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CYCLOADDITION REACTIONS OF 3,4-DIHYDRO-2H-PYRAN WITH BENZYLIDENEANILINES

Thomas L. Gilchrist* and Anne-Marie Stannard

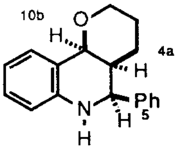
The Robert Robinson Laboratories, University of Liverpool, P.O. Box 147,
Liverpool L69 3BX, U.K.

Summary: The cycloaddition of dihydropyran to benzylideneaniline and to other anils gives tetrahydroquinolines resulting from [4 + 2] addition; contrary to a recent report, there is no evidence for the formation of [2 + 2] adducts.

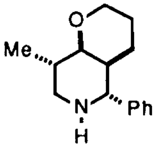
The cycloaddition reactions of benzylideneaniline and of other anils with enol ethers have been reported by several different groups to result in the formation of tetrahydroquinolines. Povarov and his co-workers reported the reaction first.[1] They found that the reaction could be carried out in the presence of boron trifluoride etherate with a range of benzylideneanilines and enol ethers. A single stereoisomer was isolated from the reaction of benzylideneaniline with dihydropyran but its stereochemistry was not specified.[1b] A further series of adducts was reported by Elsager, Worth, and their colleagues from anils and 2,3-dihydro-5-methylfuran: in the presence of boron trifluoride etherate the reactions resulted in the formation of stereoisomeric [4 + 2] adducts.[2] Kametani and co-workers reinvestigated the reaction of benzylideneaniline with dihydropyran and formulated the product as the endo adduct (1).[3] On the other hand the closely related reaction between 1-phenyl-2-aza-1,3-pentadiene and dihydropyran was reported by Mariano and his co-workers to lead to exo addition; after reductive workup with sodium borohydride a piperidine was isolated and was assigned structure (2).[4]

We have been studying the reactions between benzylideneanilines and dihydropyrans with the aims of establishing the structure of the adducts unambiguously and of determining the factors controlling the stereoselectivity. We have carried out reactions between benzylideneanilines and dihydropyran in the presence of several different Lewis acids and carboxylic acids. The structures of the adducts have been determined by ^{1}H n.m.r. In order to establish the assignments several adducts have also been prepared from 6-deuterio-dihydropyran[5]: these adducts have H-10b replaced by deuterium, which simplifies the interpretation of the n.m.r. spectra. We find that the products of the reactions are isomeric tetrahydroquinolines. Thus reactions with benzylideneaniline give either or both of the isomers (1) and (3). The endo adduct (1) is the only product which we have detected in reactions carried out in the presence of boron trifluoride etherate.[6] This is the structure proposed earlier by Kametani et al.[3] In contrast, reactions carried out in acetic acid lead to the formation in good yield of the exo adduct (3) with only a small amount (<10%) of the endo isomer. Structure (3) is assigned to this compound because of the presence of a strong NH stretching band in the i.r. spectrum, by the detection of an NH signal (removed by D_2O) in the n.m.r., and from the coupling constants.[7] We have also isolated analogous pairs of *endo* and *exo* adducts from the the reactions of substituted benzylideneanilines with dihydropyran.[§]

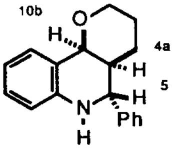
In a recent communication Laszlo and co-workers have reported an investigation of the reaction between benzylideneaniline and enol ethers.[8] With dihydropyran two adducts were isolated; these were formulated as (**1**) and as the [2 + 2] adduct (**4**). In the presence of iron(III) chloride, the two adducts were reported to be formed in a 1:1 ratio. We have repeated this reaction and have also obtained a mixture of two cycloadducts. These were isolated by p.l.c. on silica using ether—light petroleum as eluant. The faster moving component was identified as compound (**1**); the slower moving component proved to be identical to that which we had prepared earlier in acetic acid, and assigned as (**3**). The azetidine structure (**4**) is not tenable for this compound because of the presence of an NH group. There must presumably also be some doubt about the claim[8] that 2,3-dihydrofuran forms a [2 + 2] cycloadduct with benzylideneaniline.



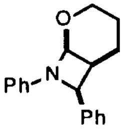
(**1**)



(**2**)



(**3**)



(**4**)

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[§] New compounds gave satisfactory C, H, and N analyses.

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[4] Y.-S. Cheng, E. Ho, P. S. Mariano, and H. L. Ammon, *J. Org. Chem.*, **50**, 5678 (1985).

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[6] (**1**), m.p. 128.5—131°C (lit.,[3] 129°C); ^1H n.m.r. spectrum corresponds to that reported.[3,8]

[7] (**3**), m.p. 94—96°C (from ether—light petroleum); $\nu_{max.}$ 3 360 cm^{-1} (NH); δ (250 MHz, $CDCl_3$) 1.05—1.90 (4 H, m), 1.95—2.06 1 H, m, 4a-H), 3.67 (1 H, ddd, 2-H), 4.00—4.10 (2 H, m, 2-H and NH, decreases to 1 H on D_2O shake), 4.33 (1 H, d, 10b-H), 4.63 (1 H, d, 5-H), 6.44 (1 H, d), 6.65 (1 H, approx. t), 7.04 (1 H, approx. t), 7.18 (1 H, d), and 7.28—7.42 (5 H, m); *J*(4a—5) 10.38 Hz and *J*(4a—10b) 2.77 Hz.

[8] J. Cabral, P. Laszlo, and M. T. Montaufier, *Tetrahedron Lett.*, **29**, 547 (1988).

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