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SHORT COMMUNICATIONS

New Method of Synthesis of Benzo[*b*]furan-2-thiols from 4-(2-Hydroxyaryl)-1,2,3-thiadiazoles

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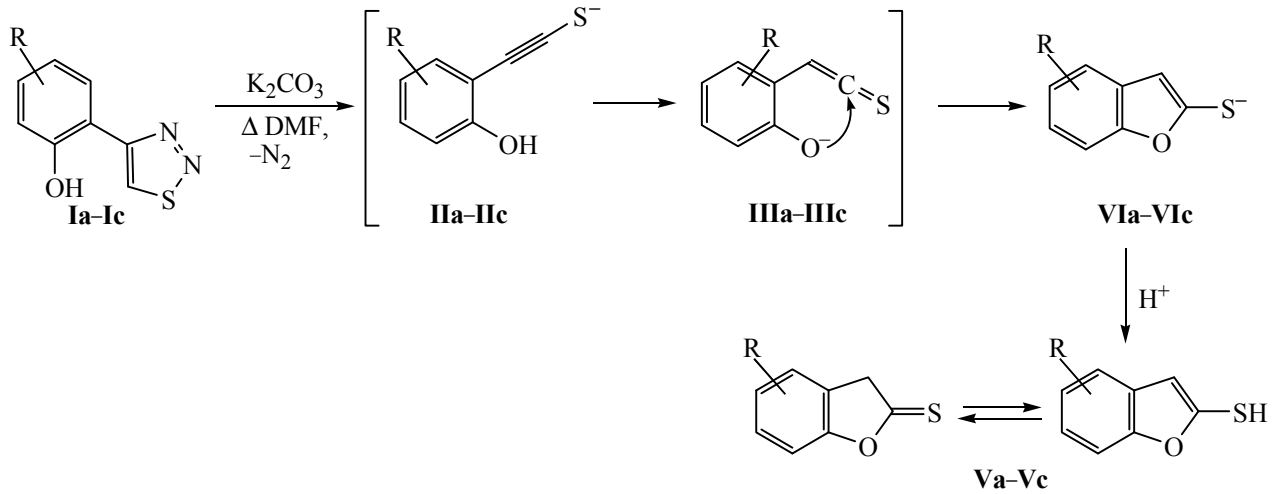
Derivatives of benzo[*b*]furan-2-thiols exhibit a biological action [1] and are employed in the organic synthesis [1–7]. Now only unsubstituted benzo[*b*]-furan-2-thiol and several 2-sulfanylbenzo[*b*]furan-3-aldehydes are known. The benzo[b]furan-2-thiol proper is obtained by the metallation of benzo[*b*]furan with butyllithiun followed by treating with sulfur and isolating the benzo[*b*]furan-2-thiol by acidification [1, 4]. 2-Sulfanyl-benzo[*b*]furan-3-aldehydes were prepared from 2-halo-benzo[*b*]furan-3-aldehydes and sodium hydrosulfite [6, 7].

We developed a new method of preparation of both unsubstituted and previously unknown substituted in the aromatic ring benzo[*b*]furan-2-thiol from easily available 4-(2-hydroxyaryl)-1,2,3-thiadiazoles. The initial 4-(2-hydroxyaryl)-1,2,3-thiadiazoles we prepared from 2-hydroxyacetophenones through the corresponding ethoxycarbonylhydrazones with subsequent treatment with thionyl chloride [8].

4-(2-Hydroxyaryl)-1,2,3-thiadiazoles **Ia–Ic** under the action of a base, potassium carbonate, in anhydrous DMF decomposed with the nitrogen elimination and the forma-

Scheme.



I, R = H (**a**), 4-Me (**b**), 5-Me (**c**); **V**, R = H (**a**), 6-Me (**b**), 5-Me (**c**).

tion of potassium 2-(2-hydroxyaryl)ethynethiolate **IIa–IIc**. Further an intramolecular proton transfer furnished thioketene derivatives **IIIa–IIIc**. As a result of the intramolecular cyclization involving the hydroxy group and the thioketene fragment after the subsequent acidifying of anions **IVa–IVc** we obtained benzo[*b*]furan-2-thiols **Va–Vc**.

The structure of compounds **Va–Vc** was proved by ^{1}H, ^{13}C NMR, and mass spectra and by comparison of constants for the compounds already described in the literature.

^{1}H NMR spectra of thiols **Va–Vc** registered in $CDCl_3$ at room temperature showed that under these conditions compounds **Va–Vc** exist as mixtures of tautomers. The proton at the sulfur atom in the enethiol tautomer appeared as a singlet in the region 3.69–4.02 ppm and had the same intensity as the signal of the H^3 proton of the benzofuran ring that was observed as a singlet in the region 6.70–6.85 ppm. At the same time two protons of the CH_2 group of the benzofuran ring corresponding to the thione form gave rise to a singlet in the region 4.19–4.40 ppm. The proton signals of the benzene rings of benzo[*b*]furan-2-thiols **Va–Vc** appeared as a complex multiplet in the region 7.0–8.0 ppm. The signals from the methyl group protons of benzo[*b*]furan-2-thiols **Va–Vc** give rise to two singlets in the region 2.2–2.5 ppm. Thus with a certain degree of inaccuracy it is possible from the intensity of these signals to estimate the ratio of the enethiol and thione tautomers of benzofurans **Va–Vc**.

The ratio of the enethiol and thione forms for benzo[*b*]furan-2-thiol (**Va**) was 1.04:1; for 6-methylbenzo[b]furan-2-thiol (**Vb**), 0.68:1; for 5-methylbenzo[*b*]furan-2-thiol (**Vc**), 0.61:1. In [2] for benzo[*b*]furan-2-thiol (**Va**) in benzene was found the ratio of enethiol and thione forms equal 1:1.

In ^{13}C NMR spectra of benzo[*b*]furan-2-thiols **Va** and **Vc** the ^{13}C signals of carbon atoms corresponding to enethiol and thione tautomers are well resolved. The methylene group signal of the thione tautomer $\delta_C(CH_2)$ appeared in the region 48.6–48.13 ppm, and the signal of the thiocarbonyl group δ_C(C=S), at 215.8–216.73 ppm. The characteristic ^{13}C signals of the enethiol form were observed in the $\delta_C(C^3)$ 110.7–111.3 and $\delta_C(C^2)$ 150.5–155.79 ppm.

In the mass spectra of benzo[*b*]furan-2-thiols **Va–Vc** peaks of the molecular ions were observed whose isotope composition was consistent with the calculated one. Further fragmentation of the molecular ions was analogous to the fragmentation of ions of 2-alkylsulfanylbenzo[*b*]furans [8], and it confirmed the structure of benzo[*b*]furan-2-thiols **Va–Vc**.

Benzo[*b*]furan-2-thiol (Va). To 0.3 g (1.68 mmol) of azole **Ia** in 10 ml of freshly distilled DMF was added in one portion 0.46 g (3.37 mmol) of freshly calcined potassium carbonate. The mixture was boiled for 1 h at stirring (TLC monitoring by the disappearance of the initial compound and by the end of nitrogen liberation). The reaction mixture was cooled, the light-brown dispersion obtained was poured into 80 ml of cold water, and concn, HCl was added till acid reaction. The separated red-yellow flaky precipitate was filtered off, washed with cold water, dissolved in 50 ml of water containing 2 equiv of KOH, and the solution was stirred with activated carbon at 30°C for several min, and then it was filtered. To the solution obtained concn. HCl was again added till acid reaction. The separated yellow flaky precipitate was thoroughly washed with cold water and dried in a vacuum. Yield 0.17 g (68%). Light-yellow crystals, mp 89–91°C (mp 95–96°C [4]), R_f 0.17 (ethyl acetate–hexane, 1 : 2). ^{1}H NMR spectrum ($CDCl_3$), ppm: 3.70 s (SH), 4.23 s (CH_2), 6.79 s (H^3, Ht), 7.18, 7.46 (H_{arom}). ^{13}C NMR spectrum ($CDCl_3$), ppm: 48.06 (CH_2), 110.11, 110.40, 110.83, 119.80, 122.56, 123.96, 124.00, 124.53, 125.18, 128.25, 128.41, 142.79(C^8, thiol); 155.79(C^2, thiol), 158.21(C^8, thione) 216.31(C=S). Mass spectrum, *m*/*z* (I_{rel}, %): 150 (100) $[M]^+$, 121 (50) $[M - O - CH]^+$, 90 (21), 77 (19), 63 (18), 51 (23), 39 (32). Found, %: C 63.67, 63.92; H 4.23, 4.34. C_8H_6OS. Calculated, %: C 63.97; H 4.03. *M* 150.20.

6-Methylbenzo[*b*]furan-2-thiol (Vb) was obtained similarly. Yield after reprecipitation from water 32%. Light-yellow crystals, mp 60–64°C, R_f 0.3 (ethyl acetate–hexane, 1:2). ^{1}H NMR spectrum ($CDCl_3$), ppm: 2.38 s (CH_3, thione), 2.44 C (CH_3, thiol), 3.66 s (SH), 4.18 s (CH_2), 6.74 s (H^3, Ht), 6.98, 7.33 m (H_{arom}). Mass spectrum, *m*/*z* (I_{rel}, %): 164 (54) $[M]^+$, 163 (7) $[M - H]^+$, 135 (29) $[M - O - CH]^+$, 131 (13) $[M - H - S]^+$, 91 (45), 77 (49), 63 (32), 51 (65), 39 (100). Found, %: C 65.93, 66.12; H 4.76, 4.99. C_9H_8OS. Calculated, %: C 65.82; H 4.91. *M* 164.22.

5-Methylbenzo[*b*]furan-2-thiol (Vc) was obtained similarly. Yield after reprecipitation from water 61%, after recrystallization from methanol 55%. Light-yellow needle crystals, mp 83–85°C, R_f 0.63 (ethyl acetate–hexane, 1:2). ^{1}H NMR spectrum ($CDCl_3$), ppm: 2.33 s (CH_3, thione), 2.40 s (CH_3, thiol), 3.68 s (SH), 4.16 s (CH_2), 6.69 s (H^3, Ht), 7.06, 7.24 (H_{arom}). ^{13}C NMR spectrum

($CDCl_3$), ppm: 20.61 (CH_3, thione), 20.85 (CH_3, thiol), 48.13 (CH_2), 109.63, 109.90, 110.73, 119.61, 124.33, 109.90, 110.73, 119.61, 124.33, 125.11, 125.21, 128.34, 128.75, 132.03, 134.36, 142.60 (C^8, thiol), 154.27(C^2, thiol), 156.30(C^8, thione), 216.73 (C=S). Mass spectrum, *m*/*z* (I_{rel}, %): 164 (100) $[M]^+$, 163 (20) $[M - H]^+$, 135 (58) $[M - O - CH]^+$, 131 (21) $[M - H - S]^+$, 121 (10), 103 (19), 91 (39), 78 (18), 63 (17), 51 (25), 39 (29). Found, %: C 65.54, 65.77; H 5.21, 5.33. C_9H_8OS. Calculated, %: C 65.82; H 4.91. *M* 164.22.

The melting points were measured on a Boetius heating block. ^1H and ^{13}C NMR spectra were registered on a spectrometer Bruker AMX-400 (400 and 100 MHz respectively), as internal references served signals of residual protons (^1H) and carbon nuclei (^{13}C) of the deuterated solvent. Mass spectra were taken on a Finnigan INCOS MAT 95 instrument with a direct sample admission into the ion source, ionizing electrons energy 70eV, ionizing chamber temperature 200°C. The reaction progress was monitored by TLC on Silufol UV-254 plates, development under UV irradiation and in iodine vapor. All solvents used in the study were purified and dried by standard procedures.

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