The Synthesis of 3,4-Dihydrocarbostyril Derivatives from $\alpha\beta$-Unsaturated Acid Chlorides and the Imines formed from Ketones and Primary Amines

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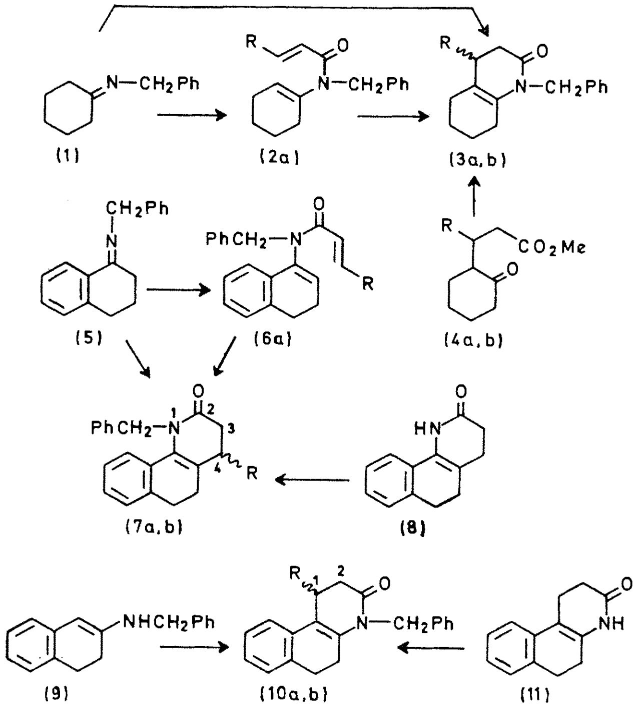
Summary The reaction of $\alpha\beta$-unsaturated acid chlorides with the imines formed from ketones and primary amines, followed by photocyclization of the resultant $\alpha\beta$-unsaturated enamides, gives 3,4-dihydrocarbostyril derivatives.

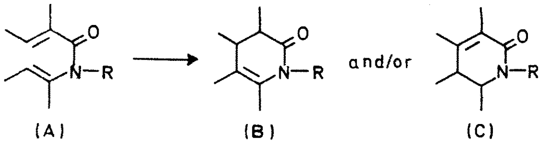
IN extension of our work on the photocyclization of *N*-benzoylenamines,[1] we have studied the *N*-acylation of imines with $\alpha\beta$-unsaturated acid chlorides. In some cases annelation to hydrocarbostyril structures occurred as well as *N*-acylation, and photocyclization of the product led to hydroquinoline derivatives.



[a; R = H, b; R = Ph]

To an ice-cooled chloroform solution of the imine prepared from cyclohexanone and benzylamine, freshly prepared acryloyl chloride was added dropwise in the presence of triethylamine, and the resulting mixture was stirred at room temperature for 10 h. From the usual work-up, the *N*-acryloylenamine (2a), m.p. 71—71·5°, ν_{max} (CHCl$_3$) 1648 cm^{-1}, δ (CDCl$_3$) 5·3—6·6 (4H, olefinic H), 4·69 (2H, s, CH_2Ph), was obtained in 58% yield. On irradiation[1] with a low-pressure mercury lamp this afforded the cyclized carbostyril (3a), b.p. 127—130°/1 mm Hg, ν_{max} (CHCl$_3$) 1647 cm^{-1}, in 61% yield, identified by direct comparison with a sample prepared by reaction of the keto-ester (4a)[2] with benzylamine.

Similarly, the imine (5),† prepared from α-tetralone and benzylamine, was acylated smoothly with acryloyl chloride to give the *N*-acryloyl-enamine (6a), b.p. 190—210°/1 mm Hg, and this was also readily photocyclized in 42% yield, to the carbostyril (7a), b.p. 160°/0·002 mm Hg, ν_{max} (CHCl$_3$) 1662 cm^{-1}. The imine (9),† prepared from β-tetralone and benzylamine, when treated with acryloyl chloride, afforded the cyclized product (10a), b.p. 200—220°/1 mm Hg, ν_{max} (CHCl$_3$) 1661 cm^{-1}, the structure of which was established by comparison with a sample prepared from benzylation of compound (11).[3] Thus, the reactions of the imine with acryloyl chloride give either *N*-acylated enamines or cyclized products, depending upon the reactivity of the β-position of the tautomeric enamine.



Treatment of the imines (1), (5), and (9) with cinnamoyl chloride under the same conditions gave annelated 4-phenylcarbostyril derivatives (3b), (7b), and (10b) in moderate yields. The structure of (3b) was identified by direct comparison with a sample prepared from the keto-ester (4b)[4] and benzylamine.‡

Since Michael-type addition of alkyl cinnamates to the enamine from cyclohexanone and pyrrolidine has not been observed, this annelation reaction, coupled with the photocyclization procedure, offers a versatile method for the preparation of hydroquinoline derivatives.

Generally, the cyclization of such an $\alpha\beta$-unsaturated acylenamine (A), either photochemically or thermally, would give either B-type product or/and C-type product, and the results here described correspond to the reaction yielding B-type products, in contrast to those reported earlier,[1] which belong to the C-type.

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† From an inspection of their i.r. spectra, we suggest that the imine (5) [ν_{max} 1630 cm^{-1} (C=N)] exists mostly in the imine form, and (9) [ν_{max} 3480 (NH), 1635 cm^{-1} (C=C–N)] mostly in the enamine form.

‡ All new compounds have satisfactory analyses and spectral data.

[1] I. Ninomiya, T. Naito, and T. Mori, *Tetrahedron Letters*, 1969, 2259, 3643.
[2] L. Birkofer and C. D. Barnikel, *Chem. Ber.*, 1958, **91**, 1996.
[3] I. Ninomiya, T. Naito, and T. Mori, unpublished data.
[4] D. Vorlander and K. Kunze, *Ber.*, 1926, **59**, 2084.