Chemistry of Heterocyclic Compounds, Vol. 41, No. 9, 2005

ACYL AND SULFONYL DERIVATIVES OF 3,5-DIAMINO-1-R-1,2,4-TRIAZOLES

V. M. Chernyshev, V. A. Rakitov, V. A. Taranushich, and V. V. Blinov

3-Acylamino-5-amino-1-R-1,2,4-triazoles are formed regioselectively on acylating 3,5-diamino-1-R-1,2,4-triazoles with an equimolar amount of anhydrides, carboxylic acid chlorides, and sulfonyl chlorides. With an excess of anhydride and carboxylic acid chloride 3,5-diacylamino-1-R-1,2,4-triazoles are formed. 3-Acylamino-5-amino-1-R-1,2,4-triazoles do not interact with sulfonyl chlorides. The higher reactivity of the 3-amino group towards acylating agents is determined by electronic and not steric factors.

Keywords: 3-acylamino-5-amino-1-R-1,2,4-triazoles, 5-amino-3-sulfonylamino-1-R-1,2,4-triazoles, amino-, 3,5-diamino-1,2,4-triazole, 3,5-diacylamino-1,2,4-triazoles, 1,2,4-triazole, acylation, regioselectivity, structure.

Depending on the reaction conditions, acylation of unsubstituted 3,5-diamino-1,2,4-triazole leads to the formation of acylation products at both the ring $N_{(1)}$ atom and at the exocyclic amino groups [1-4]. The direction of acylation of 3,5-diamino-1-R-1,2,4-triazole **1** has not been established precisely up to the present time. It has been shown that brief heating of 3,5-diamino-1-phenyl-1,2,4-triazole (**1a**) with acetic anhydride leads to the formation of a monoacetyl derivative, but refluxing in an excess of anhydride leads to the formation of a diacetyl derivative, the structures of which were not determined [5]. The product of the interaction of **1a** with acetoacetic ester was assigned the structure of 1-acetoacetyl-3,5-diimino-2-phenyl-1,2,4-triazole [6], but with cyanates and thiocyanates the carbamoyl and thiocarbamoyl derivatives at one of the exocyclic amino groups were formed [7]. The problem of the reaction direction remained open.

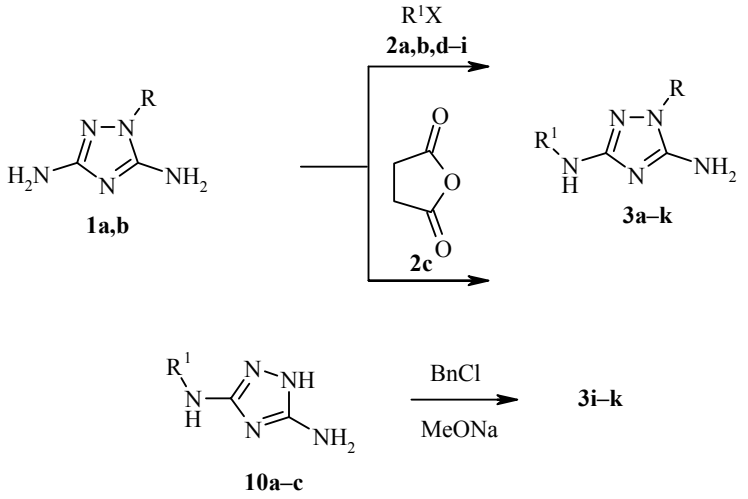
The aim of the present work is the determination of the direction of acylation and sulfonation reactions of 3,5-diamino-1-R-1,2,4-triazoles **1a,b**.

It was established that the interaction of compounds **1a,b** with an equimolar quantity of anhydrides **2a-c**, carboxylic acid chlorides **2d-f,i**, and sulfonyl chlorides **2g,h** proceeds regioselectively and gives 3-acylamino-5-amino-1-R-1,2,4-triazoles **3a-f,i,j** and 5-amino-3-sulfonylamino-1-R-1,2,4-triazoles **3g,h,k** in good yield (Scheme 1, Table 1).

According to the data of [8, 9] the ^{1}H NMR spectra of 3,5-diamino-1-R-1,2,4-triazoles in DMSO-d_6 have broad discernible singlets for the protons of the 3-NH_2 and 5-NH_2 groups in the region of 5 and 6 ppm respectively. The chemical shifts of 5.08 and 4.75 (3-NH_2), 6.15 and 6.05 ppm (5-NH_2) correspond to the protons of the amino groups of compounds **1a,b**. In the ^{1}H NMR spectra of compounds **3a-k** the 3-NH_2 signal has disappeared, but a signal for an amide proton appears at 9.8-12.5 ppm. The singlet of the 5-NH_2 protons is displaced a little towards low field and appears in the range 6.25-6.60 ppm (Table 2). These values of the

South-Russian State Technical University, Novocherkassk 346428, Russia; e-mail: tnw@novoch.ru.
Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 9, pp. 1342-1350, September, 2005. Original article submitted April 19, 2005.

Scheme 1



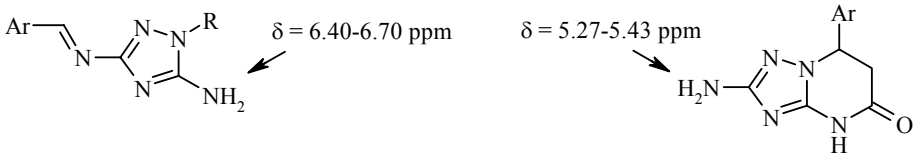
1a, **3a-h** R = Ph; **1b**, **3i-k** R = Bn; **2a**, **3a,i**, **10a** R^1 = Ac; **2b**, **3b** R^1 = CF_3CO; **3c** R^1 = $HO_2C(CH_2)_2CO$; **2d**, **3d** R^1 = PrCO; **2e**, **3e**, **10b** R^1 = *p*-MeC_6H_4CO; **2f**, **3f** R^1 = *p*-$O_2NC_6H_4CO$; **2g**, **3g,k**, **10c** R^1 = Ts; **2h**, **3h** R^1 = $MeSO_2$; **2i**, **3j** R^1 = PhCO; **2a**,**b** X = OR^1; **2d-i** X = Cl

chemical shifts are in good agreement with those of protons of the amino group of 5-amino-3-arylideneamino-1-R-1,2,4-triazoles **4** [9], but are substantially different from the chemical shifts of the NH_2 of compounds **5** [10], which may be considered as structural analogs of the isomers of acyl derivatives **3a-f.i,j**.

TABLE 1. Characteristics of Compounds **3a-k**

Compound	Empirical formula	Found, % / Calculated, % N	mp, °C*	Yield, %, (method of synthesis)
3a	$C_{10}H_{11}N_5O$	32.2 / 32.2	239-241	90 (A)
3b	$C_{10}H_8F_3N_5O$	25.9 / 25.8	213-214	61 (A)
3c	$C_{12}H_{13}N_5O_3$	25.2 / 25.4	206 (dec.)	63 (A)
3d	$C_{12}H_{15}N_5O$	28.8 / 28.6	177-179	75
3e	$C_{16}H_{15}N_5O$	24.0 / 23.9	231-232	71 (A)
3f	$C_{15}H_{12}N_6O_3$	26.1 / 25.9	282 (dec.)	89 (A)
3g	$C_{15}H_{15}N_5O_2S$	21.3 / 21.3	256-257	73 (A), 96 (C)
3h	$C_9H_{11}N_5O_2S$	27.7 / 27.8	262-263	81 (A)
3i	$C_{11}H_{13}N_5O$	30.5 / 30.3	224-225	75 (A), 70 (B)
3j	$C_{16}H_{15}N_5O$	23.9 / 23.7	168-170	63 (A), 45 (B)
3k	$C_{16}H_{17}N_5O_2S$	20.4 / 20.4	271-273	65 (A)

* Solvents: EtOH (compounds **3a-e,h-j**) and DMF–EtOH (compounds **3f,g,k**).



4 **5**

The values of the absorption frequencies of the carbonyl group of compounds **3a-f,i,j** (1650-1680 cm^{-1}) indicate that the acyl group is linked with one of the amino groups and not with the nitrogen of the triazole ring [2, 3, 11]. Otherwise the frequency of the vibrations of the carbonyl group must have a higher value (1700-1735 cm^{-1}) [3, 11]. In the IR spectra of compounds **3a-k** there are characteristic absorption bands for a free amino group at 3370-3470 cm^{-1}.

The UV spectra of the acyl derivatives having no additional chromophores in the acyl group, are analogous to the spectra of acylamino-1,2,4-triazoles described in the literature [11].

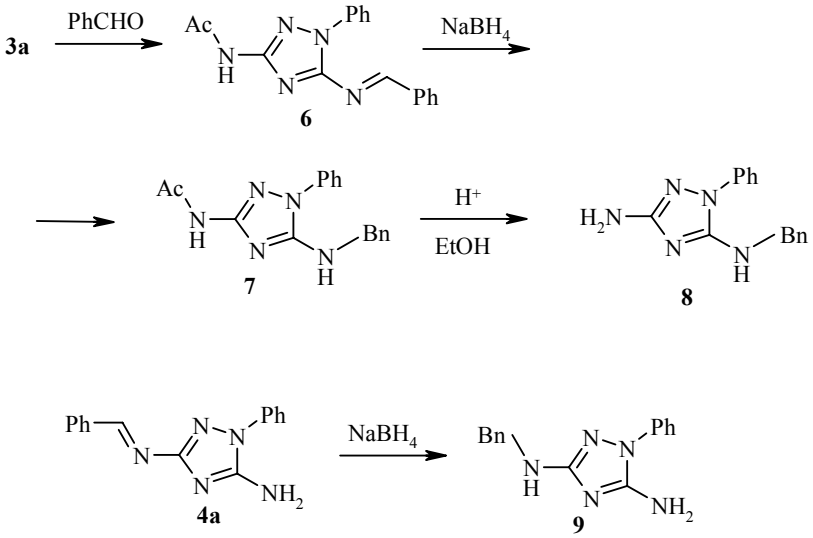
Additional conformation of the position of the acyl group was obtained by the conversions shown on Scheme 2.

On condensing compound **3a** with benzaldehyde and hydrogenating the resulting benzylidene derivative **6** to compound **7** with subsequent hydrolysis, the benzyl derivative **8** is formed which proved to be isomeric with the benzyl derivative **9**, obtained by us by hydrogenation of 5-amino-3-benzylideneamino-1-phenyl-1,2,4-triazole (**4a**), the structure of which was established in [9].

TABLE 2. Characteristics of Compounds **3a-k**

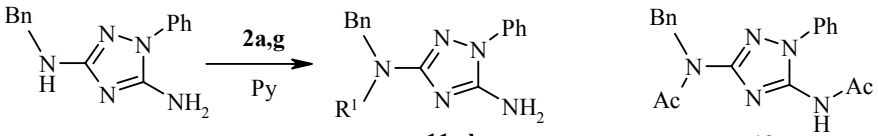
Compound	^{1}H NMR spectrum, δ, ppm (*J*, Hz)	IR spectrum, ν, cm^{-1}	UV spectrum, λ_{max},nm ($\varepsilon \cdot 10^{-3}$)
3a	2.05 (3H, s, CH_3); 6.38 (2H, s, NH_2); 7.30-7.55 (5H, m, C_6H_5); 9.92 (1H, s, NH)	1670 (CO), 3430 (NH_2)	246 (8.9)
3b	6.40 (2H, s, NH_2); 7.25-7.40 (3H, m, arom.); 8.0 (2H, m, arom.); 12.5 (1H, s, NH)	1680 (CO), 3430 (NH_2)	288 (21.5)
3c	2.45 (4H, m, $2CH_2$); 6.47 (2H, s, NH_2); 7.30-7.55 (5H, m, C_6H_5); 10.12 (1H, s, NH); 12.10 (1H, br. s, HO)	1700 (CO), 3470 (NH_2)	244 (9.6)
3d	0.94 (3H, t, *J* = 7.4, CH_3), 1.60 (2H, m, CH_2); 2.25 (2H, m, CH_2); 6.38 (2H, s, NH_2); 7.28-7.56 (5H, m, C_6H_5); 9.89 (1H, s, NH)	1650 (CO), 3360 (NH_2)	246 (9.1)
3e	2.40 (3H, s, CH_3); 6.35 (2H, s, NH_2); 7.21-7.88 (9H m, arom.); 10.27 (1H, s, NH)	1670 (CO), 3470 (NH_2)	246 (18.2)
3f	6.45 (2H, s, NH_2); 7.35-7.50 (5H, m, C_6H_5); 8.17 (2H, d, *J* = 8.9, arom.); 8.33 (2H, d, *J* = 8.9, arom.); 10.80 (1H, s, NH)	1680 (CO), 3440 (NH_2)	256 (15.1)
3g	2.38 (3H, s, CH_3); 6.40 (2H, s, NH_2); 7.30-7.85 (9H, m, arom.); 10.65 (1H, s, NH)	1160 (SO_2), 3470 (NH_2)	223 sh. (18.7), 248 sh. (8.3)
3h	3.25 (3H, s, CH_3); 6.60 (2H, s, NH_2); 7.32-7.50 (5H, m, C_6H_5); 10.46 (1H, s, NH)	1150 (SO_2), 3440 (NH_2)	246 sh. (5.5)
3i	2.0 (3H, s, CH_3); 5.01 (2H, s, CH_2); 6.25 (2H, s, NH_2); 7.15-7.38 (5H, m, C_6H_5); 9.80 (1H, s, NH)	1660 (CO), 3370 (NH_2)	227 sh. (7.1)
3j	5.07 (2H, s, CH_2); 6.30 (2H, s, NH_2); 7.25-7.50 (8H, m, arom.); 7.92 (2H, m, arom.); 10.15 (1H, s, NH)	1670 (CO), 3450 (NH_2)	224 sh. (13.6)
3k	2.41 (3H, s, CH_3); 4.93 (2H, s, CH_2); 6.27 (2H, s, NH_2); 7.09-7.28 (7H, m, arom.); 7.73 (2H, m, arom.); 10.40 (1H, s, NH)	1150 (SO_2), 3430 (NH_2)	223 sh. (14.4)

Scheme 2



Compounds **3i-k** were obtained by an alternate synthesis by the benzylation of compounds **10a-c**, which excludes structures in which the acyl or sulfonyl group is linked with the endocyclic nitrogen atom.

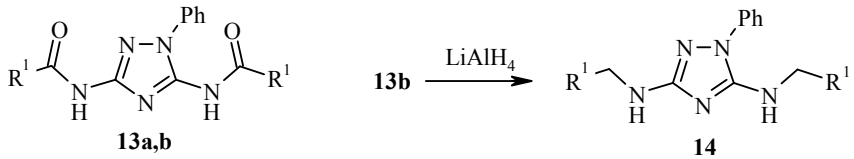
We propose that the higher nucleophilicity of the 3-amino group is caused by electronic and not by steric factors since the benzyl group in compound **9** has no influence on the reaction direction. The interaction of triazole **9** with acylating agents **2a,g** occurs at the amino group in position 3 of the ring with the formation of compounds **11a,b**. Products of monoacylation at the amino group in position 5 were not detected. Compound **12**, which is a by-product, is probably formed as a result of the acylation of triazole **11a** with an excess of anhydride **2a**.



11 a R^1 = Ac, **b** R^1 = Ts

The reduction in the nucleophilicity of the 5-amino group in comparison with the amino group in position 3 was also noted in [9, 12] and is probably connected with the fact that the 5-amino group is in linear conjugation with the electron-withdrawing system of double bonds of the triazole ring, but the 3-amino group is in cross conjugation. This difference is confirmed, according to data of X-ray structural analysis, by the reduction of the $C_{(5)}$–NH_2 bond length compared with $C_{(3)}$-NH_2 in the molecules of 3,5-diamino-1,2,4-triazole and the isomeric 1-R-3(5)-alkylthio-5(3)-amino-1,2,4-triazoles [13-15].

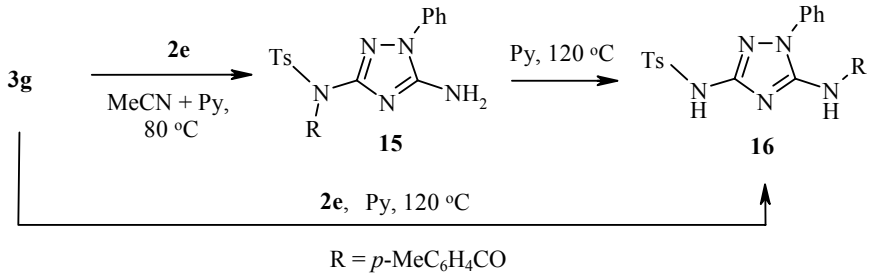
On interacting compound **1a** with an excess of acylating agent, 3,5-diacylamino-1-phenyl-1,2,4-triazoles **13a,b** were successfully obtained, in spite of the reduction in nucleophilicity of the 5-amino group.



13a R^1 = Me, **13b, 14** R^1 = *p*-MeC_6H_4

Signals for the protons of free amino groups were absent from the ^{1}H NMR spectra of compounds **13a,b**, but there were signals for two amide protons at 10.48-11.05 ppm. The band for the free amino group vibrations at 3370-3470 cm^{-1} disappears from the IR spectra (Table 2). The UV spectra were analogous to the spectra of the two acylamino-1,2,4-triazoles described in [11]. The structure of compound **13b** was confirmed by its hydrogenation to the dialkyl derivative **14**.

On acylating triazole **3g** with acid chloride **2e** in boiling acetonitrile in the presence of pyridine a compound was obtained, which on the basis of spectral data and elemental analysis, was assigned the structure of 5-amino-1-phenyl-3-(N-*p*-toluenesulfonyl)amino-1,2,4-triazole (**15**). The 3-amino group therefore displays a definite nucleophilicity even after sulfonation. Acylation of compound **3g** in boiling pyridine or boiling compound **15** in pyridine in the presence of catalytic amounts of acid chloride leads to the formation of the thermodynamically more stable compound **16**. Migration of the *p*-methylbenzoyl but not the tosyl group was confirmed. This was demonstrated by acid hydrolysis of compound **16** to the initial **3g**.



R = *p*-MeC$_6$H$_4$CO

A mixture of reaction products was formed during attempts to obtain diacyl derivatives of triazoles **1a,b**, uniting the different acyl groups in one molecule, by acylating compounds **3a-f,i,j**. The reason for this is probably the formation of intermediates analogous in structure to compound **15**. As a result of lability and the possibility of migration of any of the acyl groups, rearrangement of these intermediates leads to the formation of a mixture of compounds. Acylation of the 5-amino group with sulfonyl chlorides **2g,h** was unsuccessful, probably due to the reduced reactivity of sulfonyl chlorides compared with carboxylic acid chlorides and anhydrides. On interacting compounds **1a,b** and **9** with an excess of the sulfonyl chlorides in pyridine only monosulfonyl derivatives **3g,h,k** and **11b** were formed and on heating 3-acylamino-5-amino-1-R-1,2,4-triazoles **3a-f** with sulfonyl chlorides under analogous conditions the starting materials were isolated.

EXPERIMENTAL

The ^{1}H NMR spectra were recorded on a Varian UNITY 300 (300 MHz) instrument in DMSO-d$_6$, internal standard was TMS, IR spectra were obtained on a Specord IR-75 instrument in nujol. The UV spectra were obtained on a SF 26 spectrophotometer in water.

The starting materials were synthesized by known methods, viz. **1a** [7], **1b**, **4a** [9], **10a,b** [3], **10c** [16].

3-Acylamino-5-amino-1-R-1,2,4-triazoles 3a-f,i,j and 5-Amino-3-sulfonylamino-1-R-1,2,4-triazoles 3g,h,k. A. A solution of anhydride (for compounds **3a-c,i**) (6.6 mmol), acid chloride (for compounds **3d-f,j**), or sulfonyl chloride (for compounds **3g,h,k**) in acetonitrile (3 ml) was added dropwise to a mixture of compound **1a** or **1b** (6 mmol), pyridine (0.5 ml), and acetonitrile (5 ml). The reaction mixture was boiled for 10 min, cooled to 20°C, the precipitated solid was filtered off, and crystallized from ethanol. To isolate compound **3c** the reaction mixture was acidified with 2 N HCl solution to pH 3-4.

B. A solution of Na (0.2 g, 8.51 mmol) in MeOH (2 ml) was added to a mixture of compound **10a** (1.00 g, 7.09 mmol) and DMSO (10 ml), then benzyl bromide (1.33 g, 7.8 mmol) was added with stirring. The reaction mixture was stirred for 10 h at 20°C and the solvent distilled off in vacuum. The residue was washed

with water, and crystallized from ethanol. Compound **3i** was obtained and was identical in physicochemical properties to that obtained by method A.

Compound **3j** was obtained analogously from benzoyl derivative **10b**, and compound **3k** analogously from tosyl derivative **10c**.

C. A mixture of compound **16** (0.3 g, 0.67 mmol), alcohol (3 ml), and conc. HCl (1 ml) was refluxed for 2 h, then neutralized with saturated NaOAc solution. The precipitated solid compound **3g** was filtered off, washed with water, and crystallized from a DMF–EtOH mixture. The compound was identical to that obtained by method A.

3-Acetylamino-5-benzylideneamino-1-phenyl-1,2,4-triazole (6). A mixture of compound **3a** (1 g, 4.6 mmol), benzaldehyde (0.59 g, 5.52 mmol), and DMF (1 ml) was refluxed for 1 h, diluted with water (10 ml), and extracted with chloroform (3 × 10 ml). The extract was dried over $CaCl_2$, the chloroform distilled off, the residue was crystallized from CCl_4, and compound **6** (0.8 g, 57%) was obtained; mp 148-149°C. UV spectrum λ_{max}, nm (ε): 248 (16600), 320 sh (9900). IR spectrum, ν, cm^{-1}: 1620 (C=N), 1670 (CO). ^1H NMR spectrum, δ, ppm: 2.09 (3H, s, CH_3); 7.60-8.05 (10H, m, $2C_6H_5$); 9.23 (1H, s, CH=N); 10.57 (1H, s, NH). Found, %: N 22.8. $C_{17}H_{15}N_5O$. Calculated, %: N 22.9.

3-Acetylamino-5-benzylamino-1-phenyl-1,2,4-triazole (7). Sodium borohydride (0.11 g, 2.9 mmol) was added in portions during 10 min to a solution of compound **6** (0.6 g, 2 mmol) in ethanol (10 ml) at 50-60°C. The mixture was then refluxed for 30 min and diluted with water (10 ml). The precipitated solid compound **7** was crystallized from alcohol. Yield 0.52 g (85%); mp 133-134°C. UV spectrum, λ_{max}, nm (ε): 252 (8000). IR spectrum, ν, cm^{-1}: 1660 (CO). ^1H NMR spectrum, δ, ppm (*J*, Hz): 2.00 (3H, s, CH_3); 4.47 (2H, d, *J* = 5.9, CH_2); 7.08 (1H, t, *J* = 5.9, NH); 7.15-7.60 (10H, m, $2C_6H_5$); 10.02 (1H, s, NH). Found, %: N 22.8. $C_{17}H_{17}N_5O$). Calculated, %: N 22.8.

3-Amino-5-benzylamino-1-phenyl-1,2,4-triazole (8). A mixture of compound **7** (0.5 g, 1.63 mmol), conc. HCl (1 ml), and ethanol (3 ml) was refluxed for 2 h, then poured into 10% aqueous NaOAc solution (8 ml). The precipitated solid was crystallized from ethanol. Yield 0.36 g (60%); mp 127-128°C. UV spectrum, λ_{max}, nm (ε): 264 (6500). IR spectrum, ν, cm^{-1}: 3420 NH_2. ^1H NMR spectrum, δ, ppm (*J*, Hz): 4.40 (2H, d, *J* = 5.8, CH_2); 5.18 (2H, s, NH_2); 6.97 (1H, t, *J* = 5.8, NH); 7.20-7.50 (10H, m, $2C_6H_5$). Found, %: N 26.5. $C_{15}H_{15}N_5$. Calculated, %: N 26.4.

5-Amino-3-benzylamino-1-phenyl-1,2,4-triazole (9). Sodium borohydride (0.22 g, 5.7 mmol) was added in portions during 10 min to a suspension of 5-amino-3-benzylideneamino-1,2,4-triazole **4a** [9] in ethanol (10 ml) at 50-60°C. The mixture was then refluxed for 30 min and poured into water (10 ml). The precipitated solid was crystallized from ethanol. Yield 0.7 g (70%); mp 165-166°C. UV spectrum, λ_{max}, nm (ε): 264 (6600). IR spectrum, ν, cm^{-1}: 3450 (NH_2). ^1H NMR spectrum, δ, ppm (*J*, Hz): 4.25 (2H, d, *J* = 6.0, CH_2); 6.24 (2H, s, NH_2); 6.27 (1H, t, *J* = 6.0, NH); 7.15-7.50 (10H, m, $2C_6H_5$). Found, %: N 26.2. $C_{15}H_{15}N_5$. Calculated, %: N 26.4.

3-(N-Acetyl-N-benzyl)amino-5-amino-1-phenyl-1,2,4-triazole (11a) and 5-Acetylamino-3-(N-acetyl-N-benzyl)amino-1-phenyl-1,2-4-triazole (12). A mixture of compound **9** (0.8 g, 3 mmol), pyridine (0.5 ml), Ac_2O (0.37 g, 3.6 mmol), and acetonitrile (3 ml) was refluxed for 6 h, cooled, the precipitated solid compound **11a** was filtered off, and crystallized from ethanol. Yield 0.54 g (59%); mp 194-196°C. UV spectrum, λ_{max}, nm (ε): 242 (7500). IR spectrum, ν, cm^{-1}: 1670 (CO), 3470 (NH_2). ^1H NMR spectrum, δ, ppm: 2.26 (3H, s, CH_3); 4.91 (2H, s, CH_2); 6.66 (2H, s, NH_2); 7.15-7.53 (10H, m, $2C_6H_5$). Found, %: N 22.5. $C_{17}H_{17}N_5O$. Calculated, %: N 22.8.

Water (8 ml) was added to the reaction mixture after separating compound **11a**, the precipitated solid was filtered off, dissolved in chloroform, and passed through a column of aluminum oxide (4 × 3 cm). The chloroform was distilled off, and compound **12** crystallized from ethanol. Yield 0.20 g (19%); mp 131-133°C. UV spectrum, λ_{max}, nm (ε): 238 sh (7800). IR spectrum, ν, cm^{-1}: 1650 (CO), 1720 (CO). ^1H NMR spectrum, δ, ppm: 1.98 (3H, s, CH_3); 2.38 (3H, s, CH_3); 5.00 (2H, s, CH_2); 7.15-7.55 (10H, m, $2C_6H_5$); 10.58 (1H, s, NH). Found, %: N 20.3. $C_{19}H_{19}N_5O_2$. Calculated, %: N 20.0.

5-Amino-3-(N-benzyl-N-*p*-toluenesulfonyl)amino-1-phenyl-1,2,4-triazole (11b) was synthesized analogously to compound **11a** by the sulfonylation of compound **9** with *p*-toluenesulfonyl chloride. Yield 84%; mp 170-172°C (ethanol). UV spectrum, λ_{max}, nm (ε): 250 (10400). IR spectrum, ν, cm^{-1}: 1160 (SO_2), 3430 NH_2). ^1H NMR spectrum, δ, ppm: 2.41 (3H, s, CH_3); 4.92 (2H, s, CH_2); 6.38 (2H, s, NH_2); 7.18-7.50 (12H, m, arom.); 7.78, (2H, m, arom.). Found, %: N 16.3. $C_{22}H_{21}NO_2S$. Calculated, %: N 16.7.

3,5-Diacetylamino-1-phenyl-1,2,4-triazole (13a). A mixture of compound **1a** (1.05 g, 6 mmol) in Ac_2O (5 ml) was refluxed for 6 h, the excess of anhydride was distilled off in vacuum, and the residue crystallized from a DMF–EtOH, 1:2 mixture. Yield 1.28 g (82%); mp 210-212°C. UV spectrum, λ_{max}, nm (ε): 218 sh (18000). IR spectrum, ν, cm^{-1}: 1680 (CO). ^1H NMR spectrum, δ, ppm: 1.96 (3H, s, CH_3); 2.04 (3H, s, CH_3); 7.35-7.58 (5H, m, C_6H_5); 10.48 (1H, s, NH); 10.58 (1H, s, NH). Found, %: N 27.2. $C_{12}H_{13}N_5O_2$. Calculated, %: N 27.0.

3,5-Di-*p*-methylbenzoylamino-1-phenyl-1,2,4-triazole (13b). A mixture of compound **1a** (6 mmol), *p*-methylbenzoyl chloride (2.78 g, 18 mmol), and pyridine (5 ml) was refluxed for 6 h, then poured into water (20 ml). The precipitated oil was washed with water and dissolved in ethanol (5 ml). The resulting solid was filtered off, and crystallized from ethanol. Yield 1.53 g (62%); mp 154-156°C. UV spectrum, λ_{max}, nm (ε): 252 (37700). IR spectrum, ν, cm^{-1}: 1680 (CO). ^1H NMR spectrum, δ, ppm: 2.36 (3H, s, CH_3); 2.38 (3H, s, CH_3); 7.30-7.58 (9H, m, arom.); 7.78-7.91 (4H, m, arom.); 10.86 (1H, s, NH); 11.05 (1H, s, NH). Found, %: N 16.7. $C_{24}H_{21}N_5O_2$. Calculated, %: N 17.0.

3,5-Di-*p*-methylbenzylamino-1-phenyl-1,2,5-triazole (14). Lithium aluminum hydride (0.37 g, 9.6 mmol) was added in portions to a suspension of compound **13b** (1 g, 2.4 mmol) in THF (30 ml). The mixture was refluxed for 3 h, water (2 ml) was added, and the solvent distilled off. The residue was extracted with chloroform (3 × 20 ml), the chloroform distilled off, and the compound obtained was crystallized from ethanol. Yield 0.63 g (68%); mp 105-106°C. IR spectrum, ν, cm^{-1}: 3450 (NH_2). ^1H NMR spectrum, δ, ppm (*J*, Hz): 2.25 (6H, s, $2CH_3$); 4.18 (2H, d, *J* = 6.4, CH_2); 4.36 (2H, d, *J* = 5.7, CH_2); 6.25 (1H, t, *J* = 6.4, NH); 6.91 (1H, t, *J* = 5.7, NH); 7.07-7.45 (13H, m, arom.). Found, %: N 18.3. $C_{24}H_{25}N_5$. Calculated, %: N 18.3.

5-Amino-3-(N-*p*-methylbenzoyl-N-*p*-toluenesulfonyl)amino-1-phenyl-1,2,4-triazole (15). A mixture of compound **3g** (1 g, 3 mmol), pyridine (0.5 ml), *p*-methylbenzoyl chloride (0.7 g, 4.5 mmol), and acetonitrile (3 ml) was refluxed for 6 h, cooled, and water (10 ml) added. The precipitated solid was filtered off, dissolved by heating in chloroform (70 ml), and twice passed through a column (4 x 3 cm) of aluminum oxide. The chloroform was distilled off and the residue crystallized from ethanol. Yield 0.31 g (23%); mp 187-188°C. UV spectrum, λ_{max}, nm (ε): 240 (25200). IR spectrum, ν, cm^{-1}: 1170 (SO_2), 1710 (CO), 3420 (NH_2). ^1H NMR spectrum, δ, ppm: 2.42 (3H, s, CH_3); 2.64 (3H, s, CH_3); 6.78 (2H, s, NH_2); 7.14-7.20 (2H, m, arom.); 7.36-7.52 (9H, m, arom.), 7.94 (2H, m, arom.). Found, %: N 16.0. $C_{23}H_{21}N_5O_3S$. Calculated, %: N 15.7.

5-*p*-Methylbenzoylamino-1-phenyl-3-*p*-toluenesulfonylamino-1,2,4-triazole (16). A. A mixture of compound **3g** (1 g, 3 mmol), pyridine (3 ml), and *p*-methylbenzoyl chloride **2e** (0.7 g, 4.5 mmol) was refluxed for 6 h, cooled, and ethanol (5 ml) added. The precipitated solid was crystallized from a DMF–EtOH, 1:2 mixture. Yield 0.82 g (61%); mp 276-278°C. IR spectrum, ν, cm^{-1}: 1160 SO_2, 1660 (CO). ^1H NMR spectrum, δ, ppm (*J*, Hz): 2.34 (3H, s, CH_3); 2.37 (3H, s, CH_3); 7.28-7.44 (9H, m, arom.); 7.73 (2H, d, *J* = 8.2, arom.); 7.85 (2H, d, *J* = 8.2, arom.); 10.97 (1H, s, NH); 11.38 (1H, s, NH). Found, %: N 15.8. $C_{23}H_{21}N_5O_3S$. Calculated, %: N 15.7.

B. A mixture of compound **15** (0.5 g, 1.1 mmol), pyridine (2 ml) and acid chloride **2e** (catalytic amount) was refluxed for 6 h. Compound **16** was isolated and purified in an analogous manner to method A. Yield 0.45 g (90%), the compound was identical to that obtained by method A.

REFERENCES

1. B. G. Van Den Boss, *Rec. Trav. Chim.*, **79**, 836 (1960).
2. C. D. Selassie, E. J. Lien, and T. A. Khwaja, *J. Pharm. Sci.*, **70**, 1281 (1981).
3. M. S. Pevzner, N. V. Gladkova, and T. A. Kravchenko, *Zh. Org. Khim.*, **32**, 1230 (1996).
4. M. I. Barmin, O. A. Kolesnikov, V. P. Kononenko, and V. V. Mel'nikov, *Zh. Prikl. Khim.*, **73**, 1916 (2000).
5. G. Pellizzari and C. Roncagliolo, *Gazz. Chim. Ital.*, **31**, 477 (1901).
6. P. Papini and S. Checchi, *Gazz. Chim. Ital.*, **80**, 100 (1950).
7. E. A. Steck. R. P. Brundage, and L. T. Fletcher, *J. Am. Chem. Soc.*, **80**, 3929 (1958).
8. J. Reiter, L. Pongo, T. Somorai, and P. Dvortsak, *J. Heterocycl. Chem.*, **23**, 401 (1986).
9. J. J. Fuentes and J. A. Lenoir, *Can. J. Chem.*, **54**, 3620 (1976).
10. V. V. Lipson, S. M. Desenko, V. D. Orlov, O. V. Shishkin, M. G. Shirobokova, V. N. Chernenko, and L. I. Zinov'eva, *Khim. Geterotsikl. Soedin.*, 1542 (2000).
11. J. Reiter, L. Pongo, and P. Dvortsak, *J. Heterocycl. Chem.*, **24**, 127 (1987).
12. N. K. Beresneva, V. A. Lopyrev, and K. L. Krupin, *Khim. Geterotsikl. Soedin.*, 1118 (1969).
13. G. L. Starova, O. V. Frank-Kamenetskaya, V. V. Makarskii, and V. A. Lopyrev, *Kristallografiya*, **25**, 1292 (1980).
14. A. Kalman and G. Argay, *J. Mol. Struct.*, **102**, 391 (1983).
15. A. Kalman, L. Parkanyi, and J. Reiter, *J. Mol. Struct.*, **118**, 293 (1984).
16. W. A. Kleschik, J. E. Dunbar, S. W. Snider, and A. P. Vinogradoff, *J. Org. Chem.*, **53**, 3120 (1988).