*)-hydroxy(methoxycarbonyl)methyl]-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranose[1].

Treatment of **5** with methanesulfonyl chloride and with *p*-toluenesulfonyl chloride in pyridine at room temperature resulted in the expected monomethane- (and *p*-toluene)-sulfonates **6** and **7**, in 92 and 68% yields, respectively.

Treatment of the methanesulfonate **6** with sodium azide in anhydrous *N*,*N*-dimethylformamide at 55° in the dark, followed by immediate reduction of the resulting azide with hydrogen over 57% palladium-on-charcoal in methanol for 6 h, yielded the D- and L-α-amino esters (**9** and **10**) in 34 and 22% yields, respectively. Compound **9** exhibited a strong negative Cotton effect at 208 nm, whereas **10** exhibited

a positive Cotton effect. The L-α-amino ester **10** was shown to be identical to that previously synthesized[1] in this laboratory. In view of the fact that both the D- and L-amino esters were obtained from the methanesulfonate **6**, it was considered necessary to attempt stereospecific preparation of the D-diastereoisomer **9** from the *p*-toluenesulfonate **7** under conditions similar to those used previously[1]. Surprisingly, again both the D- and L-amino esters (**9**) and (**10**) were obtained, in 10 and 27% yields, respectively (significantly lower combined yields and also in reverse ratio). The *N*-benzoyl-D-glycine **13** has recently been prepared by an alternative procedure[8].

The proposed reason for the non-stereospecificity in the sulfonate displacement, and subsequent formation of both possible amino esters from normal sugar sulfonates, has been discussed previously[2,3]. Because no participation of the C-3 hydroxyl group can be invoked for the 3-deoxy sugars, it appears that racemization of the resultant (*R*)-α-azido ester **8** might take place during the reduction step but, as reported previously[1], the corresponding (*S*) α-azido ester undergoes very little racemization.

The configurations of the resultant α-amino esters were initially assigned from evidence of c.d. studies on the methyl esters **9** and **10** and the free amino acids **11** and **12** obtained after basic hydrolysis[9]. Methyl D-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycinate (**9**) in 95% ethanol exhibited an intense negative Cotton effect at 206 nm. Conversely, the previously described[1] methyl L-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycine (**10**) in 95% ethanol exhibited an intense positive Cotton effect at 206 nm, in agreement with the positive Cotton effects shown by other L-amino acids[9]. Hydrolysis of the D-amino ester **9** in 1.25% aqueous methanolic sodium hydroxide, followed by deionization, afforded crystalline D-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranos-3-yl)glycine (**11**) in 95% yield. The c.d. spectrum of this compound showed an intense negative Cotton effect of the same sign as that of the corresponding α-amino ester, when determined in 0.5M hydrochloric acid in 95% ethanol at a wavelength of 212 nm; this result supports the configurational assignments of **9** and **10**.

Unambiguous confirmation of the configurational assignments of the glycosyl α-amino acids was provided by converting the D-amino ester **9** into 3-deoxy-3-*C*[(*R*)-hydroxymethyl-(*N*-salicylideneamino)methyl]-1,2:5,6-di-*O*-isopropylidene-α-D-allofuranose (**14**), a previously reported compound[10], whose structure was correlated with 5-*O*-(*p*-bromophenylsulfonyl)-3-deoxy-3-*C*-(*R*)-(ethoxycarbonylformamido)methyl-1,2-*O*-isopropylidene-α-D-ribofuranoside[11]. The structure of the latter has been determined by X-ray analysis[11].

EXPERIMENTAL

General methods. — As previously described[1].

3-C-[(R)-Acetoxy(methoxycarbonyl)methyl]-1,2:5,6-di-O-isopropylidene-α-D-glucofuranose (**2**). — Acetic anhydride (20 ml) was slowly added to an ice-cold solution of **1** (2.1 g) in pyridine (40 ml) and the mixture was stirred overnight at room temperature. Evaporation of the reaction mixture afforded a pale-yellow syrup

(2.3 g, 100%), which was chromatographed on a column of silica gel H (60 g) with 1:1 benzene–ethyl acetate as eluant under a pressure of 0.5 atm, to afford crystalline **2** (1.96 g, 83%). An analytical sample was recrystallized from ethanol–*n*-hexane; m.p. 131.0–132.0° $[\alpha]_D^{24}$ +60.4° (*c* 1.3, chloroform); τ^{CDCl_3} 4.06 (d, 1, $J_{1,2}$ 3.5 Hz, H-1), 4.52 (s, 1, H-1'), 5.57 (d, 1, H-2), 5.6–6.1 (m, 4, H-4, H-5, H-6), 6.15 (s, 3, CO_2CH_3), 6.28 (s, 1, OH, exchanges with D_2O), 7.81 (s, d, OAc).

Anal. Calc. for $C_{17}H_{26}O_{10}$: C, 52.30; H, 6.71. Found: C, 52.09; H, 6.86.

3-C-[Acetoxy(methoxycarbonyl)methylene]-(Z)-3-deoxy-1,2:5,6-di-O-isopropylidene-α-D-ribo-hexofuranose (**3**). — Freshly distilled thionyl chloride (6 ml) was added to a solution of **2** (1.68 g) in pyridine (20 ml) at 0° and the mixture was stirred in the dark for 20 h. Addition of ice–water (20 ml) followed by extraction with dichloromethane (6 × 50 ml) afforded, after drying (calcium sulfate) and evaporation of the extract, an orange syrup (1.8 g). Column chromatography (silica gel H, 120 g, 4:1 benzene–ethyl acetate) afforded crystalline **3** (1.11 g, 69%). An analytical sample was recrystallized from *n*-hexane; m.p. 89.0–89.5°, $[\alpha]_D^{21}$ +103.7° (*c* 1.5, dichloromethane); τ^{CDCl_3} 4.07 (d, 1, $J_{1,2}$ 4.5 Hz, H-1), 4.27 (d, d, 1, $J_{4,2}$ 1.5 Hz, $J_{4,5}$ 3.0 Hz, H-4), 4.80 (d, d, 1, H-2), 5.77 (d, q, 1, $J_{5,6}$ 6.0 Hz, $J_{5,6'}$ 7.5 Hz, H-5), 6.04 (d, d, 1, $J_{6',6''}$ 9 Hz, H-6'), 6.20 (s, 3, CO_2CH_3), 6.29 (d, d, 1, H-6''), 7.76 (s, 3, OAc).

Anal. Calc. for $C_{17}H_{24}O_9$: C, 54.83; H, 6.50. Found: C, 54.71; H, 6.70.

3-C-[(S)-Acetoxy(methoxycarbonyl)methyl]-3-deoxy-1,2:5,6-di-O-isopropylidene-α-D-allofuranose (**4**). — Compound **3** (1.10 g) in ethyl acetate (75 ml) was hydrogenated with 5% palladium-on-carbon (500 mg) as catalyst, until no starting material remained (t.l.c., silica gel, 4:1 benzene–ethyl acetate). The catalyst was filtered off and the filtrate evaporated to afford pure **4** (1.07 g, 97%) as a clear syrup. An analytical sample was purified by molecular distillation at 105°/0.1 mm; $[\alpha]_D^{23}$ +55.3° (*c* 1, dichloromethane); τ^{CDCl_3} 4.22 (d, 1, $J_{1,2}$ 3.9 Hz, H-1), 4.31 (d, 1, $J_{1',3}$ 4.5 Hz, H-1'), 5.19 (t, 1, $J_{2,3}$ 4 Hz, H-2), 5.55–6.05 (m, 4, H-4, H-5, H-6), 6.28 (s, 3, CO_2CH_3), 7.58 (d, t, 1, $J_{3,4}$ 9.5 Hz, H-3), 7.85 (s, 3, OAc).

Anal. Calc. for $C_{17}H_{26}O_9$: C, 54.54; H, 7.00. Found: C, 54.38; H, 7.08.

3-Deoxy-3-C-[(S)-hydroxy(methoxycarbonyl)methyl]-1,2:5,6-di-O-isopropylidene-α-D-allofuranose (**5**). — Acetate **4** (0.88 g) in anhydrous methanol (50 ml) was treated with a solution of 0.1M sodium methoxide in methanol (1 ml) and the mixture was stirred under anhydrous conditions for 4 h. To this solution Amberlite IR-120 (H^+) resin (0.5 ml) was added. The mixture was stirred, filtered, and the filtrate evaporated to afford pure **5** (0.76 g, 100%) as a clear syrup. Molecular distillation of **5** at 130°/0.1 mm afforded an anlytical sample; $[\alpha]_D^{23}$ +59.4° (*c* 2.4, dichloromethane); c.d. (*c* 0.15, 95% ethanol), $[\theta]_{202}$ +1230, $[\theta]_{208}$ +1720 (peak), $[\theta]_{233}$ −370 (trough); τ^{CDCl_3} 4.22 (d, 1, $J_{1,2}$ 3.6 Hz), 5.18 (d, d, 1, $J_{2,3}$ 4.5 Hz), 5.40 (d, d, 1, $J_{1',3}$ 6.5 Hz, $J_{1',OH}$ 3 Hz, H-1'), 5.65–6.10 (m, 4, H-4, H-5, H-6), 6.18 (s, 3, CO_2CH_3), 7.57 (m, 1, $J_{3,4}$ 9.5 Hz, H-3).

Anal. Calc. for $C_{15}H_{24}O_8$: C, 54.21; H, 7.28. Found: C, 54.21; H, 7.18.

3-Deoxy-1,2:5,6-di-O-isopropylidene-3-C-[(S)-methylsulfonyloxy(methoxycarbonyl)methyl]-α-D-allofuranose (**6**). — To **5** (387 mg) in pyridine (10 ml) at 0° was added

methanesulfonyl chloride (0.35 ml). T.l.c. (silica gel, 3:2 benzene–ethyl acetate) revealed complete reaction after 5 h. Ice–water (50 ml) was added and the mixture was extracted with dichloromethane (4 × 50 ml) to afford an orange syrup after drying and removal of solvent. Column chromatography (silica gel H, 60 g, 3:2 benzene–ethyl acetate) under a pressure of 0.5 atm afforded crystalline **6** (438 mg, 92%), m.p. 136.0–136.5°, $[\alpha]_D^{22}$ +59.4° (*c* 1, dichloromethane); τ 4.20 (d, 1, $J_{1,2}$ 4 Hz, H-1), 4.38 (d, 1, $J_{1',3}$ 4.5 Hz, H-1'), 5.19 (t, 1, $J_{2,3}$ 4 Hz, H-2), 5.61 (m, 1, H-4), 5.80–6.05 (m, 3, H-5, H-6), 6.22 (s, 3, CO_2CH_3), 6.82 (s, 3, CO_2CH_3), 7.48 (d, t, 1, $J_{3,4}$ 9.5 Hz, H-3).

Anal. Calc. for $C_{16}H_{26}O_{10}S$: C, 46.82; H, 6.39. Found: C, 46.95; H, 6.60.

*3-Deoxy-1,2:5,6-di-*O*-isopropylidene-3-*C*-[(S)-*p*-tolylsulfonyloxy(methoxycarbonyl)methyl]-α-*D*-allofuranose* (**7**). — To **5** (120 mg) in pyridine (5 ml) at 0° was added *p*-toluenesulfonyl chloride (300 mg) and the mixture was stirred for 48 h at room temperature. After water (5 ml) had been added, the mixture was extracted with dichloromethane (3 × 20 ml), and the extract evaporated to yield crude **7** as an orange solid. Column chromatography (silica gel, 30 g, 4:1 benzene–ethyl acetate), under 0.5 atm afforded **7** (110 mg, 63%). Recrystallization of **7** from ethanol gave pure material, m.p. 92.0–92.5°, $[\alpha]_D$ +48.4° (*c* 1, dichloromethane); τ^{CDCl_3} 4.27 (d, 1, $J_{1,2}$ 4 Hz, H-1), 4.57 (d, 1, $J_{1',3}$ 5 Hz, H-1'), 5.29 (t, 1, $J_{2,3}$ 4 Hz, H-2), 6.40 (s, 3, CO_2Me), 7.60 (s, 3, CH_3), 7.80 (m, 1, H-3).

Anal. Calc. for $C_{22}H_{30}O_{10}S$: C, 54.32; H, 6.13. Found: C, 54.32; H, 6.22.

Methyl D*-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-*D*-allofuranos-3-yl)glycinate* (**9**) *and methyl* L*-2-(3-deoxy-1,2:5,6-di-*O*-isopropylidene-α-*D*-allofuranos-3-yl)glycinate* (**10**). — *From* **6**. A solution of sulfonate **6** (300 mg) and sodium azide (300 mg) in anhydrous *N,N*-dimethylformamide was maintained, with stirring, for 40 h at 55° in the dark. The solution was evaporated to dryness under vacuum, and the residue was then extracted with dichloromethane to afford a pale-yellow syrup. T.l.c. revealed that all sulfonate had been consumed to afford crude azido sugar **8** (R_F 0.45) and a small amount of another component R_F 0.27 (silica gel, 7:3 benzene–ethyl acetate). The mixture was then immediately hydrogenated in benzene (25 ml) with 5% palladium-on-charcoal (150 mg) as catalyst for 6 h at room temperature and atmospheric pressure. The mixture was filtered and the filtrate evaporated to afford a clear syrup that showed two ninhydrin-positive components by t.l.c., R_F 0.25 (major) and R_F 0.19 (minor) (silica gel, ethyl acetate). Column chromatography of the product (silica gel H, 60 g, ethyl acetate) afforded the pure α-amino esters **9** and **10**.

Compound **9** (84 mg, 34%), was distilled at 105°/0.1 mm; $[\alpha]_D^{22}$ +22.3° (*c* 5.9, dichloromethane); c.d. (*c* 0.19, 95% ethanol): $[\theta]_{206}$ −1370°, $[\theta]_{215}$ −750°, $[\theta]_{220}$ 0°, $[\theta]_{231}$ +1020° (peak), $[\theta]_{225}$ 0; τ^{CDCl_3} 4.21 (d, 1, $J_{1,2}$ 3.8 Hz, H-1), 5.22 (t, 1, $J_{2,3}$ 4 Hz, H-2), 5.5–6.1 (m, 5, H-1', H-4, H-5, H-6), 6.20 (s, 3, CO_2CH_3), 7.55 (m, 1, H-3), 8.15 (bs., 2, NH_2).

Anal. Calc. for $C_{15}H_{25}NO_7$: C, 54.37; H, 7.60; N, 4.23. Found: C, 54.52; H, 7.76; N, 4.25.

Compound **10** (54 mg, 22%), was distilled at 105°/0.1 mm; c.d. (*c* 0.19, 95% ethanol): $[\theta]_{206}$ +3080°, $[\theta]_{215}$ +1400°, $[\theta]_{220}$ 0°, $[\theta]_{231}$ −780° (trough), $[\theta]_{256}$ 0.

From **7**. A solution of the sulfonate **7** (55 mg) and sodium azide (55 mg) in anhydrous dimethyl sulfoxide (2 ml) was stirred in the dark for 40 h at a constant temperature of 55°. The solution was evaporated to dryness under vacuum and the residue extracted with dichloromethane. Filtration and evaporation of the filtrate afforded a light-brown oil that showed intense absorption at 2150 cm^{-1} in its i.r. spectrum. The mixture was immediately hydrogenated in methanol (10 ml), with 5% palladium-on-carbon (50 mg) as catalyst, at atmospheric pressure for 3 h. T.l.c. (silica gel, ethyl acetate) revealed that hydrogenation was complete after this time, and afforded two ninhydrin-positive components [R_F 0.25 (minor) and R_F 0.19 (major)]. Filtration and evaporation of the solvent afforded a clear syrup that was chromatographed on a column of t.l.c.-grade silica gel (15 g, ethyl acetate) to give **9** (5 mg, 10%) and **10** (11 mg, 27%).

Methyl N-*benzoyl*-D-*2*-(*3-deoxy-1,2:5,6-di*-O-*isopropylidene*-α-D-*allofuranos-3-yl*) *glycinate* (**13**). — To **9** (6 mg) in methanol (0.5 ml) was added benzoic anhydride (6 mg). The reaction mixture was stirred for 3 h, at room temperature and then evaporated to dryness to afford a clear oil that crystallized on being kept. T.l.c. revealed only one component [R_F 0.15, silica gel, 4:1 benzene–ethyl acetate), and it was recrystallized from ethanol–*n*-hexane, m.p. 141–143.5° (lit.[8] m.p. 138–140°).

D-*2*-(*3-Deoxy-1,2:5,6-di*-O-*isopropylidene*-α-D-*allofuranos-3-yl*)*glycine* (**11**). — To a solution of **9** (22 mg) in methanol (1 ml) was added 2.5% aqueous methanolic sodium hydroxide (1 ml), and the mixture was stirred for 20 min. The solution was then passed through a short column of Rexyn RG-51 (H^+) (polystyrenecarboxylic acid type resin, 5 ml) that had been prewashed with 1% acetic acid and then water. Collection and evaporation of ninhydrin-positive fractions afforded **11** (20 mg, 95%) as a hard glass, which was recrystallized from ethanol–water, m.p. 198–199° (decomp.), $[\alpha]_D^{23}$ +56.7° (*c* 1.2, 1:1 ethanol–water); c.d. (*c* 0.1, 0.5M HCl in 95% ethanol): $[\theta]_{205}$ −2400°, $[\theta]_{212}$ −2860° (trough), $[\theta]_{220}$ −2160°. $[\theta]_{230}$ −800°, $[\theta]_{245}$ 0°; τ^{D_2O}(external Me_4Si) 3.48 (d, 1, $J_{1,2}$ 3.5 Hz, H-1), 4.62 (t, 1, $J_{2,3}$ 4 Hz, H-2), 6.90 (d.t, 1, H-3).

Anal. Calc. for $C_{14}H_{23}NO_7$: C, 52.98; H, 7.30; N, 4.41. Found: C, 53.31; H, 7.30; N, 4.62.

Conversion of methyl D-*2*-(*3-deoxy-1,2:5,6-di*-O-*isopropylidene*-α-D-*allofuranos-3-yl*)*glycinate* (**9**) *into 3-deoxy-3*-C-[(R)-(*hydroxymethyl*-N-*salicylideneamino*)*methyl*]-*1,2.5,6-di*-O-*isopropylidene*-α-D-*allofuranose* (**14**). — The α-amino ester (**9**) (0.025 g) was reduced with lithium aluminum hydride (0.030 g) in anhydrous tetrahydrofuran (3 ml) for 1.5 h under reflux. After addition of 0.5M sodium hydroxide (60 μl), water (90 μl) was added and the resultant mixture centrifuged. The supernatant band was removed, tetrahydrofuran (3 × 2 ml) was added, and the extraction was repeated. The tetrahydrofuran layers were combined and evaporated to dryness under diminished pressure. To the residue (20 mg) in methanol (0.5 ml) was added salicylaldehyde (20 mg) and the mixture was maintained overnight at approximately 25°. The reaction

mixture was separated by t.l.c. on silica gel G with 1:1 benzene–ethyl acetate as developer. The salicylidene derivative **14** (7 mg) was recrystallized from ethanol: m.p. 156.5–158°, $[\alpha]_D^{22}$ +120° (*c* 0.012 in ethanol). The o.r.d. curve (ethanol, $c = 0.02$) of **14** exhibited a positive Cotton effect with extrema $[\theta]_{333}$ +2765 and $[\theta]_{300}$ −590. The literature values[10] for **14** are: m.p. 156–157°, $[\alpha]_D$ +128°; $[\theta]_{333}$ +8850, $[\theta]_{300}$ −3650.

ACKNOWLEDGMENT

The authors thank the National Research Council of Canada for financial assistance.

REFERENCES

1 A. ROSENTHAL AND KOICHI SHUDO, *J. Org. Chem.*, 37 (1972) 4391.
2 A. ROSENTHAL, COLIN M. RICHARDS, AND KOICHI SHUDO, *Carbohyd. Res.*, 27 (1973) 353.
3 A. ROSENTHAL AND COLIN M. RICHARDS, *Carbohyd. Res.*, in press.
4 K. ISONO, K. ASAHI, AND S. SUZUKI, *J. Amer. Chem. Soc.*, 91 (1969) 7490.
5 (a) D. H. R. BARTON, A. DA S. CAMPAS-NEVES, AND R. C. COOKSON, *J. Chem. Soc.*, (1956) 3500; (b) J. L. BETON, T. G. HALSALL, E. R. H. JONES, AND P. C. PHILLIPS, *ibid.*, (1957) 753; (c) T. D. INCH, G. J. LEWIS, AND N. E. WILLIAMS, *Carbohyd. Res.*, 19 (1971) 17.
6 J. E. BLACKWOOD, C. L. GLADYS, K. L. LOENING, A. E. PETRARCA, AND J. E. RUSH, *J. Amer. Chem. Soc.*, 90 (1968) 509.
7 L. D. HALL, S. A. BLACK, K. N. SLESSOR, AND A. S. TRACEY, *Can. J. Chem.*, 50 (1972) 1912.
8 A. ROSENTHAL AND K. C. DOOLEY, *Comm. Carbohyd., Nucleoside and Nucleotide Chem.*, in press.
9 J. C. CRAIG AND S. K. ROY, *Tetrahedron*, 21 (1965) 391.
10 A. J. BRINK, J. COETZER, A. JORDAAN, AND C. J. LOURENS, *Tetrahedron Lett.*, (1972) 5353.
11 J. COETZER, A. JORDAAN, G. J. LOURENS, AND M. J. NOLTE, *Acta Crystallogr.*, (1972) 3537.