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LETTERS TO THE EDITOR

Reaction of Catechol with α-Aminoacetals. Synthesis of New Polyphenols

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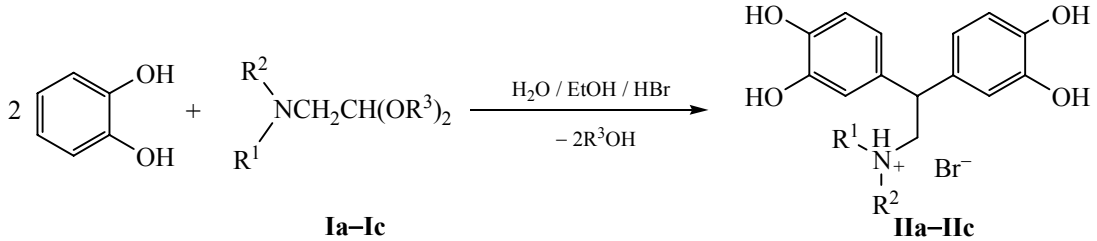
The basic method for the synthesis of calix[4]resorcinarenes is a condensation of resorcinol and their derivatives with aliphatic and aromatic aldehydes [1–3]. Recently it was shown that the condensation of resorcinol and 2-methylresorcinol with dimethylacetal of α-methylaminoacetic aldehyde in aqueous solutions of hydrogen halides results in hydrohalides of substituted diarylethylmethylamines as the products of the interaction of two molecules of resorcinol with one molecule of aminoacetal [4–7]. At the same time, in dioxane in the presence of trifluoromethanesulfonic acid these reactions lead to the formation of the corresponding calixarenes [8].

To determine the effect of the nature of the used phenol on the reaction result we carried out the reactions of α-aminoacetic aldehyde derivatives **Ia–Ic** with pyrocatechol. The reactions afford the corresponding polyphenols **IIa–IIc** comprising two catechol moieties with yields of 60–90%.



Ia–Ic **IIa–IIc**

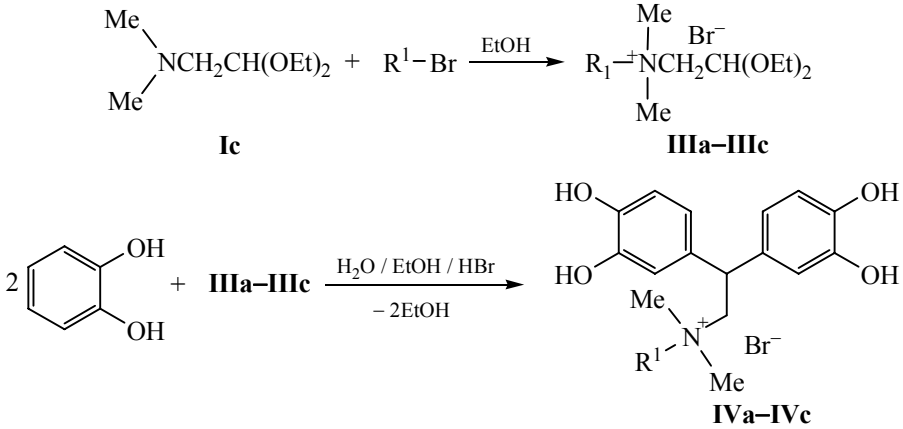
$R^1 = R^2 = H$, $R^3 = Me$ (**a**); $R^1 = H$, $R^2 = R^3 = Me$ (**b**); $R^1 = R^2 = Me$, $R^3 = Et$ (**c**).

The reaction of acetal derivative **Ib** with alkyl halides in ethanol results in acetals **IIIa–IIIc** containing an onium moiety in the molecule. The reaction of pyrocatechol acetals in an aqueous alcohol medium in the presence of hydrobromic acid leads to the formation of polyphenols **IVa–IVc**. Due to the presence of the quaternary ammonium moiety the latter are of interest as antibiotics, antivirals and antifungicidal agents.

The structure and composition of the products obtained were confirmed by spectroscopic methods and elemental analysis.

2,2-Bis(3,4-dihydroxyphenyl)ethylamine hydrobromide (IIa). To a solution of 0.24 g of acetal **Ia** and 0.50 g of catechol in 4 ml of ethanol was added 1 ml of concentrated hydrobromic acid. The reaction mixture was refluxed for 5 h. After the removal of the solvent the residue was washed with ether (3 × 50 ml) and dried in a vacuum (10 h, 15 mm Hg). Yield 0.77 g (98%), mp 172°C. IR spectrum, ν, cm^{-1}: 1607 (Ar), 2723 (NH^+), 3320 (OH). ^1H NMR spectrum (CD_3OD), δ, ppm (*J*, Hz): 3.47 d (2H, CH_2, *J* 8.24), 4.05 t (1H, CH, *J* 8.20), 6.69 d. d (2H, CH_{Ar}, *J* 8.13, 2.10), 6.74 d (2H, CH_{Ar}, *J* 2.10), 6.78 d (2H, CH_{Ar}, *J* 8.13). Found, %: C 49.01; H 4.81; Br 23.63; N 4.11. $C_{14}H_{16}BrNO_4$. Calculated, %: C 49.14; H 4.71; Br 23.35; N 4.09.

2,2-Bis(3,4-dihydroxyphenyl)-*N*-methylethylamine hydrobromide (IIb) was prepared similarly



R^1 = Me (**a**), *n*-Bu (**b**), *n*-$C_{10}H_{21}$ (**c**).

from 1.35 g of acetal **Ib**, 2.50 g of pyrocatechol, and 3 ml of concentrated hydrobromic acid. Yield 2.80 g (89%), mp 160°C. IR spectrum, ν, cm^{-1}: 1610 (Ar), 2730 (NH^+), 3180 (OH). ^1H NMR spectrum (D_2O), δ, ppm (*J*, Hz): 2.62 s (3H, CH_3N), 3.44 d (2H, CH_2, *J* 8.25), 4.01 t (1H, CH, *J* 8.20), 6.63 d. d (2H, CH_{Ar}, *J* 8.16, 1.92), 6.77 d (2H, CH_{Ar}, *J* 1.92), 6.77 d (2H, CH_{Ar}, *J* 8.16). Found, %: C 50.03; H 5.22; Br 22.51; N 3.83. $C_{15}H_{18}BrNO_4$. Calculated, %: C 50.58; H 5.09; Br 22.43; N 3.93.

2,2-Bis(3,4-dihydroxyphenyl)-*N*,*N*-dimethylethylamine hydrobromide (IIc) was prepared similarly from 0.73 g of acetal **Ic**, 1.0 g of catechol, and 1 ml of concentrated hydrobromic acid. Yield 0.99 g (59%), mp 154°C. IR spectrum, ν, cm^{-1}: 1610 (Ar), 2730 (NH^+), 3180 (OH). ^1H NMR spectrum (D_2O), δ, ppm (*J*, Hz): 2.59 s (6H, CH_3N), 3.31 d (2H, CH_2, *J* 8.49), 3.89 t (1H, CH, *J* 8.44), 6.49 d. d (2H, CH_{Ar}, *J* 8.25, 2.14), 6.66 d (2H, CH_{Ar}, *J* 8.25), 6.67 d (2H, CH_{Ar}, *J* 2.14). Found, %: C 51.65; H 5.53; Br 21.65; N 3.52. $C_{16}H_{20}BrNO_4$. Calculated, %: C 51.90; H 5.44; Br 21.58; N 3.78.

***N*-(2,2-Diethoxy)ethyl-*N*,*N*,*N*-trimethylammonium bromide (IIIa).** To a cooled (–20°C) solution of 1.77 g of acetal **Ic** in 3 ml of ethanol was added 1.15 g of cooled (–20°C) methyl bromide. The reaction mixture was kept at room temperature for 12 h. After removal of the solvent, the waxy residue was dried in a vacuum (2 h, 0.01 mm Hg). Yield 2.60 g (89%). ^1H NMR spectrum (CD_3OD), δ, ppm (*J*, Hz): 1.25 t (6H, CH_3 *J* 7.06), 3.27 s (9H, CH_3N), 3.55 d (2H, CH_2, *J* 4.67), 3.69 q (2H, CH_2O, *J* 7.06), 3.79 q (2H, CH_2O, *J* 7.06), 5.06 t (1H, CH, *J* 5.03). Found, %: C 36.83; H 7.97; Br 35.01; N 6.16. $C_7H_{18}BrNO_2$. Calculated, %: C 36.85; H 7.95; Br 35.03; N 6.14.

***N*-(2,2-Diethoxy)ethyl-*N*,*N*-dimethyl-*N*-butylammonium bromide (IIIb).** To a solution of 2.65 g of acetal **Ic** in 5 ml of ethanol was added 2.25 g of *n*-butyl bromide. The reaction mixture was refluxed for 2 h. After removal of the solvent, the waxy residue was washed with diethyl ether and dried in a vacuum (2 h, 0.01 mm Hg). Yield 4.01 g (82%). ^1H NMR spectrum (CD_3OD), δ, ppm (*J*, Hz): 1.03 t (3H, CH_3, *J* 7.40), 1.25 t (6H, CH_3, *J* 7.05), 1.38–1.48 m (2H, CH_2), 1.76–1.86 m (2H, CH_2), 3.23 s (6H, CH_3N), 3.46–3.50 m (2H, CH_2N), 3.53 d (2H, CH_2N, *J* 4.95), 3.71 q (2H, CH_2O, *J* 7.05), 3.78 q (2H, CH_2O, *J* 7.05), 5.07 t (1H, CH, *J* 4.92). Found, %: C 44.40; H 8.98; Br 29.55; N 5.17. $C_{10}H_{24}BrNO_2$. Calculated, %: C 44.45; H 8.95; Br 29.57; N 5.18.

***N*-(2,2-Diethoxy)ethyl-*N*,*N*-dimethyl-*N*-decylammonium bromide (IIIc)** was prepared analogously from 1.0 g of acetal derivative **Ic** and 1.37 g of 1-bromodecane as a waxy gum. Yield 2.30 g (97%). ^1H (CD_3OD), δ, ppm (*J*, Hz): 0.89 t (3H, $C\underline{H}_3CH_2$, *J* 6.94), 1.23 t (6H, $C\underline{H}_3CH_2O$, *J* 7.02), 1.32 m (12H, $(CH_2)_6$), 1.40 m (2H, $C\underline{H}_2CH_2CH_2N$), 1.81–1.83 m (2H, $C\underline{H}_2CH_2N$), 3.33 s (6H, CH_3N), 3.45–3.49 m (2H, $CH_2C\underline{H}_2N$), 3.51 d (2H, $CHC\underline{H}_2N$, *J* 4.84), 3.68–3.81 m (4H, CH_2O), 5.06 t (1H, CH, *J* 4.92). Found, %: C 56.41; H 10.40; Br 20.97; N 3.59. $C_{18}H_{40}BrNO_2$. Calculated, %: C 56.54; H 10.47; Br 20.94; N 3.66.

***N*-2,2-Bis(3,4-dihydroxyphenyl)ethyl-*N*,*N*,*N*-trimethylammonium bromide (IVa).** To a mixture of 2.0 g of acetal **IIIa**, 1.72 g of pyrocatechol, and 10 ml of ethanol was added 2 ml of concentrated hydrobromic acid. The reaction mixture was refluxed for 5 h, and the solvent was removed. The residue was washed with diethyl ether and dried in a vacuum (10 h, 15 mm Hg). Yield 2.58 g (86%), mp 145°C. IR

spectrum, ν, cm^{-1}: 1605 (Ar), 3300 (OH). ^1H NMR spectrum (D_2O), δ, ppm (*J*, Hz): 2.79 s (9H, CH_3N), 3.74 d (2H, CH_2, *J* 6.82), 4.13 t (1H, CH, *J* 6.62), 6.66 d. d (2H, CH_{Ar}, *J* 8.24, 2.14), 6.77 d (2H, CH_{Ar}, *J* 8.24), 6.82 d (2H, CH_{Ar}, *J* 2.14). Found, %: C 53.04; H 5.83; Br 20.70; N 3.58. $C_{17}H_{22}BrNO_4$. Calculated, %: C 53.14; H 5.77; Br 20.79; N 3.65.

***N*-2,2-Bis(3,4-dihydroxyphenyl)ethyl-*N*,*N*-dimethyl-*N*-butylammonium bromide (IVb)** was prepared analogously from 0.98 g of acetal **IIIb**, 0.72 g of catechol, and 1 ml of concentrated hydrobromic acid. Yield 0.80 g (57%), mp 132°C. IR spectrum, ν, cm^{-1}: 1609 (Ar), 3325 (OH). ^1H NMR spectrum (D_2O), δ, ppm (*J*, Hz): 0.69 t (3H, CH_3, *J* 7.33), 0.88–0.98 m (2H, CH_2), 1.28–1.38 m (2H, CH_2), 2.77 s (6H, CH_3N), 2.86–2.94 m (2H, CH_2), 3.71 d (2H, CH_2, *J* 6.42), 4.11 t (1H, CH, *J* 6.30), 6.69 d. d (2H, CH_{Ar}, *J* 8.20, 1.94), 6.79 d (2H, CH_{Ar}, *J* 8.20), 6.86 d (2H, CH_{Ar}, *J* 1.94). Found, %: C 56.30; H 6.72; Br 18.55; N 3.18. $C_{20}H_{28}BrNO_4$. Calculated, %: C 56.34; H 6.62; Br 18.74; N 3.29.

***N*-2,2-Bis(3,4-dihydroxyphenyl)ethyl-*N*,*N*-dimethyl-*N*-decylammonium bromide (IVc)** was prepared analogously from 1.73 g of acetal **IIIc**, 1.0 g of catechol, and 1 ml of concentrated hydrobromic acid. Yield 0.85 g (37%), mp 155°C. IR spectrum, ν, cm^{-1}: 1601 (Ar), 3305 (OH). ^1H NMR spectrum (CD_3OD), δ, ppm (*J*, Hz): 0.91 t (3H, $C\underline{H}_3CH_2$, *J* 6.93), 1.08–1.18 m (2H, $CH_3C\underline{H}_2$), 1.23–1.38 m [12H, $(CH_2)_6$], 1.59–1.69 m (2H, $C\underline{H}_2CH_2N$), 3.05 s (6H, CH_3N), 3.20–3.27 m (2H, $CH_2C\underline{H}_2N$), 4.00 d (2H, $CHC\underline{H}_2N$, *J* 6.50), 4.32 t (1H, CH, *J* 6.30), 6.77 d (2H, CH_{Ar}, *J* 8.09), 6.81 d. d (2H, CH_{Ar}, *J* 8.09, 2.02), 6.89 d (2H, CH_{Ar}, *J* 2.02). Found, %: C 61.10; H 7.98; Br 15.53; N 2.68. $C_{26}H_{40}BrNO_4$. Calculated, %: C 61.17; H 7.90; Br 15.65; N 2.74.

The ^1H NMR spectra were recorded on an Avance 600 instrument operating at 600.13 MHz relative to the residual protons of the deuterated solvent (CD_3OD). The IR spectra were registered on an UR-20 spectrometer in the range of 400–3600 cm^{-1} in a slurry in mineral oil or in thin layer. All solvents were purified before use [9].

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