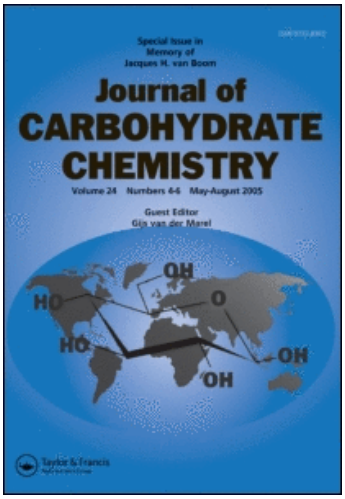

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Studies on the Thioglycosides of N-Acetylneuraminic Acid 1: Synthesis of Alkyl α-Glycosides of 2-Thio-N-Acetylneuraminic Acid

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STUDIES ON THE THIOGLYCOSIDES OF N-ACETYLNEURAMINIC ACID 1: SYNTHESIS OF ALKYL α-GLYCOSIDES OF 2-THIO-N-ACETYLNEURAMINIC ACID

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ABSTRACT

Methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-2-S-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosonate (2) was prepared via methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-2-chloro-2,3,5-trideoxy-D-glycero-α-D-galacto-2-nonulopyranosonate (1) and was converted into the sodium salt (3). Condensation of 3 with n-alkyl bromides gave the corresponding methyl (alkyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onates, which were converted, via O-deacetylation and hydrolysis of the methyl ester group, into the title compounds.

INTRODUCTION

Derivatives, analogs and glycosides of N-acetylneuraminic acid are of interest as substrates and inhibitores for sialidases or sialyl transferases, and potential modifiers of cell-surface sialic acid.[1]

In this communication, we report a stereoselective and high yield synthesis of α-alkyl glycosides of 2-thio-N-acetylneuraminic acid.

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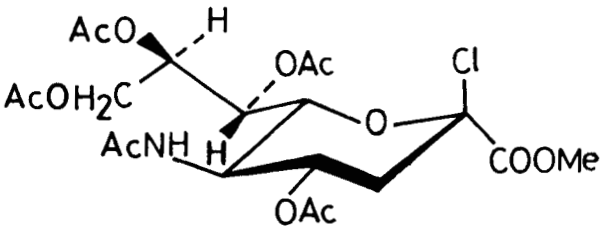
RESULTS AND DISCUSSION

Treatment of methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-2-chloro-2,3,5-trideoxy-D-glycero-β-D-galacto-2-nonulopyranosonate[2] (1), freshly prepared from methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-D-glycero-D-galacto-2-nonulopyranosonate[3], with potassium thioacetate in dry dichloromethane gave methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-2-S-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosonate (2) in 90% yield; significant signals in the NMR spectrum were a one-proton doublet of doublets at δ 2.63 ($J_{3a,3e}$ 12.9, $J_{3e,4}$ 4.6 Hz, H-3e) and one-proton multiplet at δ 4.89 for H-4 proton, for the α-anomer (for H-3e in β Neu Ac_6 : δ 2.47, and for H-4 at δ 5.28[4]), and a three-proton singlet at δ 2.28 (S-acetyl). Other NMR data are given in the Experimental section, and are consistent with structure 2.

Selective S-deacetylation of 2 with the amount of sodium methoxide calculated to be equivalent to 2 in dry methanol at -40°C, gave the sodium salt of methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosonate (3), which was used for the next reaction without further purification. When reacted with 1-bromo-n-hexane in dry N,N-dimethylformamide (DMF) under nitrogen atmosphere, compound 3 yielded methyl (n-hexyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onate (4) in 91% yield, after purification, on the basis of 2. The structure was unambiguously proved by 270-MHz, ^{1}H-NMR spectroscopy. The observed chemical shifts and coupling constants (δ 2.74, $J_{3a,3e}$ 12.4, $J_{3e,4}$ 4.8 Hz for H-3e, and δ 4.85 for H-4) for H-3e and H-4, are characteristic for α-glycosidic linkages[5-7] (δ 2.60-2.85, $J_{3a,3e}$ 12.4-12.6, $J_{3e,4}$ 4.4-4.8 Hz for H-3e, and δ 4.85-4.95 for H-4). Other NMR data are consistent with structure 4.

In the same way, when treated with n-dodecyl or n-octadecyl bromide, compound 3 afforded the corresponding α-thioglycosides (5 and 6) of N-acetylneuraminic acid methyl ester in 83 and 66% yields, respectively. O-Deacetylation of compounds (4, 5, and 6) with sodium methoxide in methanol, gave methyl (alkyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onates (7, 8, and 9) in in high yields; significant signals in the NMR spectrum of compound 9,



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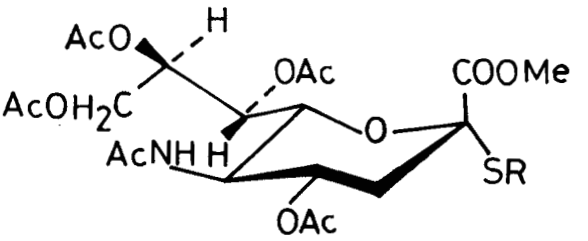
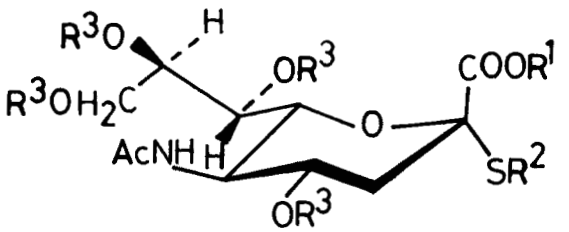


2 R = Ac

3 R = Na



4 R^1 = Me, R^2 = hexyl, R^3 = Ac

5 R^1 = Me, R^2 = dodecyl, R^3 = Ac

6 R^1 = Me, R^2 = octadecyl, R^3 = Ac

7 R^1 = Me, R^2 = hexyl, R^3 = H

8 R^1 = Me, R^2 = dodecyl, R^3 = H

9 R^1 = Me, R^2 = octadecyl, R^3 = H

10 R^1 = R^3 = H, R^2 = hexyl

11 R^1 = R^3 = H, R^2 = dodecyl

12 R^1 = R^3 = H, R^2 = octadecyl

were two three proton singlet at δ 2.02 (N-acetyl), 3.85 (COOMe), two one-proton doublet of doublets at δ 1.86 and 2.81 ($J_{3a,3e}$ 12.8, $J_{3a,4}$ 11.4 Hz, H-3a and $J_{3e,4}$ 4.7 Hz, H-3e). Other NMR data are consistent with structure 9. Saponification of the methyl ester group in compounds (7,8, and 9) with 0.2M potassium hydroxide in 1,4-dioxane afforded the desired alkyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosidoic acids (10, 11, and 12) in quantitative yields.

This stereoselective and high yield synthesis of alkyl α-thioglycosides of N-acetylneuraminic acid are noteworthy.

EXPERIMENTAL

General Procedures. Melting points were determined with a Yanagimoto micro melting-points apparatus and are uncorrected. Specific rotations were determined with a Union MP-201 polarimeter, and IR spectra were recorded with a Jasco 1R-1 spectrophotometer. H^1-NMR spectra were recorded with a Jeol JMN-GX 270 spectrometer. Preparative chromatography was performed on silica gel (Waco Co,; 200 mesh) with the solvent systems specified. Evaporations were conducted in vacuo.

Methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-2-S-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosonate (2). To a solution of methyl 5-acetamido-4,7,8,9-tetra-O-acetyl-2-chloro-3,5-dideoxy-D-glycero-β-D-galacto-2-nonulopyranosonate[3] (1; 3.3 g) in dry dichloromethane (30 mL) was added potassium thioacetate (3.5 g). The mixture was stirred overnight at room temperature, and evaporatead, the residue extracted with chloroform, and the extract washed with water, dried (sodium sulfate), and evaporated to a syrup. The product was chromatographed on a column of silica gel (200 g) with 100:1 chloroform-methanol, to give 3.2 g (90%) of compound 2 as an amorphous mass; mp 74-76° , $[\alpha]_D^{25}$ -15.6° (c 0.75, chloroform); 1R (Nujol): 3280 (NH), 1750 and 1230 (ester), 1690 (AcS), and 1665 and 1555 cm^{-1}(amide); NMR ($CDCl_3$): δ 1.88(s, 3H, AcN), 1.89(t, 1H, $J_{3a,3e}$ 12.9, $J_{3a,4}$ 12.9 Hz, H-3a), 2.02, 2.04, 2.12, 2.14 (4s, 12H, 4AcO), 2.28 (s, 3H, AcS), 2.63 (dd, 1H, $J_{3a,3e}$ 12.9, $J_{3e,4}$ 4.6 Hz, H-3e), 3.80(s, 3H, MeO), 4.03 (dd, 1H, $J_{9,9'}$ 12.5, $J_{8,9}$ 6.2 Hz, H-9), 4.14 (q, 1H, $J_{4,5}$ =

$J_{5,6}$ = $J_{5,NH}$ = 10.3 Hz, H-5), 4.41 (dd, 1H, $J_{9,9'}$ 12.5, $J_{8,9}$ 2.6 Hz, H-9'), 4.66(dd, $J_{5,6}$ 10.5, $J_{6,7}$ 2.4 Hz, H-6), 4.89 (m, 1H, H-4), 5.22 (m, 1H, $J_{7,8}$ 6.1 Hz, H-8), 5.36 (dd, 1H, $J_{6,7}$ 2.4, $J_{7,8}$ 6.1 Hz, H-7), and 5.48 (d, 1H, $J_{5,NH}$ 10.3 Hz, NH).

Anal. Calcd for $C_{22}H_{31}NO_{13}S$: C, 48.08; H, 5.69; N, 2.55. Found: C, 48.03; H, 5.69; N, 2.46.

Methyl (n-hexyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio- D-glycero-α-D-galacto-2-nonulopyranosid)onate (4). To a stirred solution of 2 (100 mg) in dry methanol (3 mL), cooled to -40°C, was added a solution of sodium metal (4.0 mg) in dry methanol (1.0 mL). The mixture was stirred for 40 min at -40°C, the course of the reaction being monitored by t.l.c., and evaporated at 0°C, to give compound 3 as an amorphous mass, which was dissolved in dry N,N-dimethylformamide (DMF; 2 mL). To the stirred solution was added 1-bromo-n-hexane (20 mg) in dry DMF (1 mL), and the mixture was stirred under nitrogen overnight at room temperature, and then evaporated to a syrup, which was extracted with chloroform. The extract was washed with water, dried (sodium sulfate), and evaporated to a syrup, which was chromatographed on a column of silica gel (20 g) with chloroform, and then 150:1 chloroform-methanol. The latter eluate gave compound 4 (97.5 mg, 91%) as an amorphous mass; mp 118-120°, $[\alpha]_D^{25}$ +23.9° (c 0.75, chloroform); IR (Nujol): 3280 (NH), 2940, 2850 (Me, methylene), 1750 and 1220 (ester), and 1660 and 1545 cm^{-1} (amide); NMR ($CDCl_3$): δ 0.88, (t, 3H, J_{Me,CH_2} 6.6 Hz, $MeCH_2$), 1.26-1.40 (m, 8H, $4CH_2$), 1.88 (s, 3H, AcN), 1.94 (near t, 1H, $J_{3a,3e}$ = $J_{3a,4}$ = 12.4 Hz, H-3a), 2.03, 2.04, 2.14, 2.16 (4s, 12H, 4AcO), 2.63 (m, 2H, CH_2S), 2.74 (dd, 1H, $J_{3a,3e}$ 12.4, $J_{3e,4}$ 4.8 Hz, H-3e), 3.80 (s, 3H, MeO), 3.83 (dd, 1H, $J_{5,6}$ 10.6, $J_{6,7}$ 2.2 Hz, H-6), 4.09 (q, 1H, $J_{4,5}$ = $J_{5,6}$ = J_{NH} = 10.2 Hz, H-5), 4.12 (dd, 1H, $J_{8,9}$ 4.5, $J_{9,9'}$ 12.4 Hz, H-9), 4.32 (dd, 1H, $J_{8,9'}$ 2.4 Hz, H-9'), 4.86 (m, 1H, H-4), 5.20 (d, 1H, $J_{NH,5}$ 10.2 Hz, NH), and 5.30-5.37 (m, 2H, H-7,8).

Anal. Calcd for $C_{26}H_{41}NO_{12}S$: C, 52.78; H, 6.98; N, 2.37. Found: C, 52.51; H, 6.96; N, 2.36.

Other methyl (alkyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onates (5 and 6) were synthesized according to the method described for 4.

Methyl (n-dodecyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onate (5). Compound 5 was obtained as an amorphous mass in 83% yield; mp 48-50°, $[\alpha]_D^{25}$ + 21.4° (c 0.69, chloroform); IR (Nujol): 3280 (NH), 2940 and 2850 (Me, methylene), 1740 and 1220 (ester), and 1660 and 1550 cm^{-1} (amide); NMR ($CDCl_3$): δ 0.88 (t, 3H, J_{Me,CH_2} 6.6 Hz, $MeCH_2$), 1.22-1.40 (m, 20H, $10CH_2$), 1.88 (s, 3H, AcN), 1.95 (near t, 1H, $J_{3a,3e} = J_{3a,4} \simeq 12.5$ Hz, H-3a), 2.02, 2.03, 2.16, 2.18 (4s, 12H, 4AcO), 2.64 (m, 2H, CH_2S), 2.72 (dd, 1H, $J_{3a,3e}$ 12.5, $J_{3e,4}$ 4.7 Hz, H-3e), 3.80 (s, 3H, MeO), 3.82 (dd, 1H, $J_{5,6}$ 10.5, $J_{6,7}$ 2.2 Hz, H-6), 4.07 (q, 1H, $J_{4,5} = J_{5,6} = J_{NH,5} = 10.5$ Hz, H-5), 4.13 (dd, 1H, $J_{8,9}$ 4.8, $J_{9,9'}$ 12.5 Hz, H-9), 4.33 (dd, 1H, $J_{8,9'}$ 2.4 Hz, H-9'), 4.86 (m, 1H, H-4), and 5.32-5.40 (m, 3H, H-7,8 and NH).

Anal. Calcd for $C_{32}H_{53}NO_{12}S$: C, 56.87; H, 7.90; N, 2.07. Found: C, 56.72; H, 8.15; N, 2.06.

Methyl (n-octadecyl 5-acetamido-4,7,8,9-tetra-O-acetyl-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onate (6). Compound 6 was obtained as a syrup in 66% yield; $[\alpha]_D^{25}$ + 21.3° (c 0.48, chloroform); IR (film): 3270 (NH), 2940 and 2850 (Me, methylene), 1745 and 1220 (ester), and 1660 and 1545 cm^{-1} (amide); NMR ($CDCl_3$): δ 0.88 (near t, 3H, J_{Me,CH_2} 6.6 Hz, $MeCH_2$), 1.25-1.35 (m, 32H, $16CH_2$), 1.88 (s, 3H, AcN), 1.94(t, 1H, $J_{3a,3e} = J_{3a,4}$ = 12.4 Hz, H-3a), 2.02, 2.04, 2.16, 2.18 (4s, 12H, 4AcO), 2.65 (m, 2H, CH_2S), 2.73 (dd, 1H, $J_{3a,3e}$ 12.4, $J_{3e,4}$ 4.6 Hz, H-3e), 3.80 (3, 3H, MeO), 3.83 (dd, 1H, $J_{5,6}$ 10.2, $J_{6,7}$ 2.3 Hz, H-6), 4.08 (q, 1H, $J_{4,5} = J_{5,6} = J_{5,NH}$ = 10.2 Hz, H-5), 4.13 (dd, 1H, $J_{8,9}$ 4.8, $J_{9,9'}$ 12.5 Hz, H-9), 4.33 (dd, 1H, $J_{8,9'}$ 2.5 Hz, H-9'), 4.86 (m, 1H, H-4), 5.22 (d, 1H, $J_{NH,5}$ 10.2 Hz, NH), and 5.29-5.35 (m, 2H, H-7,8).

Anal. Calcd for $C_{38}H_{65}NO_{12}S$: C, 60.06; H, 8.62; N, 1.84. Found: C, 60.23; H, 8.90; N, 1.85.

Methyl (n-hexyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onate (7). To an ice-cooled solution of 4 (73 mg) in dry methanol (2 mL) was added trace amounts of sodium methoxide, and the mixture was kept for 4 h at room temperature; at that time, all of the starting material had been converted into 7. The mixture was treated with Amberlite IR-120 (H^+) resin, to remove the base. Crystallization from ether-hexane afforded 7 (40 mg, 76.5%);

mp 154-156°, $[\alpha]_D^{25}$+51.2° (c 0.5, 1:1 chloroform-methanol); IR (KBr): 3370 (OH), 3270 (NH), 2940 and 2850 (Me, methylene), 1720 and 1220 (ester), and 1630 and 1570 cm^{-1} (amide): NMR (1:1 $CDCl_3$-CD_3OD): δ 0.89 (near t, 3H, J_{Me,CH_2} 6.6 Hz, $MeCH_2$), 1.20-1.35 (m, 8H, $4CH_2$), 1.86 (dd, 1H, $J_{3a,3e}$ 12.8 Hz, $J_{3a,4}$ 11.4 Hz, H-3a), 2.02 (s, 3H, AcN), 2.63 (m, 2H, CH_2S), 2.81 (dd, $J_{3a,3e}$ 12.8, $J_{3e,4}$ 4.7 Hz, H-3e), 3.34 (dd, 1H, $J_{8,9}$, 1.5 Hz, $J_{9,9}$, 12.5 Hz, H-9'), 3.53 (dd, 1H, $J_{6,7}$ 1.4, $J_{7,8}$ 8.8 Hz, H-7), 3.65 (m, 1H, H-4), 3.72 (dd, 1H, $J_{8,9}$ 4.9 Hz, H-9), 3.80 (q, 1H, $J_{4,5} = J_{5,6} = J_{5,NH}$ = 10.1 Hz, H-5), 3.85 (s, 3H, MeO), and 3.85-3.90 (m, 2H, H-6,8).

Anal. Calcd for $C_{18}H_{33}NO_8S$: C, 51.05; H, 7.85; N, 3.31. Found: C, 51.22; H, 7.91; N, 3.28.

Other methyl (alkyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onates (8 and 9) were prepared from the corresponding peracetylated derivatives (5 and 6) according the procedure described for 7.

Methyl (n-dodecyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onate (8). Compound 8 was obtained as an amorphous mass in quantitative yield; mp 88-90°, $[\alpha]_D^{25}$ + 41.5° (c 0.9, 1:1 chloroform-methanol); IR (KBr): 3450-3250 (OH, NH), 2940 and 2850 (Me, methylene), 1720 and 1220 (ester), and 1640 and 1560 cm^{-1} (amide); NMR (1:1 $CDCl_3$-CD_3OD): δ 0.88 (near t, 3H, J_{Me,CH_2} 6.5 Hz, $MeCH_2$), 1.22-1.35 (m, 20H, $10CH_2$), 1.86 (dd, 1H, $J_{3a,3e}$ 12.6, $J_{3a,4}$ 11.1 Hz, H-3a), 2.03 (s, 3H, AcN), 2.66 (m, 2H, CH_2S), 2.81 (dd, $J_{3a,3e}$ 12.6, $J_{3e,4}$ 4.7 Hz, H-3e), and 3.85 (s, 3H, MeO).

Anal. Calcd for $C_{24}H_{45}NO_8S$: C, 56.78; H, 8.93; N, 2.76. Found: C, 56.60; H, 9.15; N, 2.70.

Methyl (n-octadecyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosid)onate (9). Compound 9 was obtained as an amorphous mass in quantitative yield; mp 104-106°, $[\alpha]_D^{25}$ + 42.0° (c 0.39, 1:1 chloroform-methanol); IR (KBr): 3360-3280 (OH, NH), 2940 and 2850 (Me, methylene), 1720 and 1225 (ester), and 1630 and 1550 cm^{-1} (amide); NMR (1:1 $CDCl_3$-CD_3OD): δ 0.89 (t, 3H, J_{Me,CH_2} 6.6 Hz, $MeCH_2$), 1.20-1.34 (m, 32H, $16CH_2$), 1.85 (dd, 1H, $J_{3a,3e}$ 12.8, $J_{3a,4}$ 11.2 Hz, H-3a), 2.02 (s, 3H, AcN), 2.66 (m, 2H, CH_2S),2.81 (dd, $J_{3a,3e}$ 12.8, $J_{3e,4}$ 4.7 Hz, H-3e), 3.64 (m, 1H, H-4), 3.78 (q, 1H, $J_{4,5} = J_{5,6} = J_{5,NH}$ = 10.0 Hz, H-5), and 3.85 (s, 3H, MeO).

Anal. Calcd for $C_{30}H_{57}NO_8S$: C, 60.88; H, 9.71; N, 2.37. Found: C, 60.56; H, 9.85; N, 2.26.

n-Hexyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosidoic acid (10). To a solution of 7 (25 mg) in 1,4-dioxane (2 mL) was added 0.2M potassium hydroxide (1.5 mL) at 0°C, and the mixture was stirred for 4 h, and then treated with Amberlite IR-120 (H^+) resin to remove the base. The resin was filtered off and washed with water, and the filtrate and washings were combined, and lyophilized, to afford 10 as an amorphous mass in quantitative yield, which showed a single spot in t.l.c.; mp 139-141°, $[\alpha]_D^{25}$ + 33.5° (c 0.26, 1:1 1,4-dioxane-water); IR (KBr): 3350-3260 (OH, NH), 2940 and 2850 (Me, methylene), 1700 (C=O), and 1630 and 1560 cm^{-1} (amide); NMR (1:1 D_2O-CD_3OD): δ 0.76 (t, 3H, J_{Me,CH_2} 6.8 Hz, $MeCH_2$), 1.18-1.31 (m, 8H, $4CH_2$), 1.69 (dd, 1H, $J_{3a,3e}$ 12.4, $J_{3a,4}$ 11.9 Hz, H-3a), 1.93 (s, 3H, AcN), 2.64 (m, 2H, CH_2S), 2.70 (dd, $J_{3a,3e}$ 12.4, $J_{3e,4}$ 4.6 Hz, H-3e), 3.21 (m, 1H, H-9), and 3.48 (dd, 1H, $J_{6,7}$ 1.3, $J_{7,8}$ 8.6 Hz, H-7).

Anal. Calcd for $C_{17}H_{31}NO_8S$: C, 49.86; H, 7.63; N, 3.42. Found: C, 49.58; H, 7.82; N, 3.33.

Other alkyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosidoic acids (11 and 12) were prepared from the corresponding methyl esters (8 and 9) according to the procedure described for 10.

n-Dodecyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosidoic acid (11). Compound 11 was obtained as an amorphous mass in quantitative yield; mp 149-151°, $[\alpha]_D^{25}$ + 19.0° (c 0.49, 1,4-dioxane); IR (KBr): 3400-3250 (OH, NH), 2940 and 2850 (Me, methylene), 1700 (C=O), and 1640 and 1560 cm^{-1} (amide); NMR (1:1 $CDCl_3$-CD_3OD): δ 0.89 (t, J_{Me,CH_2} 6.6 Hz, $MeCH_2$), 1.17-1.27 (m, 20H, $10CH_2$), 1.83 (t, 1H, $J_{3a,3e} = J_{3a,4}$ = 11.0 Hz, H-3a), 2.04 (s, 3H, AcN), 2.67 (m, 2H, CH_2S), and 2.83 (dd, 1H, $J_{3a,3e}$ 11.0, $J_{3e,4}$ 4.6 Hz, H-3e).

Anal. Calcd for $C_{23}H_{43}NO_8S$: C, 55.96; H, 8.78; N, 2.84. Found: C, 55.71; H, 8.93; N, 2.78.

n-Octadecyl 5-acetamido-3,5-dideoxy-2-thio-D-glycero-α-D-galacto-2-nonulopyranosidoic acid (12). Compound 12 was obtained as an amorphous mass in quantitative yield; mp 124-126°, $[\alpha]_D^{25}$ + 12.7° (c 0.2, 1:1 1,4-dioxane-water); IR (KBr): 3420-3270 (OH, NH), 2930 and 2850 (Me, methylene), 1700 (C=O), and 1630 and 1550 cm^{-1} (amide); NMR (1:1

$CDCl_3$-CD_3OD): δ 0.89 (t, 3H, J_{Me,CH_2} 6.4 Hz, $MeCH_2$), 1.17-1.27 (m, 32H, $16CH_2$), 1.81 (t, 1H, $J_{3a,3e} = J_{3a,4}$ = 11.0 Hz, H-3a), 2.04 (s, 3H, AcN), 2.68 (m, 2H, CH_2S), and 2.77 (dd, 1H, $J_{3a,3e}$ 11.0, $J_{3e,4}$ 4.6 Hz, H-3e).

Anal. Calcd for $C_{29}H_{55}NO_8S$: C, 60.28; H, 9.59; N, 2.42. Found: C, 60.11; H, 9.59; N, 2.48.

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