

THIOCARBONYL PHOTOCHEMISTRY VII PHOTOCHEMISTRY OF 1,3-DIMETHYL
4-THIOURACIL IN PRESENCE OF TRIETHYLAMINE

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We have shown that 4-thiouracil derivatives interact photochemically with primary amines (1) We report now that irradiation of 1,3-dimethyl 4-thiouracil 1 in presence of a tertiary amine such as triethylamine produces a mixture of tetrahydro-bipyrimidines which have been assigned d, l and meso structures 2a and 2b respectively

A methanolic (or aqueous) solution of 1,3-dimethyl 4-thiouracil 1 containing 5 % of triethylamine is irradiated (2) until the complete disappearance of the starting material The two major reaction products are isolated after silica gel column chromatography in an overall yield of 60 %

Compounds 2a (mp 194-195°) and 2b (mp 264-266°) display very similar analytical and spectral data Both show the molecular ion in their mass spectrum at m/e 314 (Base peak m/e 157) These photoproducts are 5,6-dihydro 4-thiouracil derivatives as shown by their IR, UV and NMR spectra (Table 1) These results suggest that 2a and 2b arise through coupling of two identical hydropyrimidinyl radicals

The ¹³C NMR spectra of compound 2a and 2b show six signals (Table 2), one of which is assigned to a secondary carbon and another to a tertiary carbon In order to determine which carbon atoms are involved in the formation of the new bond 1,3-dimethyl 5-deutero-4-thiouracil 1 (d₁) was prepared (3) and irradiated to produce the bis-deuterocompounds 2a (d₂) and 2b (d₂). Their ¹³C NMR spectra are devoid of secondary carbon signal demonstrating that the linkage between the two pyrimidines is at position C-6. This result is confirmed by inspection of the H-5 signals of the proton NMR spectra of photooxidized products (4) 3a (mp 220-222°) and 3b (mp 278-279°) In both 3a and 3b the two H-5 signals appear as the AB part of an ABX system ($J_{AB} = 17$ Hz) and are expectedly found at higher field than the multiplet due to H-6 (4c)

The assignment of d, l and meso structures to compound 2a and 2b was accomplished by observing changes in the proton NMR spectra of derivatives 2 and 3 in the presence of optically active europium shift reagent:tris(3-trifluoroacetyl) d-camphoratoeuropium (III) (5) In the spectrum of the d and l isomers (2a and 3a) the N-methyl signals are separated in the presence of the optically active shift reagent (Table 1), thus distinguishing the d, l from the meso isomers

TABLE I

	IR	UV	$^1\text{H NMR}$ (δ ppm, solvent CDCl_3)			
	ν (cm^{-1})	$\epsilon_{\lambda_{\text{max}}}$	$\text{N}_{(1, 1')}\text{-CH}_3$	$\text{N}_{(3, 3')}\text{-CH}_3$	$\text{H}_{5, 5'}$	$\text{H}_{6, 6'}$
<u>2a</u>	1705	$\epsilon_{283} = 23800$	3.05 4.17 [†]	3.70 4.43 [†] 4.38 [†]	3.33	
<u>2b</u>	1700	$\epsilon_{283} = 21300$	3.17	3.45	3.33	
<u>3a</u>	1720 1670	—	3.03 4.31 [†] 4.27 [†]	3.21 4.42 [†] 4.35 [†]	2.60 3.10 ^{†*}	3.50
<u>3b</u>	1740 1680	—	3.09	3.18	2.55 3.10 ^{†*}	3.45

[†] After addition of optically active shift reagent

^{†*} This signal is absent in the spectrum of the $\text{C}_{5, 5'}$ deuterated compound

We have established that 4-thiouracil derivatives are photoreactive towards amines. To our knowledge amine photoreduction, a well known reaction in the case of ketones (6), has never been reported to occur with thiocarbonyl compounds. Since, the photoreduction pathway should be closely related for these two types of chromophores, we suggest the mechanism depicted in the scheme to account for the formation of the photoproducts.

The deuterio compounds 2a (d_2) and 2b (d_2) have been photooxidized yielding 3a (d_2) and 3b (d_2). A noteworthy finding in their NMR spectra is the absence of the higher field H-5 signal which is observed in the spectra of 3a and 3b. Accordingly, the protonation process leading to the hydroxypyrimidinyl radical 4 is stereospecific.

The formation of reductive type dimers 2a and 2b proves that radical 4 is an intermediate in this photoreaction. Radicals of this type might be also produced in several kinds of photoreduction processes encountered so far with 4-thiouracils, such as photohydroxyalkylation by alcohols (4b) and intramolecular rearrangements involving Norrish II hydrogen abstraction processes (7). The various structural types of products isolated in these photoreactions illustrate the reactivity of the 5-hydro 4-thiouracil radicals under different reaction conditions.

SCHEME

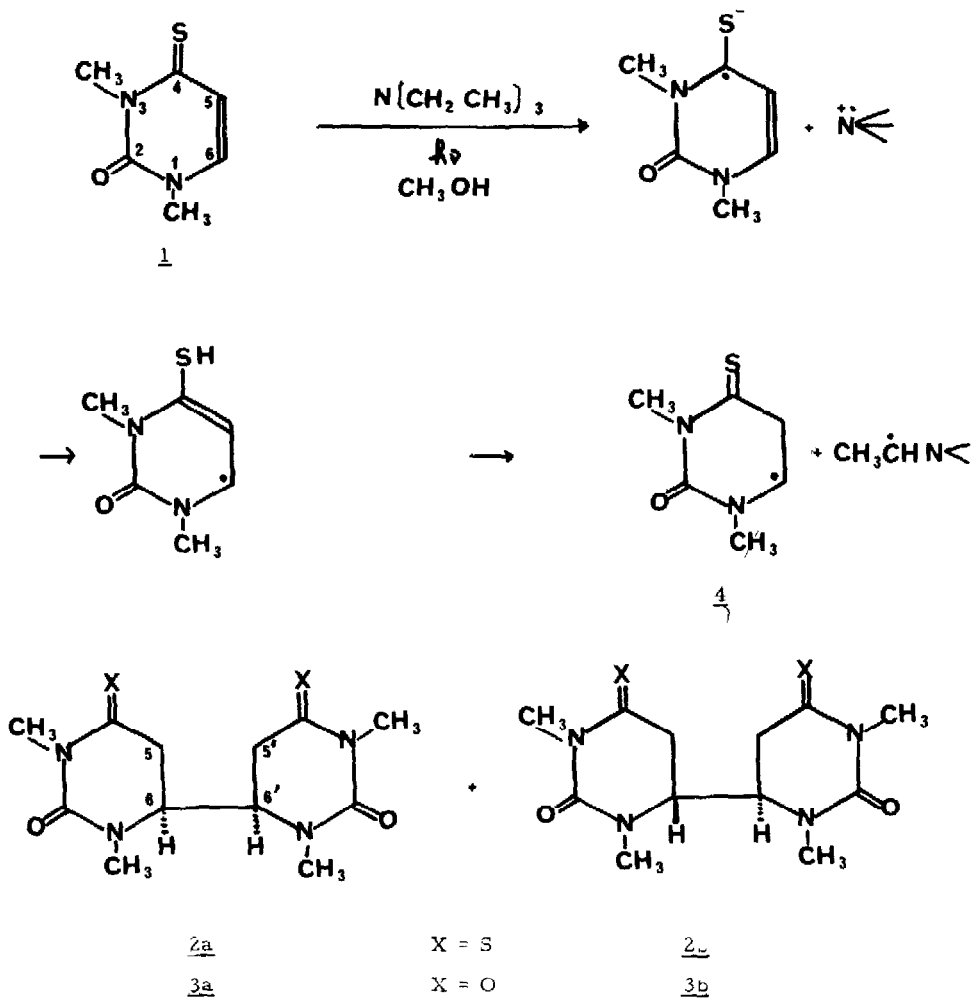


TABLE 2 (^{13}C NMR Data)

	C_2	C_4	N- CH_3	C_5	C_6
<u>2a</u>	150.10	200.29	38.21 35.48	42.89	56.54
<u>2b</u>	150.00	199.70	37.70 35.70	43.20	55.70

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