

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

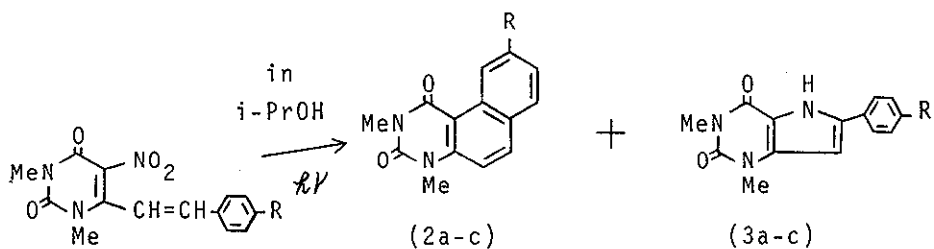
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Irradiation of 5-nitro-6-styryluracil and 6-anilino-5-nitrouracil derivatives causes a photoreductive cyclization to give the pyrrolo[3,2-d]-pyrimidines and the alloxazines, respectively.

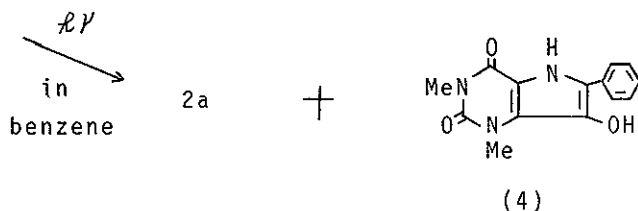
During the last few years, a number of novel and interesting photochemical reactions of aromatic and olefinic nitro compounds have been found.<sup>1</sup> We report here on the photochemistry of the 5-nitrouracil derivatives having a styryl group or an anilino group at the 6-position, which provides 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<sup>2</sup> and the alloxazines.

A Pyrex-filtered irradiation<sup>3</sup> of 1,3-dimethyl-5-nitro-6-styryluracil<sup>4</sup>(1a) in isopropanol solution ( $3 \times 10^{-3}M$ ) under

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

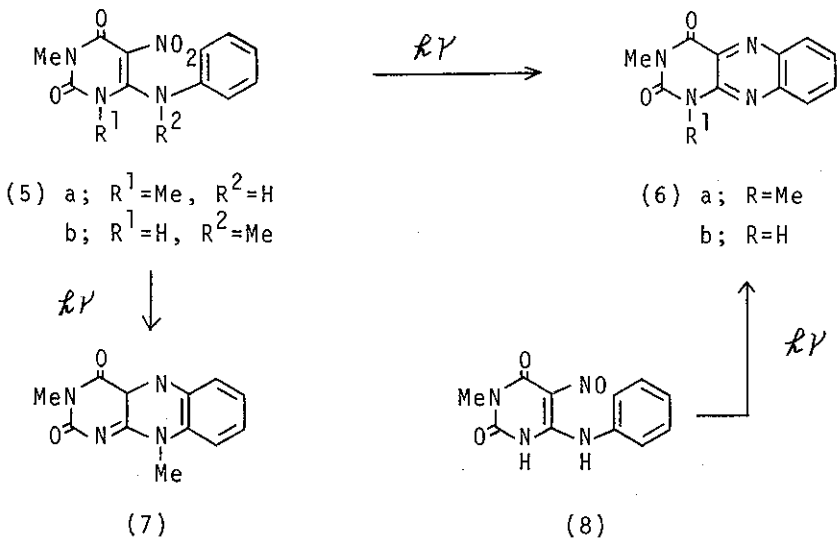


It would be reasonable to presume that the tricyclic products (2a-c) would be formed by a  $6\pi$ -electron system cyclization followed by a loss of nitrous acid. The formation of (3a-c) was greatly dependent on the solvent used.

Thus, in contrast to the above irradiation in isopropanol, the photolysis of (1a) in benzene solution ( $8 \times 10^{-3}M$ ) did not produce (3a), but instead (2a) and the 8-hydroxy-6-phenylpyrrolo[3,2-d]pyrimidine (4)<sup>7</sup>: 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<sup>8</sup> 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.<sup>8</sup>

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



It is generally recognized that an excited aromatic nitro compound abstracts a hydrogen from a hydrogen donating molecule to give a nitroso compound.<sup>9</sup> Therefore, we carried out the irradiation of 6-anilino-5-nitroso-3-methyluracil (8).<sup>10</sup> 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<sup>11</sup> 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.
- 2 S. Senda and K. Hirota, Chem. Pharm. Bull., (Tokyo), 1974, 22, 2593.
- 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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