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BASE CATALYZED CONDENSATION OF ACETONE WITH 3-PYRROLIN-2-ONE: DIRECT INTRODUCTION OF A SUBSTITUTED VINYL GROUP INTO THE LACTAM RING

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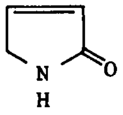
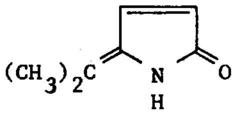
The chemistry of 2-pyrrolinones is interesting because of the presence of these unsaturated lactam ring system in some antibiotics (Holomycin, Althiomycin, etc.) and in bile pigments as terminal groups[1]; they are also involved in the tentative synthesis of some pyrrole macrocycles[2]. Recent studies on monocyclic pyrrolinones show that the endocyclic double bond may assume a Δ^3 or a Δ^4 position depending on the nature and the position of the ring substituents[3]. The tautomeric hydroxypyrrole structure does not occur, although the compounds may react in some cases in the enolic form[4].

The ready preparation of 2-pyrrolinone (I) in our laboratories by the oxidation of pyrrole with hydrogen peroxide[5] led us to the study of some aspects of its chemical reactivity. In this communication we report the unexpected results obtained by reacting (I) with acetone: if equimolecular quantities were reacted at room temperature in the presence of a trace of ethanolic KOH, after neutralization with 2N HCl, 5-isopropyliden-3-pyrrolin-2-one (II) (m.p. 190°C, λ_{max}^{MeOH} 298 mμ, IR, NMR, mass spectrum and analysis in agreement with the proposed structure) was isolated together with a second product (III), the structure of which was based on the following data (ν_{OH} 3500, ν_{NH} 3220 and ν_{CO} 1690 cm^{-1}; M$^+$ at *m/e* 181; NMR (60 MHz, $CDCl_3$) 1.5 (s, 6H), 1.98 (s, 6H), 4.3 (broad, OH), 9.7 (broad, NH) and 6.9 (d, J = 1.5 cps, 1H) ppm (δ); by adding D_2O the peaks at 4.3 and 9.7 ppm disappeared and that at 6.9 ppm became decoupled from the amidic proton).

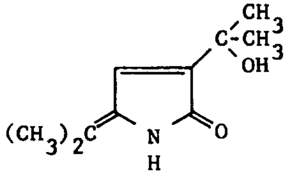
If the same condensation reaction was carried out at higher temperature in the presence of an excess of acetone and KOH, a yellow crystalline substance (IV), m.p. 175°, was obtained, with minor quantities of (II) and (III) (about 50, 20 and 15% respectively). The structure (IV) was assigned on the basis of the following evidence:



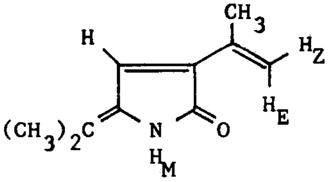
(I)



(II)



(III)

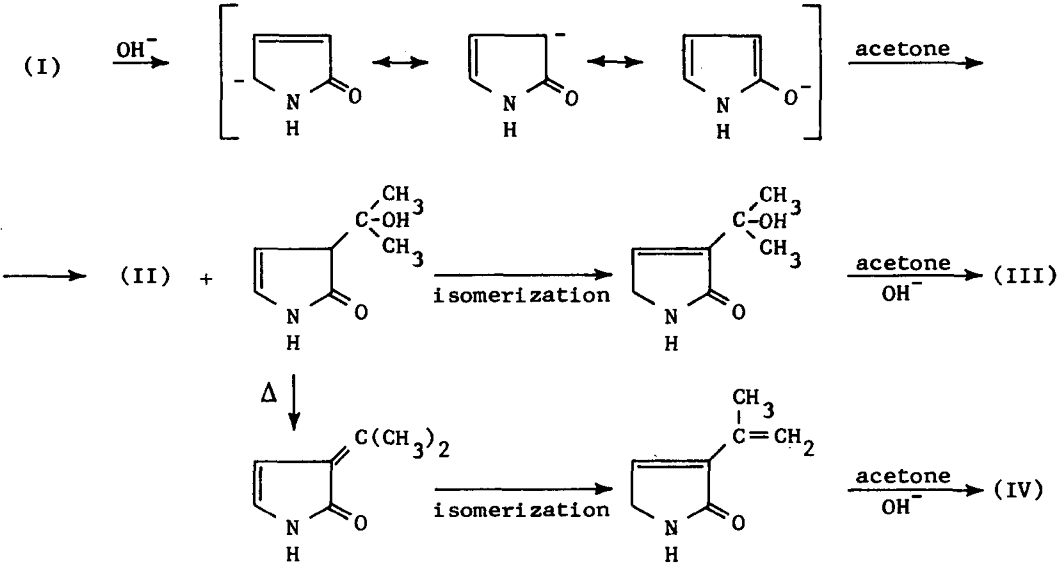


(IV)

(a) the analysis and mass spectrum suggest the formula $C_{10}H_{13}NO$; *(b)* by catalytic hydrogenation, in mild conditions, three moles of hydrogen were absorbed giving 95% of 3,5-di-isopropyl-2-pyrrolidinone, m.p. 90° (this structure was confirmed by spectroscopic techniques); *(c)* high yields of acetone and formaldehyde were obtained by ozonolysis (t.l.c. and mixed m.p. with authentic samples of their phenylhydrazones); *(d)* λ_{max}^{MeOH} 310mμ: the small bathochromic shift with respect to the absorption of (II) is not consistent with a double bond extending the chromophore of (II); *(e)* NMR (60 MHz, $CDCl_3$) shows a narrow multiplet at 2·05 ppm (δ) integrated for nine protons (three methyl groups) and other absorption at 5·27 ppm (broad singlet, H_Z), 6·38 ppm (d, H_E, $J_{H_E H_Z}$ = 2·25 cps), 7·0 ppm (d, H_4, $J_{H_4 H_M}$ = 1·6 cps) and 9·9 ppm (broad, H_M); as the anisotropic effect from

the carbonyl group is expected to cause a greater deshielding of H_E that of H_Z, the former is found at a lower field. Quite similar NMR spectrum has been very recently reported for 3-(2-propenyl)-3-thiolen-2-one[6].

The behaviour of (IV) with acetone could be explained by the following hypothesis (it should be noted that neither (II) nor (III) react further under the conditions that gave (IV):



Similar products were isolated from the reaction of (I) with cyclopentanone, cyclohexanone and 4-methyl-cyclohexanone.

Attempts to obtain the system with an unsubstituted vinyl group by the reaction of (I) with acetaldehyde failed.

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