Available online at www.sciencedirect.com
ScienceDirect
Mendeleev Commun., 2016, **26**, 106–108

Mendeleev Communications

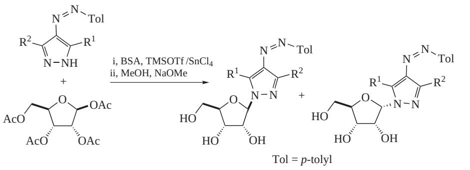
Non-natural nucleosides bearing 4-aryldiazenylpyrazole aglycone

Anna E. Ivanova,* Yanina V. Burgart and Viktor I. Saloutin

I. Ya. Postovsky Institute of Organic Synthesis, Ural Branch of the Russian Academy of Sciences, 620990 Ekaterinburg, Russian Federation. Fax: +7 343 374 5954; e-mail: ivanova@ios.uran.ru

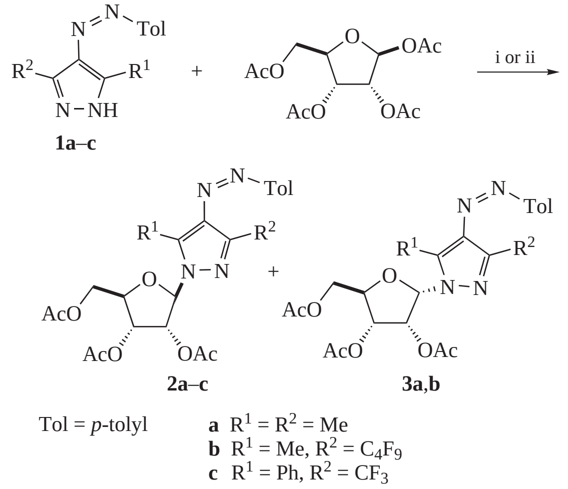
DOI: 10.1016/j.mencom.2016.03.006

Ribosylation of 4-aryldiazenyl-3-R-5-R′-pyrazoles with 1,2,3,5-tetra-*O*-acetyl-β-D-ribofuranose in the presence of tin(IV) chloride gives α- and β-anomeric *N*-(2,3,5-tri-*O*-acetylribofuranosyl)-substituted derivatives. Their HPLC separation and deacetylation (MeOH, MeONa) affords 1-(β-D-ribofuranosyl)-3-R-5-R′-4-(aryldiazenyl)-1*H*-pyrazoles.



The use of pyrazoles as aglycones in the synthesis of non-natural nucleosides is a promising way to prepare bioactive compounds. Pyrazofurin, a nucleoside antibiotic, and its α-epimer are used for treatment of diseases induced by DNA-viruses.[1] Incorporation of a D-ribofuranosyl moiety into 4-iodopyrazole-3-carboxylates increases the antiproliferative activity,[2] while incorporation of poly-O-acetylated sugars into 3-(bromomethyl)pyrazole-3-carboxylates results in a cytostatic effect on the cells of HeLa tumor lines.[3] 4-Fluoro-1-β-D-ribofuranozylpyrazole-3-carboxamide manifests activity against A and B influenza viruses.[4] Pyrazol-3-ones that contain trifluoromethyl and aryldiazenyl substituents along with an *N*-glucopyranozyl moiety exhibit an antitumor effect.[5] These data stimulate interest in creating new nucleosides that contain a pyrazole substituent as the base.

In this study, a ribofuranose substituent was incorporated into 4-aryldiazenylpyrazoles **1a**–**c** by their condensation with 1,2,3,5-tetra-*O*-acetyl-β-D-ribofuranose. Two one-reactor methods were tested for ribosylation of pyrazoles **1a**,**b** (Scheme 1).[†] Incorporation of peracetylated ribofuranose into pyrazoles **1a**,**b**



Scheme 1 *Reagents and conditions*: i, BSA, TMSOTf, MeCN, 25 °C; ii, $SnCl_4$, MeCN, 25 °C.

[†] NMR spectra were recorded in $CDCl_3$ using a Bruker DRX-400 spectrometer (400 MHz for ^1H, relative to TMS; 376 MHz for ^{19}F, relative to C_6F_6). IR spectra were recorded on a Perkin Elmer Spectrum One Fourier IR spectrometer in the 4000–400 cm^{-1} range using an attenuated full total internal reflection device (FTIR) or a diffuse reflectance accessory (DRA). Melting points were measured in open capillaries in a Stuart SMP30 melting point measuring device. Column chromatography was carried out on silica gel 60 (0.063–0.2 mm). Mass spectra were recorded using an Agilent GC 7890A MSD 5975C inert XL EI/CI gas chromato-mass-spectrometer with an HP5-MS quartz capillary column (dimethylpolysiloxane, 5% of phenyl groups, 30 m × 0.25 mm, film thickness 0.25 μm) and a quadrupole mass spectrometric detector in electron ionization mode (70 eV). Helium was used as the carrier gas and chloroform was used as the solvent. HPLC was performed in an Agilent 1200 Series preparative liquid chromatograph with a diode matrix detector, a preparative autosampler (900 μl) and a ZORBAX Eclipse XDB-C18 PrepHT 21.2×150 mm column, particle size 5 μm. Acetonitrile–water mixtures (70:30 and 80:20) were used as the eluents to isolate acetylribofuranosylpyrazole **2b** and to separate products **2a** and **3a**, respectively. The flow rate was 20 ml min^{-1}. The wavelength was 330 nm. Elemental analysis was carried out with a Perkin Elmer PE 2400 series II analyzer. Optical rotations were determined at room temperature using a Perkin Elmer M 341 polarimeter.

1,2,3,5-Tetra-*O*-acetyl-β-D-ribofuranose was purchased from Alfa Aesar.

Synthesis of aryldiazenylpyrazoles **1a**–**c**. 4,4,4-Trifluoro-2-[(4-methylphenyl)diazenyl]-1-phenylbutane-1,3-dione, 4,4,5,5,6,6,7,7,7-nonafluoro-3-[(4-methylphenyl)diazenyl]octane-2,4-dione or 3-[(4-methylphenyl)-diazenyl]pentane-2,4-dione (obtained using the reported procedure[9]) (0.03 mol) was dissolved in ethanol (20 ml), then hydrazine hydrate (1.75 g, 0.035 mol) and glacial acetic acid (10 ml) were added, and the mixture was refluxed for 8 h. The product was precipitated with water, filtered and recrystallized from 50% ethanol.

*4-[(4-Methylphenyl)diazenyl]-5-trifluoromethyl-3-phenyl-1*H*-pyrazole* **1c**. Yield 87%, mp 230–231 °C. FTIR (ν/cm^{-1}): 3230 (N–H), 1125–1160 (C–F). ^1H NMR ($CDCl_3$) δ: 2.43 (s, 3H, C_6H_4Me), 7.28–7.30 (m, 2H, *m*-H, C_6H_4Me), 7.52–7.57 (m, 3H, *m*,*p*-H, Ph), 7.75–7.77 (m, 2H, *o*-H, C_6H_4Me), 7.82–7.85 (m, 2H, *o*-H, Ph). ^{19}F NMR, δ: 99.2 (s, CF_3). Found (%): C, 61.75; H, 3.76; N, 16.84. Calc. for $C_{17}H_{13}N_4F_3$ (%): C, 61.82; H, 3.97; N, 16.96.

Synthesis of β-D- and α-D-ribofuranosyl substituted pyrazoles **2a**–**c** *and* **3a**–**c**. *Method A*. Pyrazole **1a**,**b** (2.8 mmol) and 1,2,3,5-tetra-*O*-acetyl-*β*-D-ribofuranose (2.9 mmol) were dissolved in anhydrous MeCN, then BSA (3.8 mmol) and TMSOTf (3.8 mmol) were added. The mixture was kept overnight. Distilled water (0.5 ml) was added and the mixture was neutralized with $NaHCO_3$. The resulting suspension was filtered and the filtrate was concentrated. The product was purified by column chromatography using chloroform as the eluent. Products **2a** and **3a** (35%), **2b** and **3b** (23%) were obtained as mixtures in 5:1 and 1:1 ratios, respectively.

by treatment with bis(trimethylsilyl)acetamide (BSA) and trimethylsilyl trifluoromethanesulfonate (TMSOTf) gave a mixture of products **2a**,**b** and **3a**,**b** in 5:1 and 1:1 ratios and in 35 and 23% yields, respectively. Such low yields result from incomplete conversion of the starting pyrazoles **1a**,**b**. The use of $SnCl_4$ as a Lewis acid turned to be more efficient and provided 62% (**2a**,**b**) and 56% (**3a**,**b**) yields of nucleosides. Moreover, in the case of pyrazole **1b** the selectivity was greater as ratio **2b**:**3b** rose to 10:1. However, the ratio of products **2a** and **3a** did not change.

The use of HPLC allowed us to separate dimethyl-substituted products **2a** and **3a** and to isolate pure fluorinated compound **2b**.

Similar ribosylation of trifluoromethylpyrazole **1c** in the presence of $SnCl_4$ afforded the only β-isomer **2c** in 59% yield.

We have shown previously that alkylation of pyrazoles **1** with 4-bromobutylacetate produces a mixture of regioisomeric 3-R^F- and 5-R^F-*N*-acetoxybutyl-substituted pyrazoles, whereas the reaction with (2-acetoxyethoxy)methyl acetate is regiospecific and gives only 3-R^F-*N*-[(2-acetoxyethoxy)methyl]pyrazoles.[6] Ribosylation of pyrazoles **1a**,**b** also affords two types of isomeric products **2a**,**b** and **3a**,**b**. However, these isomers are α- and β-anomers within a sugar moiety rather than a pyrazole substituent. In particular, in case of non-symmetric pyrazole **1b** ^{19}F NMR spectra of both products **2b** and **3b** are essentially close thus evidencing the same substitution pattern in heterocycle.

To elucidate the substituent position in pyrazole moieties, we used ^{19}F NMR data. It is known[7] that the 3-CF_3 group in 4-(het)arylazo-3,5-bis(trifluoromethyl)-1-methylpyrazoles resonates upfield (δ_F ~ –99.1 to –100.2) in comparison with the 5-CF_3 group (δ_F ~ –102.1 to –104.1). In compound **2c**, CF_3 group resonates at –99.4 ppm, which is close to N-unsubstituted pyrazole **1c** with δ_F –99.2. This indicates that compound **2c** is the 3-CF_3 isomer. For pyrazoles **2b** and **3b** with C_4F_9 substituents, the chemical shift of the fluorine atoms in the α-CF_2 group is a characteristic parameter. The resonance of the α-CF_2 groups in N-substituted pyrazoles **2b**, **3b** (δ_F –53.3 to –53.4) is located in the same region as in the original pyrazole **1b** (δ_F ~ –52.9 to –53.0), which allows us to assign them to 3-R^F-pyrazoles.

Based on these data, one may conclude that ribosylation of polyfluoroalkyl-containing pyrazoles **1b**,**c** occurs at the nitrogen atom more distant from electron-withdrawing polyfluoroalkyl substituent. The process is thus regiospecific and gives only N-substituted 3-R^F-pyrazoles **2a–c** and **3a**,**b**. The moderate yield of the products is explained by incomplete conversion of the starting pyrazoles **1a–c** and difficulties of their preparative isolation using column chromatography and HPLC.

^{1}H NMR data were used to determine the anomeric structures of products **2a–c** and **3a**,**b**, since differences in chemical shifts and coupling constants for all protons of ribosyl moiety are

---

Method B. Pyrazole **1a–c** (2.8 mmol) and 1,2,3,5-tetra-*O*-acetyl-*β*-D-ribofuranose (2.9 mmol) were dissolved in anhydrous MeCN, then a catalytic amount of $SnCl_4$ was added and the mixture was kept overnight. The products were isolated as in method A. Products **2a** and **3a** were obtained as a mixture with 5:1 ratio and were separated by means of HPLC (52 and 10%). Products **2b** and **3b** were obtained as a mixture of isomers with 10:1 ratio. Product **2b** (56%) was isolated from the mixture by means of HPLC. The yield of compound **2c** was 59%.

*1-(2,3,5-Tri-*O*-acetyl-β-D-ribofuranosyl)-3,5-dimethyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole* **2a**. Orange oil, $[\alpha]_D$ –64.43 (*c* 1.004, $CHCl_3$). FTIR (ν/cm^{-1}): 1747 (C=O). ^{1}H NMR ($CDCl_3$) δ: 2.07 (s, 3H, $MeCO_2$), 2.13 (s, 3H, $MeCO_2$), 2.13 (s, 3H, $MeCO_2$), 2.41 (s, 3H, C_6H_4Me), 2.47 (s, 3H, 3-Me), 2.64 (s, 3H, 5-Me), 4.17 (dd, 1H, $H^{5'}$, $J_{5',5''}$ 11.9 Hz, $J_{4',5'}$ 5.5 Hz), 4.39 (dt, 1H, $H^{4'}$, $J_{3',4'}$ 6.0 Hz, $J_{4',5'}$ 5.5 Hz, $J_{4',5''}$ 3.5 Hz), 4.47 (dd, 1H, $H^{5''}$, $J_{5',5''}$ 11.9 Hz, $J_{4',5''}$ 3.5 Hz), 5.82 (dd, 1H, $H^{3'}$, $J_{3',4'}$ 6.0 Hz, $J_{2',3'}$ 4.9 Hz), 5.89–5.92 (m, 2H, $H^{2'}$ and $H^{1'}$), 7.25–7.27 (m, 2H, *m*-H, C_6H_4), 7.68–7.70 (m, 2H, *o*-H, C_6H_4). MS, *m/z* (%): 472 $[M]^+$ (8), 214 $[M-C_{11}H_{14}O_7]^+$ (21), 123 $[C_6H_7N_4]^+$ (44), 95 $[C_6H_7N_2]^+$ (7), 91 $[C_7H_7]^+$ (15), 43 $[MeCO]^+$ (100). Found (%): C, 58.39; H, 5.85; N, 11.96. Calc. for $C_{23}H_{28}N_4O_7$ (%): C, 58.47; H, 5.97; N, 11.86.

*1-(2,3,5-Tri-*O*-acetyl-β-D-ribofuranosyl)-3-trifluoromethyl-5-phenyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole* **2c**. Orange oil, $[\alpha]_D$ –45.84 (*c* 1.024, $CHCl_3$). FTIR (ν/cm^{-1}): 1750 (C=O), 1231–1257 (C–F). ^{1}H NMR ($CDCl_3$) δ: 2.07 (s, 3H, $MeCO_2$), 2.09 (s, 3H, $MeCO_2$), 2.10 (s, 3H, $MeCO_2$), 2.39 (s, 3H, C_6H_4Me), 4.22 (dd, 1H, $H^{5'}$, $J_{5',5''}$ 12.2 Hz, $J_{4',5'}$ 4.4 Hz), 4.41 (m, 1H, $H^{4'}$), 4.51 (dd, 1H, $H^{5''}$, $J_{5',5''}$ 12.2 Hz, $J_{4',5''}$ 3.2 Hz), 5.85 (t, 1H, $H^{3'}$, *J* 5.7 Hz), 5.85 (d, 1H, $H^{1'}$, $J_{1,2}$ 3.0 Hz), 6.00 (dd, 1H, $H^{2'}$, $J_{2',3'}$ 5.2 Hz, $J_{1',2'}$ 3.0 Hz), 7.21–7.23 (m, 2H, *m*-H, C_6H_4Me), 7.54–7.56 (m, 3H, *m*,*p*-H, Ph), 7.61–7.65 (m, 4H, *o*-H, C_6H_4Me and Ph). ^{19}F NMR, δ: 99.4 (s, CF_3). MS, *m/z* (%): 588 $[M]^+$ (2), 330 $[M - C_{11}H_{14}O_7]^+$ (13), 239 $[M - C_{11}H_{14}O_7 - C_6H_4Me]^+$ (8), 91 $[C_7H_7]^+$ (27), 43 $[MeCO]^+$ (100). Found (%): C, 57.28; H, 4.78; N, 9.45. Calc. for $C_{28}H_{27}N_4F_3O_7$ (%): C, 57.14; H, 4.62; N, 9.52.

*1-(2,3,5-Tri-*O*-acetyl-α-D-ribofuranosyl)-3,5-dimethyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole* **3a**. Orange oil, $[\alpha]_D$ 50.07 (*c* 1.16, CH_2Cl_2). FTIR (ν/cm^{-1}): 1748 (C=O). ^{1}H NMR ($CDCl_3$) δ: 1.86 (s, 3H, $MeCO_2$), 2.12 (s, 3H, $MeCO_2$), 2.13 (s, 3H, $MeCO_2$), 2.41 (s, 3H, C_6H_4Me), 2.49 (s, 3H, 3-Me), 2.62 (s, 3H, 5-Me), 4.27 (dd, 1H, $H^{5'}$, $J_{5',5''}$ 12.4 Hz, $J_{4',5'}$ 4.1 Hz), 4.47 (dd, 1H, $H^{5''}$, $J_{5',5''}$ 12.4 Hz, $J_{4',5''}$ 2.8 Hz), 4.98 (ddd, 1H, $H^{4'}$, $J_{3',4'}$ 6.8 Hz, $J_{4',5'}$ 4.1 Hz, $J_{4',5''}$ 2.8 Hz), 5.28 (m, 1H, $H^{3'}$), 5.82 (dd, 1H, $H^{2'}$, $J_{2',3'}$ 6.6 Hz, $J_{1',2'}$ 5.5 Hz), 6.24 (d, 1H, $H^{1'}$, $J_{1',2'}$ 5.5 Hz), 7.25–7.27 (m, 2H, *m*-H, C_6H_4), 7.68–7.70 (m, 2H, *o*-H, C_6H_4). MS, *m/z* (%): 472 $[M]^+$ (10), 214 $[M - C_{11}H_{14}O_7]^+$ (15), 123 $[C_6H_7N_4]^+$ (44), 95 $[C_6H_7N_2]^+$ (7), 91 $[C_7H_7]^+$ (13), 43 $[MeCO]^+$ (100). Found (%): C, 58.68; H, 5.87; N, 11.92. Calc. for $C_{23}H_{28}N_4O_7$ (%): C, 58.47; H, 5.97; N, 11.86.

Deacetylation of β-D- and α-D-ribofuranosyl substituted pyrazoles **2a–c** *and* **3a–c**. *Method A.* Compound **2a** (0.23 g, 0.5 mmol) was dissolved in ethanol (5 ml) and aqueous ammonia (0.5 ml) was added to the solution. The reaction mixture was stirred for 3 h at room temperature and neutralized with glacial AcOH. The product was extracted with CH_2Cl_2 (2×40 ml), washed with H_2O (300 ml) and dried with Na_2SO_4. The solution was concentrated and product **4a** was purified by HPLC.

Method B. Compound **2b**, **2c** or **3a** (0.5 mmol) was dissolved in methanol (5 ml), added to MeONa prepared from Na (0.03 g, 1.3 mmol) and MeOH (5 ml) and the mixture was refluxed for 30 min. Then the mixture was cooled, neutralized with glacial AcOH and concentrated. The products were extracted with CH_2Cl_2 (2×40 ml), washed with H_2O (300 ml) and dried with Na_2SO_4. The solution was concentrated. Products **4b**,**c** and **5a** were purified by column chromatography (eluent: chloroform, followed by chloroform–ethyl acetate, 3:1).

*1-(β-D-Ribofuranosyl)-3,5-dimethyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole* **4a**. Yield 35%, yellow powder, mp 78–80 °C, $[\alpha]_D$ –73.45 (*c* 1.155, CH_2Cl_2). IR (DRA, ν/cm^{-1}): 3340 (O–H). ^{1}H NMR ($CDCl_3$) δ: 2.31 (s, 3H, C_6H_4Me), 2.40 (s, 3H, 3-Me), 2.64 (s, 3H, 5-Me), 3.73 (d, 1H, $H^{5'}$, $J_{5',5''}$ 12.4 Hz), 3.99 (d, 1H, $H^{5''}$, $J_{5',5''}$ 12.4 Hz), 4.30 (br. s, 1H, $H^{4'}$), 4.58 (br. s, 1H, $H^{3'}$), 4.81 (t, 1H, $H^{2'}$, $J_{2',1'}$ 4.3 Hz), 5.84 (d, 1H, $H^{1'}$, $J_{1',2'}$ 4.3 Hz), 7.19–7.21 (m, 2H, *m*-H, C_6H_4), 7.60–7.62 (m, 2H, *o*-H, C_6H_4). Found (%): C, 58.69; H, 6.25; N, 16.28. Calc. for $C_{17}H_{22}N_4O_4$ (%): C, 58.95; H, 6.40; N, 16.17.

*1-(β-D-Ribofuranosyl)-3-trifluoromethyl-5-phenyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole* **4c**. Yield 77%, yellow powder, mp 120–122 °C, $[\alpha]_D$ –79.12 (*c* 1.08, MeOH). FTIR (ν/cm^{-1}): 3393 (O–H), 1123–1140 (C–F). ^{1}H NMR ($CDCl_3$) δ: 2.38 (s, 3H, C_6H_4Me), 3.79 (dd, 1H, $H^{5'}$, $J_{5',5''}$ 12.8 Hz, $J_{4',5'}$ 1.9 Hz), 4.02 (dd, 1H, $H^{5''}$, $J_{5',5''}$ 12.8 Hz, $J_{4',5''}$ 2.1 Hz), 4.29 (m, 1H, $H^{4'}$), 4.71 (dd, 1H, $H^{3'}$, $J_{4',3'}$ 4.8 Hz, $J_{3',2'}$ 3.6 Hz), 4.97 (t, 1H, $H^{2'}$, $J_{2',1'}$ 4.5 Hz), 5.95 (d, 1H, $H^{1'}$, $J_{1',2'}$ 4.1 Hz), 7.18–7.20 (m, 2H, *m*-H, C_6H_4Me), 7.54–7.62 (m, 7H, *m*,*p*-H, Ph, *o*-H, C_6H_4Me and Ph). ^{19}F NMR, δ: 99.2 (s, CF_3). Found (%): C, 57.35; H, 4.65; N, 12.26. Calc. for $C_{22}H_{21}N_4F_3O_4$ (%): C, 57.14; H, 4.58; N, 12.12.

*1-(α-D-Ribofuranosyl)-3,5-dimethyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole* **5a**. Yield 85%, yellow powder, mp 166–168 °C, $[\alpha]_D$ 38.35 (*c* 1.293, MeOH). IR (DRA, ν/cm^{-1}): 3333 (O–H). ^{1}H NMR ($CDCl_3$) δ: 2.42 (s, 3H, C_6H_4Me), 2.51 (s, 3H, 3-Me), 2.69 (s, 3H, 5-Me), 3.76 (dd, 1H, $H^{5'}$, $J_{5',5''}$ 11.8 Hz, $J_{4',5'}$ 3.5 Hz), 3.84 (d, 1H, $H^{5''}$, $J_{5',5''}$ 11.8 Hz, $J_{4',5''}$ 2.4 Hz), 4.37 (br. s, 1H, $H^{4'}$), 4.23 (br. s, 1H, $H^{3'}$), 4.60 (t, 1H, $H^{2'}$, $J_{1',2'}$ 6.5 Hz), 6.02 (d, 1H, $H^{1'}$, $J_{2',1'}$ 6.5 Hz), 7.26–7.28 (m, 2H, *m*-H, C_6H_4), 7.69–7.71 (m, 2H, *o*-H, C_6H_4). Found (%): C, 58.75; H, 6.65; N, 16.28. Calc. for $C_{17}H_{22}N_4O_4$ (%): C, 58.95; H, 6.40; N, 16.17.

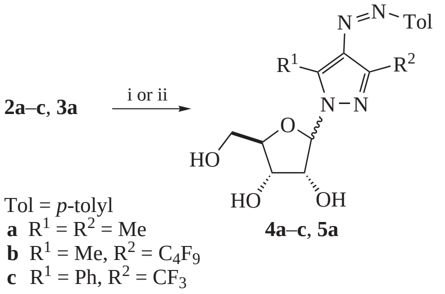
For characteristics of compounds **1a**,[10] **1b**, **2b**, **3b**, **4b**, see Online Supplementary Materials.

typical of peracetylated α- and β-1-ribofuranosyl-3,5-dimethyl-1*H*-pyrazoles.[8] The largest difference is observed in the chemical shifts of H(1′) protons and the $J_{1',2'}$ constants of the sugar residue. In fact, the signal of the H(1′) proton for the α-anomer is observed in lower field ($\delta_{H(1')}$ 6.26) and with higher coupling constant (*J* 5.2 Hz) as compared to similar values for the β-anomer ($\delta_{H(1')}$ 5.88, *J* 2.4 Hz). In our case, the ^{1}H NMR spectra of compounds **2a–c** revealing signals of the H(1′) protons in upper field and with smaller coupling constant ($\delta_{H(1')}$ 5.85–5.99, *J* 3.0–3.1 Hz) were assigned to β-anomers, while the spectra of compounds **3a**,**b** with resonance of the H(1′) protons at δ_H 6.24–6.36 with *J* 5.5–6.1 Hz were assigned to α-anomers.

Comparison of the ratios of the resulting β- and α-anomers **2a–c** and **3a**,**b** shows that the β-anomers are formed preferentially. The formation of only β-anomeric isomer **2c** from pyrazole **1c**, which has a bulky phenyl substituent at the 5-position, can be caused by steric hindrance.

Deprotection of peracetylated ribose moieties was performed for individual compounds **2a–c** and **3a**. Initially, mild deacetylation was attempted for compound **2a** at room temperature in ethanol with aqueous ammonia. After stirring for 3 h, the desired product **4a** was obtained with admixture of partially acetylated derivative in 1:1 ratio (according to ^{1}H NMR spectroscopy for the mixture). Compound **4a** was isolated by HPLC in 35% yield.

Deacetylation of compounds **2b**,**c** and **3a** was carried out more successfully under more drastic conditions by refluxing in methanol in the presence of MeONa (Scheme 2).† The target ribofuranosyl-substituted pyrazoles **4b**,**c** and **5a** were obtained in 77–85% yields.



Scheme 2 *Reagents and conditions*: i, NH$_4$OH, EtOH, ~20 °C; ii, MeONa, MeOH, Δ.

The structure of pyrazole **5a** was confirmed by XRD data (Figure 1).‡

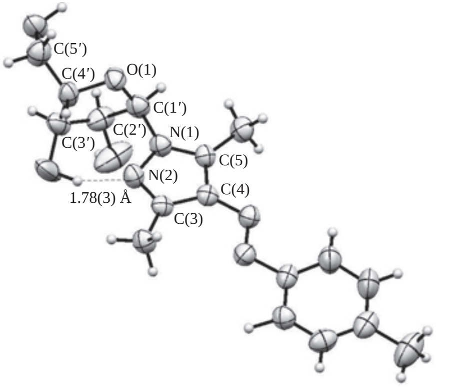


Figure 1 Molecular structure of 1-(α-D-ribofuranosyl)-3,5-dimethyl-4-[(4-methylphenyl)diazenyl]-1*H*-pyrazole **5a**.

In conclusion, we have obtained new ribofuranosylpyrazoles **4a–c** and **5a** by regiospecific condensation of 4-aryldiazenylpyrazoles **1a–c** with 1,2,3,5-tetra-*O*-acetyl-β-D-ribofuranose in the presence of SnCl$_4$. Efficient O-deacetylation of a peracetylated sugar residue is performed by refluxing in methanol in the presence of sodium methoxide.

This study was supported by the project UB RAS (no. 15-21-3-5).

Online Supplementary Materials

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.mencom.2016.03.006.

References

1 G. H. Elgemeie, W. A. Zaghary, K. M. Amin and T. M. Nasr, *Nucleosides Nucleotides Nucleic Acids*, 2005, **24**, 1227.
2 S. Manfredini, R. Bazzanini, P. G. Baraldi, D. Simoni, S. Vertuani, A. Pani, E. Pinna, F. Scintu, D. Lichino and P. La Colla, *Bioorg. Med. Chem. Lett.*, 1996, **6**, 1279.
3 M. T. Garcia-López, R. Herranz and G. Alonso, *J. Med. Chem.*, 1979, **22**, 807.
4 R. Storer, C. J. Ashton, A. D. Baxter, M. M. Hann, C. L. P. Marr, A. M. Mason, Ch.-L. Mo, P. L. Myers, S. A. Noble, C. R. Penn, N. G. Weir, J. M. Woods and P. L. Coe, *Nucleosides Nucleotides Nucleic Acids*, 1999, **18**, 203.
5 I. M. Abdou, A. M. Saleh and H. F. Zohdi, *Molecules*, 2004, **9**, 109.
6 A. E. Ivanova, Ya. V. Burgart and V. I. Saloutin, *Chem. Heterocycl. Compd. (Engl. Transl.)*, 2013, **49**, 1128 (*Khim. Geterotsikl. Soedin*., 2013, 1212).
7 O. G. Khudina, E. V. Shchegol’kov, Y. V. Burgart, M. I. Kodess, O. N. Kazheva, A. N. Chekhlov, G. V. Shilov, O. A. D’yachenko, V. I. Saloutin and O. N. Chupakhin, *J. Fluorine Chem*., 2005, **126**, 1230.
8 W. C. Kett, M. Batley and J. W. Redmond, *Carbohydr. Res*., 1997, **299**, 129.
9 O. G. Khudina, E. V. Shchegol’kov, Ya. V. Burgart, M. I. Kodess, V. I. Saloutin, O. N. Kazheva, G. V. Shilov, O. A. D’yachenko, M. A. Grishina, V. A. Potemkin and O. N. Chupakhin, *Russ. J. Org. Chem*., 2007, **43**, 380 (*Zh. Org. Khim*., 2007, **43**, 381).
10 S. A. Sankpal, M. B. Deshmukh, P. V. Anbhule, D. K. Salunkhe, K. N. Alsundkar, P. P. Patil, D. R. Chandam, S. D. Jagadale, A. G. Mulik and S. S. Rokade, *J. Chem. Pharm. Res*., 2010, **2**, 574.
11 G. M. Sheldrick, *Acta Crystallogr.*, 2008, **A64**, 112.

Received: 28th July 2015; Com. 15/4693

---

‡ *Crystallographic data for* **5a**: C$_{17}$H$_{22}$N$_4$O$_4$, M = 346.39, monoclinic, space group *C*-2, a = 25.510(3), b = 5.9740(5) and c = 13.2660(17) Å, β = 96.862(10)°, V = 1771.2(3) Å^3, Z = 4, d_{calc} = 1.299 g cm^{-3}, μ(MoKα) = = 0.094 cm^{-1}, F(000) = 736. The total number of reflections, 3810, was measured using an XCalibur S diffractometer at 295(2) K [ω-scanning, λ(MoKα) = 0.71073 Å, graphite monochromator, CCD detector]. The number of independent reflections was 2456 and the number of reflections was 1480. The structure was solved by direct methods and subsequent Fourier syntheses using the SHELXS-97 program, and refined by the least squares method in anisotropic full matrix approximation for all non-hydrogen atoms using the SHELXL-97 program[11] down to R_1 = 0.0354, wR_2 = 0.0707 and to R_1 = 0.0706, wR_2 = 0.0751 (for all reflections).

CCDC 945715 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre *via* http://www.ccdc.cam.ac.uk.

The pyrazole moiety is arranged in the same plane as the aryldiazenyl moiety, while the ribofuranosyl part has a C-envelope conformation in which the C(1′) atom is by 0.498 Å out of the C(2′)C(3′)C(4′)O(1) plane. The hydroxy group at C(3′) and the hydroxymethyl substituent at C(4′) occupy oppositely directed pseudo-axial positions, while the hydroxy group at C(2′) occupies a pseudo-equatorial position. The mutual orientation of the furanose ring and the pyrazole base in the molecule corresponds to a *syn*-conformation with an O(1)C(1′)N(1)N(2) torsion angle of 58.97°. The structure of molecule **5a** contains a strong hydrogen bond between the N(2) atom of the pyrazole ring and the hydroxy group at C(3′) [N(2)···HOC(3′)···1.78(3) Å].