

## Some Reactions of 3,5-Dimethoxy-4-acetyl-*p*-quinol

RUNE MAGNUSSON

*Department of Organic Chemistry, Chalmers University of Technology and University of Göteborg, S-402 20 Göteborg 5, Sweden*

Treatment of 3,5-dimethoxy-4-acetyl-*p*-quinol (I) with 5 N hydrochloric acid gives the benzofuranone III. This is a vinylogous carboxylic acid with  $pK_a$  2.85. Esterification of III with ethanol or treatment of the *p*-quinol I with ethanolic hydrochloric acid gives the benzofuranone V. The latter compound also has acidic properties which can be ascribed to its hydroxyl group ( $pK_a$  11.2), since its acetate is insoluble in alkali.

2,5-Dimethoxy-*p*-benzoquinone reacts with acetone in the presence of sodium hydroxide, sodium carbonate, or aluminium oxide, giving an adduct which has been shown to be 3,5-dimethoxy-4-acetyl-*p*-benzoquinol (I).<sup>1-4</sup> This quinol can be regarded as the ester of a vinylogous carboxylic acid, and the reactions described below can be interpreted on this basis. Thus, on treatment with aqueous 5 N hydrochloric acid at room temperature, both the methoxyl groups were split off, giving an acid with  $pK_a$  2.85. The equivalent weight and composition of this product showed that hydrolysis had been accompanied by the loss of 1 mol of water. These findings and the spectroscopic data for the substance are in accordance with structure III. The ultraviolet spectrum (Fig. 1) was similar to that of the starting material (I), and thus strongly supported a *p*-quinol structure. The NMR spectrum (see Experimental) showed a methyl group triplet due to coupling of the methyl protons with the C(3) and C(7) protons, and showed the C(5) proton as a singlet. The two hydroxyl protons appeared as a broad band.

The formation of the benzofuranone III probably proceeds *via* the acid IIa and its tautomeric form IIb, which would give III on elimination of water.

Treatment of 3,5-dimethoxy-4-acetyl-*p*-quinol (I) or its ethoxy analogue (IV) with ethanolic hydrochloric acid gave a product which from its elemental composition and spectroscopic properties (see Fig. 1 and Experimental) was 4-ethoxy-3a-hydroxy-2-methyl-6(3a*H*)-benzofuranone (V). The structural relationship between the acid III and the ethyl ester V was confirmed by the partial conversion of the former (III) to the latter (V) on treatment with ethanol at room temperature.

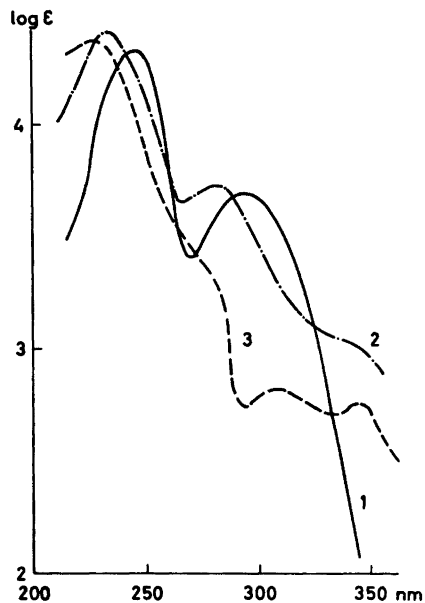
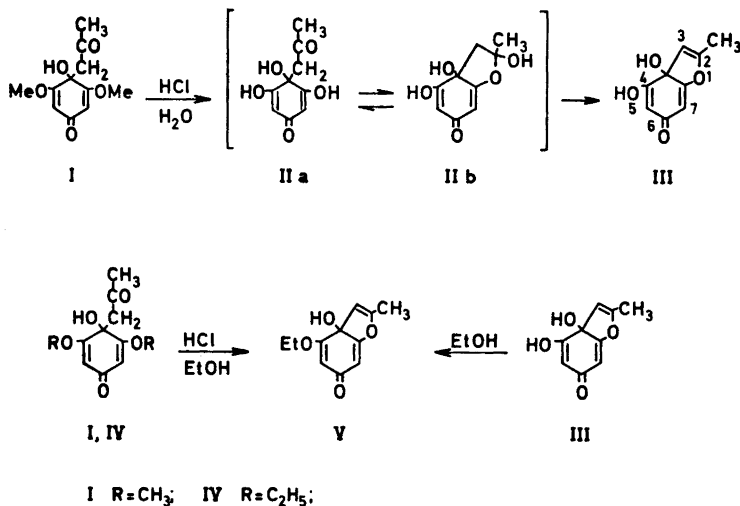


Fig. 1. Absorption spectra. 1, 3,5-Dimethoxy-4-acetyl-*p*-quinol (I); 2, 3a,4-dihydroxy-2-methyl-6(3a*H*)-benzofuranone (III); 3, 4-ethoxy-3a-hydroxy-2-methyl-6(3a*H*)-benzofuranone (V). Solvent: 95 % ethanol.



Unexpectedly, the benzofuranone V was soluble in alkali; it had a  $pK_a$  of approximately 11.2. If the freshly prepared alkaline solution was acidified within a few minutes, the starting substance (V) precipitated. The acidic properties of this substance must be due to its hydroxyl group, its acetate being insoluble in alkali.

## EXPERIMENTAL

NMR spectra were recorded with a Varian A 60 instrument, using dimethyl sulfoxide solutions, and are recorded as  $\delta$ -values in ppm from TMS.

*Treatment of 3,5-dimethoxy-4-acetonyl-p-quinol (I) with 5 N HCl.* *p*-Quinol I (4.7 g) was dissolved in 5 N HCl (25 ml) and the solution allowed to evaporate over several days almost to dryness. The large dark crystals that had formed were washed cautiously with water (yield 2.4 g) and recrystallised from a very small amount of water, giving 3a,4-dihydroxy-2-methyl-6(3aH)-benzofuranone (III) as colourless crystals, m.p. 189° (slow decomposition). (Found: C 60.38; H 4.50. Calc. for  $C_9H_8O_4$ : C 60.00; H 4.47);  $pK_a$  2.85 (potentiometric titration); equiv. wt.: 179 (calc. 180.1); NMR: 2.22 (t,  $CH_3$ ); 3.37 (m,  $H^a$ ); 4.95 (s,  $H^b$ ); 5.85 (m,  $H^c$ ); 8.8 (b, 2 OH).

*Treatment of 3,5-dimethoxy-4-acetonyl-p-quinol (I) with ethanolic HCl.* Compound I (9.1 g) was dissolved in absolute ethanol (50 ml), and gaseous hydrogen chloride (approx. 5 g) was passed into the solution for 1 h. The crystalline product V, which deposited slowly, was recrystallised from ethanol (yield 5.3 g, 69 %) and from water; colourless prisms, m.p. 196–197°. (Found: C 63.75; H 5.77;  $OC_2H_5$  21.52. Calc. for  $C_{11}H_{12}O_4$ : C 63.45; H 5.81;  $OC_2H_5$  21.64.) The substance was soluble in 5 N NaOH, and was recovered unchanged (m.p. and mixed m.p.) when reprecipitated by acidification after a few minutes.  $pK_a$  11.2 (potentiometric titration); NMR: 1.35 (t,  $CH_3-CH_2$ ); 2.22 (t,  $CH_3$ ); 3.42 (m,  $H^a$ ); 4.15 (q,  $CH_2$ ); 5.28 (s,  $H^b$ ); 5.87 (m,  $H^c$ ); 6.55 (s, OH).

*3a-Acetoxy-4-ethoxy-2-methyl-6(3aH)-benzofuranone.* The benzofuranone V (320 mg) was dissolved in a 2 M solution of acetic anhydride in ethyl acetate containing 1 %  $HClO_4$ .<sup>5</sup> After 10 min, the mixture was shaken with water, and then with  $NaHCO_3$  solution. The residue obtained on evaporation of the organic phase was recrystallised from methanol; prisms (240 mg), m.p. 137–139°. (Found: C 62.27; H 5.79. Calc. for  $C_{13}H_{14}O_5$ : C 62.39; H 5.64.) The substance was insoluble in alkali, and its infrared spectrum showed no hydroxyl band.

*Treatment of 3,5-diethoxy-4-acetonyl-p-quinol (IV) with ethanolic HCl.* The diethoxyquinol IV was treated in the same way as the methoxy analogue. The product was identical (IR spectrum) with that obtained from the methoxy compound.

*Esterification of 3a,4-dihydroxy-2-methyl-6(3aH)-benzofuranone (III).* The benzofuranone III (100 mg) was dissolved in absolute EtOH (1 ml). After two months, the precipitate formed was filtered off and identified as 4-ethoxy-3a-hydroxy-2-methyl-6(3aH)-benzofuranone (V) by its infrared spectrum.

*3,5-Diethoxy-4-acetonyl-p-quinol (IV).* A solution of 2,6-diethoxy-*p*-quinone (1 g) in acetone (100 ml) was stirred with  $K_2CO_3$  (10 g) until the yellow colour had disappeared. The product obtained after filtration and evaporation of the solvent was 3,5-diethoxy-4-acetonyl-*p*-quinol in almost quantitative yield. Recrystallisation from acetone/hexane gave pale brown crystals, m.p. 122–124°. (Found: C 61.93; H 7.23;  $OC_2H_5$  35.85. Calc. for  $C_{13}H_{18}O_5$ : C 61.40; H 7.13;  $OC_2H_5$  35.44.)

## REFERENCES

1. Aghoramurthy, K., Rao, K. V. and Seshadri, T. R. *Proc. Indian Acad. Sci.* **37** (1953) 798.
2. Magnusson, R. *Acta Chem. Scand.* **12** (1958) 791.
3. Aghoramurthy, K., Sarngadharan, M. G. and Seshadri, T. R. *J. Indian Chem. Soc.* **39** (1962) 439.
4. Singh, G. and Singh, S. *Indian J. Chem.* **2** (1964) 374.
5. Fritz, J. S. and Schenk, G. H. *Anal. Chem.* **31** (1959) 1808.

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