

The Formation of Pyrrolinones and 2-Dialkylaminofurans from γ -Oxoamides

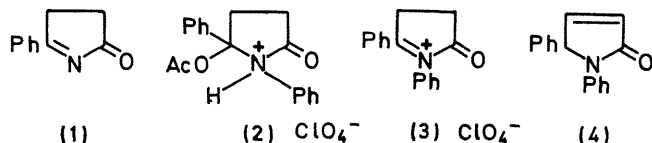
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Summary γ -Oxobutyramides were cyclised in the presence of acetic anhydride-perchloric acid into a variety of cyclic immonium salts, some of which were converted into pyrrolinones or 2-dialkylaminofurans; the chemistry of a typical 2-dialkylaminofuran is reported.

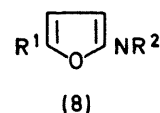
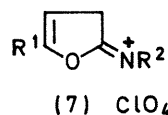
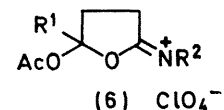
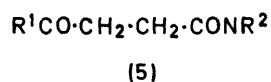
THE action of acetic anhydride-perchloric acid on compounds of the general formula $\text{OC}\cdot\text{X}\cdot\text{Y}\cdot\text{CO}$ gives a variety of heterocyclic cations containing oxygen: 1,3,4-oxadiazolium salts are obtained from diacylhydrazines,¹ 5-oxo-oxazolium salts from α -acylamino-acids,² and isoimidium salts from amic acids.³ When the reagent was applied to amides of γ -oxocarboxylic acids we found that the type of product formed depended on the structure of the amide and reaction conditions.

Addition of perchloric acid to a suspension of β -benzoylpropionamide in acetic anhydride yielded an unstable oily perchlorate which on treatment with triethylamine gave the phenylpyrrolinone (1), m.p. 112°, ν_{max} 1685 and 1595 cm^{-1} , n.m.r. (CDCl_3) τ 6.56 and 6.65 (AA'BB', 2 CH_2 , J 4 Hz) and aromatic protons. Since simple Δ^1 -pyrrolin-5-ones are difficult to obtain⁴ we intend to study the scope of this synthesis further. Treatment of the secondary amide, β -benzoylpropionanilide, with acetic anhydride-perchloric acid gave a perchlorate of m.p. 88–89° (decomp.), whose i.r. (3200, 3050, 1780, 1710, 1610, and 1100 cm^{-1}) and n.m.r. spectra [($\text{CF}_3\cdot\text{CO}_2\text{H}$) τ 7.70 (s, Me), 6.20 and 6.61 (AA'BB', 2 CH_2), 2.45 (s, N-Ph), and 1.8–2.4 (m, C-Ph)] are consistent with formula (2). When a solution of this salt in acetic acid was briefly heated to 100° the elements of acetic acid were lost and the oxopyrrolinium perchlorate (3), [m.p. 151°, ν_{max} 1825, 1590 and 1100 cm^{-1} , n.m.r. ($\text{CF}_3\cdot\text{CO}_2\text{H}$) τ 5.73 and 6.59 (AA'BB', 2 CH_2 , J 2 and 5 Hz), and 2.4 (m, N-Ph and C-Ph)] was formed. Deprotonation of the latter with triethylamine gave 1,5-diphenyl- Δ^3 -pyrrolin-2-one (4), m.p. 167–168°, ν_{max} 1685 and 1595 cm^{-1} , n.m.r. (CDCl_3) τ 3.7 (H-4), 4.29 (H-5) (J_{34} 5.8 Hz, J_{45} 1.7 Hz), 2.75 (s, N-Ph), and 2.7 (m, C-Ph). The signal of H-3 was submerged in the aromatic envelope.



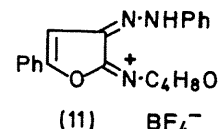
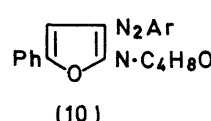
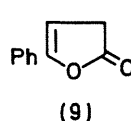
The action of acetic anhydride-perchloric acid on tertiary γ -oxoamides was studied in detail. *N*- β -Benzoylpropionylmorpholine (5a) yielded the acetoxy-compound (6a), m.p. 153°, ν_{max} 1780, 1715, and 1100 cm^{-1} , n.m.r. ($\text{CF}_3\cdot\text{CO}_2\text{H}$) τ 7.72 (s, Me), 6.12 and 6.60 (AA'BB', 2 $\times \text{CH}_2$), 5.8 (AA'BB', 4 $\times \text{CH}_2$, morpholino), and 1.8–2.6 (m, Ph), when the reaction was conducted at 0–5°; but at 20–25° the unsaturated perchlorate (7a), m.p. 173–174° (decomp.), ν_{max} 1720, 1655, and 1100 cm^{-1} , n.m.r. ($\text{CF}_3\cdot\text{CO}_2\text{H}$) τ 5.69 (4 $\times \text{CH}_2$, morpholino), 5.81 (CH_2), 3.80 (=CH) (ABX),

and 2.5 (m, Ph), was formed. The acetate (6a) was converted into the salt (7a) in hot acetic acid. Analogous unsaturated perchlorates (7b), m.p. 148–150° (decomp.),

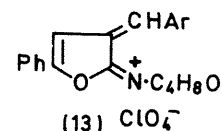
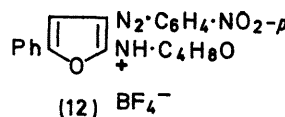


a; NR^2 = morpholino, R^1 = Ph
 b; NR^2 = piperidino, R^1 = Ph
 c; NR^2 = morpholino, R^1 = *p*- ClC_6H_4
 d; NR^2 = morpholino, R^1 = *p*- $\text{MeO}\cdot\text{C}_6\text{H}_4$
 e; NR^2 = morpholino, R^1 = Me

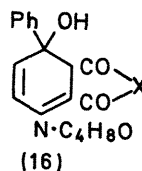
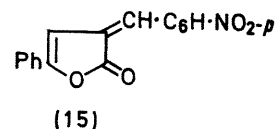
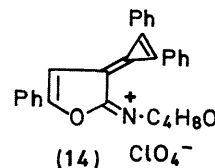
(7c), m.p. 159–161° (decomp.), and (7d), m.p. 165° (decomp.) were obtained by treatment of the tertiary amides (5b–d), respectively, with acetic anhydride-perchloric acid at 20–25°. The aliphatic morpholide (5e), on the other



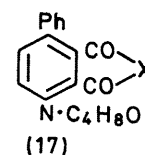
a; Ar = Ph
 b; Ar = *p*- $\text{NO}_2\cdot\text{C}_6\text{H}_4$



a; Ar = Ph
 b; Ar = *p*- $\text{MeO}\cdot\text{C}_6\text{H}_4$
 c; Ar = *p*- $\text{Me}_2\text{N}\cdot\text{C}_6\text{H}_4$



a; X = O
 b; X = NPh



† Satisfactory analytical and spectroscopic data were obtained for all new compounds.

hand, yielded the acetoxy-compound (**6e**), m.p. 105–106° (decomp.), at 0° and 30°; the corresponding propionate, m.p. 93–94° (decomp.), was formed in the presence of propionic anhydride–perchloric acid. These salts could not be converted into the unsaturated perchlorate (**7e**) under any conditions tried.

The perchlorate (**7a**) readily lost the elements of perchloric acid on treatment with triethylamine to give 2-morpholino-5-phenylfuran (**8a**), m.p. 72–73°, ν_{\max} 1610, 1590, 1580, 1550, and 1120 cm^{-1} , n.m.r. (CDCl_3) τ 3.48 (H-3) and 4.78 (H-4) (AB, $J_{3,4}$ 4 Hz), 6.16 and 6.82 (AA'-BB', $4 \times \text{CH}_2$, morpholino), and 2.4–2.84 (m, Ph); the piperidino-analogue (**8b**), m.p. < 20°, and the morpholinofurans (**8c**), m.p. 106–107°, and (**8d**), m.p. 102°, were obtained similarly. Salts of type (**6**) do not behave in such a simple manner towards triethylamine; compound (**6a**) yielded a mixture of the furan (**8a**) and the oxo-amide (**5a**), while only the morpholide (**5e**) could be isolated from the reaction of the perchlorate (**6e**) with a number of bases.

2-Dialkylaminofurans have been prepared previously by the action of secondary amines on activated 2-halogenofurans.⁵ We have investigated the reactions of the morpholinophenylfuran (**8a**) and its hydroperchlorate (**7a**). The furan is stable towards boiling aqueous alkali but is easily hydrolysed by dilute acids into the butenolide (**9**); the same compound is formed by the action of water on the perchlorate (**7a**). The furan behaves as a typical enamine in its reactions with diazonium salts yielding the azo-compounds (**10a**), orange, m.p. 146–147° (decomp.), and (**10b**), green, m.p. 230–231°, when treated with benzenediazonium

and *p*-nitrobenzenediazonium fluoroborate, respectively, in the presence of triethylamine. In the absence of the base the corresponding fluoroborates (**11**), red, m.p. 274–275° (decomp.), and (**12**), orange, m.p. 261–262° (decomp.), are obtained. The assignment of the site of protonation in the salts is as yet only tentative and based on their visible light absorption. The perchlorate (**7a**) readily condensed with benzaldehyde, anisaldehyde, *p*-dimethylaminobenzaldehyde, and diphenylcyclopropenone to yield the salts (**13a**), red, m.p. 236–237° (decomp.), (**13b**), red, m.p. 233–234° (decomp.), (**13c**), green, m.p. 258–259°, and (**14**), orange, m.p. 227–228° (decomp.), respectively. Reaction with *p*-nitrobenzaldehyde was accompanied by hydrolysis to give the butenolide (**15**).

The morpholinofuran, unlike simple enamines,⁶ did not function as a dipolarophile towards diphenylnitrilimine and *p*-nitrophenyl azide, being recovered after treatment with these reagents. On the other hand, its role as a 1,3-diene in Diels–Alder reactions is that of a typical furan: it reacted with maleic anhydride at room temperature but the initial adduct readily rearranged to yield a yellow hydroxy-anhydride, m.p. 230–232°, tentatively assigned structure (**16a**); with *N*-phenylmaleimide the analogue (**16b**), yellow, m.p. 177–179°, was obtained. These compounds were dehydrated in boiling acetic anhydride to yield the yellow phthalic anhydride (**17a**), m.p. 248°, and the yellow phthalimide (**17b**), m.p. 179–180°, respectively.

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