

Reactivity of 3,5-bis-(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole

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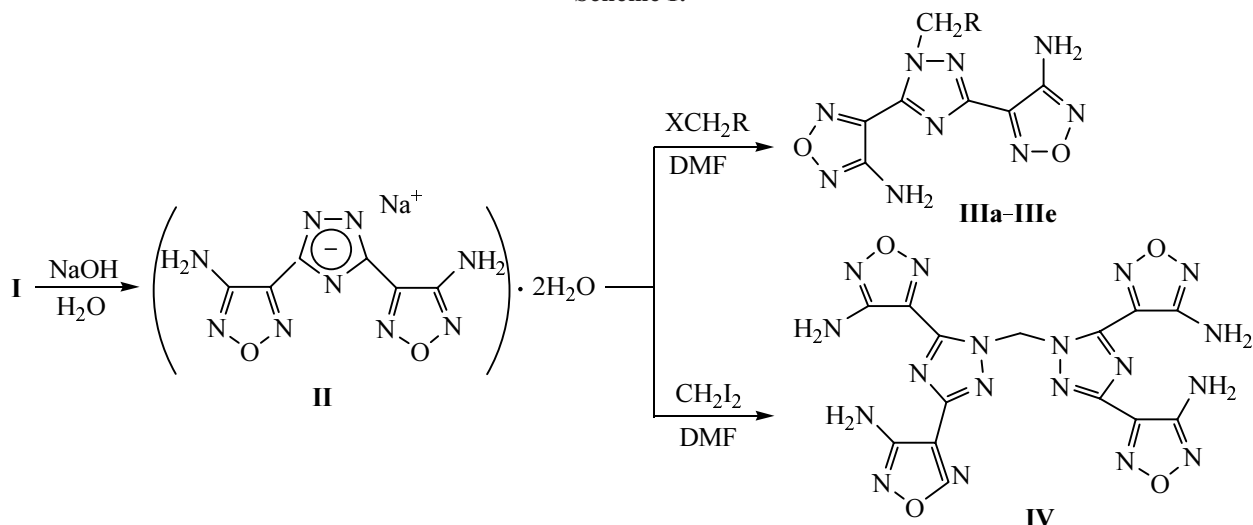
Abstract—Alkylation of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole with haloalkanes afforded N-CH₂R derivatives, and nitration furnished the corresponding bis-N-nitramine isolated as a trisodium salt. Treatment of the latter with CH₃I resulted in denitration. Diazotization and oxidation of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole, its N-methyl and N-carboxy derivatives gave rise to the corresponding azido and nitro derivatives. Salts of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazol-5-acetic acid with nitrogen-containing bases were synthesized. It was established that the character of reaction products of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole with formaldehyde depended on the acid-base properties of the medium.

Formerly by melting 1,4-bis-(4-amino-1,2,5-oxadiazol-3-yl)-1-amino-4-oxo-2,3-diaza-1-butene we obtained 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole (**I**) and started the investigation of its reactivity. As an NH-acid azole **I** in the form of a sodium salt **II** cleanly underwent alkylation with methyl iodide affording a mixture of 2- and 4-methyl-3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazoles (**IIIa**) with the 2-isomer prevailing (15:1) [1] (Scheme 1). We did not observe alkylation of the amino group at the 1,2,5-oxadiazole ring. These results indicated that the introduction into the 3 and 5 positions of the triazole ring of an amino-1,2,5-oxadiazole fragment increased the selectivity of the alkylation. It proved that the alkylation of the triazole rings with the other haloalkyls XCH₂R (R

= Me, Pr, CO₂Et, Ph) also occurred with a high selectivity. Alkylation products **IIIb–e** were obtained in over 95% yield, and the impurity of the 4-isomer was present in as small amount as affording a practically pure 2-isomer after a single recrystallization.

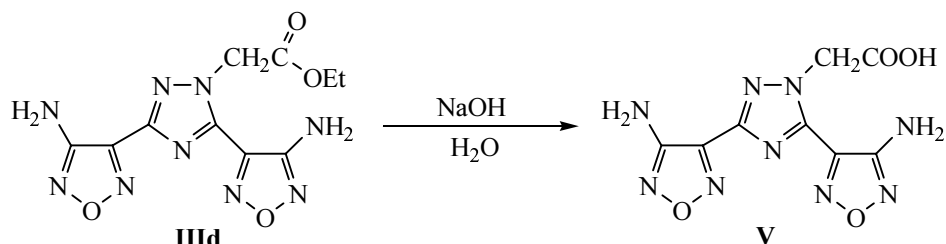
Sodium salt **II** suffered alkylation also with methylene iodide in DMF giving 1,1-methylene-bis-3,5-(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole (**IV**). The ¹H NMR spectrum of compound **IV** contained a signal in the region 7.4 ppm corresponding to the protons of the CH₂ group at the triazole ring, and the signals in the regions 6.7 and 6.45 ppm from the protons of the NH₂ group attached to the 1,2,5-oxadiazole ring (integral intensity ratio was 1:2:2).

Scheme 1.

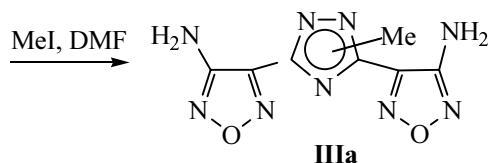
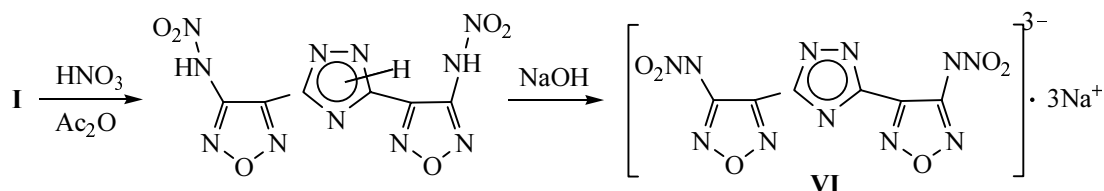


R = H (**a**), Me (**b**), Pr (**c**), COOEt (**d**), Ph (**e**). DMF = DMF

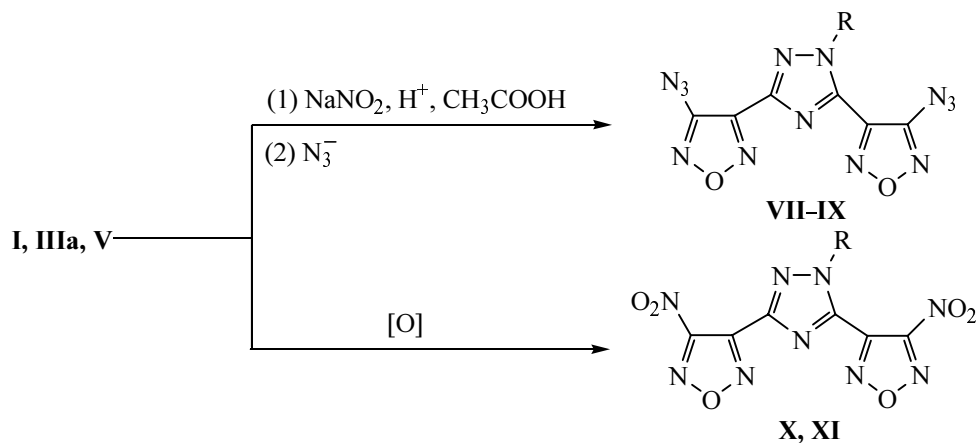
Scheme 2.



Scheme 3.



Scheme 4.



R = H (**I, VII, X**), Me (**III a, VIII, XI**), COOH (**V, IX**).

Ester **III d** was easily hydrolyzed by short boiling (5 min) in 30% water solution of NaOH furnishing acid **V** in a virtually quantitative yield.

In the ^1H NMR spectrum of acid **V** proton signals were observed in the region 12.0 ppm (OH group), 6.67 and 6.45 ppm (amino groups of the 1,2,5-oxadiazole ring), and 5.5 ppm ($\text{CH}_2\text{-N}$ group) at the ratio of integral intensity 1:2:2:2.

Compound **I** nitrated with HNO_3 in Ac_2O gave 3,5-bis(4-nitramino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole isolated as trisodium salt **VI**. The attempt to alkylate the

latter unexpectedly resulted in denitration affording compound **III a**.

Similarly to the other amino-1,2,5-oxadiazoles azole **I**, its methyl derivative **III a**, and acid **V** on diazotization followed by treatment with sodium azide readily furnished the corresponding azido derivatives **VII-IX**.

The behavior of triazole **I**, its methyl derivative **III a**, and acid **V** in oxidation with mixtures based on hydrogen peroxide [$30\% \text{H}_2\text{O}_2 + (\text{F}_3\text{CCO})_2\text{O}$] is different: compounds **I** and **III a** afforded nitro derivatives **X** and **XI**, whereas the oxidation of acid **V** resulted in a complex

product mixture, and we failed to isolate therefrom a nitro derivative.

The high tendency to alkaline hydrolysis of ester **III**d hampered the attempts to synthesize 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazol-1-acetic acid derivatives, in particular, the corresponding hydroxamic acid, amide, and hydrazide by treating ester **III**d with hydroxylamine, ammonia, and hydrazine. In all cases either the ester **III**d was recovered unchanged, or the reaction product was acid **V**. This outcome is apparently due to weaker nucleophilic quality of hydroxylamine, ammonia, and hydrazine as compared to the hydroxide ion.

Acid **V** heated in water solution with nitrogen-containing bases readily formed salts **XII**a–**XII**f without cleavage of the N–CH₂ bond (Scheme 5).

It was expected that the large difference in the character of the nitrogen functions (NH₂ group at the 1,2,5-oxadiazole ring and NH group in the triazole ring) would ensure selective preparation of an N-hydroxymethyl derivative. It turned out however that reaction of amine **I** with formaldehyde was fairly complicated and depended on the acid-base properties of the medium. In the reaction mixture obtained in dilute water solutions at pH ~6.5–7 the TLC test revealed the presence of a new compound, but the attempt of its isolation resulted in recovery of initial compound **I**. The acylation of the reaction mixture with acetic anhydride led to bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole diacetate **XIII** whose structure was proved by comparison with an authentic sample prepared by acylation of amine **I**; however in the former case the acylation occurred rapidly and did not require heating or catalyst, whereas the acylation of pure amine

I proceeded at long heating in the presence of sodium acetate.

These results indirectly confirm that azole **I** reaction with formaldehyde in a neutral or weakly acidic media is reversible, and the equilibrium is strongly shifted to the initial compound **I**.

In reaction with 30% formaldehyde water solution at pH ~4–5 a compound was isolated of mp 275°C whose ¹H NMR spectrum contained signals in the region 7.15 (NH, OH), 6.15 (CH₂), and 5.10 ppm (OCH₂) suggesting a formation of a polymer tris(hydroxymethyl) derivative **XIV**.

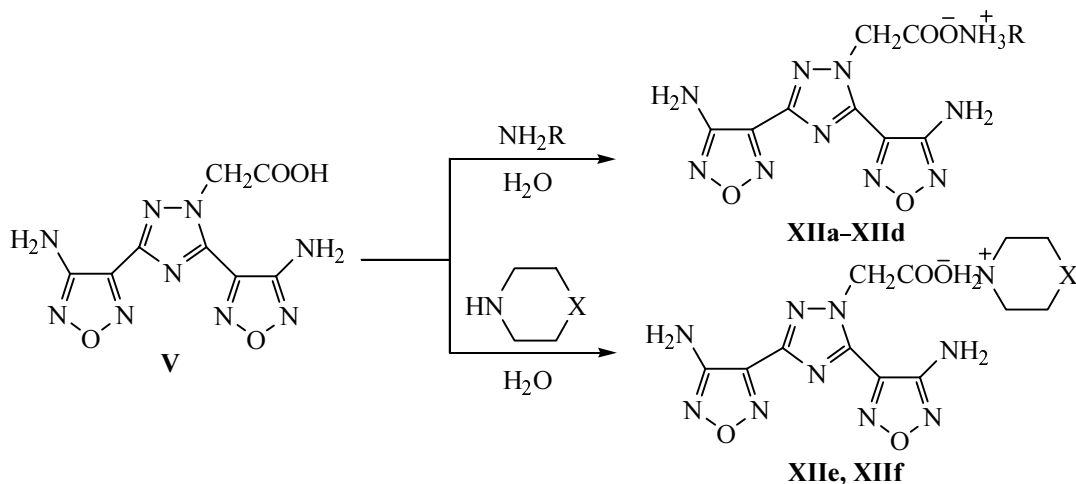
In 100% H₂SO₄ apart from polymer hydroxymethyl derivative **XIV** we succeeded to isolate from the mixture of the reaction products a compound of mp 142–145°C that was assigned structure **XV**.

Thus amine **I** including two electron-acceptor amino-1,2,5-oxadiazole fragments is capable of reacting not only at the nitrogen atom in the 1,2,4-triazole ring but at the amino groups attached to the oxadiazole rings in keeping with the reactivities of both amino-1,2,5-oxadiazoles [2–3] and nitro-1,2,4-triazole in reactions with formaldehyde [4].

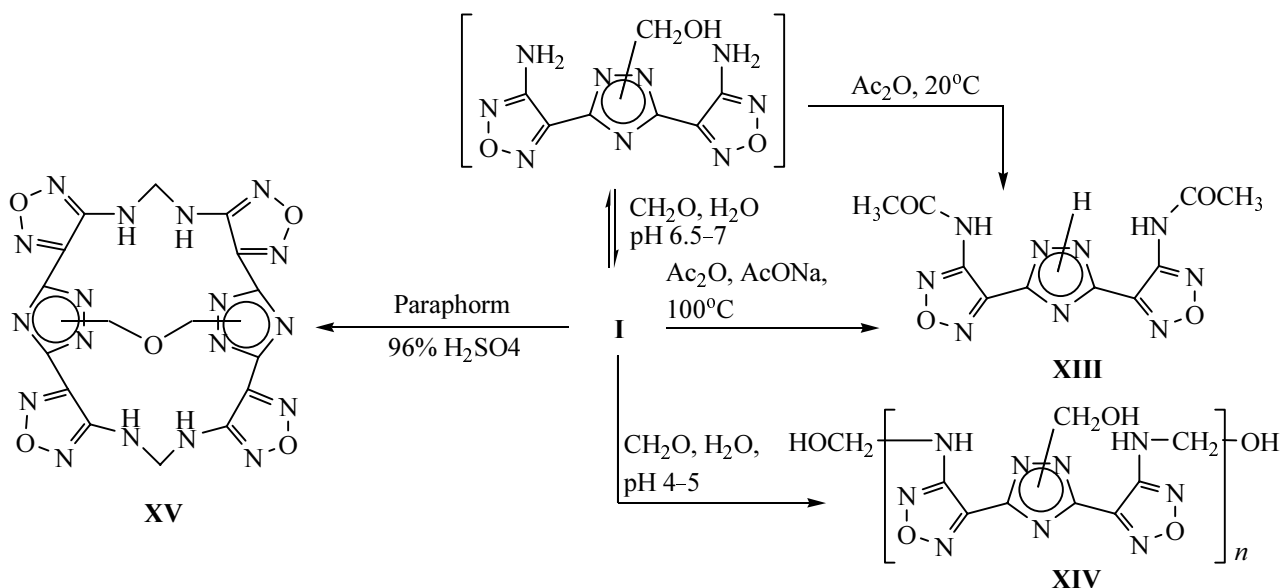
EXPERIMENTAL

IR spectra were measured on a Shimadzu FTIR 8400 spectrometer on a KBr sublayer. ¹H and ¹³C NMR spectra were registered on a spectrometer Bruker DRX 500 (internal reference HMDS, solvent DMSO-*d*₆). TLC was carried out on Silufol UV-254 plates using a solvent system CCl₄–CH₃COOH–*i*-PrOH, 80:5:15. Initial azole **I** was prepared as in [1].

Scheme 5.



Scheme 5.



3,5-Bis(4-amino-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazole sodium salt (II). A mixture of 25.3 g (100 mmol) of 1-amino-1,4-bis(4-amino-1,2,5-oxadiazol-3-yl)-4-oxo-2,3-diazabut-1-ene and 100 ml of tetradecene was heated at 245°C for 10 min, then cooled to 40°C, the precipitate was filtered off, dissolved at the same temperature in 30 ml of 20% NaOH solution, and the solution was filtered while hot. On cooling the mother liquor the separated precipitate was filtered off and dried in air. Yield 24.3 g (95%), mp > 320°C. IR spectrum, cm^{-1} : 3288 (H_2O , NH_2), 1668, 1640 (NH_2), 1608, 1576, 1544 ($\text{C}=\text{N}$), 1204, 1188 ($\text{N}-\text{O}$), 996. ^1H NMR spectrum, δ , ppm: 6.70 s (4H, NH_2). Found, %: C 24.0; H 2.50; N 42.91. $\text{C}_6\text{H}_4\text{N}_9\text{NaO}_2 \cdot 2\text{H}_2\text{O}$. Calculated, %: C 24.60; H 2.71; N 43.07.

General alkylation procedure of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazole sodium salt. A solution of 0.6 g (2.3 mmol) of salt II, 2.4 mmol of haloalkane, and 1 g of NaI in 5 ml of DMF was stirred for 2 h at 40–50°C, then cooled, and poured into a 5-fold water volume. The separated precipitate was filtered off and recrystallized from ethanol. Thus compounds IIIb, IIIc were obtained.

4-[3-(4-Amino-1,2,5-oxadiazol-3-yl)-1-ethyl-1H-1,2,4-triazol-5-yl]-1,2,5-oxadiazol-3-amine (IIIb). Yield 93%, mp 191–193.5°C. ^1H NMR spectrum ($\text{DMSO}-d_6$), δ , ppm: 6.65 s (2H, NH_2), 6.43 s (2H, NH_2), 4.62 q (2H, CH_2), 1.53 t (3H, CH_3). Found, %: C 36.35; H 4.18; N 47.64. $\text{C}_8\text{H}_9\text{N}_9\text{O}_2$. Calculated, %: C 36.51; H 3.45; N 47.89.

4-[3-(4-Amino-1,2,5-oxadiazol-3-yl)-1-butyl-1H-1,2,4-triazol-5-yl]-1,2,5-oxadiazol-3-amine (IIIc). Yield 94%, mp 162–163°C. ^1H NMR spectrum ($\text{DMSO}-d_6$), δ , ppm: 6.67 s (2H, NH_2), 6.42 s (2H, NH_2), 4.61 q (2H, CH_2), 1.95 t (3H, CH_3), 1.42 m (2H, CH_2), 0.97 m (2H, CH_2). Found, %: C 41.32; H 4.65; N 43.40. $\text{C}_{10}\text{H}_{13}\text{N}_9\text{O}_2$. Calculated, %: C 41.24; H 4.50; N 43.28.

Ethyl 2-[3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-1-yl]acetate (IIIId). A mixture of 10 g (39 mmol) of salt II, 50 ml of DMF, and 63 mmol of ethyl chloroacetate was maintained under stirring at room temperature for 24 h, then the reaction mixture was poured into 100 ml of water, the separated precipitate was filtered and washed with water on the filter (2×50 ml). The precipitate was dissolved in 50 ml of *i*-PrOH, the solution was heated to boiling, kept at boiling for 5 min, cooled, the precipitate was filtered off again, and dried. Yield 11.8 g (94%), mp 235°C. IR spectrum, cm^{-1} : 3444, 3257 (NH_2), 1745 ($\text{C}=\text{O}$), 1637 (NH), 1599, 1558, 1238, 1210 ($\text{C}-\text{O}-\text{C}$), 1163 ($\text{N}-\text{O}$), 985. ^1H NMR spectrum, δ , ppm: 6.65 s (2H, NH_2), 6.5 s (2H, NH_2), 5.55 s (2H, CH_2), 4.15 q (2H, CH_2), 1.12 t (3H, CH_3). Found, %: C 37.23; H 3.52; N 39.09. $\text{C}_{10}\text{H}_{11}\text{N}_9\text{O}_4$. Calculated, %: C 37.39; H 3.45; N 39.24.

4-[3-(4-Amino-1,2,5-oxadiazol-3-yl)-1-benzyl-1H-1,2,4-triazol-5-yl]-1,2,5-oxadiazol-3-amine (IIIe). Yield 91%, mp 197–198°C. ^1H NMR spectrum, δ , ppm: 7.35 s (5H, Ph), 6.63 s (2H, NH_2), 6.39 s (2H, NH_2), 5.89 s (2H, CH_2). Found, %: C 48.12; H 4.08; N 39.05. $\text{C}_{13}\text{H}_{11}\text{N}_9\text{O}_2$. Calculated, %: C 48.00; H 3.41; N 38.75.

4-{3-(4-Amino-1,2,5-oxadiazol-3-yl)-1-[3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-1-ylmethyl]-1H-1,2,4-triazol-5-yl}-1,2,5-oxadiazol-3-amine (IV). At stirring 0.6 g (2.3 mmol) of compound **II** was dissolved in 5 ml of DMF, 0.8 g (2.9 mmol) of methylene iodide was added, and the mixture was heated for 2 h at 40–50°C. Then it was poured into a 5-fold volume of water, the separated precipitate was filtered off and recrystallized from *i*-PrOH. Yield 0.4 g (85%), mp >300°C. IR spectrum, cm⁻¹: 3388, 3315, 2894, 1640, 1608, 1551, 1487, 1461, 1434, 1334, 1288, 1184, 1136, 1013, 978, 864. ¹H NMR spectrum, δ, ppm: 7.40 s (2H, CH₂), 6.70 s (4H, NH₂), 6.45 s (4H, NH₂). Found, %: C 32.41; H 2.38; N 52.21 C₁₃H₁₀N₁₈O₄. Calculated, %: C 32.37; H 2.09; N 52.27.

2-[3,5-Bis(4-amino-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-1-yl]acetic acid (V). A mixture of 1 g (1 mmol) of ethyl ester **III**d and 30 ml of 30% NaOH solution was heated for 10 min. The reaction mixture was acidified with concn. HCl till pH ~1–2, the separated precipitate was filtered off and dried. Yield 0.9 g (99%), mp 227°C. IR spectrum, cm⁻¹: 3442, 3361, 3329 (NH₂,OH), 1749 (C=O), 1628 (NH₂), 1599, 1558, 1160 (N–O), 985. ¹H NMR spectrum, δ, ppm: 12.0 (1H, OH), 6.67 s (2H, NH₂), 6.43 s (2H, NH₂), 5.5 s (2H, CH₂). Found, %: C 32.52; H 2.85; N 43.39. C₈H₇N₉O₄. Calculated, %: C 32.79; H 2.41; N 43.02.

3,5-Bis(4-nitramino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole trisodium salt (VI). To a mixture of 2.5 ml HNO₃ (C 1.5 g/cm³) and 5 ml of acetic anhydride prepared at a temperature not higher than 0°C was added a powder of 0.5 g (2.1 mmol) of amine **I**, the mixture was maintained for 0.5 h at 0°C and then poured on ice. The resulting mixture was extracted with ether (2×50 ml), the extract was dried over anhydrous Na₂SO₄, the solvent was distilled off, and the oily residue was mixed with an alcoholic NaOH solution. The separated presipitate was filtered off and dried in air. We obtained 0.45 g (50%) of salt dihydrate, mp 235°C (decomp.). IR spectrum, cm⁻¹: 1632, 1560, 1376, 1004. Found, %: C 16.51; H 1.05; N 35.97. C₆N₁₁Na₃O₆·2H₂O. Calculated, %: C 16.86; H 0.93; N 36.06.

Reaction of 3,5-bis(4-nitramino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole trisodium salt (VI) with methyl iodide. In 5 ml of DMF was dissolved 0.3 g (0.7 mmol) of salt **VI**, and at 20°C 2 g (14 mmol) of methyl iodide was added, the mixture was kept for 1 h and then poured into 20 ml of water. The separated precipitate was filtered off and dried in air. We obtained 0.15 g (88%) of

colorless crystals, mp 263–264.5°C. ¹H NMR spectrum, δ, ppm: 6.68 s (2H, NH₂), 6.49 s (2H, NH₂), 4.23 s (3H, CH₃). Found, %: C 34.06; H 2.97; N 51.13. C₇H₇N₉O₂. Calculated, %: C 33.73; H 2.81; N 50.60.

On mixing the product obtained with a sample of compound **III**a prepared by alkylation of amine **I** no melting point depression was observed.

3-Azido-4-[3-(4-azido-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-5-yl]-1,2,5-oxadiazole (VII). To 8 ml of 95% H₂SO₄ at 0–5°C while stirring was added first 0.29 g (4.1 mol) of NaNO₂, then in one portion 0.5 g (2.1 mmol) of compound **I**, the mixture was kept at this temperature for 3 h (till compound **I** dissolved completely) Then maintaining the temperature below 10°C 10 ml of AcOH and 0.3 g (4.6 mmol) of NaN₃ was added (the reaction was accompanied by gas evolution). After keeping the reaction mixture for 30 min it was poured on 70 g of ice. The separated colorless reaction product was filtered off, washed on the filter with water till neutral washings, and dried. Yield 0.49 g (81%), mp 168°C (on crystallization from ethanol with activated carbon). ¹³C NMR spectrum, δ, ppm: 153.4 (C–N₃), 147.1 (C, furazan), 141.6 (C, triazole). Found, %: C 24.98; H 1.02; N 63.35. C₆HN₁₃O₂. Calculated, %: C 25.10; H 0.35; N 63.41.

3,5-Bis(4-azido-1,2,5-oxadiazol-3-yl)-1-methyl-1,2,4-triazole (VIII). To 8 ml 95% H₂SO₄ at 0–5°C while stirring was added first 0.28 g (4.05 mol) of NaNO₂, then in one portion 0.5 g (2.01 mmol) of compound **III**a, the mixture was kept at this temperature for 3 h (till complete dissolution), then at 10°C 10 ml of acetic acid and 0.31 g (4.77 mmol) of NaN₃ was added (observing the nitrogen liberation). After keeping the reaction mixture for 30 min it was poured on 70 g of ice. The separated precipitate was filtered off, washed on the filter with water till neutral washings, and dried. We obtained 0.5 g of solid substance, mp 109–109.5°C (on crystallization from ethanol with activated carbon). ¹H NMR spectrum (DMSO-*d*₆), δ, ppm: 4.24 s (3H, CH₃). ¹³C NMR spectrum, δ, ppm: 153.88 and 153.40 (C, CN₃), 149.88 and 140.50 (C, triazole), 143.48 and 142.40 (C, furazan), 39.41 (C, CH₃). Found, %: C 27.29; H 2.28; N 41.83. C₇H₃N₁₃O₂. Calculated, %: C 27.18; H 0.97; N 40.77.

2-[3,5-Bis(4-azido-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-1-yl]acetic acid (IX). A mixture of 0.47 g (0.68 mmol) of NaNO₂ and 10 ml concn. H₂SO₄ was stirred at room temperature till complete homogenization, the solution was cooled to 0–5°C, 1 g (3.4 mmol) of acid **V** was added, the reaction mixture was kept till the acid completely dissolved, then was added in succession 5 ml

of acetic acid and 0.44 g (0.68 mmol) of NaN_3 , and the mixture was maintained at 5°C for 40 min, and then it was poured on ice. The separated precipitate was filtered off, washed with water till neutral washings, and dried. We obtained 0.35 g (30%) of colorless crystals, mp 100°C . IR spectrum, cm^{-1} : 2150 (N_3). ^1H NMR spectrum, δ , ppm: 5.55 s (2H, CH_2), 12.0 s (1H, OH). Found, %: C 27.71; H 0.74; N 52.45. $\text{C}_8\text{H}_3\text{N}_{13}\text{O}_4$. Calculated, %: C 27.81; H 0.87; N 52.72.

3-Nitro-4-[3-(4-nitro-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-5-yl]-1,2,5-oxadiazole (X). *a.* To a solution of trifluoroacetic acid prepared from 1.5 g of 84% hydrogen peroxide and 17 g of trifluoroacetic anhydride was added at 20°C while stirring 0.5 g (2.1 mmol) of compound **I**, and the mixture was heated at $60\text{--}65^\circ\text{C}$ for 30 min. Then it was poured on ice, extracted with ether (3×20 ml), the extract was dried over anhydrous Na_2SO_4 , and the solvent was distilled off. We obtained a light-yellow oily substance that was dissolved in boiling toluene with silica gel (L 5/40 μ) added. The precipitate formed on cooling was filtered off. Yield 0.28 g (44%), mp 105°C . IR spectrum, cm^{-1} : 3163, 1078, 1597, 1558, 1447, 1379, 1322, 1266, 1178, 1133, 1106, 1041, 990, 894, 826. ^{13}C NMR spectrum, δ , ppm: 160.13 (C, C- NO_2), 146.16 (C, furazan), 142.50 (C, triazole). Mass spectrum, m/z : 295 [M] $^+$, 249 [$M-\text{NO}_2$] $^+$. Found, %: C 24.45; H 1.62; N 42.78. $\text{C}_6\text{HN}_9\text{O}_6$. Calculated %: C 24.42; H 0.34; N 42.71. M 295.13.

b. To a mixture of 15 ml of 30% hydrogen peroxide and 25 ml of sulfuric acid (C 1.84 g/cm^3) at $60\text{--}70^\circ\text{C}$ was added dropwise a solution of 5 g (1.9 mmol) of compound **I** sodium salt in 12 ml of DMF, and the mixture was kept at this temperature for 30 min. Then it was cooled, poured on ice, extracted with ether (3×30 ml), the extract was dried over anhydrous Na_2SO_4 , and the solvent was distilled off. The oily residue was worked up as described in procedure *a*. Yield 4.0 g (70%) of colorless crystals, mp 105°C . On mixing the product obtained with a sample prepared along procedure *a* no melting point depression was observed.

1-Methyl-3,5-bis(4-nitro-1,2,5-oxadiazol-3-yl)-1,2,4-triazole (XI). *a.* To a solution of trifluoroacetic acid prepared from 3.24 g of 84% hydrogen peroxide and 20 ml of trifluoroacetic anhydride was added at 20°C while stirring 0.25 g (1 mmol) of compound **IIIa**, and the reaction mixture was heated at $60\text{--}65^\circ\text{C}$ for 30 min, then it was poured on ice, the separated oily substance was isolated, the mother liquor was extracted with ether (3×20 ml), the oily substance was combined with the ex-

tract and dried over anhydrous Na_2SO_4 . On removing the solvent the viscous residue was crystallized from toluene with added silica gel (L 5/40 μ) to obtain 0.15 g (48%) of colorless substance, mp 68°C . ^1H NMR spectrum (DMSO- d_6), δ , ppm: 4.20 s (3H, CH_3) and 3.92 s (3H, of CH_3 -isomer). ^{13}C NMR spectrum, δ , ppm: 160.50 and 160.02 (C, C- NO_2), 148.87 and 143.08 (C, furazan), 141.02 and 141.92 (C, triazole), 34.39 (C, CH_3). Mass spectrum, m/z : 309 [M] $^+$, 279 [$M-\text{NO}$] $^+$, 263 [$M-\text{NO}_2$] $^+$. Found, %: C 27.29; H 2.28; N 41.83. $\text{C}_7\text{H}_3\text{N}_9\text{O}_6$. Calculated, %: C 27.18; H 0.97; N 40.77. M 309.15.

b. In 12 ml of 95% H_2SO_4 was dissolved 0.5 g (2.01 mmol) of compound **IIIa**, the mixture was heated to $60\text{--}70^\circ\text{C}$, and thereto was added dropwise a mixture of 10 ml of 30% hydrogen peroxide and 6 ml of 95% H_2SO_4 . On keeping the reaction mixture at the same temperature for 30 min it was cooled, poured on ice, and extracted with ether (3×20 ml). After drying the extract with anhydrous Na_2SO_4 and removing the solvent the viscous residue was crystallized from toluene with added silica gel (L 5/40 μ) to obtain 0.22 g (35%) of product, mp 68°C . On mixing the product obtained with a sample prepared along procedure *a* no melting point depression was observed.

General procedure for preparation of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1H-1,2,4-triazol-1-ylacetic acid salts (XII). A dispersion in water of an equimolar mixture of acid **V** and a nitrogen-containing base was heated on a water bath till homogenization, cooled, the separated crystals were filtered off and recrystallized from water. On drying in air compounds **XIIa-f** were obtained..

Ammonium salt (XIIa), mp 241°C . Found, %: C 30.82; H 3.78; N 45.02. $\text{C}_8\text{H}_{10}\text{N}_{10}\text{O}_4$. Calculated, %: C 30.97; H 3.25; N 45.15.

Hydrazinium salt (XIIb), mp $>300^\circ\text{C}$. Found, %: C 29.31; H 4.06; N 47.16. $\text{C}_8\text{H}_{11}\text{N}_{11}\text{O}_4$. Calculated, %: C 29.54; H 3.41; N 47.37.

Hydroxylammonium salt (XIIc), mp $>300^\circ\text{C}$. Found, %: C 29.11; H 3.57; N 43.07. $\text{C}_8\text{H}_{10}\text{N}_{10}\text{O}_5$. Calculated, %: C 29.45; H 3.09; N 42.93.

Guanidinium salt (XII d), mp 240°C . Found, %: C 30.89; H 4.07; N 47.49. $\text{C}_9\text{H}_{12}\text{N}_{12}\text{O}_4$. Calculated, %: C 30.69; H 3.43; N 47.71.

Morpholinium salt (XII e), mp 235°C . Found, %: C 37.98; H 4.69; N 36.73. $\text{C}_{12}\text{H}_{16}\text{N}_{10}\text{O}_5$. Calculated, %: C 37.90; H 4.24; N 36.83.

Piperidinium salt (XIIf), mp 248°C. Found, %: C 41.03; H 5.32; N 37.18. $C_{13}H_{18}N_{10}O_4$. Calculated, %: C 41.27; H 4.80; N 37.02.

3,5-Bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole diacetate(XIII). A mixture of 1 g (4.2 mmol) of amine **I** and a pinch of a freshly calcined AcONa in 20 ml of Ac_2O was stirred at 40°C till complete consumption of initial compound **I** (TLC monitoring; around 6 h). The reaction mixture was poured into 50 ml of water, the precipitate formed on decomposing the excess acetic anhydride was filtered off and dried in air. Yield 0.93 g (70%), mp 230–231°C (from ethanol). 1H NMR spectrum, δ , ppm: 10.9 (2H, NH), 2.3 (6H, 2CH₃). Found, %: C 37.13; H 3.31; N 38.94. $C_{10}H_9N_9O_4$. Calculated, %: C 37.60; H 2.81; N 39.50.

Reaction of 3,5-bis(4-amino-1,2,5-oxadiazol-3-yl)-1,2,4-triazole with paraformaldehyde in concn. H_2SO_4 . To a solution of 1 g (4.2 mmol) of azole **I** in 30 ml of 100% H_2SO_4 0.2 g of paraformaldehyde was added, the mixture obtained was stirred for 3 h at 18–20°C, poured into 150 ml of ice water and left overnight. The precipitate was filtered off, washed with water till neutral washings, and dried in air. We obtained 1.1 g of solid sub-

stance which was washed with dioxane (4×25 ml). The residue was dried in air to obtain 0.9 g (65%) of compound **XV**, mp 275°C (decomp.). 1H NMR spectrum, δ , ppm: 7.50 (NH, OH), 6.15 (2H, NH), 5.10 (2H, CH₂). Found, %: C 33.64; H 3.54; N 39.22. $C_9H_{11}N_9O_5$. Calculated, %: C 33.20; H 3.38; N 38.76.

On removing the solvent from the dioxane solution we obtained 0.2 g of a solid substance, mp 142–145°C. 1H NMR spectrum, δ , ppm: 16.00 (1H, NH), 7.88–7.12, 5.90–5.05 (2H, NH) and 5.10 (2H, CH₂). Found, %: C 36.56; H 2.95; N 46.35. $C_{16}H_{12}N_{18}O_5$. Calculated, %: C 35.83; H 2.25; N 47.00.

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