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THIOCARBONYL PHOTOCHEMISTRY. IV. THE PHOTOREACTION OF 4-THIOURIDINE AND 4-THIOTHYMIDINE WITH UNSATURATED NITRILES

C. FOMBERT, J.L. FOURREY, P. JOUIN and J. MORON

Institut de Chimie des Substances Naturelles, C.N.R.S., 91190 Gif-sur-Yvette, France

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It has already been shown by Ofengand (1) that 4-thiouridine 1 adds to acrylonitrile 2 (R_1 = ribosyl) (Michael reaction). Accordingly, along with our current research on 4-thiouracil derivatives photochemistry (2) it was of interest to investigate the excited state reaction of 4-thiouridine triacetate 3 and 4-thiothymidine diacetate 4 with acrylonitrile 2 and methacrylonitrile 5.

I - Irradiation of compounds 3 and 4 in presence of acrylonitrile 2

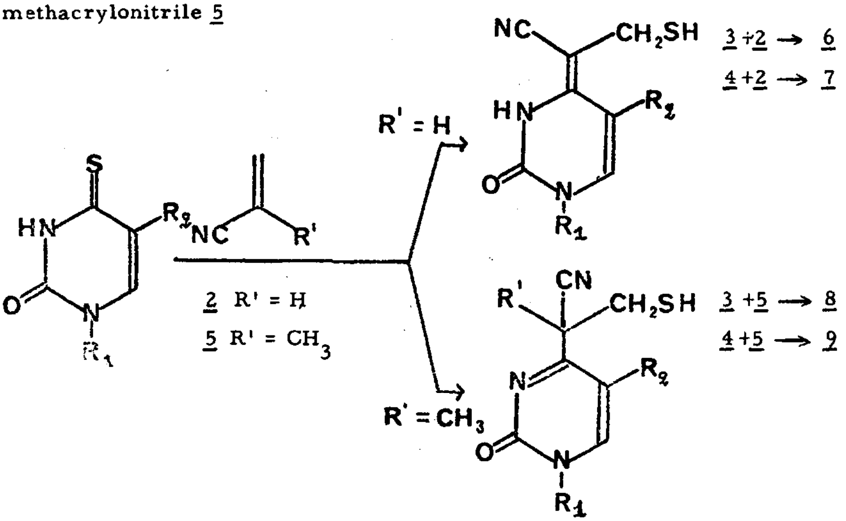
Irradiation (3) of compound 3 in presence of acrylonitrile 2 until complete disappearance of the starting material leads to the formation of compound 6 whose structure is based on the following data. An intense 2.200 cm^{-1} absorption band in its IR spectrum is indicative of the presence of an α β conjugated nitrile. In addition to the signals due to protons belonging to the ribosyl moiety its NMR spectrum manifests an AB system centered at 6.15 and 6.90 ppm (J = 9 Hz) attributed to protons H_5 and H_6, respectively. Further, the triplet at 1.95 ppm (SH) and the multiplet at 9.5 ppm (NH) disappear after deuterium exchange while the doublet at 3.45 ppm (CH_2SH) collapses to a singlet. The UV spectrum shows two absorption maxima at 314 (ϵ 15 000) and 267 nm (ϵ 13 000).

Under the same conditions 4-thiothymidine diacetate 4 displays a very similar behaviour yielding compound 7 whose structure can be deduced from the spectral data (IR : ν_{CN} 2 200 cm^{-1}, NMR : H_6 : 6.65 ppm CH_2S 3, 7 ppm).

II - Irradiation of compound 4 and 5 in presence of methacrylonitrile 6

Irradiation of 4-thiouridine triacetate 3 in presence of methacrylonitrile 5 yields compound 8. Although its mass spectrum shows that 8 is a 3 + 5 adduct its IR spectrum is devoid of C≡N vibration which can be expected for a non conjugated nitrile (4). Its UV (ϵ_{317} = 7, 800) spectrum is indicative of a 4-alkyl 2-pyrimidinone structure, a finding which can be confirmed by NMR since the H_6 proton signal is shifted to 8.2 ppm and the methine signal (CH_2SH) now appears at 3.2 ppm. The signal at 1.80 ppm is attributed to a tertiary methyl group. By following a similar line of arguments structure 9 (UV : ϵ_{325} = 7, 800 NMR : H_6 = 7.85 ppm $\underline{C}H_2SH$: 3.20 ppm $\underline{C}H_3$-C-CN : 1.8 ppm) can be attributed to the photoproduct isolated after irradiation of 4-thiothymidine diacetate 4 in presence of methacrylonitrile 5

1 R_1 = Ribosyl
R_2 = H
3 R_1 = Ribosyl triacetate
R_2 = H
4 R_1 = Deoxyribosyl diacetate
R_2 = CH_3



The photoproducts obtained by interaction of N-1 substituted 4-thiouracil derivatives with acrylonitrile are similar to those obtained with 1,3-disubstituted 4-thiouracil as earlier reported (2). Comparison of the NMR data previously recorded for photoproduct of 1,3-dimethyl 4-thiouracil and acrylonitrile leads us to propose that compounds 6 et 7 have the exocyclic double bond stereochemistry as shown on the figure (5).

The formation of the above photoproducts can be best explained through the intermediacy of an unstable thietane which collapses to products. This mechanism has been suggested by LEONARD (6) and we have shown that in some cases thietanes are indeed obtained from a 4-thiouracil derivative (7).

The synthetic applicability of this photoreaction to form carbon-carbon bond between olefins and readily accessible thionamides is currently under study in this laboratory.

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REFERENCES

1 - J. Ofengand, (1967), J.Biol.Chem., 242, 5034.
2 - J.L. Fourrey, P. Jouin and J. Moron, (1973), Tetrahedron Letters, 3239.
3 - Standard irradiation conditions were the following : a 5.10^{-3} M solution of the 4-thiouracil derivative in CH_2Cl_2 : unsaturated nitrile (9:1) was irradiated under nitrogen in a pyrex apparatus using a Hanau QF 81 lamp.
4 - L.J. Bellamy, The Infrared Spectra of Complex Molecule p.225.
5 - P. Jouin, Unpublished observations.
6 - D.E. Berstrom, N.J. Leonard, (1972), Biochemistry, 11, 1
7 - Preceding Communication.