Synthesis of 4,7-diaminopyridazino[4,5-*c*]furoxan

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4,7-Diaminopyridazino[4,5-*c*]furoxan was synthesized by intramolecular cyclization of 3-cyanofuroxan-4-carbamidrazone obtained from 3,4-dicyanofuroxan and hydrazine.

Key words: 3,4-dicyanofuroxan, 4,7-diaminopyridazino[4,5-*c*]furoxan, 4,7-diaminopyridazino[4,5-*c*]furoxan diacetate, 3-cyanofuroxan-4-carbamidrazone.

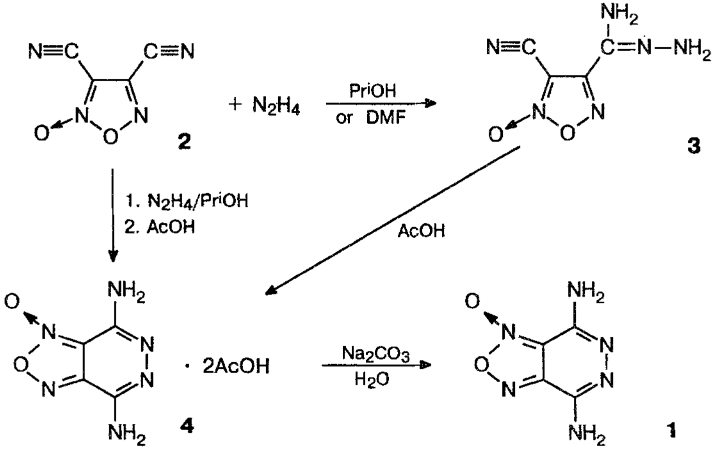
Condensed heterocyclic systems containing the furoxan ring[1,2] are interesting as starting compounds for various syntheses[3—5] as well as biologically active compounds.[1]

One of these systems, 4,7-diaminopyridazino[4,5-*c*]furoxan (**1**) was described[6] as a product of the reaction of 3,4-dicyanofuroxane (**2**) with hydrazine, which has a b.p. of 118 °C. It was established in this work that the product is 3-cyanofuroxan-4-carbamidrazone (**3**). We synthesized an adduct of compound **2** with hydrazine, which is similar in its m.p. to that described earlier.[6] However, its IR spectrum contains a nitrile group band at 2240 cm^{-1} in addition to known bands[6] (3400, 3370, and 1600 cm^{-1}). The presence of the nitrile group also follows from the ^{13}C NMR spectrum (see Ref. 6), in which a signal at δ 107.33 corresponding[7] to the CN group is registered. This signal can be assigned[6] to C-3 of the furoxan ring. However, it was shown for isomers of phenylcyanofuroxan[7] and, by us, for 4-amino-3-cyanofuroxan that the signals observed at δ 95.4 and 94.0, respectively, are associated with C-3 connected with the CN group.

We found that furoxan **3** being treated with AcOH is subjected to intramolecular cyclization with the formation of condensed heterocyclic system **1** (Scheme 1). Thereby the product precipitates as diacetate (**4**), from which diamine **1** can be isolated by treatment with Na_2CO_3 in aqueous medium. Product **4** can also be obtained from furoxan **2** and hydrazine without isolation of amidrazone **3** in pure form by the treatment of the reaction mixture with acetic acid.

The structure of product **1** was confirmed by elemental analysis and spectral methods and was proved unambiguously by X-ray analysis, the results of which will be published elsewhere.

Scheme 1



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Translated from *Izvestiya Akademii Nauk. Seriya Khimicheskaya,* No. 8, pp. 1559—1560, August, 1995.

Experimental

The ^{13}C NMR spectrum was recorded on a Bruker AC-200 spectrometer in DMSO-d$_6$ using a solvent signal (δ 39.5) as a reference. IR spectra were recorded with a Specord 75-IR device; the mass spectrum was recorded on a Finnigan MAT-212 spectrometer. Melting points were measured on a Boetius stage. 3,4-Dicyanofuroxan was obtained by the known procedure.[8]

3-Cyanofuroxan-4-carbamidrazone (3). *A.* 0.8 g (16 mol) of 85 % hydrazine hydrate in 5 mL of DMF was added dropwise for 30 min to a solution of 1 g (8 mmol) of compound **2** in 30 mL of DMF, prepared by stirring and cooling (0—2 °C), and the mixture was stirred at 0 °C for 2 h. Then, it was diluted with water (50 mL) and extracted with ether (2×75 mL). Combined ethereal extracts were washed with water (2×15 mL) and dried over MgSO$_4$, and the ether was removed *in vacuo.* 0.5 g (40 %) of product **3** was obtained in the form of light yellow crystals with m.p. 117—119 °C (decomp.). Found (%): C, 28.3; H, 2.4; N, 50.1. $C_4H_4N_6O_2$. Calculated (%): C, 28.57; H, 2.38; N, 50.00. IR (KBr), ν/cm^{-1}: 3475 s, 3390 s, 3250 m, 3225 m, 2910 m, 2860 w, 2240 m, 1630 s, 1590 s, 1560 s, 1540 s, 1460 s, 1395 w, 1345 w, 1290 w, 1255 w, 1190 w, 1170 w, 1075 w, 1010 w, 990 m, 830 m, 770 w, 740 m, 700 m, 625 m, 580 m, 530 w, 430 m.

B. 4.6 mL (290 mmol) of 95.5 % hydrazine were added dropwise to a solution of 18 g (144 mmol) of compound **2** in 220 mL of Pr^{i}OH with stirring and cooling (5—0 °C). Crystals began falling out 15 min after the start of the addition. Stirring was continued for 1 h, and then crystals were separated by filtration, washed with cold Pr^{i}OH (2×25 mL), and dried. 17.34 g (78 %) of product **3** were obtained, m.p. 118—119 °C (decomp.), identical according to IR data to the sample of **3** synthesized by procedure *A.*

4,7-Diaminopyridazino[4,5-c]furoxan diacetate (4). *A.* A solution of 17.34 g of compound **3** in 75 mL of AcOH was allowed to stand at 20 °C overnight. Crystals formed were isolated by filtration, washed with ether (3×50 mL), and dried. 37.85 g (99.3 %) of product **4** were obtained in the form of purple crystals with m.p. >300 °C (decomp.). Found (%): C, 33.3; H, 4.1; N, 29.1. $C_8H_{12}N_6O_6$. Calculated (%): C, 33.33; H, 4.17; N, 29.17. IR spectrum (KBr), ν/cm^{-1}: 3420 s, 3310 m, 3180 s, 1685 s, 1610 s, 1555 s, 1510 s, 1415 m, 1370 m, 1285 s, 1120 w, 1005 m, 970 m, 895 w, 700 w, 630 m, 550 w.

B. 4.6 mL (290 mol) of 95.5 % hydrazine were added dropwise to a solution of 18 g (144 mol) of compound **2** in 220 mL of Pr^{i}OH with stirring and cooling (5—8 °C). The mixture was stirred at 8—10 °C for 1 h, 150 mL of AcOH were added, and the mixture was allowed to stand at ~20 °C overnight. The precipitate formed was filtered off, washed with ether (3×50 mL), and dried. 37.95 g (99.5 %) of product **4** were obtained (m.p. >300 °C (decomp.)), which is identical according to IR data to the sample of **4** synthesized by procedure *A.*

4,7-Diaminopyridazino[4,5-*c*]furoxan (1). $Na_2CO_3 \cdot 10H_2O$ was added in small portions to a suspension of 37.95 g (143 mmol) of acetate **4** in 200 mL of water until the pH was adjusted to 8—9. A precipitate was filtered off, washed with water (2×50 mL), and dried. 22.08 g (99.3 %) of product **1** were obtained in the form of dark red crystals with m.p. >300 °C (decomp.). Found (%): C, 28.5; H, 2.2; N, 49.75. $C_4H_4N_6O_2$. Calculated (%): C, 28.5; H, 2.38; N, 50.0. IR (KBr), ν/cm^{-1}: 3470 s, 3380 s, 3120 s, 1625 s, 1590 m, 1555 s, 1505 s, 1445 m, 1385 w, 1360 w, 1260 w, 1175 m, 1125 m, 1010 m, 975 m, 750 w, 705 w, 550 m. ^{13}C NMR, δ: 103.51; 142.67 (furoxan ring); 140.74; 144.46 (pyridazine ring). Mass spectrum, *m/z*: 168 [M]$^+$.

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Received September 28, 1994;
in revised form February 22, 1995