2-PYRIDONES

VII.* REACTION OF 6-PHENYL-2-PYRIDONE WITH UNSATURATED COMPOUNDS

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6-Phenyl-2-pyridone adds diethyl acetylenedicarboxylate, acrylonitrile, and methyl acrylate to give N-substituted 6-phenyl-2-pyridones.

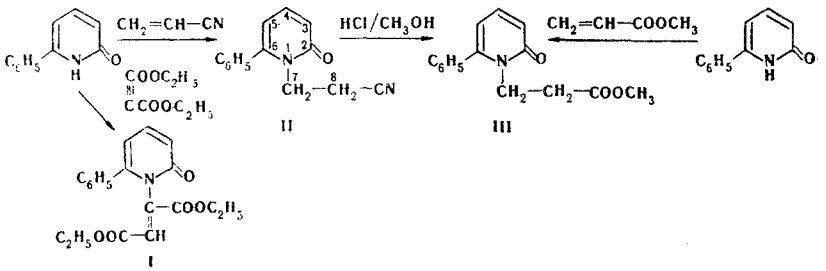
It is known that the reaction of 2-pyridones with unsaturated compounds, the multiple bond of which is activated by conjugation, may proceed either to give a reaction of the Diels–Alder type [2-4] or of the Michael condensation type [2, 5], depending on the structure of the reagents.

6-Phenyl-2-pyridone reacts with diethyl acetylenedicarboxylate to give diethyl 1-(6-phenyl-2-pyridonyl)fumarate (I).

Acrylonitrile and methyl acrylate react with 6-phenyl-2-pyridone to give 1-(β-cyanoethyl)-6-phenyl-2-pyridone (II) and 1-(β-carbomethoxyethyl)-6-phenyl-2-pyridone (III) only in the presence of basic catalysts, of which potassium tert-butoxide gives the best results. No products other than I-III could be detected in these reactions by chromatography.

Absorption of an NH group is absent in the IR spectra of I-III, but the absorption of an amide carbonyl group is observed; the signal of the proton of an NH group is absent in the PMR spectra, but signals of protons of a pyridone ring are present at 6-7.8 ppm. These data confirm the structure of I-III as products of the addition of unsaturated compounds at the nitrogen atom of 6-phenyl-2-pyridone. In analogy with the literature data for adducts of other 2-pyridones with diethyl acetylenedicarboxylate [2, 5], the trans configuration was assigned to ester I.

Ester III (identical to the product of reaction of 6-phenyl-2-pyridone with methyl acrylate) was obtained by acid alcoholysis of nitrile II; ester III was readily converted to 1-(β-carboxyethyl)-6-phenyl-2-pyridone (IV) by alkaline hydrolysis.



EXPERIMENTAL

The IR spectra of mineral-oil suspensions of the compounds were recorded with an IKS-22 spec-

* See [1] for communication VI.

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trometer. The PMR spectra of $CDCl_3$ solutions were recorded with a Varian T-60 spectrometer at 60 MHz and 35° with hexamethyldisiloxane as the external standard.

Diethyl 1-(6-Phenyl-2-pyridonyl)fumarate (I). A solution of 1.7 g (0.01 mole) of 6-phenyl-2-pyridone (mp 196° [6]) and 2.6 g (0.015 mole) of diethyl acetylenedicarboxylate in 30 ml of xylene was refluxed for 20 h. The xylene was then evaporated, and the residue was chromatographed with a column filled with Al_2O_3 in chloroform to give 0.78 g (23%) of ester I with mp 98° (from ether) and R_f 0.5 [chloroform–alcohol (20:1)]. IR spectrum cm^{-1}: 1720 (ester CO), 1660 (amide CO), and 1590-1610 (C=C). PMR spectrum ($CDCl_3$, δ, ppm): 1.2 m* (6H, $-CH_3$), 4.15 m (4H, $-CH_2-$), 6.7 s (1H, vinyl proton), 6.15 d (1H, 3-H), 6.5 d (1H, 5-H), and 7.1-7.8 m (6H, 4-H, and aromatic ring protons). Found, %: C 66.7; H 5.6; M^+ 341.† $C_{19}H_{19}NO_5$. Calculated, %: C 66.9; H 5.6; M 341.

1-(β-Cyanoethyl)-6-phenyl-2-pyridone (II). A mixture of 1.7 g (0.01 mole) of 6-phenyl-2-pyridone, 100 ml of toluene, and 0.06 g of potassium tert-butoxide was heated until the reagents had dissolved completely, after which the solution was cooled slightly, and a solution of 1.1 g (0.02 mole) of acrylonitrile in 5 ml of toluene was added slowly dropwise. The mixture was refluxed for 30 h, and the course of the reaction was monitored by means of TLC. The toluene was removed by vacuum distillation, and the residue was chromatographed with a column filled with aluminum oxide in ethyl acetate to give 1.2 g (53%) of pyridone II with mp 80-81° (from water) and 81-82° (from ether) and R_f 0.5 [chloroform–ethyl acetate (1:1)]. IR spectrum, cm^{-1}: 1665 (amide CO) and 2260 (C≡N). PMR spectra ($CDCl_3$, δ, ppm): 2.6 m (2H, 8-H), 4.1 t (2H, 7-H), 6.2 d (1H, 3-H), 6.6 d (1H, 5-H), 7.7.8 m (6H, 4H, and aromatic ring protons). Found, %: C 74.9; H 5.4. $C_{14}H_{12}N_2O$. Calculated, %: C 75.0; H 5.4.

1-(β-Carbomethoxyethyl)-6-phenyl-2-pyridone (III). A) A solution of 0.5 g (2.2 mmole) of 1-(β-cyanoethyl)-6-phenyl-2-pyridone in 20 ml of absolute methanol was saturated with dry hydrogen chloride as the mixture was cooled with ice. It was then allowed to stand overnight, and 0.1 ml of concentrated H_2SO_4 was added. The mixture was then refluxed for 30 min, after which it was cooled, and the alcohol was removed by vacuum distillation. The residue was neutralized with 2 N aqueous sodium carbonate and extracted with ether. The ether solution was dried with magnesium sulfate. The solvent was removed, and the residual mass began to crystallize after standing for 24 h in a refrigerator to give 0.34 g (60% yield) of III with mp 58-59° (from ether) and R_f 0.65 [ethyl acetate–chloroform (1:1)]. IR spectrum, cm^{-1}, 1665 (amide CO) and 1745 (ester CO). Found, %: C 70.0; H 5.7. $C_{15}H_{15}NO_3$. Calculated, %: C 70.0; H 5.9.

B) A 0.08-g sample of potassium tert-butoxide and (slowly with stirring) a solution of 2.2 g (25 mmole) of methyl acrylate in 8 ml of toluene were added to a solution of 2 g (12 mmole) of 6-phenyl-2-pyridone in 250 ml of toluene. The mixture was stirred and refluxed for 35 h, and the course of the reaction was monitored by TLC. The toluene was removed by vacuum distillation, and the residue was dissolved in ethyl acetate and chromatographed with a column filled with aluminum oxide to give 0.5 g (16%) of pyridone III with mp 58-60° (from ether). No melting point depression was observed for a mixture of this product with a sample of ester obtained by acid alcoholysis of nitrile II.

1-(β-Carboxyethyl)-6-phenyl-3-pyridone (IV). A 0.3-g (1.2 mmole) sample of 1-(β-carbomethoxyethyl)-6-phenyl-2-pyridone was dissolved in 2 ml of aqueous sodium hydroxide, and the solution was acidified after 10 min to pH 2 with concentrated HCl. The precipitated crystals of IV [0.22 (80%)] were recrystallized from water and vacuum dried over P_2O_5 at 110° to give a product with mp 134-135° (from water). IR spectrum, cm^{-1}: 1665 (amide CO) and 1710 (acid CO). Found, %: C 69.1; H 5.4. $C_{14}H_{15}NO_3$. Calculated, %: C 69.1; H 5.4.

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* The following abbreviations are used here and subsequently: s is singlet, d is doublet, t is triplet, and m is multiplet.

† The mass spectrum was recorded with an MKh-1303 spectrometer.