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FORMATION OF 3,5-DICYANO-4-(N,N-DIMETHYLFORMAMIDINO)-2,6-DIPHENYL-4<u>H</u>-PYRAN FROM ω-CYANOACETOPHENONE

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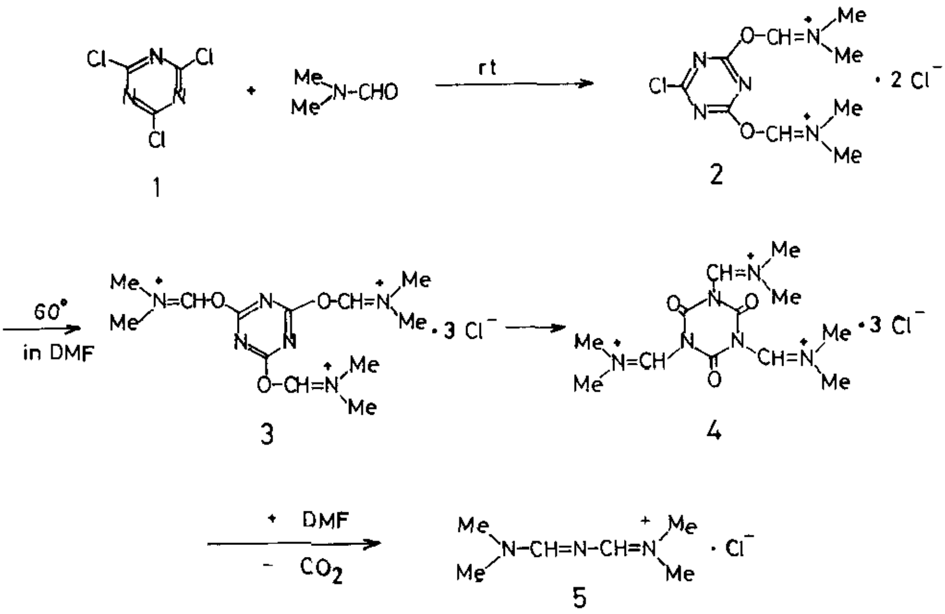
<u>Abstract</u> —— A 4<u>H</u>-pyran derivative, 3,5-dicyano-4-(N,N-dimethylformamidino)-2,6-diphenyl-4<u>H</u>-pyran (<u>9</u>) was obtained by the reaction of [N-(dimethylaminomethylene)aminomethylene] dimethylammonium chloride (<u>5</u>) with ω-cyanoacetophenone (<u>8</u>).

Developments concerning Vilsmeier reagents are one of the most interesting subjects in synthetic organic chemistry. Gold[1)] has reported that the reaction of cyanuric chloride (<u>1</u>) with N,N-dimethylformamide (DMF) afforded the 1:2 adduct (<u>2</u>) at room temperature and then <u>2</u> gave [N-(dimethylaminomethylene)aminomethylene]dimethylammonium chloride (<u>5</u>) via the 1:3 adducts, (<u>3</u>) and (<u>4</u>) at elevated temperature (above 60°C) (scheme 1).



Scheme 1

Oda et al[2)] have found that the 1:2 adduct (2) was a modified Vilsmeier reagent, which could be successfully used in formylation reactions of aromatic compounds, such as N,N-dimethylaniline and dimethoxybenzene. Recently, the author has found that treatment of acetophenone (6) with 1 in DMF at 60-70°C afforded 5-chloro-1,5-diphenyl-2,4-pentanedien-1-one (7) instead of 3-chloro-3-phenylpropenal which was expected by the reaction of 6 with normal Vilsmeier reagent such as the DMF-$POCl_3$ adduct[3)]. This result suggested the reaction of the 1:3 adduct (4) with 6 to give 7. Further, it has been found that the reaction of ω-substituted acetophenones, such as propiophenone and benzyl phenyl ketone, with the adduct (4) gave different products (2,4-dien-1-one type and propenal type compounds) according to the property of substituent[4)]. In the present paper, the author wishes to report that the reaction of ω-cyanoacetophenone (8) with 5 provides heterocyclic compound such as pyran (9).

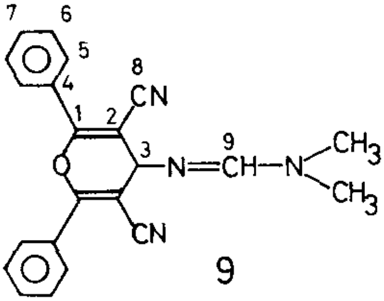
Treatment of 8 with 1 in DMF at 60-70°C for 5 h gave a product (10) having the formula, $C_{12}H_{12}N_2O_2$ based on its elementary analysis and high-resolution mass spectrum. The product (10) shows infrared absorption (Nujol mull) at 2175 cm^{-1} (C≡N), 1645 cm^{-1}(C=O), and 1600 cm^{-1}(C=C). In the ^1H nmr spectrum (in $CDCl_3$), the twelve protons of 10 were assigned as follows: at 3.18 ppm (3H, S, N-CH_3); at 3.42 ppm (3H, S, N-CH_3); and at 7.30-7.90 ppm (6H, m, five aromatic protons and one proton of =CH-N). Thus, 10 was determined as 1-benzoyl-1-cyano-2-dimethylaminoethylene. This compound (10) may be produced by an apparent simple dehydration of 8 with DMF. However, in a comparative experiment, no formation of 10 was observed by a similar treatment of 8 with DMF in the absence of 1. Therefore, the intermediate in the formation of 10 may be the adduct (4)[5)].

At higher temperature (110-120°C), treatment of 8 with 1 in DMF gave another product (9) accompanied by 10. The product (9) has the formula, $C_{22}H_{18}N_4O$ based on its elementary analysis and high-resolution mass spectrum, and shows infrared absorption (Nujol mull) at 2230 cm^{-1}(C≡N), 1660 cm^{-1}(C=N), and 1630, 1595 cm^{-1}(C=C). The structure of 9 was determined as 3,5-dicyano-4-(N,N-dimethylformamidino)-2,6-diphenyl-4H-pyran from the ir and nmr spectra. In the ^1H nmr spectrum (in $CDCl_3$), six protons of the dimethylamino group gave a singlet at 2.95 ppm, while a singlet occured at 4.66 ppm which was assigned to the proton of the pyran ring. In addition, signals corresponding to the aromatic protons and the proton in -N=CH-N appeared at 7.20-8.10 ppm. The off resonance decoupling and the complete ^1H

noise decoupling ^{13}C nmr spectra of 9 were recorded. The ^{13}C sheilding for each carbon atom in 9 is given in Table 1, and the numbering scheme used for the carbon atoms is given in Fig. 1.

Table 1. Assignment of ^{13}C-NMR of 9

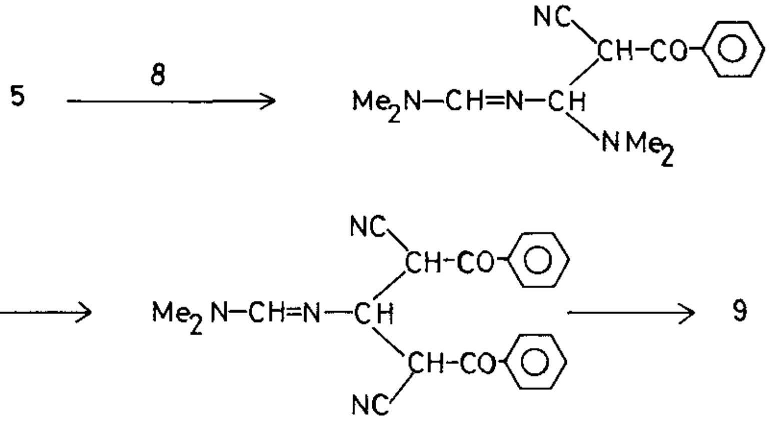
Peak No.	Chemical Shift (ppm)	Carbon No.
1	158.0	1
2	156.3	9
3	131.3	aromatic carbon
4	130.2	
5	128.4	
6	127.5	
7	117.3	8
8	90.0	2
9	58.3	3



9

Fig 1

When subjected to the reaction conditions under which 9 was obtained, the 1:3 adduct (4) decomposed leaving the decomposition product (5) as reported$^{1)}$, suggesting that the intermediate in the formation of 9 might be 5. In order to clarify this assumption, the following experiment was carried out. Heating of 1 in DMF at 60-70°C was continued until evolution of carbon dioxide ceased and then 8 was added at room temperature. The resulting mixture was heated at 110-120°C for 5 h. Chromatographic separation also afforded 9 and 10. From these results and from the structure of 9, it is thought that the reaction might proceed as shown in scheme 2.



Scheme 2

Acknowledgment

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Experimental

IR and ^{1}H nmr spectra were recorded on a JASCO infrared spectrophotometer Model IRA-2 and a Varian A-60D NMR spectrometer, respectively. The mass spectra were obtained using a JEOL 01SG high resolution mass spectrometer. The ^{13}C nmr spectra were recorded on a Varian XL-100A-15 spectrometer in the Fourier transform mode, using TMS as the internal standard. All spectra were taken at room temperature. Melting points are not corrected.

Reaction of ω-Cyanoacetophenone (8) with DMF-Cyanuric Chloride Adduct

(a) .... Into a stirred solution of 14.5 g(0.1 mol) of ω-cyanoacetophenone (8) in 80 ml of DMF was added 27.0(0.15 mol) of cyanuric chloride (1) for a period of 10 min at 10-15°C. The mixture was heated slowly up to 60°C and stirred at 60-70°C for 5 h. To the reaction mixture were added 200 ml of benzene and 300 ml of

5% aqueous sodium hydrogencarbonate at 20-30°C with stirring. The benzene layer was separated, washed with water and dried over anhydrous sodium sulfate. The solvent was then removed under reduced pressure. The resulting residue was recrystallized from a mixture of benzene and petroleum benzine (1:3) to give 10.8 g(54% on the basis of 8) of 1-benzoyl-1-cyano-2-dimethylaminoethylene (10): pale orange crystals, mp 113-114°C. Anal. Calcd. for $C_{12}H_{12}N_2O$: C, 71.98; H, 6.04; N, 13.99%. Found: C, 71.95; H, 5.90; N, 13.89%.

(b) ... Into a stirred solution of 14.5 g(0.1 mol) of 8 in 80 ml of DMF was added 27.0 g(0.15 mol) of 1 for a period of 10 min at 10-15°C. The mixture was heated at 110-120°C for 4 h with stirring. The reaction mixture was worked up by a similar procedure to that mentioned in (a). The resulting residue was chromatographed on Silica Gel (Merck, 70-230 mesh) with a mixture of benzene and ethyl acetate (2:1). Initial fraction yielded 6.1 g(30%) of 10. The second fraction yielded 3.4 g(19% on the basis of 8) of 3,5-dicyano-4(N,N-dimethylformamidino)-2,6-diphenyl-4H-pyran (9) which was crystallized as pale orange crystals, mp 165-166°C from ethanol. Anal. Calcd. for $C_{22}H_{18}N_4O$: C, 74.55; H, 5.12; N, 15.81%. Found: C, 74.46; H, 5.11; N, 15.73%.

(c) ... When the mixture of 27.0 g(0.15 mol) of 1 and 80 ml of DMF was stirred at 60-70°C, evolution of carbon dioxide occurred for a period of 2 h. After evolution of carbon dioxide ceased the mixture was kept at 60-70°C for an additional 1 h. Into the stirred mixture was added 14.5 g(0.1 mol) of 8 over a period of 10 min at room temperature. The mixture was heated up to 110°C and stirred at 110-120°C for 5 h. Treatment of the reaction mixture and chromatographic separation of the resulting residue carried out according to a procedure similar to that mentioned in (b) gave 2.8 g(14%) of 10 and 4.1 g(23%) of 9.

References

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2. R. Oda and K. Yamamoto, *Nippon Kagaku Kaishi*, 1962, 83, 1292.

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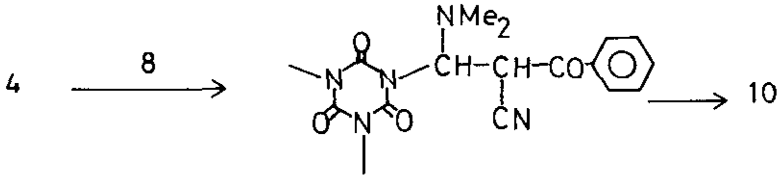
4. S. Morimura, The details will be published elsewhere.

5. The possible reaction path might be depicted as shown below.



Scheme 3

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