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PHOTOCHEMICAL REACTIONS OF PYRAZINE-N-OXIDES

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An extensive investigation on the photochemical reactions of quinoline-N-oxides has been made by Ishikawa, Kaneko et al. (1), demonstrating that the reaction goes via an oxazirane ring as the intermediate. A recent report on the ring contraction of pyridine- and α-picoline-N-oxides by photolysis (2) prompted publication of the present communication.

A benzene suspension of 2, 5-dimethylpyrazine-N-oxide (Ia), stirred by a stream of nitrogen, was irradiated with ultraviolet light* at room temperature for 5 hrs. and the products separated by alumina chromatography. Fifty percent of the starting material was recovered from the benzene fraction. Compound IIa, m. p. 111-113° from the ether fraction, and compound IIIa, m. p. 91-92°, from the 5% methanol-ether fraction, were obtained in yields of 5% and 15%, respectively, from the chromatography. The structure of compound IIa, $C_6H_8ON_2$**, was determined to be 2-acetyl-4-methylimidazole by the following spectral data; λ_{max} (MeOH) 290 mμ (log e, 4. 1); ν_{max}(CHCl$_3$) 3350 (NH), 1680 cm^{-1} (acetyl); n. m. r., δ_{TMS}(CDCl$_3$) 2. 64 (3H), 2. 34 (3H), 7. 01 ppm (1H); mass spectrum, m/e 124 (M$^+$). Compound IIIa, $C_5H_8N_2$, λ_{max} (MeOH) 213 (log e, 3. 8),

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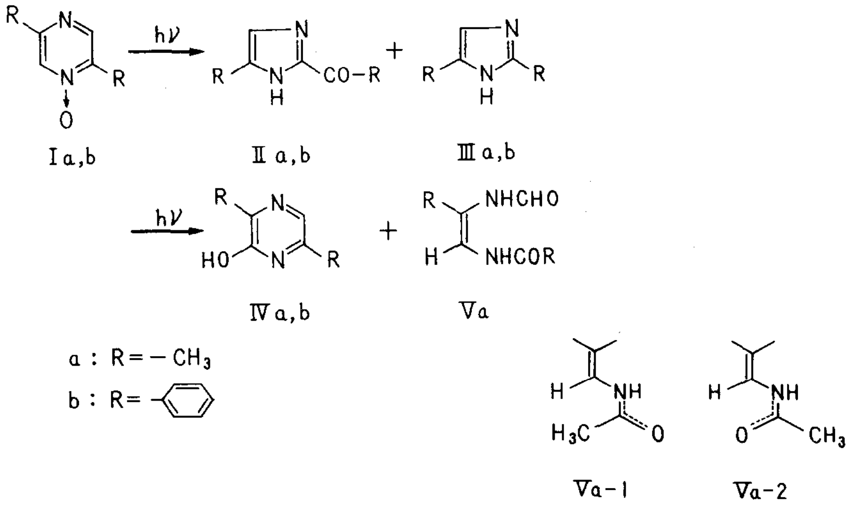
* A high pressure mercury lamp (100 W) of Ushio Electric Inc. was used in this study. A Pyrex filter was used to eliminate irradiation shorter than 280 mμ.

** All the compounds described gave satisfactory analytical values.

267 mμ (log e, 2.11); n.m.r. 2.36 (3H), 2.20 (3H), 6.61 ppm (1H); mass spectrum m/e 96 (M^+), gave a picrate, m.p. 143°. Compound IIIa was shown to be 2,4-dimethylimidazole by the spectral data and by the identity of the melting points of base and picrate with those previously reported (3).

When the irradiation of Ia was carried out in water solution, subsequent silica gel chromatography gave 20% yield of recovered starting material in the 2% methanol-benzene fraction, 10% yield of 2-hydroxy-3,6-dimethylpyrazine (IVa), m.p. 208-210°, which was identified by direct comparison with an authentic specimen (4), and 20% yield of compound Va, m.p. 109-112°. The structure of Va, $C_6H_{10}O_2N_2$, was suggested to be 1-acetylamino-2-formylamino-1-propene by the spectral data: λ_{max}(MeOH) 252 mμ (log e, 4.16); ν_{max} (KBr) 1730 (NHCHO), 1692, 1655 cm^{-1} (NHAc). The structure was also confirmed by the n.m.r. spectrum: 1.85s(3H), 1.99s(3H), 2.04s(3H), 2.08s(3H)(-NHCOC$\underline{H}_3$ and C=C-C$\underline{H}_3$); 6.13d(1H, 11 cps), 6.30d(1H, 10 cps)(C=C-$\underline{H}$); 8.06d(1H, 2 cps), 8.34d(1H, 11 cps)(-NHC$\underline{H}$O). The presence of two signals corresponding to each type of proton may be due to a equilibrated mixture such as Va-1 and Va-2.



Ultraviolet irradiation of 2,5-diphenylpyrazine-N-oxide (Ib), m.p. 193-195° (5), in benzene solution gave 3% of benzene insoluble material, m.p. 246° (sublim.); λ_{max} (MeOH) 262 (log e, 4.0), 360 mμ (log e, 4.25); ν_{max}(KBr) 1640 cm^{-1}, which was identical with an authentic specimen of 2, 5-diphenyl-6-hydroxypyrazine (IVb) (6). From the benzene solution, 50% of 2, 5-diphenylpyrazine (benzene fraction), 29% of compound IIIb (10% ether-benzene fraction) and 5% of compound IIb (ether fraction) were obtained in crystalline form by alumina chromatography. The compound IIIb had m. p. 160°, $C_{15}H_{12}N_2$, λ_{max}(MeOH), 297 mμ (log e, 4. 36), mass spectrum m/e 220 (M^+); picrate, m. p. 192° (needles), $C_{21}H_{15}O_7N_5$. These data coincided with those for 2, 5-diphenylimidazole reported previously (3) (7). Compound IIb, m. p. 192-194°; λ_{max}(MeOH) 255 (log e, 4. 18), 335 mμ (log e, 4. 08); ν_{max} (KBr) 3320 (NH), 1620 cm^{-1} (C=O), was identical with an authentic specimen of 2-benzoyl-4-phenylimidazole prepared by the method of Gallagher (6).

It is very interesting that different irradiation products were obtained in nonpolar and polar solvents. In the case of quinoline-N-oxide, only one oxazirane ring formation should occur at the first step (1). However, in pyrazine-N-oxide, and also probably in the case of pyridine derivative, two kinds of oxazirane compounds can be formed. Therefore, two reaction paths should exist. In benzene solution the two oxazirane compounds thus formed by irradiation may give two kinds of 2, 5-diazaoxepine, VI and VII, by valence bond tautomerism (8). Intermediates VI and VII may be stabilized by forming II and III. A similar reaction mechanism was reported by Streith and Sigwalt (2) in the photochemical reaction of pyridine- and α-picoline-N-oxides in an inert solvent.

On the other hand, in polar solvents such as water, the N-O bond of the oxazirane ring may be cleaved heterolytically and form the epoxy isomer VIII. From both oxazirane compounds, the same epoxy isomer may be formed. Product IV may arise from VIII or the original oxazirane. Diazaoxepine IX, which is a valence bond tautomer of VIII, may be hydrated at the less hindered N=C bond, and upon ring opening Va may be formed***. Another possible mechanism for the formation of Va is the hydrolysis of 1-acetyl-4-methyl-

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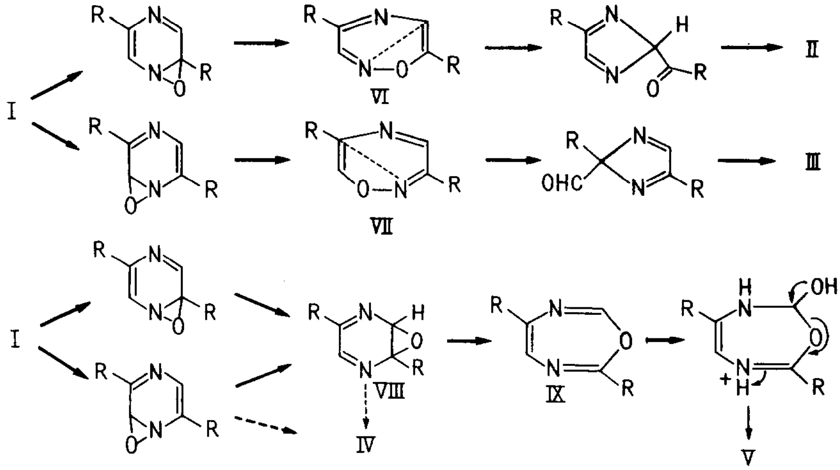
***A similar reaction mechanism for the photochemical reaction of several quinoxaline-N-oxides has been suggested by C. Kaneko and M. Ishikawa et al. The authors thank them for sending us the manuscript before publication. C. Kaneko, S. Yamada and I. Yokoe, Tetrahedron Letters, in press. C. Kaneko, I. Yokoe, S. Yamada and M. Ishikawa, Chem. Pharm. Bull., in press. One of the referees has suggested compounds II and III may also be formed from intermediate VIII.

imidazole (X) during the isolation procedure. This can be rejected because hydrolysis of X did not occur under these conditions.



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