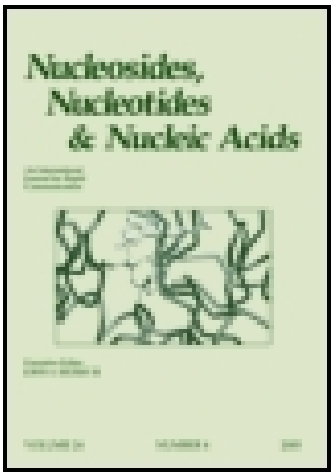

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Studies on Epimeric D-xylo-and D-lyxo-Tetritol-yl-2-phenyl-2H-1,2,3-triazoles. Synthesis and Anomeric Configuration of 4-(α- and β-D-Threofuranosyl)-2-phenyl-2H-1,2,3-triazole C-Nucleoside Analogs

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NUCLEOSIDES, NUCLEOTIDES & NUCLEIC ACIDS, 19(5&6), 941–954 (2000)

STUDIES ON EPIMERIC D-*XYLO*-AND D-*LYXO* -TETRITOL-1-YL-2-PHENYL-2 *H*-1,2,3-TRIAZOLES. SYNTHESIS AND ANOMERIC CONFIGURATION OF 4-(α- AND β-D-THREOFURANOSYL)- 2-PHENYL-2*H*-1,2,3- TRIAZOLE *C*-NUCLEOSIDE ANALOGS

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ABSTRACT – Treatment of 4-(D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(1)** with one mole equivalent of tosyl chloride in pyridine solution, afforded the *C*-nucleoside analog; 4-(β-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole **(2)** in 55% yield, as well as the byproduct 4-(4-chloro-4-deoxy-D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(4).** Treatment of the epimeric 4-(D-*lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(6)** with tosyl chloride in pyridine solution afforded the anomeric *C*-nucleoside analog ;4-(α–D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole **(7)** in 29% yield, as well as the byproduct 4-(4-chloro-4-deoxy-D-*lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(9).** Similar treatment of **1** and **6** with trifluoromethanesulfonyl chloride in pyridine solution afforded **2** and **7**, respectively. The structure and anomeric configuration of these compounds were determined by acetylation, NMR, NOE, and circular dichroism spectroscopy, as well as mass spectrometry.

We have been interested lately[1-7] in the synthesis of *C*-nucleoside analogs by acid catalyzed dehydrative cyclization of heterocyclic polyhydroxylalkyl analogs. Heterocycle pentahydroxypentyl analogs give a mixture of anomeric pyranosyl and furanosyl *C*-nucleosides[6]. Studies on acid catalyzed dehydration of epimeric saccharide tetrahydroxybutyl heterocycles indicated that, the reaction is stereospecific with the formation of a preponderant furanosyl *C*-nucleoside analog having *trans* arrangement of C-2′-OH and the base moiety[3-5,7,8]. The major isomer is obtained from both epimers of the epimeric pair, without inversion at C-1′ of the acyclic precursor epimer having *cis* arrangement of 1′-OH and 2′-OH and with inversion at C-1′ of the precursor epimer

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having *trans* arrangement. The ease of the acid catalyzed dehydrative cyclization process is greatly affected by the type and bulk of the base moiety[4].

The anomeric furanosyl *C*-nucleoside heterocycles having *cis* arrangement of 1′-OH and the base moiety could not be synthesized by this acid catalyzed dehydrative cyclization process. The dehydrative cyclization in basic medium of the epimeric pair D-*arabino* and D-*ribo*-2-phenyl-2*H*-1,2,3,-triazoles[9] was studied and the difficulty accessible α- D-erythrofuranosyl anomer having *cis* arrangement of 1′-OH and the base moiety was isolated and its anomeric configuration was ascertained .

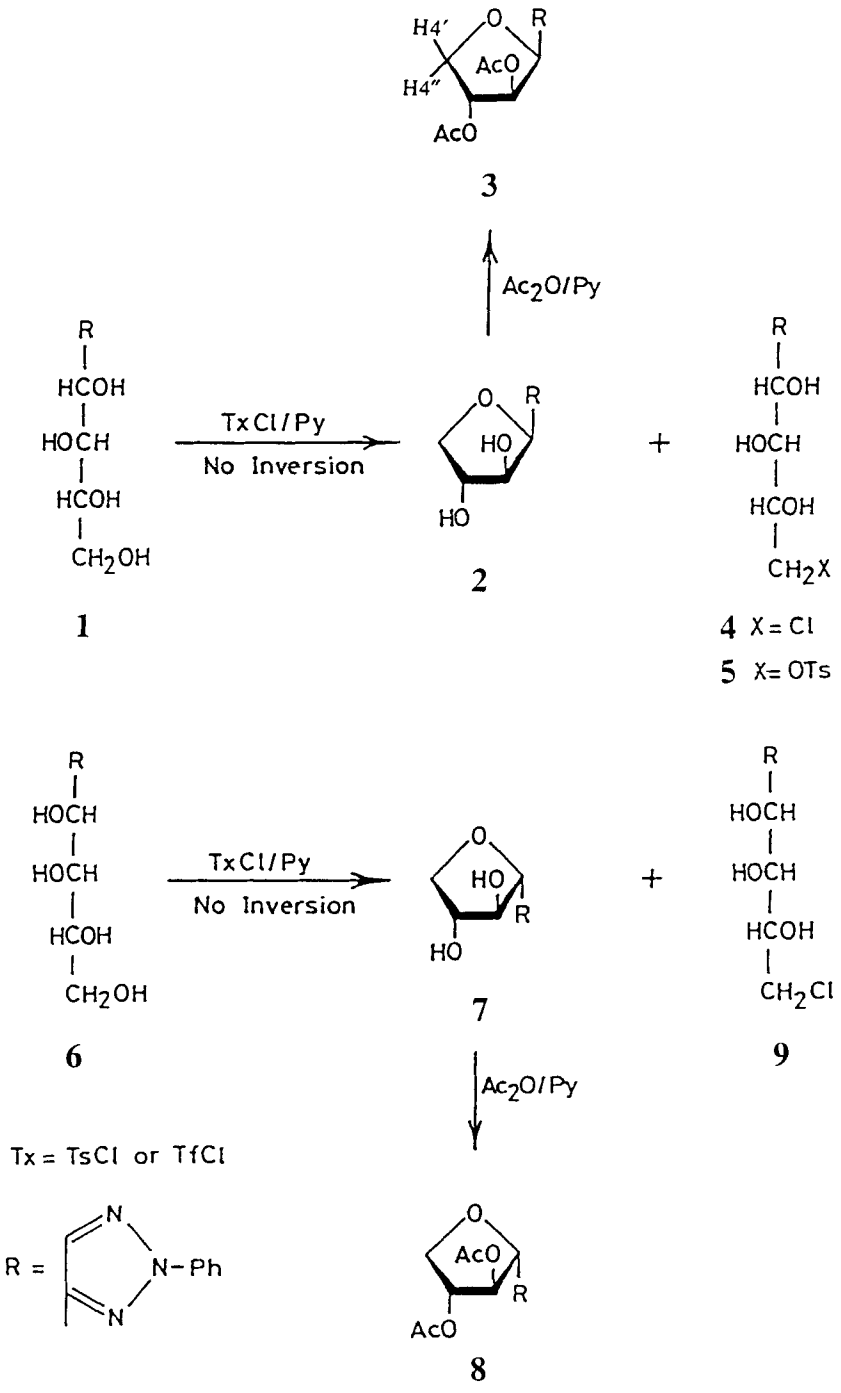
In this work the dehydrative cyclization in basic medium for the epimeric 4-(D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(1)** and 4-(D-*lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(6)** was studied . The structure and anomeric configuration of the products were determined by NMR, NOE, and circular dichroism spectorscopy, as well as mass spectrometry.

RESULTS AND DISCUSSION

Treatment of 4-(D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(1)** with one mole equivalent of *p*-toluenesulfonyl chloride in pyridine solution afforded the *C*-nucleoside analog namely ; 4-(β-D-threofuranosyl)-2*H*-1,2,3-triazole **(2)** in 55% yield (Scheme 1). Compound **2** was isolated by column chromatography. In addition, 4-(4-chloro-4-deoxy-D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(4)** was isolated as a byproduct. Similar treatment of **1**, with one mole equivalent of trifluoromethanesulfonyl chloride instead of tosyl chloride, in pyridine solution afforded **2** in 36% yield as well as the byproduct **4** . The intermediate byproduct 4-(*O*-*p*-tolylsulfonyl-D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(5)** was also isolated from the reaction mixture.

The ^{1}H NMR spectrum (Table I) of **2** showed the anomeric proton as a doublet at δ 5.14 having a coupling constant $J_{1',2'}$ 3.4 Hz. This coupling constant value is not low enough to define the anomeric configuration of **2**[10-12] . Likewise, its di-*O*-acetyl derivative **3** showed the anomeric proton as a doublet at δ 5.43 having a coupling constant $J_{1',2'}$ 3.9 Hz which cannot uniquivocally ascertain the anomeric configuration.

In order to confirm the anomeric configuration of **2** and to shed some light on the mechanism and the steric course of the dehydration process in basic medium, the



Scheme 1

Table I. ^{1}H NMR DATA, CHEMICAL SHIFTS (δ)[a] AND FIRST-ORDER COUPLING CONSTANTS (*J* Hz)[a] FOR COMPOUNDS **2,3,7** AND **8.**

Compound	Glycosyl part							2-Phenyl-2*H*-1,2,3-triazole			
	H-1′	H-2′	H-3′	H-4′	H-4″	OH	OAc	H-5	*o*-	*m*-	*p*-
2[b]	5.14d $J_{1',2'}$ 3.4	4.01d $J_{2',3'}$ 3.5	4.16t	4.14d $J_{3',4'}$ 4.1	3.63dd $J_{3',4''}$ 4.5 $J_{4',4''}$ 8.2	5.18d 5.28d		7.92s	7.98t	7.55m	7.38m
3[c]	5.43d $J_{1',2'}$ 3.9	5.52dd $J_{2',3'}$ 1.2	5.32m	4.51dd $J_{3',4'}$ 5.2	3.90dd $J_{3',4''}$ 2.5 $J_{4',4''}$10.7		1.95s 2.15s	7.80s	8.04dd	7.47dd	7.31dd *J* 7.4
7[b]	4.82d $J_{1',2'}$ 3.3	4.14t	4.08m	3.98dd $J_{3',4'}$ 4.4	3.83dd $J_{3',4''}$ 2.1 $J_{4',4''}$ 9.2	5.12d 5.53d		7.97s	7.98m	7.55m	7.40m
8[c]	5.10d $J_{1',2'}$ 3.2	5.49d	5.23m	4.20dd $J_{3',4'}$ 2.5 $J_{4',4''}$10.8	4.07m		1.98s 2.08s	7.80s	8.01m	7.41m	7.28m

[a] *J* and δ values for the sugar protons were measured after exchanging with CD_3CO_2D at 500 MHz ;
[b] In$(CD_3)_2SO$; [c] In $CDCl_3$.

epimer 4-(D-*lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole **(6)**, was similarly treated with equimolar amount of *p*-toluenesulfonyl chloride in pyridine solution and the products were separated by columm chromatography. It gave the *C*-nucleoside analog, namely; 4-(α-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole **(7)**[3], in 29% yield, as well as the acyclic byproduct 4-chloro-4-deoxy analog **9**. Similar treatment of **6** with one mole equivalent of trifluoromethanesulfonyl chloride instead of tosyl chloride in pyridine solution afforded **7** in 36% yield, as well as the acyclic byproduct **9**.

The ^{1}H NMR srectrum of **7** showed the anomeric proton as a doublet at δ 4.82 having a coupling constant $J_{1',2'}$ 3.3 Hz. This large coupling constant value cannot define[10-12] the anomeric configuration of **7**. Likewise, its di-*O*-acetyl derivative showed the anomeric proton as a doublet at δ 5.10 having a coupling constant $J_{1',2'}$ 3.2 Hz.

The assignment of the anomeric configuration of **2** and **7** from these coupling constant values was not possible. However , having the two anomers on hand, the anomeric assignment can be determined from the chemical shift values of their anomeric protons (H-1′). Compound **2** having the anomeric proton at lower field (δ 5.14) than the corresponding value (δ 4.82) for compound **7** , is in accord [13,14] with a *cis* arrangement of H-1′ and H-2′ for **2** and a *trans* arrangement for **7**. This chemical shift concept is also applicable for the anomeric di-*O*-acetyl derivatives **3** and **8**. Compound **3** showed the anomeric resonance at lower field (δ 5.43) than that for compound **8** (δ 5.10) which is in accord with a *cis* arrangement of H-1′ and H-2′ for **3** and a *trans* arrangement for **8** .

The ^{13}C NMR chemical shift values for the anomeric carbons of compound **2** and **7**, (Table II) are in accord with their ^{1}H NMR values. For compound **2** the *cis* anomeric carbon (C-1′) was shown at higher field (δ 76.2) than that for **7** (δ 79.9) having *trans* anomeric arrangement[10] . Similar correlation was observed for the chemical shift values of the anomeric carbons of **3** and **8**. The *cis* anomeric carbon of **3** was shown at higher field (δ 75.6) than of the *trans* carbon (δ 78.2) for **8** .

Nuclear Overhauser Effect (NOE) is considered as a more reliable tool for anomeric assignment[15,16]. For β-glycofuranosides, the configuration of carbons bonded to the ring oxygen (C-1′ and C-4′) place the respective hydrogens on the same face of the furanosyl ring and an NOE at H-4″ upon saturation of H-1′ indicates β-

Table II. ^{13}C NMR DATA FOR COMPOUNDS **2**,**3**,**7** AND **8** AT 125.7 MHz.

Compound	Glycosyl Part						2-Phenyl-2*H*-1,2,3-Triazole					
	C-1′	C-2′	C-3′	C-4′	OAc		C-4	C-5	*o*-	*m*-	*p*-	C-a
					CH_3	CO						
2[a]	76.2	77.6	77.0	73.7			139.6	136.4	118.4	129.8	127.6	148.1
3[b]	75.6	76.8	77.5	72.1	20.6 20.9	169.1 169.8	139.7	134.9	118.9	129.3	127.6	145.0
7[a]	79.9	82.8	77.1	73.8			139.2	134.8	118.2	129.7	127.5	150.4
8[b]	78.2	80.9	77.6	72.1	20.5	169.3 169.7	139.5	133.8	118.6	129.0	127.3	147.3

[a] In $(CD_3)_2SO$; [b] In $CDCl_3$

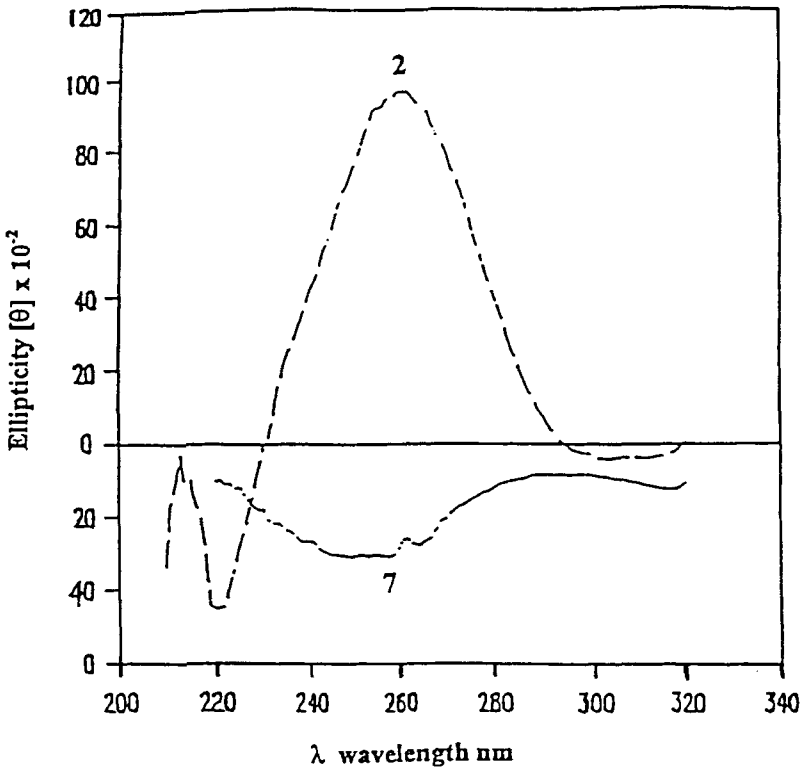


FIG. 1. CD spectra of (2) 4-(β-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole (- - - -) and (7) 4-(α-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole (____)

configuration. Irradiation of H-1′ of compound **3** resulted in an enhancement (2%) of H-4″ (trans to H-3′). Similarly, irradiation of H-4″ resulted in an enhancement (2.7%) of H-1′ in accord with the β-configuration for **3**. For α-furanosides, saturation of H-1′ results in an NOE at H-3′. Irradiation of H-1′ of compound **8** showed enhancement (1.8%) of H-3′ without enhancement of H-4″ . Similarly , saturation of H-3′ showed enhancement (2.3%) of H-1′, in accord with an α-configuration for **8** .

Additional evidence for the anomeric configuration of compounds **2** and **7** was obtained from their chiroptical properties. Their circular dichroism (CD) spectra (Fig. 1) showed an opposite Cotton effect at 230-300 nm. The absorption at this region is manifested by the configuration of the carbon atom α to the triazole base moiety.

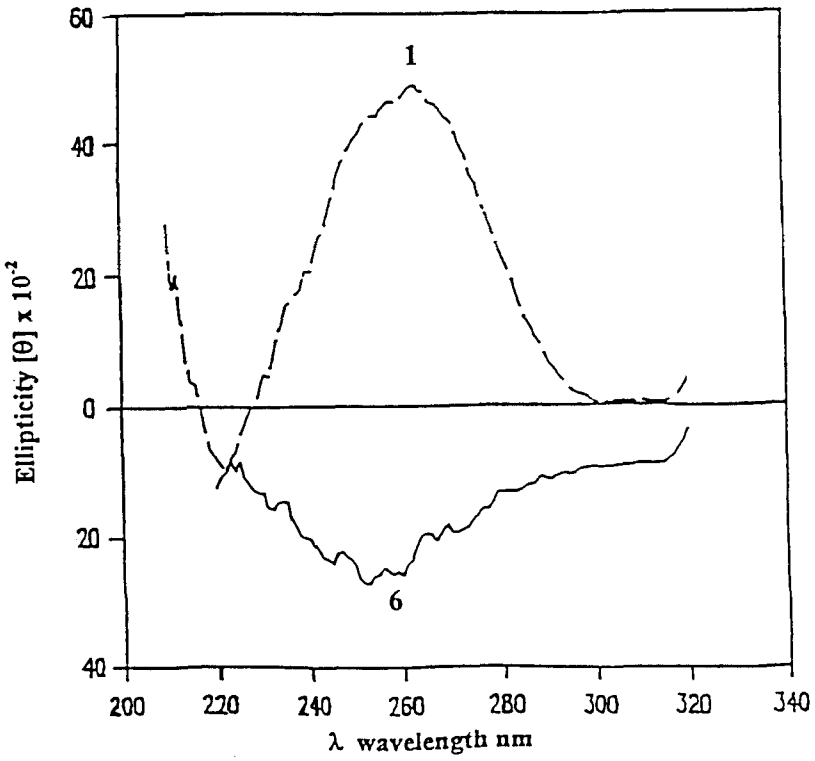


FIG. 2. CD spectra of (1) 4-(D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (- - - -) and (6) 4-(D-*lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (____)

Compound **2** showed positive Cotton effect at 230-300 nm (Fig. 1) having the same sign as the Cotton effect of the precursor triazole **1** (Fig. 2), in accord with a D-*glycero*-configuration at C-1′. Therefore, **2** is obtained from **1** without inversion of the configuration of C-1′, that is, the furanosyl group is formed with a β-D-*threo* configuration. On the other hand, compound **7** showed a negative Cotton effect at the same region (Fig. 1) having the same sign as its precursor triazole **6** (Fig. 2), in accord with an L-*glycero* configuration at C-1′ which is formed from **6** without inversion of the configuration of C-1′, i.e. the furanosyl group is formed with an α-D-*threo* configuration.

The formation of the *C*-nucleoside triazoles **2** and **7** from their precursor analogs **1** and **6** , respectively, in basic medium, can be explained by the formation of

the 4′-*O*-*p*-tolylsulfonyl chloride or trifluoromethylsulfonyl chloride intermediates as kinetic products which cyclize by S_Ni attack of the C-1′ hydroxyl on C- 4′, giving the thermodynamically stable *C*-nucleosides **3** and **7**, respectively .The isolation of the intermediate 4′-*O*-*p*- tolylsulfonyl derivative **5**, from the reaction mixture supports this mechanism.

In conclusion, the isolation of the anomer **2** by the dehydrative cyclization of **1** in basic medium, reports an easy synthesis for the difficulty accessible stereo less-favored α-D-threofuranosyl heterocyclic *C*-nucleoside analogs having *cis* arrangement of 2′-OH and the base moiety. The acid medium dehydrative cyclization affords only the stereofavored *trans* isomer form both acyclic epimers **1** and **6**, in better yield. However, the dehydrative cyclization in basic medium can be used as the method of choice for the synthesis of either pure anomer (α or β) from the corresponding acyclic tetrahydroxybutyl heterocyclic analogs in reasonable yields.

The mass spectrum of **2** showed the molecular ion peak at m/z 247. The base peak was shown at m/z 174 corresponding to the fragment BCHOH which is characteristic for *C*-nucleosides. The mass spectra of compounds **4** and **9** showed molecular ion peaks at m/z 283 and 285 in the ratio of 3:1 corresponding to the chlorine isotopes. The base peaks were shown at m/z 174 corresponding to the fragment BCHOH. The mass spectra of the acetyl derivatives **3** and **8** showed molecular ion peaks at m/z 331. The base peak was shown at m/z 43 for **3**, corresponding to the fragment CH_3CO and that for **8** was shown at m/z 212, corresponding to the fragment M – AcOH - OAc.

EXPERIMENTAL

General – Melting points are uncorrected. Evaporations were performed under diminshed pressure at < 60°C. Thin-layer chromatography (TLC) was conducted on silica gel (Kiesel gel G, Merck) with solvent **A**, 3:1 ethyl acetate-hexane and solvent **B**, 1:1 ethyl acetate-hexane. The products were detected by UV light at 254 nm. Circular dichroism (CD) measurements were recorded for solutions in methanol on Jasco-J500A spectropolarimeter, at a dynode voltage not exceeding 0.75kV, at concentration 1 mg/ml MeOH (0.2 ml microcell). ^{1}H NMR spectra were recorded with Bruker (500

MHz) spectrometer using tetramethylsilane as an internal standard.^{13}C NMR spectra were recorded with Bruker 500 MHz instrument at 125.8 MHz. The assignment of the carbons was verified by ^{1}H-^{13}C NMR COSY experiments. Mass spectra were recorded with AEI MS 902 spectrometer . High resolution mass spectra were recorded with a VG 70-250S spectrometer . Combustion analyses were performed in Galbraith Laboratories, Inc., Knoxville, TN, USA.

Treatment of 4-(D-*Xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (1) with *p*-Toluenesulfonyl Chloride in Pyridine Solution. A solution of **1**[17] (3 g, 11.3 mmol) in dry pyridine (20 mL) was treated at room temperature with *p*-toluenesulfonyl chloride (2.15 g, 11.3 mmol) in dry pyridine (10 mL) and the mixture was kept at room temperature for 48 h. TLC (solvent A) showed the disappearance of the starting material. Few drops of water were added to stop the reaction and the mixture was evaporated to a syrup. Traces of pyridine were removed by coevaporation with toluene, and the dry syrup was purified by flash chromatography on silica gel G 60, eluting with solvent A and collecting (5 mL) fractions.

(a) 4-(β-D-Threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole (2). Fractions 51-270 were combined and evaporated to dryness giving **2** as a colorless precipitate (1.46 g). The fractions containing the more mobile spots were collected and rechromatographed on silica gel , eluting with solvent A gave a further crop of **2** (89 mg); total yield 1.55g (55%). It was recrystallized from benzene, giving colorless needles, m.p. 105-106 °C; R_f 0.39 (solvent A) ; for ^{1}H and ^{13}C NMR data see Tables I and II ; mass spectral data (EI selected ions): m/z 247 (26, M), 188 (21, BCH_2CHOH, where B = 2-phenyl-2*H*-1,2,3-triazole-4-yl moiety), 187 (9, BCH_2CHO), 175 (25, BCH_2OH), 174 (100, BCHOH), 173 (10, BCHO), 158 (9, BCH_2), 92 (18, PhNH), 91 (45, PhN), 77 (38, Ph), 64 (13), 56 (11, cyclopentadiene ion), 55 (9), and 51 (11) ; accurate measurement of the molecular-ion peak : Found 247.0906 (Calcd for $C_{12}H_{13}N_3O_3$, 247.0927) ; Anal. Calcd for $C_{12}H_{13}N_3O_3$: C, 58.29; H, 5.30; N, 16.99% . Found : C, 58.32; H, 5.40; N, 16.87%.

(b) 4-(4-Chloro-4-deoxy-D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (4).- Fractions 30-50 were combined and evaporated to dryness giving **4** as a colorless syrup; R_f 0.53 (solvent A) ; mass spectral data (EI selected ions): m/z 285 (0.2, ^{37}M),

283 (0.7, ^{35}M), 247 (4, M - 2 H_2O), 212 (8, M – 2 H_2O - Cl), 211 (49, M - 2 H_2O - HCl), 188 (4, BCH_2CHOH), 175 (25, BCH_2OH), 174 (100, BCHOH), 173 (11, BCHO), 172 (6, BCO), 158 (8), 149 (22), 146 (2, BH_2), 145 (2, BH), 144 (0.3, B), 92 (20, PhNH), 91 (88, PhN), and 77 (35, Ph); accurate measurement of the molecular-ion peak: Found 283.0723 (Calcd for $C_{12}H_{14}N_3O_3Cl$, 283.0724)

(c) 4-(4-*O*-*p*-Tolylsulfonyl-D-*xylo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (5).- Fractions 2-12 were combined and evaporated to dryness giving **5** as a colorless syrup, which was purified by rechromatography on a short column (1 x 10 cm) of silica gel G 60 , eluting with solvent A; R_f 0.78 (solvent A); mass spectral data (EI, selected ions): m/z 401 (4, M), 246 (20, M - Ts), 230 (9, M - OTs), 229 (63, M - TsOH), 212 (53, M - TsOH - OH), 188 (3, BCH_2CHOH, where B = 2-phenyl-2*H*-1,2,3-triazole-4-yl moiety), 187 (7, BCH_2CHO), 186 (6, BCH_2OH), 175 (12, BCH_2OH), 174 (100, BCHOH), 173 (28, BCHO), 172 (6, BCO), 158 (16), 103 (6), 92 (20, PhNH), 91 (49, PhN), 77 (25, Ph), 65 (14), 64 (7), 51 (5), and 45 (8); accurate measurement of the molecular-ion peak: Found 401.1038 (Calcd for $C_{19}H_{19}N_3O_5S$, 401.1062).

Treatment of 1 with trifluoromethanesulfonyl chloride in pyridine solution. Compound **1** (500 mg) in dry pyridine (10 mL) was treated dropwise with trifluoromethanesulfonyl chloride (0.30 mL) at room temperature under nitrogen atmosphere, with stirring for 24 h. The mixture was diluted with methanol and evaporated to dryness. Traces of pyridine were removed by coevaporation with toluene. The dry residue was chromatographed on a column (30 x 2.5 cm) of silica gel G 60, eluting with solvent A. Identical fractions were combined and evaporated to dryness giving **2** as a colorless syrup; R_f 0.39 (solvent A), yield 170 mg (36%). It was crystallized from chloroform-hexane as colorless needles, m.p. and mixed m.p. (with **2**)101-103 °C.

4-(2,3-Di-*O*-acetyl-β-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole(3).- Compound **2** (50 mg) was treated with a mixture (1:1) of pyridine-acetic anhydride (20 mL) and kept at room temperature for 24 h. The mixture was evaporated to dryness and traces of pyridine were removed by coevaporation with toluene. The residual syrup was chromatographed on a short column (1 x 10 cm) of silica gel G 60, eluting with solvent

B. Identical fractions were collected and evaporated to dryness giving a colorless syrup, yield 35 mg (52%). It was crystallized from diethyl ether-hexane giving colorless needles of **3**, m.p. 80-82 °C; R_f 0.58 (solvent B) ; for ^1H and ^{13}C NMR data see Tables I and II ; mass spectral data (EI, selected ions): m/z 331 (3, M), 271 (12, M - AcOH), 229 (10, M - OAc - Ac), 213 (28, M - 2 OAc), 212 (96, M - AcOH - OAc), 211 (11, M – 2 AcOH), 200 (8), 188 (4, BCH_2CHOH), 187 (10, BCH_2CHO), 175 (8, BCH_2OH), 174 (63, BCHOH), 173 (16, BCHO), 172 (12, BCO), 158 (7, BCH_2), 144 (1, B), 117 (3, B - HCN), 116 (9, B - N_2), 115 (69, B - H - N_2), 92 (9, PhNH), 91 (28, PhN), 77 (23, Ph), 65 (4), 64 (8), 51 (5), 44 (6), and 43 (100, CH_3CO); accurate measurement of the molecular-ion peak: Found 331.1166 (Calcd for $C_{16}H_{17}N_3O_5$, 331.1168); Anal. Calcd for $C_{16}H_{17}N_3O_5$: C, 58.00; H, 5.17; N, 12.68%. Found: C, 58.12; H, 5.38; N, 12.52%

Treatment of 4-(D-*Lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (6) with *p*-Toluenesulfonyl Chloride in Pyridine Solution. A solution of **6**[17] (2.5 g, 9.4 mmol) in dry pyridine (20 mL), was treated at room temperature with a solution of *p*-toluenesulfonyl chloride (1.8 g, 9.4 mmol) in dry pyridine (10 mL) and the mixture was kept at room temperature for 24 h. TLC (solvent A) indicated the disappearance of the starting material. Few drops of water were added to stop the reaction and the mixture was evaporated to a syrup. Traces of pyridine were removed by coevaporation with toluene, and the dry syrup was applied on a column of silica gel G 60, eluting with solvent A and collecting (5 mL) fractions.

(a) 4-(α-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole (7). Fractions 40-120 were combined and evaporated to dryness giving a colorless precipitate, yield 0.67 g (29%). It was recrystallized form diethyl ether giving colorless needles, m.p. 95-98 °C (lit[3] m.p. 97-99 °C), R_f 0.37 (solvent A); for ^1H and ^{13}C NMR data see Tables I and II .

(b) 4-(4-Chloro-4-deoxy-D-*lyxo*-tetritol-1-yl)-2-phenyl-2*H*-1,2,3-triazole (9). Fractions 15-25 were combined and evaporated to dryness giving **9** as a colorless syrup; R_f 0.46 (solvent A); mass spectral data (EI , selected ions) :m/z 285 (0.2, ^{37}M), 283 (0.7, ^{35} M), 247 (5, M – 2 H_2O), 229 (7, M – 3 H_2O), 212 (11, M – 2 H_2O - Cl), 211 (33, M - 2 H_2O - HCl), 188 (7, BCH_2CHOH), 187 (5, BCH_2CHO), 179 (11), 175 (27, BCH_2OH), 174 (100, BCHOH), 173 (15, BCHO), 172 (10, BCO), 158 (7), 146 (2,

BH_2), 145 (2, BH), 144 (0.4, B), 117 (4, B - HCN), 107 (16, PhN_2H_2), 106 (10, PhN_2H_2), 91 (67, PhN) 79 (7), 78 (8, PhH), and 77 (52, Ph); accurate measurement of the molecular-ion peak: Found 283.0723 (Calcd for $C_{12}H_{14}N_3O_3Cl$, 283.0724).

Treatment of 6 with trifluoromethanesulfonyl chloride in pyridine solution.- Compound **6** (500 mg) in dry pyridine (10 mL) was treated dropwise with trifluoromethanesulfonyl chloride (0.30 mL) at room temperature under nitrogen atmosphere, with stirring for 24 h. The mixture was processed as described for **1**. Compound **7** was separated as a colorless syrup ; R_f 0.37 (solvent A), yield 165 mg (35%). It was crystallized from diethyl ether , as colorless needles , m.p. and mixed m.p. (with **7**) 88-90 °C.

4-(2,3-Di-*O*-acetyl-α-D-threofuranosyl)-2-phenyl-2*H*-1,2,3-triazole(8).- Compound **7** (170 mg) was treated with a mixture (1:1) of pyridine-acetic anhydride (20mL) and kept at room temperature for 24 h. The mixture was processed as described for **3**. It gave a colorless syrup, yield 200 mg (88%); for ^1H and ^{13}C NMR data see Tables I and II; mass spectral data (EI, selected ions): m/z 331 (1, M), 271 (8, M - AcOH), 229 (5, M - OAc - Ac), 213 (14, M – 2 OAc), 212 (100, M - AcOH - OAc), 211 (5, M - 2 AcOH),188 (4,BCH_2CHOH),187 (4, BCH_2CHO), 175 (3, BCH_2OH), 174 (21, BCHOH), 173 (5, BCHO), 172 (7, BCO), 158 (3, BCH_2), 115 (20, B - H N_2), 91 (12, PhN), 77 (11, Ph), 65 (4), 64 (8), 51 (5), 44 (6), and 43 (46,CH_3CO) ; accurate measurement of the molecular-ion peak : Found 331.1174 (Calcd for $C_{16}H_{17}N_3O_5$, 331.1168).

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