PHOTOREDUCTIVE CYCLIZATION OF 5-NITRO-6-STYRYL(OR ANILINO)-URACIL DERIVATIVES TO PYRROLO[3,2-D]PYRIMIDINE AND ALLOXAZINE DERIVATIVES

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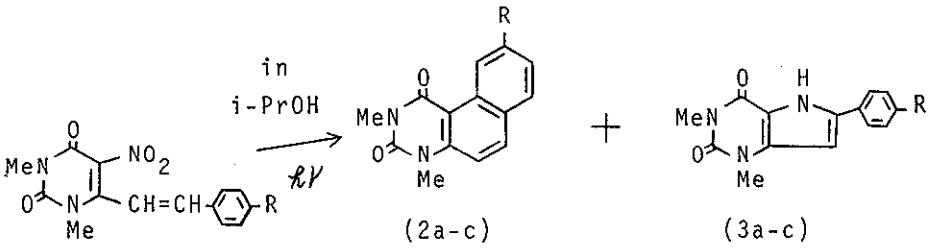
Irradiation of 5-nitro-6-styryluracil and 6-anilino-5-nitrouracil derivatives causes a photoreductive cyclization to give the pyrrolo[3,2-d]-pyrimidines and the alloxazines, respectively.

During the last few years, a number of novel and interesting photochemical reactions of aromatic and olefinic nitro compounds have been found.[1] We report here on the photochemistry of the 5-nitrouracil derivatives having a styryl group or an anilino group at the 6-position, which provides a novel photochemical reaction involving photoreductive cyclization of a nitro group with an o-substituent and also provides a synthetic route to biologically interesting condensed pyrimidines, e.g. the pyrrolo[3,2-d]pyrimidines[2] and the alloxazines.

A Pyrex-filtered irradiation[3] of 1,3-dimethyl-5-nitro-6-styryluracil[4](1a) in isopropanol solution (3×10^{-3}M) under

nitrogen affored two types of photoproducts, the benzo[f]quinazoline(2a):[5] mp 196° (8 % yield) and the 6-phenyl-pyrrolo[3,2-d]pyrimidine(3a):[4] mp >300° (16 %). Similar results were observed on the photolysis of the 5-nitro-6-(p-substituted styryl)uracils(1b) and (1c), giving (2b):[6] mp 199° (3 % yield), (3b): mp >300° (8 %) and (2c): mp 232° (3 %), (3c): mp >300° (8 %), respectively.



(1) a; R=H
b; R=Me
c; R=OMe

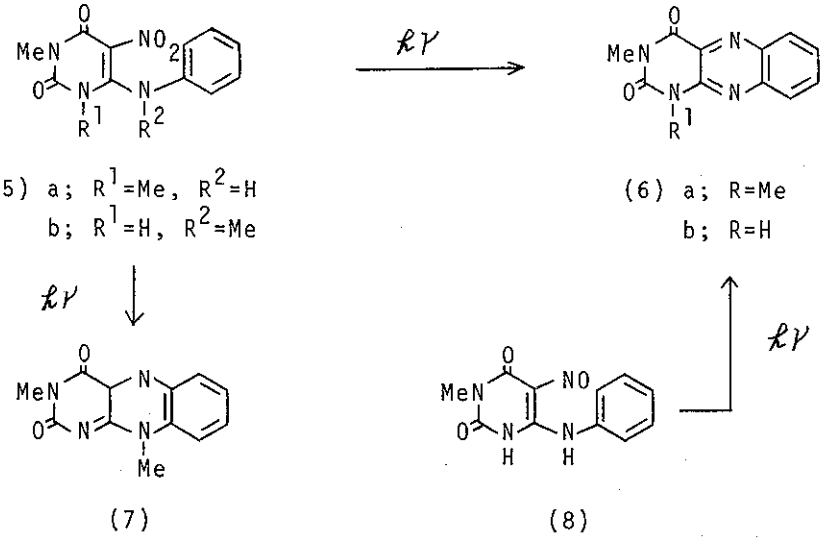
(4)

It would be reasonable to presume that the tricyclic products (2a-c) would be formed by a 6π-electron system cyclization followed by a loss of nitrous acid. The formation of (3a-c) was greatly dependent on the solvent used.

Thus, in contrast to the above irradiation in isopropanol, the photolysis of (1a) in benzene solution (8×10^{-3}M) did not produce (3a), but instead (2a) and the 8-hydroxy-6-phenyl-pyrrolo[3,2-d]pyrimidine (4)[7]: mp >300°, were obtained in 10 %

and 8 % yields, respectively. This results would imply that the key step in the formation of (3a) from (1a) is the deoxygenation of the nitro group[8] in an excited state with an alcoholic molecule. This may be confirmed also by the fact that the pyrrolo[3,2-d]pyrimidine (3a) could be obtained in 12 % yield by the photolysis of (1a) even in benzene solution (10^{-3}M) with the addition of benzaldehyde, which is known to be a hydrogen donor for an excited nitro group , in stead of alcoholic solvents.[8]

An analogous photoreductive cyclization occurred on the photolysis of the 6-anilino-5-nitorouracils (5a,b)[9] (a : R^1=CH_3, R^2=H, b : R^1=H, R^2=CH_3) in methanol solution (2 x 10^{-3}M), affording 1,3-dimethylalloxazine (6a):[10] mp 248° (15 % yield) and 3,9-dimethylisoalloxazine (7): mp>300° (14 %).



(5) a; R^1=Me, R^2=H
b; R^1=H, R^2=Me

(6) a; R=Me
b; R=H

(7)

(8)

It is generally recognized that an excited aromatic nitro compound abstracts a hydrogen from a hydrogen donating molecule to give a nitroso compound.[9] Therefore, we carried out the irradiation of 6-anilino-5-nitroso-3-methyluracil (8).[10] Thus, photolysis of the nitroso compound (8) in benzene solution (10^{-3}M) gave 3-methylalloxazine (6b) in 77 %. These facts imply a possible route to the alloxazines involving the 5-nitroso compound in our photoreductive cyclization of the 6-anilino-5-nitrouracil.

Although the present photoreductive cyclizations of the 5-nitrouracils do not proceed quantitatively, this type of photochemical reduction of the o-substituted nitro groups has been scarcely observed[11] even in the case of o-nitrostilbenes and o-nitrobiphenylamines which are proto-types of our compounds.

REFERENCES AND FOOTNOTES

1 For some examples see: J. T. Pinhey and E. Rizzardo, Tetrahedron Letters, 1973, 4057; D. Döpp, D. Müller, and K. -H. Sailer, ibid, 1974, 2137; C. P. Joshua and P. K. Ramdas, ibid, 1974, 4359; P. M. Crosby, K. Salisbury, and G. P. Wood, J. C. S. Chem. Comm., 1975, 312; Y. Maki, T. Furuta, M. Kuzuya, and M. Suzuki, ibid, 1975, 616.

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3 The light source was a Riko-UVL 100W high-pressure mercury lamp and the photolysis was continued until the starting material had been consumed.

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5 Compound (2a) was confirmed also by a dimethylation of the 1,3-dihydroxybenzo[f]quinazoline prepared by the Rosowsky's method; A. Rosowsky and E. J. Modest, J. Org. Chem., 1966, 31, 2607.

6 All new compounds described herein gave satisfactory elemental analyses and had spectra consistent with the assigned structures. All melting points are uncorrected.

7 Compound (4) may be formed by a direct addition of 5-nitro group to an ethylenic bond in 6-styryl group as observed in o-nitrostilbene; J. S. Splitter and M. Calvin, J. Org. Chem., 1955, 20, 1086.

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Received, 12th December, 1975