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# SYNTHESIS OF MONOESTERS OF *D*-SORBITOL AND AROMATIC ACIDS

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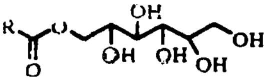
*Water-soluble monoesters of* D-*sorbitol with aromatic acids have been synthesized by the transesterification of their methyl esters. The structures of the compounds obtained have been confirmed by IR, UV, and* $^{13}C$ *NMR spectroscopies.*

Phenolcarboxylic, cinnamic, and other aromatic acids, which play an important role in the vital activity of plants, are frequently found in Nature in the form of esters with polyhydric alcohols and carbohydrates [1]. The use of natural esters of aromatic acids and polyols is restricted by their poor availability, which is a consequence of the difficulty of isolating them from plants and the complexity of their synthesis (necessity for the use of protective groups), and by the formation of by-products when acid chlorides and anhydrides are used [2, 3].

In view of this, interest is presented by the development of a simple and accessible method of obtaining water-soluble analogs of natural aromatic acid esters. In the present paper we describe the synthesis of monoesters of *D*-sorbitol with phenolcarboxylic, cinnamic, anthranilic, and *p*-nitro- and *o*-chlorobenzoic acids.

We obtained the monoesters of *D*-sorbitol and aromatic acids (**1-6**) by the transesterification of the methyl esters of the corresponding acids with *D*-sorbitol in dimethylformamide (DMFA) in the presence of $K_2CO_3$.



**1.** R=$C_6H_4$(*o*-OH) **2.** R=$C_6H_5$(2,4-OH)
**3.** R=$C_6H_4$(*o*-$NH_2$) **4.** R=$C_6H_5$-CH=CH-
**5.** R=$C_6H_4$(*o*-Cl) **6.** R=$C_6H_4$(*n*-$NO_2$)

The reactivity of methyl esters of aromatic acids in the transesterification reaction ($S_N2$ nucleophilic substitution) depends on the polar influence (electronic and steric effects) of the donor ($-OH$, $-NH_2$) and acceptor ($-NO_2$, $-Cl$) substituents in the aromatic ring on the reaction center (carbonyl carbon atom). In view of this, the yields of monoesters varied considerably (from 15% for the monoester of 2,4-dihydroxybenzoic acid to 52% for the monoester of *p*-nitrobenzoic acid).

The monoesters of *D*-sorbitol and aromatic acids (**1-6**), isolated by column chromatography on silica gel, were microcrystalline substances readily soluble in water, alcohol, DMFA, and DMSO, and insoluble in benzene and chloroform.

The PMR spectra of the compounds synthesized had a group of signals from the protons of the $-CH-$ and $-CH_2-$ groups of the sorbitol part of the molecule at 3.2-4.8 ppm. Signals of the protons of the aromatic ring were observed at 6.5-8 ppm. The spectrum of the monoester of sorbitol and cinnamic acid (**4**) contained two one-proton doublets at 6.5 and 7.7 ppm (J = 15 Hz) caused by the *trans*-orientated olefinic protons.

The UV spectra of the monoesters of *D*-sorbitol and aromatic acids were determined by the chromophores of the initial acids. The values of the extinctions of the absorption bands agreed with the results calculated for monoesters.

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The $^{13}C$ NMR spectra confirmed the fact that it was mainly the primary hydroxy groups of *D*-sorbitol that were acylated, since the carbon atoms present in the α-position to a C-1 ester group underwent a downfield shift by 2.5-4 ppm, while in the case of the C-2 position an upfield shift by 1.5-2.7 ppm as compared with the carbon atoms of unsubstituted *D*-sorbitol was observed.

## EXPERIMENTAL

IR spectra (tablets with KBr) were taken on a UR-20 spectrophotometer, UV spectra on a Specord UV-VIS, PMR spectra on a Tesla 487 (80 MHz, $CD_3OD$, 0 — TMS), and $^{13}C$ NMR spectra on a Bruker WP-80 (20.15 MHz, $CD_3OD$, 0 — TMS).

The course of the reactions was monitored by TLC on Silufol UV-254 plates. The substances were purified and separated by column chromatography on silica gel L (0.04-0.1 mm).

**Synthesis of Monoesters of *D*-Sorbitol and Aromatic Acids.** With heating to 90-95°C and stirring, 27 g (0.15 mole) of *D*-sorbitol was dissolved in 100-120 ml of redistilled DMFA. Then 7.56-9.05 g (0.05 mole) of the methyl ester of the appropriate aromatic acid and, as catalyst, 0.69 g (0.005 mole) of $K_2CO_3$ (calcined at 250°C) were added. The reaction was performed at 105-115°C and a residual pressure of 130-150 mm Hg in an atmosphere of nitrogen for 10-12 h. After the end of the reaction (monitoring by TLC in the chloroform–methanol (4:1) system) the DMFA was distilled off (in vacuum). Then 150-200 ml of alcohol was added to the reaction mixture and it was boiled under reflux until the sorbitol esters had dissolved and was then cooled to room temperature and the precipitate of unchanged sorbitol was filtered off. The solution was evaporated to dryness, and the residue was dried in a vacuum drying chest at 65-70°C and a pressure of 5-10 mm Hg. The reaction products were chromatographed on columns of silica gel L with elution by chloroform–methanol (9→4:1).

This gave 6.95 g (46%) of substance (**1**), $R_f$ 0.50 (chloroform–methanol (4:1)), mp 125-127°C. Found, %: C 51.43; H 5.87. $C_{13}H_{18}O_8$. Calculated, %: C 51.66; H 5.96.

UV spectrum (EtOH, $\lambda_{max}$, nm): 208, 239, 308 (lgε 4.35; 3.82; 3.55).

IR spectrum (KBr, ν, cm$^{-1}$): 1500, 1600, 1700 (CO, ester) (Ar), 3200-3600 (OH).

PMR spectrum (δ, ppm, $CD_3OD$): 3.2-4.8 (8H, sorb.), 6.6-7.8 (4H, Ar).

Substance **2**: 2.38 g (15%), mp 162-165°C, $R_f$ 0.22. Found, %: C 49.05; H 5.66. $C_{13}H_{18}O_9$. Calculated, %: C 48.87; H 5.58.

IR spectrum (KBr, ν, cm$^{-1}$): 1500, 1610 (Ar), 1680 (CO, ester), 3200-3600 (OH).

UV spectrum (EtOH, $\lambda_{max}$, nm) 209, 222, 260, 299, (lgε 4.24; 3.99; 4.06; 3.64).

PMR spectrum (δ, ppm, $CD_3OD$): 3.2-4.8 (8H, sorb.), 6.6-7.9 (3H, Ar).

Substance **3**: 6.28 g (42%), mp 70-73°C, $R_f$ 0.38. Found, %: C 51.72; H 6.24; N 4.56. $C_{13}H_{19}NO_7$. Calculated, %: C 51.83; H 6.31; N 4.65.

IR spectrum (KBr, ν, cm$^{-1}$): 1500, 1600 (Ar), 1700 (CO, ester), 3000-3600 (OH, $NH_2$).

UV spectrum (EtOH, $\lambda_{max}$, nm): 222, 250, 345 (lgε 4.65; 4.11; 3.90).

PMR spectrum (δ, ppm, $CD_3OD$): 3.2-4.8 (8H, sorb.), 6.2-7.8 (4H, Ar), 7.8 (t, 2H, $NH_2$).

Substance **4**: 4.68 g (30%), mp 75-78°C, $R_f$ 0.45. Found, %: C 55.81; H 6.03. $C_{15}H_{19}O_7$. Calculated, %: C 55.90; H 6.09.

IR spectrum (KBr, ν, cm$^{-1}$): 1500 (Ar), 1700 (CO, ester), 3100-3600 (OH).

UV spectrum (EtOH, $\lambda_{max}$, nm): 205, 216, 222, 277 (lgε 3.86; 4.13; 3.89; 4.16).

PMR spectrum (δ, ppm, $CD_3OD$): 3.2-4.8 (8H, sorb.), 6.5 (d, CH=, J = 15 Hz), 7.0-7.5 (5H, Ar), 7.7 (d, CH=, J = 15 Hz).

Substance **5**: 7.52 g (47%), mp 127-130°C, $R_f$ 0.36. Found, %: C 48.71; H 5.37; Cl 11.02. $C_{13}H_{17}ClO_7$. Calculated, %: C 48.75; H 5.31; Cl 11.09.

IR spectrum (KBr, ν, cm$^{-1}$): 750 (Cl), 1600 (Ar), 1710 (CO, ester), 3100-3600 (OH).

UV spectrum (EtOH, $\lambda_{max}$, nm): 230, 282 (lgε 3.92; 3.10).

PMR spectrum (δ, ppm, $CD_3OD$): 3.2-4.8 (8H, sorb.), 7.2-7.8 (4H, Ar).

Substance **6**: 8.61 g (52%), mp 110-112°C, $R_f$ 0.45. Found, %: C 47.04; H 5.09; N 4.16. $C_{13}H_{17}NO_9$. Calculated, %: C 47.13; H 5.14; N 4.23.

IR spectrum (KBr, $\nu$, $cm^{-1}$): 1350 ($NO_2$), 1610 (Ar), 1720 (CO, ester), 3200-3600 (OH).
UV spectrum (EtOH, $\lambda_{max}$, nm): 258 (lg$\varepsilon$ 3.99).
PMR spectrum ($\delta$, ppm, $CD_3OD$): 3.2-4.8 (8H, sorb.), 6.8-7.8 (4H, Ar).

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