Russian Journal of General Chemistry, Vol. 73, No. 6, 2003, pp. 985–987. Translated from Zhurnal Obshchei Khimii, Vol. 73, No. 6, 2003, pp. 1041–1043.

Heterocyclization of 6-*tert*-Butyl-3-hydrazino-2,5-dihydro-1,2,4-triazin-5-one with Benzoyl Chloride and Formic Acid

L. M. Mironovich and M. A. Ivanov

Sumy State University, Sumy, Ukraine

Received May 21, 2001

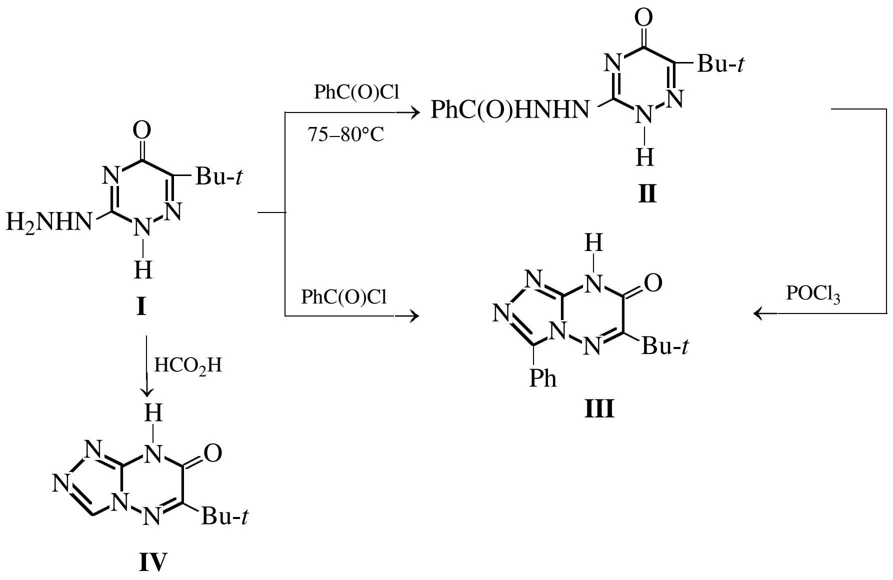
Abstract—Reaction of 6-*tert*-butyl-3-hydrazino-2,5-dihydro-1,2,4-triazin-5-one with excess benzoyl chloride or formic acid afforded 6-*tert*-butyl-[1,2,4]triazolo[4,3-*b*][1,2,4]triazin-7(8*H*)-ones.

Reactions of substituted 5-hydrazino-2,3-dihydro-1,2,4-triazin-3-ones with carbonyl compounds were studied in [1]. The present communication describes the behavior of 6-*tert*-butyl-3-hydrazino-2,5-dihydro-1,2,4-triazin-5-one (**I**) in reactions with formic acid and benzoyl chloride. We have found that, unlike 5-hydrazino derivatives, 3-hydrazinodihydrotriazin-5-ones undergo heterocyclization at the N^2 atom of the triazine ring to give a bicyclic system. Initial compound **I** was synthesized by reaction the of 6-*tert*-butyl-3-thioxo-2,3,4,5-tetrahydro-1,2,4-triazin-5-one with hydrazine according to the procedure reported in [2].

Heating of a mixture of compound **I** with excess benzoyl chloride to 75–80°C resulted in acylation of the amino group in the hydrazine moiety with formation of 6-*tert*-butyl-3-benzoylhydrazino-2,5-dihydro-1,2,4-triazin-5-one (**II**). The reaction follows the nucleophilic substitution pattern. The reactivity of the hydrazine fragment is reduced due to the electron-acceptor effect of the triazine ring; therefore, the reaction requires a long time to be complete.

The presence of nucleophilic centers in molecule **II** (endocyclic nitrogen atoms) provides the possibility for subsequent intramolecular nucleophilic attack by N^2 on the electrophilic carbonyl carbon atom with formation of a tetrahedral intermediate; elimination of a water molecule from the latter could give a bicyclic system. However, the cyclization does not occur at 78–80°C. Therefore, the reaction of **I** with excess benzoyl chloride was carried out under more severe conditions, i.e., on heating under reflux. As a result, we isolated 7-*tert*-butyl-3-phenyl[1,2,4]triazolo[4,3-*b*]-[1,2,4]triazin-7(8*H*)-one (**III**).

Compound **III** was also synthesized by treatment of **II** with phosphoryl chloride in an inert solvent on



1070-3632/03/7306-0985 $25.00 © 2003 MAIK “Nauka/Interperiodica”

heating under reflux. By heating compound **I** in boiling formic acid we obtained 7-*tert*-butyl[1,2,4]triazolo[4,3-*b*][1,2,4]triazin-7(8*H*)-one (**IV**). Presumably, the process includes initial formylation at the hydrazino group with formation of the corresponding formylhydrazino derivative which was not isolated from the reaction mixture.

It is known [3] that 3-hydrazino-1,2,4-triazin-5-one can exist as several tautomeric forms. Probably, under the reaction conditions, the predominating tautomer is 2,5-dihydro-1,2,4-triazin-5-one where the electron density on N^2 is considerably greater than on N^4; Therefore, the ring closure occurs at the N^2 atom.

The presence in the initial triazine molecule of several nucleophilic centers, ring nitrogen atoms and amino group of the hydrazine moiety, could give rise to a number of acylation products. According to [4], sp^3-hybridized nitrogen atoms possess increased electron density and are more nucleophilic than sp^2-hybridized nitrogen atoms. Taking into account the different hybrid states of the hydrazine amino group and N^2 (sp^3), on the one hand, and nitrogen atoms in positions *1* and *4* of the heteroring (sp^2), the acylation should involve the amino group or N^2. The nucleophilicity of the amino nitrogen atom is higher than that of N^2 due to the α-effect intrinsic to amino group; therefore, the reaction occurs at the amino group. This is confirmed by the presence in the ^{1}H NMR spectrum of the product of a singlet at δ 12.67 ppm, belonging to the NH group.

Compounds **II**–**IV** are colorless crystalline substances which are insoluble in water but soluble in oxygen-containing organic solvents. Their structure was confirmed by the data of elemental analysis and ^{1}H NMR, IR, and mass spectra.

The ^{1}H NMR spectra of compounds **II** and **III** contain a multiplet signal at δ 7.53–7.94 and 7.33–7.73 ppm, respectively, from protons of the phenyl group and a singlet at δ 1.28–1.34 ppm from the *tert*-butyl group. Protons of the hydrazino group in **II** give singlets at δ 9.3 and 10.48 ppm, and the singlets at δ 12.67 and 9.01 ppm in the spectra of **II** and **IV**, respectively, belong to the ring NH protons. In the spectrum of **IV** we also observed a singlet from 3-H at δ 1.9 ppm. The carbonyl absorption band appears in the IR spectra at 1714 (**III**) and 1590 cm^{-1} (**IV**). The mass spectrum of **III** contains the molecular ion peak with *m*/*z* 269.

EXPERIMENTAL

The IR spectra were recorded on a UR-10 instrument from samples pelleted with KBr. The ^{1}H NMR spectra were obtained on a Tesla BS-487B spectrometer operating at 80 MHz; HMDS was used as internal reference. The mass spectrum was recorded on an MS-1302 spectrometer. The purity of the products was checked by TLC on Silufol UV-254 plates using chloroform–acetone–benzene (1 : 3 : 1) as eluent.

3-Benzoylhydrazino-6-*tert*-butyl-2,5-dihydro-1,2,4-triazin-5-one (II). A mixture of 0.92 g of compound **I** and 10 ml of benzoyl chloride was heated for 5 h at 75–80°C. The mixture was cooled, and the precipitate was filtered off, dried in air, and recrystallized from a 1 : 2 2-propanol–water mixture. Yield 1.2 g (84%), mp 223–224°C. IR spectrum, ν, cm^{-1}: 1665, 1725 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.28 s (9H, *t*-Bu), 7.53–7.94 m (5H, Ph), 9.3 s (1H, NH), 10.48 s (1H, NH), 12.67 s (1H, NH). Found, %: C 58.5; H 6.0; N 24.4. $C_{14}H_{17}N_5O_2$. Calculated, %: C 58.52; H 5.96; N 24.37.

6-*tert*-Butyl-5-phenyl[1,2,4]triazolo[4,3-*b*][1,2,4]-triazin-7(8*H*)-one (III). *a.* A solution of 0.37 g of compound **I** in 10 ml of benzoyl chloride was heated for 5 h under reflux. The mixture was cooled, and the precipitate was filtered off, dried in air, and recrystallized from a 1 : 2 2-propanol–water mixture. Yield 0.4 g (74%), mp 248–249°C. IR spectrum, ν, cm^{-1}: 1714 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.34 s (9H, *t*-Bu), 7.33–7.77 m (5H, Ph). Mass spectrum, *m*/*z*: 269 $[M]^+$, 254, 240, 226, 214, 199, 187, 173, 164, 146, 138, 129, 113, 104, 96, 77, 68, 57, 41. Found, %: C 62.3; H 5.7; N 26.5. $C_{14}H_{15}N_5O$. Calculated, %: C 62.44; H 5.62; N 26.0.

b. A solution of 0.57 g of compound **II** and 2 ml of $POCl_3$ in 20 ml of anhydrous *p*-xylene was heated for 8 h under reflux. The solvent and excess phosphoryl chloride were distilled off under reduced pressure, a 1 : 1 2-propanol–water was added to the residue, and the mixture was kept for 12 h at room temperature. The precipitate was filtered off, dried in air, and recrystallized from a 1 : 2 2-propanol–water mixture. Yield 0.36 g (67%), mp 248–249°C. No depression of the melting point was observed on mixing the samples of **III** prepared as described in *a* and *b*. Found, %: C 62.5; H 5.6; N 26.3. $C_{14}H_{15}N_5O$. Calculated, %: C 62.44; H 5.62; N 26.0.

6-*tert*-Butyl[1,2,4]triazolo[4,3-*b*][1,2,4]triazin-7(8*H*)-one (IV). A solution of 0.92 g of compound **I** in 10 ml of formic acid was heated for 6 h under reflux. The mixture was filtered while hot, cooled, and diluted with three volumes of water. The precipitate was filtered off, dried in air, and recrystallized from 2-propanol. Yield 0.76 g (79%), mp 210–211°C. IR spectrum, ν, cm^{-1}: 1590 (C=O). ^{1}H NMR spectrum, δ, ppm: 1.35 s (9H, *t*-Bu), 1.91 s (1H, 3-H), 9.0 s (1H, NH). Found, %: C 49.7; H 5.8; N 36.3. $C_8H_{11}N_5O$. Calculated, %: C 49.73; H 5.74; N 36.25.

REFERENCES

1. Mironovich, L.M., *Ukr. Khim. Zh.,* 2000, vol. 66, no. 8, p. 122.
2. Heinisch, L., *J. Prakt. Chem.,* 1974, vol. 316, no. 4, p. 667.
3. Ritha, J., Fiedler, P., and Gut, J., *Collect. Czech. Chem. Commun.,* 1966, vol. 31, no. 6, p. 1864.
4. Mironovich, L.M. and Promonenkov, V.K., *Itogi Nauki Tekh., Ser. Org. Khim.,* 1990, vol. 22, p. 3.