

THE CYCLOADDITION REACTION OF 2,6-DIMETHYLPHENYLISONITRILE
WITH DIMETHYL ACETYLENEDICARBOXYLATE

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We recently reported a novel cycloaddition reaction of isonitrile with substituted acetylene giving cyclopentenetriimine (acetylene:isonitrile 1:3) and bisketenimine (1:2) derivatives via iminocyclopropene (1:1) intermediate⁽¹⁾. Especially the reaction with dimethyl acetylenedicarboxylate gave many complex compounds in addition to 1:3 and 1:2 adducts. Recently Winterfeldt⁽²⁾ reported the similar reaction to give dihydrofuran derivative (2:1). In this communication we wish to report the formation of another type of compounds, pyridine derivatives (3:2) in the reaction of the isonitrile with dimethyl acetylenedicarboxylate.

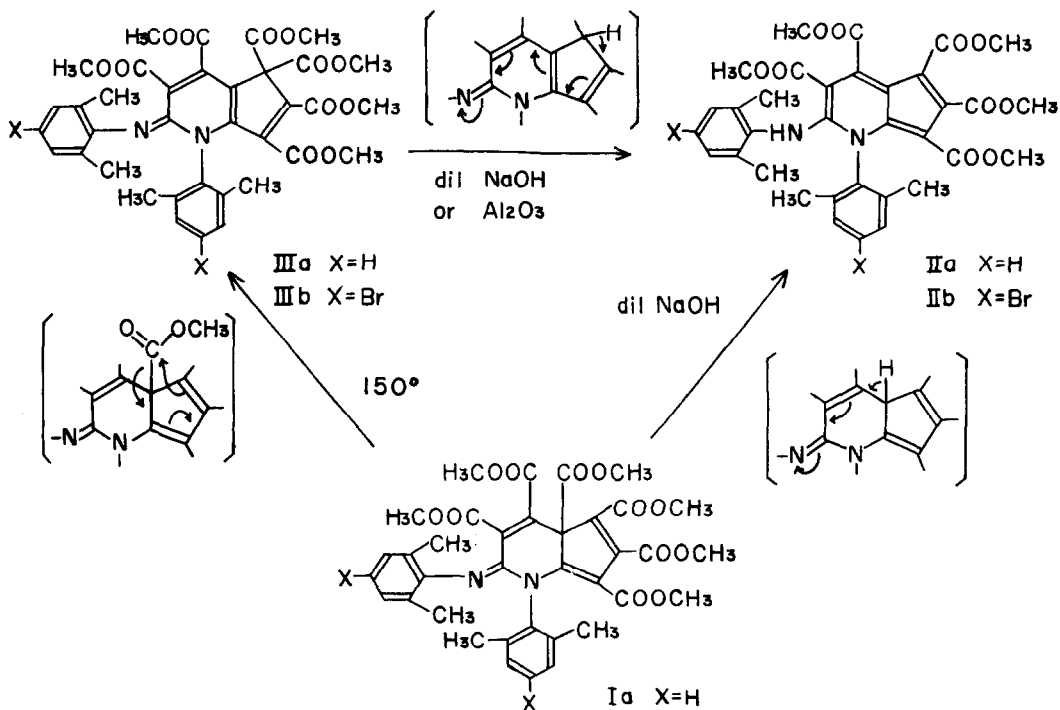
The reaction of 2,6-dimethylphenylisonitrile with dimethyl acetylenedicarboxylate was carried out in benzene at room temperature for 24 hours. After the work-up as mentioned previously⁽¹⁾, there were obtained yellow crystal (Ia), $C_{36}H_{36}N_2O_{12}$, decomp. $> 150^\circ$ in 9.9 % yield, yellow crystal (IIa), $C_{34}H_{34}N_2O_{10}$, mp $233-234^\circ$ in 5.9 % yield and small amount of deep violet crystal (IIIa), $C_{36}H_{36}N_2O_{12}$, mp 245° . The composition of these compounds was determined by elemental analysis and molecular weight determination⁽³⁾. An interesting relation was found between these three compounds. Compound Ia isomerized almost quantitatively to compound IIIa by heating above 150° , and IIIa was further transformed to IIa by the action of sodium hydroxide or alumina.

The reaction of 4-bromo-2,6-dimethylphenylisonitrile with dimethyl acetylenedicarboxylate gave similar compounds as above, orange crystal (IIIb),

$C_{36}H_{34}N_2O_{12}Br_2$, mp 254-255° in 6.6 % yield and yellow crystal (IIb),
 $C_{34}H_{32}N_2O_{10}Br_2$, mp 264-265° in 8.4 % yield, but analogous product of Ia was not
 isolated in this reaction. The relation between IIIb and IIb was also similar to
 that between IIIa and IIa.

As it was difficult to determine the structure of these compounds I-III by
 their spectral data and chemical reactions, compound IIIb was subjected to X-ray
 analysis⁽⁴⁾, by which the structure of IIIb was established to be 1-(4-bromo-
 2,6-dimethylphenyl)-2-(4-bromo-2,6-dimethylphenyl)imino-1,2-dihydro-3,4,5,5,6,7-
 hexacarbomethoxy-5H-1-pyridine as shown in the scheme I. IIIb showed the
 following characteristic IR, UV and NMR spectrum: IR absorptions at 1742 cm^{-1} ($\nu_{C=O}$)
 and 1630 cm^{-1} ($\nu_{C=N}$): UV maxima in ethanol at 258 $m\mu$ ($\log \epsilon$ 4.49), 337 $m\mu$ (3.78)
 and 465 $m\mu$ (3.72): NMR signals at 2.70 τ (s, 2H), 3.00 τ (s, 2H), 6.24 τ (s, 12H),
 6.70 τ (s, 3H), 6.90 τ (s, 3H), 7.80 τ (s, 6H) and 8.05 τ (s, 6H).

Scheme I

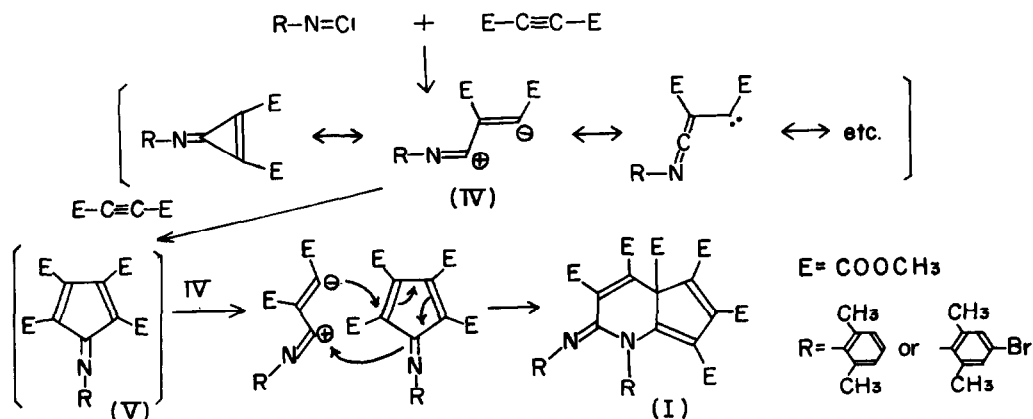


On the basis of the elemental analysis and molecular weight determination, it was found that I Ib was formed from IIIb as the result of the elimination of $C_2H_2O_2$ fragment. In the IR region, I Ib exhibited the characteristic peaks at 3310 cm^{-1} (ν_{N-H}) and at 1732 cm^{-1} ($\nu_{C=O}$), which indicated the presence of amino group and ester group, respectively. The peak at 1630 cm^{-1} which was due to imino group observed in IIIb disappeared in the compound I Ib. I Ib showed also characteristic UV and NMR spectrum: UV maxima in ethanol at $233\text{ m}\mu$ (sh), $260\text{ m}\mu$ ($\log \epsilon$ 4.32), $287\text{ m}\mu$ (4.32) and $388\text{ m}\mu$ (4.34): NMR signals at 2.60τ (s, 2H), 2.85τ (s, 2H), 3.80τ (s, 1H), 6.10τ (s, 3H), 6.19τ (s, 3H), 6.23τ (s, 3H), 6.70τ (s, 3H), 6.80τ (s, 3H), 7.89τ (s, 6H) and 7.94τ (s, 6H). In contrast with the NMR signals of IIIb, those of I Ib at $6.1-6.80\tau$ indicated the presence of five ester groups. Accordingly I Ib might be formed by the hydrolysis of one of geminal ester groups at 5 position in IIIb followed by the decarboxylation and the prototropic rearrangement as shown in the scheme I. Thus the structure of I Ib was assumed to be 1-(4-bromo-2,6-dimethylphenyl)-2-(4-bromo-2,6-dimethyl)-anilino-3,4,5,6,7-pentacarbomethoxy-1H-1-pyridine.

Compound Ia, the isomer of IIIa, showed IR absorptions at 1740 cm^{-1} , 1725 cm^{-1} , 1705 cm^{-1} , 1640 cm^{-1} and 1620 cm^{-1} which were due to ester groups, imino group and/or C=C double bond: UV maxima in ethanol at $240\text{ m}\mu$ ($\log \epsilon$ 4.41), $330\text{ m}\mu$ (3.56) and $418\text{ m}\mu$ (3.98): NMR signals at $2.8-3.2\tau$ (m, 6H), 6.15τ (s, 6H), 6.23τ (s, 6H), 6.85τ (s, 3H), 6.89τ (s, 3H), 7.75τ (s, 9H) and 8.25τ (s, 3H). The presence of geminal ester groups at 5 position of 1-pyridine, IIIa, indicated that the rearrangement of one ester group took place during the stage of forming IIIa from the isonitrile and dimethyl acetylenedicarboxylate. The thermal isomerization of Ia to IIIa might be also considered to be caused by the rearrangement of one ester group. When Ia was treated by sodium hydroxide under such a condition as IIIa was not formed thermally, IIa was obtained in good yield. All these results indicated that Ia had one ester group which easily rearranged to 5 position and was hydrolyzed by base to give IIa in the similar fashion of the hydrolysis of IIIa. Now, considering a route of the formation of Ia from the isonitrile and dimethyl acetylenedicarboxylate, it is reasonable to assume that primary 1:1 adduct (IV) is formed^(1,2,5) and subsequent cyclization of IV with

acetylene triple bond gives iminocyclopentadiene derivatives (V)⁽²⁾, of which further cyclization reaction with IV might be resulted in the formation of 1-pyridine derivatives (Ia) as shown in the scheme II. Consequently we believe that the structure of Ia should be 1,2-dihydro-1-(2,6-dimethylphenyl)-2-(2,6-dimethylphenyl)imino-3,4,4a,5,6,7-hexacarbomethoxy-4aH-1-pyridine.

Scheme II



In addition to these 3:2 adducts I-III, 2:3 adducts were also obtained in this reaction. The structure of these compounds is now under investigation and these results will be published in the near future.

References

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- (2) E. Winterfeldt, Angew. Chem. internat. edit., 6, 423 (1967); E. Winterfeldt, D. Schumann and H. J. Dillinger, Chem. Ber., 102, 1656 (1969).
- (3) All compounds reported hereafter showed satisfactory results on elemental analysis and molecular weight determination. Melting points are uncorrected.
- (4) This result will be published in the near future.
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