Triazolines IX. A New Ring Transformation Reaction of a 4,5-Acyl-substituted-1,2,3-triazoline: A New Route to the Synthesis of Enamine and Pyrrolidine Ketones (1)

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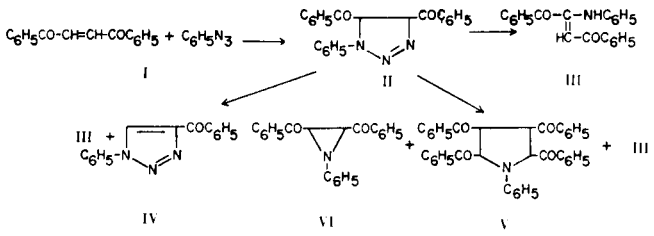
A new ring transformation reaction of a 4,5-dibenzoyl-1,2,3-triazoline, which appears to involve nitrogen expulsion followed by a C-N proton shift, is described. The reaction affords a new route to the synthesis of enaminodiketones and tetraacylpyrrolidines, *via* triazoline intermediates.

J. Heterocyclic Chem., 13, 1153 (1976).

Sir:

Four major decomposition paths of the 1,2,3-triazoline molecule have been recorded (2). Thermal decomposition involves expulsion of nitrogen, often followed by a hydride shift, and leads to mixtures of aziridine and imine products. Photolysis is more selective and yields predominantly the aziridines. Acid-induced decompositions lead to a wide variety of products such as acid cleavage products of aziridines, amines, aldehydes, and ketones, arising from the initially formed 2-aminoalkyldiazonium ions. Bases induce triazolines bearing acyl, carbalkoxy and nitrile groups at the 4-position to give the isomeric ring-opened diazo compounds. The different decomposition paths provide useful routes to the synthesis of azomethines, carbonyl and aziridine compounds (2,3). We report here a new ring transformation reaction of a 4,5-acyl-substituted-1,2,3-triazoline, which appears to involve nitrogen expulsion followed by a C-N proton shift. The reaction opens up a new route to the synthesis of enaminodiketones and tetraacylpyrrolidines.

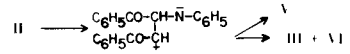
The reaction of phenyl azide with trans-1,2-dibenzoylethylene (I) in methanol at room temperature, gave after 45 days, the enamino-1,4-diketone (III) (4) [m.p. 126-127°, M^+ 327, δ 12.48 (broad, NH), 8.03-7.70 (4 doublets, 4 ArH), 7.50-7.10 (m, 6 ArH), 7.10-6.84 (m, 5 ArH) and 6.09 (s, CH)]. The nmr spectrum of the crude reaction mixture indicated exclusive formation of III. In benzene, at room temperature after 18 days, in addition to III, an equal amount of a second compound, whose structure was elucidated by spectroscopic methods to be that of a 4-benzoyl-1,2,3-triazole (IV), was also obtained [m.p. 125-126°, M^+ 249, δ 9.54 (s, 5-CH), 8.20 (m, 2H), 7.94 (m, 2H) and 7.59 (m, 6H)]. The formation of IV is clear indication that the reaction of phenyl azide with I proceeds *via* the 1,3-cycloadduct, 1-phenyl-4,5-dibenzoyl-1,2,3-triazoline (II), formed *in situ*. When there was no solvent present, III was again accompanied by IV. The triazoline (II), comparatively more stable in the absence of the protic solvent methanol with high dielectric constant (2), eliminates the elements of benzaldehyde and gives the resonance-stabilized triazole (IV). Other examples of triazole formation from triazolines by loss of stable molecules are known (5)



In methanol, when heated under reflux for 20 hours or less, the reaction yielded a mixture of III and the pyrrolidine derivative (V) [m.p. 166-167°, δ 8.03-7.83 (2 doublets, 4H), 7.70-6.36 (m, containing two doublets at the low field shoulder end, 21 H), 6.19 (dd, 2-CH and 5-CH) and 4.62 (dd, 3-CH and 4-CH)], always present in a 1:1 ratio, along with very minor amounts of the aziridine (VI). In the presence of a few drops of phenylhydrazine, however, the reaction took a more selective course to yield III as the major product, along with only 8% of V and traces of VI as before. The same results could also be

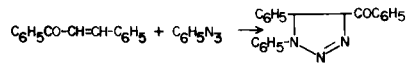
obtained by using undistilled phenyl azide, which usually contains traces of phenylhydrazine as an impurity. By employing the latter procedure, it was possible to prepare the pure enamino-1, 4-diketone in almost 50% yield.

The results indicate that at room temperature, only in the protic solvent methanol, there is exclusive formation of III. In benzene, both III and IV are formed. Compound V is obtained only when the reaction mixture is heated, and it is greatly reduced by traces of phenylhydrazine. From all of these observations, it appears very likely that loss of nitrogen generates the zwitterionic 1,3-dipole (VII) and that the latter achieves stabilization from the presence of an additional negative substituent, the acyl group on the 5-position of II, which induces a C-N proton shift leading to the formation of enamine (III). (A hydride shift which would result in imine formation is completely suppressed).



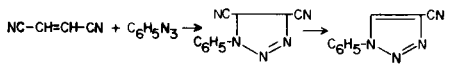
VII

Hydrogen bonding interactions between the β-carbonyl oxygen and the amino hydrogen also seem to play an important role in facilitating enamine formation. In the absence of a 5-acyl group, C-N proton migration should become less favored and indeed the reaction of benzalacetophenone and phenyl azide in methanol at room temperature yields the stable 1,2,3-triazoline (VIII) as the sole reaction product (6). The exclusive formation of 4-cyano-



VIII

triazole (IX) and the complete absence of an enamine in the reaction of fumaronitrile and phenyl azide (5,6), may also be explained in terms of the loss of the negative group

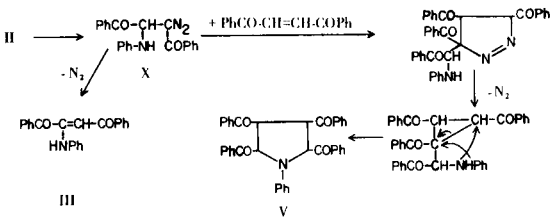


IX

at the 5-position of the triazoline molecule, as elimination of the elements of hydrogen cyanide involving the 5-cyano group apparently proceeds faster than nitrogen expulsion. However, enamines are formed in the reaction of certain heterocyclic azides with fumaric and maleic acids (7). A full account of the action of aryl azides with the various negatively substituted ethylenes will be published at a later date.

At higher temperatures, there is equal opportunity for the zwitterionic 1,3-dipole (VII) to rearrange to give III or be trapped by I to yield V. Ring closure to VI is also possible. This mechanism would also explain the predominance of III in the presence of phenylhydrazine, the base apparently assisting the C-N proton migration leading to III.

The possibility of the dibenzoylethylene reacting with III at elevated temperatures to give V was also examined, but found negative. Likewise, the formation of compounds (III) and (V) from the diazo compound (X), which, in turn, could arise by an isomeric ring opening of II, was



III V

also considered. However, it was not possible to detect any X in any of the reaction mixtures in either methanol or benzene at room temperature. If formed at all, it appears to be too labile for a trapping reaction with I at higher temperatures. Also, diazoketones are known to be very sluggish in cycloaddition reactions (8).

REFERENCES AND NOTES

(1) This is Part 10 in "Heterocyclic Synthesis *via* 1,3-Cycloaddition Reactions". For Part 9, see P. K. Kadaba, *J. Org. Chem.*, 41, 1073 (1976).

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(4) All compounds were identified by elemental analyses, nmr and mass spectra.

(5) R. Huisgen, G. Szeimies, and L. Moebius, *Chem. Ber.*, 99, 475 (1966).

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