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SYNTHESIS OF D-MANNITE ESTERS OF ALIPHATIC AND AROMATIC ACIDS

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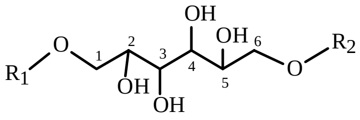
Mono- and diesters of D-mannite with aliphatic acids and mixed diesters with aliphatic and aromatic acids were synthesized by transesterification of their methyl esters. The structures of the products are confirmed by PMR, ^{13}C NMR, and IR spectra.

Key words: synthesis, D-mannite esters, acids.

In continuation of research on the modification of natural and synthetic organic acids with carbohydrates [1, 2], we present results from the synthesis of D-mannite esters with aliphatic and aromatic acids. Mono- and diesters of D-mannite and aliphatic (caproic, caprylic, and capric) acids were prepared by reaction of the methyl ester of the corresponding acid and mannite taken in a 1:3 mole ratio for synthesis of monoesters **1-3** and 2:1, for diesters **4-6**. Mixed diesters of D-mannite **7-10** with caproic, capric, salicylic, and cinnamic acids were prepared by reaction of monoesters **1** and **3** with methylsalicylate or methylcinnamate taken in an equimolar ratio. Mono- and diesters of mannite are crystalline substances that are soluble in alcohol, DMF, and DMSO and insoluble in benzene and $CHCl_3$. Monoesters, in contrast with diesters, are very soluble in water.



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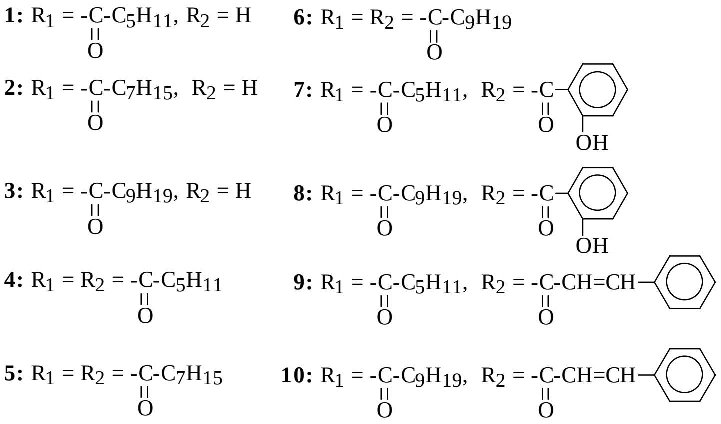

1: $R_1 = -\underset{\underset{O}{\|}}{C}-C_5H_{11}$, R_2 = H

2: $R_1 = -\underset{\underset{O}{\|}}{C}-C_7H_{15}$, R_2 = H

3: $R_1 = -\underset{\underset{O}{\|}}{C}-C_9H_{19}$, R_2 = H

4: $R_1 = R_2 = -\underset{\underset{O}{\|}}{C}-C_5H_{11}$

5: $R_1 = R_2 = -\underset{\underset{O}{\|}}{C}-C_7H_{15}$

6: $R_1 = R_2 = -\underset{\underset{O}{\|}}{C}-C_9H_{19}$

7: $R_1 = -\underset{\underset{O}{\|}}{C}-C_5H_{11}$, $R_2 = -\underset{\underset{O}{\|}}{C}-$

8: $R_1 = -\underset{\underset{O}{\|}}{C}-C_9H_{19}$, $R_2 = -\underset{\underset{O}{\|}}{C}-$

9: $R_1 = -\underset{\underset{O}{\|}}{C}-C_5H_{11}$, $R_2 = -\underset{\underset{O}{\|}}{C}-CH=CH-$

10: $R_1 = -\underset{\underset{O}{\|}}{C}-C_9H_{19}$, $R_2 = -\underset{\underset{O}{\|}}{C}-CH=CH-$

IR spectra of esters **1-10** contain stretches of carbonyl at 1680-1740 cm^{-1} and a broad band at 3100-3600 cm^{-1} for the stretching of associated hydroxyls. The PMR spectra of **1-10** have signals at 0.6-0.8 and 0.9-1.5 ppm for methyls and methylenes that are not deshielded. A signal at 2.1-2.2 ppm is characteristic of the α-methylene in the esters. Signals of CH-

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and CH_2-protons of D-mannite are observed at 4-5 ppm. ^{13}C NMR spectra confirm that the primary hydroxyls are acylated because the C-1 and C-6 atoms, which are situated in the α-position with respect to the ester, experience a shift to weak field whereas C-2 and C-5 in the β-position shift to strong field by 2.5-3 ppm compared to the chemical shifts of the corresponding atoms in unsubstituted D-mannite.

EXPERIMENTAL

IR spectra were recorded on a UR-20 instrument (KBr pellets); PMR and ^{13}C NMR spectra, on a Mercury-300 instrument at working frequencies 300 and 75 MHz, respectively, in C_5D_5N (TMS = 0). The course of reactions was monitored by TLC on Silufol UV-254 plates. The R_f values of esters were measured using $CHCl_3$—CH_3OH (4:1). Compounds **1-10** were isolated by column chromatography on silica gel L (0.04-0.1 mm) with elution by $CHCl_3$—CH_3OH (8-19:1). Elemental analyses of all compounds agreed with those calculated.

Mono- and Diesters of D-Mannite and Aliphatic Acids. D-Mannite (0.05-0.15 mole) was dissolved in DMF (100-200 mL) and heated to 90-95°C, treated with the methyl ester of the corresponding acid (0.05-0.1 mole) and K_2CO_3 (0.005-0.01 mole), and held at 95-110°C at reduced pressure (100-140 mm Hg) under N_2 for 10-14 h. DMF was removed under vacuum after the reaction was finished. Monoester products were treated with alcohol. The precipitate of unreacted mannite was filtered off. Diester products were treated with $CHCl_3$ to remove unreacted methyl ester of the acid. After removing solvents, the reaction products were dried under vacuum (5-10 mm Hg) at 60-65°C.

Compound 1. Yield 50.3%, $C_{12}H_{24}O_7$, mp 134-135°C, R_f 0.35. IR spectrum (ν, cm^{-1}): 740 ($-CH_2$), 1730 (C=O), 3100-3650 (–OH). PMR (δ, ppm, J/Hz): 0.65 (3H, t, J = 7, $-CH_3$), 1.02-1.46 (6H, m, $-CH_2$), 2.17 (2H, t, J = 7.5, $-CH_2COO$), 4.25-5.01 (8H, m, CH), 5.45 (5H, s, –OH). ^{13}C NMR (δ, ppm): aliphat. C: 13.56, 22.02, 24.38, 30.92, 33.86; mannite C: C-1 67.76, t ($\Delta\delta$ = +2.70); C-2 69.80, d (-3.03); C-3 70.80, d (-0.73), C-4 70.95, d (-0.58); C-5 72.65, d (-0.18); C-6 65.06, t; –COO: s, 173.74.

Compound 2. Yield 49.7%, $C_{14}H_{28}O_7$, mp 141-142°C, R_f 0.35. IR spectrum (ν, cm^{-1}): 730 ($-CH_2$), 1735 (C=O), 3100-3650 (–OH). PMR (δ, ppm, J/Hz): 0.72 (3H, t, J = 7, $-CH_3$), 1.02-1.48 (10H, m, $-CH_2$), 2.20 (2H, t, J = 7.5, $-CH_2COO$), 4.23-5.0 (8H, m, CH), 5.38 (5H, s, –OH). ^{13}C NMR (δ, ppm): aliphat. C: 13.75, 22.33, 24.74, 28.67, 28.78, 31.32, 33.94; mannite C: C-1 67.75, t (+2.69); C-2 69.82, d (-3.01); C-3 70.80, d (-0.73); C-4 70.95, d (-0.58); C-5 72.63, d (-0.19); C-6 65.03, t (-0.03); –COO: s, 173.70.

Compound 3. Yield 50.1%, $C_{16}H_{32}O_7$, mp 165-166°C, R_f 0.38. IR spectrum (ν, cm^{-1}): 720 ($-CH_2$), 1740 (C=O), 3000-3600 (–OH). PMR (δ, ppm, J\Hz): 0.76 (3H, t, J = 7, $-CH_3$), 1.05-1.48 (14H, m, $-CH_2$), 2.19 (2H, t, J = 7.5, $-CH_2COO$), 4.24-5.02 (8H, m, CH), 5.36 (5H, s, –OH). ^{13}C NMR (δ, ppm): aliphat. C: 13.83, 22.42, 24.76, 28.88, 29.01, 29.15, 31.57, 33.96; mannite C: C-1 67.77, t (+2.72); C-2 69.80, d (-3.02); C-3 70.82, d (-0.71); C-4 70.96, d (-0.57); C-5 72.65, d (-0.18); C-6 65.04, t (-0.02); –COO: s, 173.77.

Compound 4. Yield 40.3%, $C_{18}H_{34}O_8$, mp 137-138°C, R_f 0.66. IR spectrum (ν, cm^{-1}): 740 ($-CH_2$), 1730 (C=O), 3000-3650 (–OH). PMR (δ, ppm, J/Hz): 0.60 (6H, t, J = 7, $-CH_3$), 0.94-1.42 (12H, m, $-CH_2$), 2.10 (4H, t, J = 7.5, $-CH_2COO$), 4.58-4.97 (8H, m, CH), 5.31 (4H, s, –OH). ^{13}C NMR (δ, ppm): aliphat. C: 13.54, 22.02, 24.37, 30.90, 33.83; mannite C: C-1,6 67.74, t (+2.69); C-2,5 69.72, d (-3.11); C-3,4 70.27, d (-1.26); –COO: s, 173.72.

Compound 5. Yield 39.5%, $C_{22}H_{42}O_8$, mp 135-136°C, R_f 0.66. IR spectrum (ν, cm^{-1}): 730 ($-CH_2$), 1735 (C=O), 3100-3650 (–OH). PMR (δ, ppm, J/Hz): 0.67 (6H, t, J = 7, $-CH_3$), 0.97-1.42 (20H, m, $-CH_2$), 2.13 (4H, t, J = 7.5, $-CH_2COO$), 4.59-4.98 (8H, m, CH), 5.30 (4H, –OH). ^{13}C NMR (δ, ppm): aliphat. C: 13.75, 22.33, 24.72, 28.67, 28.78, 31.32, 33.91; mannite C: C-1,6 67.76, t (+2.70); C-2,5 69.75, d (-3.07); C-3,4 70.30, d (-1.23); –COO: s, 173.74.

Compound 6. Yield 40.1%, $C_{26}H_{50}O_8$, mp 138-139°C, R_f 0.70. IR spectrum (ν, cm^{-1}): 720 ($-CH_2$), 1740 (C=O), 3000-3600 (–OH). PMR (δ, ppm J/Hz): 0.76 (6H, t, J = 7, $-CH_3$), 1.04-1.48 (28H, m, $-CH_3$), 2.20 (4H, t, J = 7.5, $-CH_2COO$), 4.67-5.03 (8H, m, CH), 5.34 (4H, s, –OH). ^{13}C NMR (δ, ppm): aliphat. C: 13.83, 22.44, 24.75, 28.86, 29.04, 29.17, 31.57, 33.93; mannite C: C-1,6 67.78, t (+2.72); C-2,5 69.77, d (-3.06); C-3,4 70.32, d (-1.21); –COO: s, 173.76.

Mixed Esters of D-Mannite and Aliphatic and Aromatic Acids. Monoester (**1** or **3**, 0.05 mole) was dissolved in DMF (60-80 mL), treated with methylsalicylate or methylcinnamate (0.05 mole) and K_2CO_3 (0.005 mole), and held at 95-115°C and reduced pressure (100-140 mm Hg) under N_2 for 10-14 h. DMF was removed under vacuum. The reaction products were dried at 60-70°C (5-10 mm Hg).

Compound 7. Yield 37%, $C_{19}H_{28}O_9$, mp 110-112°C, R_f 0.61. IR spectrum (ν, cm^{-1}): 740 (–CH_2), 1680 (ArC=O), 1730 (AlkC=O), 1490, 1585, 1610 (C=C), 3100-3600 (–OH). PMR (δ, ppm, J/Hz): 0.65 (3H, t, J = 7, –CH_3), 1.01-1.51 (6H, m, –CH_2), 2.15 (2H, t, J = 7.5, –CH_2COO), 4.21-5.04 (8H, m, CH), 5.54 (4H, s, –OH), 6.57-7.82 (4H, Ar). ^{13}C NMR (δ, ppm): aliphat. C: 13.53, 21.99, 24.32, 30.89, 33.83; arom. C: 162.67, 135.47, 131.14, 120.46, 117.14, 112.64; mannite C: C-1 67.55, t (+2.49); C-2 69.82, d (-3.01); C-3,4 70.15, d (-1.38); C-5 70.43, d (-2.40); C-6 68.71, t (+3.65); –COO: 170.07, s (Ar); 173.90, s (Alk).

Compound 8. Yield 33%, $C_{23}H_{36}O_9$, mp 113-115°C, R_f 0.63. IR spectrum (ν, cm^{-1}): 720 (–CH_2), 1680 (ArC=O), 1740 (AlkC=O), 1485, 1585, 1610 (C=C), 3100-3600 (–OH). PMR (δ, ppm, J/Hz): 0.76 (3H, t, J = 7, –CH_3), 1.05-1.50 (14H, m, –CH_2), 2.19 (2H, t, J = 7.5, –CH_2COO), 4.25-5.03 (8H, m, CH), 5.42 (4H, s, –OH), 6.60-7.42 (4H, Ar). ^{13}C NMR (δ, ppm): aliphat. C: 13.83, 22.42, 24.75, 28.88, 29.15, 31.57, 33.95; arom. C: 162.88, 135.47, 131.14, 120.46, 117.14, 112.66; mannite C: C-1 67.70, t (+2.64); C-2 69.80, d (-3.03); C-3,4 70.31, d (-1.24); C-5 70.58, d (-2.25); C-6 68.60 (+3.54); –COO: 170.05, s (Ar); 173.88, s (Alk).

Compound 9. Yield 18.5%, $C_{21}H_{30}O_8$, mp 158-159°C, R_f 0.68. IR spectrum (ν, cm^{-1}): 730 (–CH_2), 1690 (ArC=O), 1730 (AlkC=O), 1500, 1580, 1620 (C=C), 3100-3600 (–OH). PMR (δ, ppm, J/Hz): 0.64 (3H, t, J = 7, –CH_3), 1.02-1.48 (6H, m, –CH_2), 2.16 (2H, t, J = 7.5, –CH_2COO), 4.23-5.02 (8H, m, CH), 5.51 (4H, s, –OH), 6.49 (1H, d, J = 16, –CH=), 7.18-7.40 (5H, arom.), 7.76 (1H, d, J = 16, –CH=). ^{13}C NMR (δ, ppm): aliphat. C: 13.54, 22.00, 24.35, 30.91, 33.85; arom. C: 134.40, 130.14, 128.80, 128.02; –CH= 144.11, 118.55; mannite C: C-1 67.74, t (+2.68); C-2 69.85, d (-2.98); C-3,4 70.32, d (-1.21); C-5 70.21, d (-2.60); C-6 68.15, t (+3.09); –COO: 167.00, s (Ar); 173.90, s (Alk).

Compound 10. Yield 16%, $C_{25}H_{38}O_8$, mp 150-152°C, R_f 0.71. IR spectrum (ν, cm^{-1}): 720 (–CH_2), 1690 (ArC=O), 1740 (AlkC=O), 1490, 1585, 1610 (C=C), 3100-3600 (–OH). PMR (δ, ppm, J/Hz): 0.75 (3H, t, J = 7, –CH_3), 1.04-1.49 (14H, m, –CH_2), 2.17 (2H, t, J = 7.5, –CH_2COO), 4.22-5.01 (8H, m, CH), 5.40 (4H, m, –OH), 6.50 (1H, d, J = 16, –CH=), 7.18-7.41 (5H, Ar), 7.76 (1H, d, J = 16, –CH–). ^{13}C NMR (δ, ppm): aliphat. C: 13.85, 22.43, 24.76, 28.89, 29.02, 29.17, 31.60, 33.98; arom. C: 134.38, 130.13, 128.82, 128.04; –CH= 144.08, 118.52; mannite C: C-1 67.72, t (+2.66); C-2 69.82, d (-3.01); C-3,4 70.65, d (-0.90); C-5 70.28, d (-2.53); C-6 67.98, t (+2.94); –COO: 167.02, s (Ar); 173.85, s (Alk).

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