

PYRIMIDINIUM N-DICYANOMETHYLIDE. SYNTHESIS AND REACTIVITY TOWARDS
DIMETHYL ACETYLENEDICARBOXYLATE

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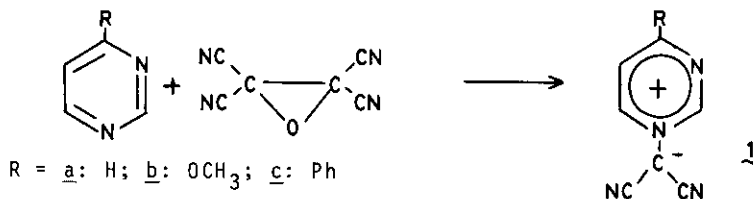
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Abstract- The titled compound (1a) has been prepared by reaction of pyrimidine with tetracyanoethyleneoxide (TCNEO). Reaction of 1a with DMAD yielded two regioisomer pyrrolopyrimidines (2a and 3a), via a 1,3-dipolar cycloaddition. Concerning the regioselectivity of the reaction, experimental results are in agreement with theoretical calculations.

Kobayashi¹ and Zugravescu² reported the preparation of 4-methoxy- and 4-phenylpyrimidinium N-dicyanomethylides, respectively, by reaction of the corresponding pyrimidines with TCNEO, however synthesis of the unsubstituted dicyanomethylide 1a failed¹.



Since we had predicted³ that pyrimidine is basic enough to react with TCNEO, we decided to carry out the reaction in ethyl ether for 24 h at room temperature

(ref. 3, method B). With this procedure 1a is formed in 17% yield. Subsequently the yield was improved till 60% using more concentrated solutions of the reactants. Structure of ylide 1a has been established on the basis of the analytical and spectroscopic data. The i.r. spectrum shows the typical strong doublet due the cyano groups³ at 2140 and 2180 cm^{-1} . $^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ spectra of 1a are summarized in Tables 1 and 2.

Table 1
 $^1\text{H-NMR}$ spectrum of 1a in DMSO-d_6 (internal standard TMS)

$\delta(\text{ppm})$				$J(\text{Hz})$					
H-2	H-3	H-4	H-5	$J_{2,4}$	$J_{2,5}$	$J_{2,6}$	$J_{4,5}$	$J_{4,6}$	$J_{5,6}$
9.15	8.57	7.77	8.72	0.0	1.4	2.2	5.0	1.6	6.5

H-4 and H-6 have been differentiated by the $J_{2,4}$ and $J_{4,6}$ values. This assignment is in agreement with that of 1b¹ and pyrimidinium N-oxide data⁴.

Table 2
 $^{13}\text{C-NMR}$ spectrum of 1a in DMSO-d_6 (internal standard TMS)

	$\delta(\text{ppm})$	$^1J_{\text{CH}}(\text{Hz})$	q_{C}^{π} a)	$\Delta\delta^b)$
C-2	142.4	209	0.19	-16.0
C-4	151.9	187	0.20	-4.5
C-5	122.8	179	-0.09	+1.4
C-6	139.2	197	0.13	-17.2
C ⁻	55.8 ^{c)}	-	-0.57	-
CN	117.4	-	0.20	-

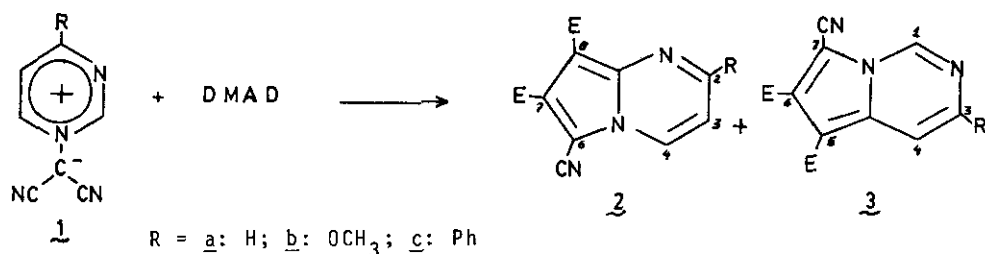
a) MINDO/2 calculation

b) $\Delta\delta = \delta_{\text{1a}} - \delta_{\text{pyrimidine}}(\text{CDCl}_3)$ ⁵

c) in agreement with other N-dicyanomethylides^{6,7}.

^{13}C -chemical shifts of ring atoms have been assigned on the basis of $^1J_{\text{CH}}$ values. Distinction between C-4 and C-6 has been made by comparison of π -charge density⁸ and $\Delta\delta$ values from pyrimidine⁵.

Reactions of ylides 1b¹ and 1c² with DMAD yielded pyrrolo[1,2-a]pyrimidines 2b and 2c by a (3+2) cycloaddition reaction followed by loss of HCN. The regioisomer 3, resulting from cycloaddition to C-6, was not detected. However, theoretical



calculations obtained from a second order perturbational treatment⁹ predicted that in the case of the unsubstituted pyrimidinium methylenide 4, the cycloaddition of DMAD to C-6 is more favoured than that to C-2.

Ylide 1a was allowed to react with DMAD in acetonitrile at room temperature for 9 h, and thus a mixture of both pyrrolopyrimidine regioisomers 2a and 3a was obtained in a 3:7 ratio in isolated product.

Structures 2a and 3a were established on the basis of analytical and spectroscopic data.

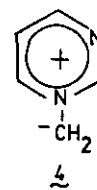


Table 3

¹H-NMR of pyrrolopyrimidines 2a and 3a in CDCl₃ (internal standard TMS)

	H-1	H-2	H-3	H-4	CH ₃	J _{1,3}	J _{2,3}	J _{2,4}	J _{3,4}
<u>2a</u>	-	8.63	7.27	8.87	3.82,3.90	-	4.5	1.8	7.2
<u>3a</u>	9.27	-	7.90	8.05	3.80,3.90	1.4	-	-	6.5

A second order perturbational treatment¹⁰, using molecular energies and atom orbital coefficients obtained from molecular wave functions calculated by the MINDO/2 method, which is known to be more useful than the CNDO/2 used before¹¹, gave similar results: $\Delta E(\text{a.u.} \times 10^3)$ for 2a is -7.11 and -8.70 for 3a.

EXPERIMENTAL

Melting points were determined on a Büchi 510 D apparatus and are uncorrected. IR spectra were recorded on a Perkin-Elmer 257 spectrometer. Proton NMR spectra were recorded at 60 MHz on a Varian T-60A spectrometer. ¹³-Carbon NMR spectra were recorded at 20 MHz in a Varian FT-80A spectrometer.

Pyrimidinium N-Dicyanomethylenide (1a) by Improved Method.

A solution of TCNEO (0.01 mol) in 50 ml of dry ethyl ether was added to a solution of pyrimidine (0.01 mol) in 5 ml of dry ether. After stirring at room temperature for 24 h, the precipitate was filtered off. A second fraction could be obtained

by stirring the mother liquor for 24 h more. Total yield: 60%, m.p.: 187-189°C (from ethanol).

Reaction of 1a with DMAD.

DMAD (0.011 mol) was added to a suspension of 1a (0.01 mol) in 50 ml of dry acetonitrile. After stirring at room temperature for 9 h, the solvent was removed in vacuum and the residue was chromatographed on a column of 80 g of silica gel (60-300 mesh) and eluted with a mixture of toluene-ethyl acetate (9:1) to give 7-cyano-5,6-diethoxycarbonylpyrrolo [1,2-c] pyrimidine 3a (yield: 30%, m.p.: 112-113°C (methanol), IR: ν_{\max} (KBr): ν_{CN} 2230; ν_{CO} 1725 and 1705 cm^{-1}) and 6-cyano-7,8-diethoxycarbonylpyrrolo [1,2-a] pyrimidine 2a (yield: 12%, m.p.: 190-191°C (from methanol); IR: ν_{\max} (KBr): ν_{CN} 2220; ν_{CO} 1725 and 1710 cm^{-1}).

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