Communications to the Editor

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CORRECT MOLECULAR STRUCTURE OF THE PRODUCT OBTAINED FROM THE REACTION OF ACETYLSALICYLOYLCHLORIDE WITH N-PHENYLHYDROXYLAMINE. ELECTROCHEMICAL AND X-RAY CRYSTALLOGRAPHIC STUDIES

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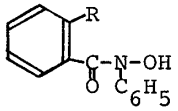
The structure of the product of the reaction of acetylsalicyloyl-chloride with N-phenylhydroxylamine was suggested by electrochemical method to be an O-acetylhydroxamic acid derivative, and its molecular structure was confirmed by X-ray analysis.

KEYWORDS——oxidation potential; anodic oxidation; hydroxamic acid; acetylsalicyloylchloride; O-acetyl-N-phenyl-N-salicyloylhydoxylamine; O- to O-acetyl migration; X-ray analysis

Electrochemical methods provide much useful information on the chemical fearues of organic compounds, but in the determination of a molecular structure, the methods are rather ineffective. The present study demonstrates as a rare exception that electrochemical methods did elucidate the correct structure of acetylated molecule which could not be assigned on the basis of the common spectroscopic studies.

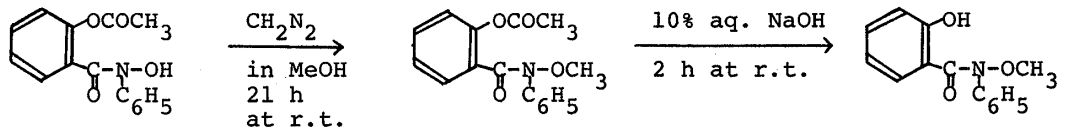
In a series of studies on anodic oxidation of hydroxamic acids,[1] we prepared the acids 1—6 using the common reaction of the corresponding acylchloride with N-phenylhydroxylamine.[2—7] Among the acids, acid 6 has been used as a suitable analytical reagent for metal ions with no doubt as to its mocelular structure.[3—6] The oxidation process of the acids 1—5 was found to be similar to that reported,[1] that is, a two electron oxidation releasing a proton and an accompanying C-N bond fission to give the corresponding carboxylic acids. In the case of acid 6, however, only a confusing result was obtained, and the cyclic voltammetric oxidation potential of 6 at a glassy-carbon electrode was also much higher (1.60 V vs. SCE) than those of 1—5 (1.22—1.26 V).



1: R=OH, 2: R=Cl, 3: $R=NO_2$
4: $R=OCH_3$, 5: $R=OC_2H_5$, 6: $R=OCOCH_3$

The methods used to prepare 6 were those described by Kalkote et al.[2] and Bamberger et al.,[7] and the structure of the product was reconfirmed to be 6 by the former authors in 1977. (mp 128°C, lit. 118°C [2] 128°C [4,5]); IR ν_{max} (C=O)

1640 and 1795 cm^{-1}, lit.[2] ~1650 and ~1790 cm^{-1}, NMR $\delta(CD_3CN)$ 2.11(3H, s) 6.4—7.4 (9H, m) 9.15(1H, br). The observed C=O bond frequencies seemed to be slightly higher than those of acetylsalicylic acid (1700 and 1770 cm^{-1}) or phenyl acetate (1760 cm^{-1}), and rather close to those of O-acetyl-N-benzoyl-N-phenylhydroxylamine (1665 and 1780 cm^{-1}) [8] or O-acetyl-N-3,5-dinitrobenzoyl-N-phenylhydroxylamine (1660 and 1790 cm^{-1}).[9] Though the spectra of our sample 6 do not definitely conflict with the proposed structure, the high value of its oxidation potential strongly suggested that the hydroxy hydrogen of the hydroxylamino group should be substituted by another group,[1,10,11,12] probably acetyl, in this case. If the structure of the acid 6 is correct, the compound 8 should be derived from 6 according to the reactions indicated in equation (1).



6 7 8 (1)

Comparison of the IR and NMR spectra of the final product thus obtained with those of 4 and a mixed melting point experiment indicated that the product was completely identical with 4. The peak potentials of cyclic voltammetry for both compounds were also the same, and the anodic oxidations of the product as well as 4 at 1.30 V at a reticulated vitreous carbon electrode in acetonitrile containing 0.1 M $NaClO_4$ led to O-methoxybenzoic acid. These results suggest that the structure of the acid 6 shown above is wrong and the acid 6 must be O-acetyl-N-phenyl-N-salicyloylhydroxylamine 9.

In order to establish the structure of the acid, X-ray structure analysis was performed, since IR and NMR spectroscopic studies could not definitely distinguish between the structures of 6 and 9. Crystal data of the acid: $C_{15}H_{13}NO_4$, M_r=271.3, a=12.814(5), b=7.126(1), c=22.244(8) Å, β=138.98(2)°, V=1333.1(5)Å^3, space group $P2_1/c$, z=4, D_m=1.343(3) Mgm^{-3}, D_x=1.352 Mgm^{-3}, μ(Cu Kα)=8.35 cm^{-1}. Intensity data were collected on a Rigaku AFC-5 diffractometer with graphite monochromated Cu Kα radiation (λ=1.5418 Å) up to 2θ=135°, employing ω-2θ scan mode. The structure was solved by a direct method (MULTAN-78)[13] and refined by a block-diagonal least-squares method (HBLS-V)[14] with anisotropic temperature factors for all non-hydrogen atoms and with isotropic ones for possible 9 hydrogen atoms to a conventional R of 0.08 using 1410 reflections.[15] The molecular structure of the acid drawn by ORTEP [16] is shown in the Figure. Interatomic bond lengths and angles are all normal. The dihedral angle between the planar benzene and phenol ring is 68.2(3)°. As indicated by the lines in Figure, there is a bifurcated hydrogen bond from O1 to O2' (intermolecular) and to O2 (intramolecular); O1...O2'=2.93(1) Å, O1...O2=2.73(1) Å, C6-O1...O2'=141.9(6)°, and C6...O2=81.6(6)°, respectively.

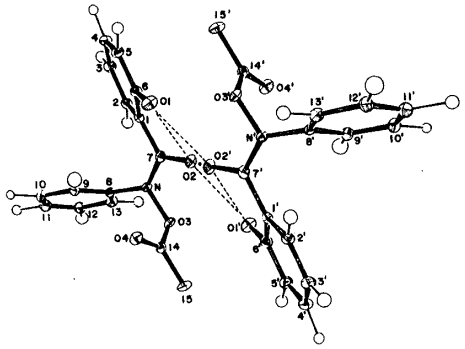
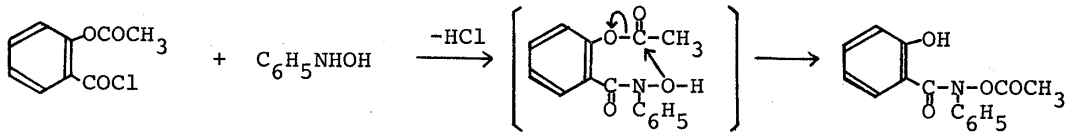


Figure: ORTEP Drawing of 9
Thermal ellipsoids are drawn at the 50% probability level. The two molecules are related by a center of symmetry.

The results shown above indicate that a quite facile and complete O- to O-acetyl migration occurs even in neutral or acidic media under very mild conditions as shown in equation (2) and the reaction product is 9.



(2)

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