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# LETTERS TO THE EDITOR

## FORMYLATION OF CARBONYL-CONTAINING SPIROHYDROCHROMANS

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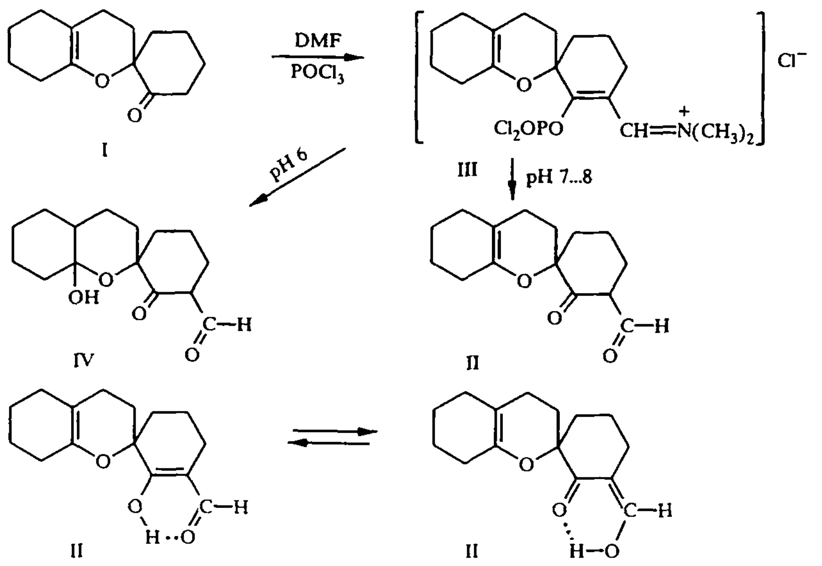
There is no information in the literature on reactions at the α-methylene unit of condensed spirohydrochromans containing a cyclohexane residue at the $C_2$ position of the heterocycle.

We found a new application of the Vilsmeier–Haak reaction for the functionalization of 3,4,5,6,7,8-hexahydrospiro(chromen-2,1′-cyclohexane)-2′-one (I). When the last reacts with N,N-dimethylformamide and phosphorus oxychloride in absolute benzene, two reaction paths are followed depending on the conditions of treatment of the reaction mass.



At pH 7-8 (NaOH), 3′-formyl-3,4,5,6,7,8-hexahydrospiro(chromen-2,1′-cyclohexane)-2′-one (II) is formed. At pH 6, protonation of the C=C bond of the dihydropyran ring occurs probably simultaneously with the hydrolysis of the intermediate (III) and, as a result, the substituted hemiketal, 9-hydroxy-3′-formyl-3,4,5,6,7,8-hexahydrospiro(chromen-2,1′-cyclohexane)-2′-one (IV), is formed.

It was shown that the spirohydrochroman (II) can form both the intramolecular hydrogen bond (intra-HB, 3587 $cm^{-1}$) and the intermolecular hydrogen bond (inter-HB, 3290 $cm^{-1}$) in $CH_2Cl_2$; this follows from IR spectral data obtained for solutions of different concentrations. Using the MNDO/M method [1] for the tautomeric forms (IIa) and (IIb), the energies of the intra-HB (31.77 and 34.69 kJ/mole correspondingly) and enthalpies of formation (−535.46 and −540.89 kJ/mole), indicating their thermodynamic equivalence, were calculated. The energy of activation of the process of proton transfer is characterized by the value 43.05 kJ/mole, which conforms with the data of the work [2] and corresponds with the rate transfer

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constant k $\sim 2 \cdot 10^7$ $sec^{-1}$. On the basis of the data of $^1H$ NMR spectroscopy, a conclusion was drawn on the preferred enolization of the aldehyde function. The results obtained allow the prediction of the synthesis of new heterocyclic compounds based on formyl-substituted spirohydrochromans. Compound (I) was obtained with a yield of 63% by the method described in the work [3].

**3'-Formyl-3,4,5,6,7,8-hexahydrospiro(chromen-2,1'-cyclohexan)-2'-one (II).** To the mixture of 8.2 g (0.054 mole) of freshly distilled $POCl_3$, 20 ml of abs. benzene, and 1.97 g (0.027 mole) of DMF, stirred at 5-6°C, are added 6 g (0.027 mole) of compound (I). The temperature is raised to 75-80°C, and is maintained for 24 h. The solution is neutralized with sodium carbonate to pH 7-8 prior to extraction with 2 × 30 ml of chloroform and drying with magnesium sulfate. The solvent is distilled off, and (II) is obtained with a yield of 3.84 g (57.3%) and mp 186-187°C. The $^1H$ NMR spectrum (DMSO) is as follows: 5.21 ppm (C=C−H) and 3.15 ppm (−OH).

**9-Hydroxy-3'-formyl-3,4,5,6,7,8-hexahydrospiro(chromen-2,1'-cyclohexan)-2'-one (IV).** By analogy with the description above, 10 g (0.045 mole) of the spiran (I), 11 g (0.09 mole) of $POCl_3$ in 20 ml of abs. benzene, and 3.32 g (0.045 mole) of DMF at pH 6 afford 6.03 g (53.5%) of compound (IV) with mp 132-133°C (with decomposition). The $^1H$ NMR spectrum (DMSO) is as follows: 9.03 ppm (O=C−H) and 3.05 ppm (−OH).

The data of the elemental analysis correspond with the calculated data.

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