CH_2Cl); 4.20 (q, 2H, CH_2); 4.87 (dd, 1 H, H5); 6.50 (1 H, NH).

(4*R*,5*S*)-5-Chloromethyl-4-ethoxycarbonyl-4-methyl-2-oxazolidinone (31). $[\alpha]_D^{20}$ +40°. ^1H NMR, δ: 1.32 (t, 3 H, Me); 1.68 (s, 3 H, Me); 3.80 (d, 2 H, CH_2Cl); 4.25 (q, 2 H, CH_2); 4.60 (t, 1 H, H5); 6.87 (1 H, NH). MS (70 eV), *m/z* (I_{rel}, %): 221 $[M]^{+\cdot}$(24), 172 $[M-CH_2Cl]^+$(12), 148 $[M-CO_2Et]^+$(100), 104 $[M-117]^+$(88).

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New type of interaction of 5-iodopyrimidine nucleosides with alkynes

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The interaction of 1-(β-*D*-xylofuranosyl)-5-iodo(bromo)uracil derivatives with terminal alkynes in the presence of catalytic amounts of 10% Pd/C and CuI affords the corresponding derivatives of 3-(β-*D*-xylofuranosyl)-6-*R*-furo[2,3-*d*]pyrimidin-2-ones in high yields.

Key words: 1-(β-*D*-xylofuranosyl)-5-iodo(bromo)uracils, alkynes; Pd/C catalysis, 3-(β-*D*-xylofuranosyl)-6-*R*-furo[2,3-*d*]pyrimidin-2-ones.

5-Substituted pyrimidine nucleosides possess high biological activity.[1,2] 5-Alkynyl derivatives are among the promising compounds of this series; their synthesis is usually carried out by $PdCl_2(PPh_3)_2$-catalyzed coupling of 5-iodonucleosides with terminal alkynes in the presence of CuI.[3—15] Recently, it was shown that the coupling of bromoarenes with alkynes also proceeds over a heterogeneous Pd/C catalyst in the presence of CuI and PPh_3.[17] Having used this catalyst in the reaction of 5-nucleosides with alkynes,[16] we have found that with acetonitrile as a solvent the addition of PPh_3 is not necessary. It must be noted, however, that heterocyclization proceeds in the course of the reaction with the resultant formation of furo[2,3-*d*]pyrimidine nucleosides. Thus, the reactions of nucleosides **1—4** with phenylacetylene (**5**) under the action of Pd/C and CuI in acetonitrile in the presence of triethylamine afford 3-(2-O-acetyl-3,5-di-O-benzoyl-β-*D*-xylofuranosyl)- and 3-(3,5-di-O-benzoyl-β-*D*-xylofuranosyl)-6-phenylfuro[2,3-*d*]pyrimidine-2-ones (**6,7**). Unlike iodides, which give products in a high yield, 5-bromides **3** and **4** react slowly and in a low yield.

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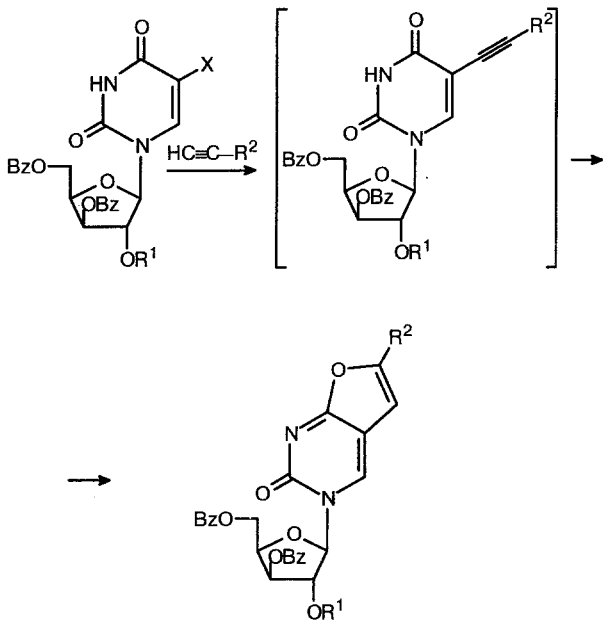
Table 1. Reaction time and yield of products

Original nucleoside	Alkyne	Catalyst	Reaction time (h)	Product	Yield (%)
1	**5**	Pd/C, CuI, PPh_3, MeCN, Et_3N	5	**6**	82
2	**5**	»	8	**7**	76
1	**5**	Pd/C, CuI, MeCN, Et_3N	5	**6**	82
2	**5**	»	8	**7**	76
1	**8**	»	6	**9**	81
2	**8**	»	8	**10**	68
3	**5**	»	18	**6**	20
4	**5**	»	20	**7**	15
1	**11**	»	9	**12, 13, 14**	8, 14, 44
2	**11**	»	11	**14**	61
3	**5**	Pd/C, CuI, PPh_3, MeCN, Et_3N	18	**6**	20



1: X = I, R^1 = Ac
2: X = I, R^1 = H
3: X = Br, R^1 = Ac
4: X = Br, R^1 = H

6: R = Br, R^1 = Ac, R^2 = Ph
7: R = Br, R^1 = H, R^2 = Ph
9: R = Br, R^1 = Ac, R^2 = $Me(CH_2)$
10: R = Br, R^1 = H, R^2 = $Me(CH_2)_7$
12: R = Br, R^1 = Ac, R^2 = CH_2OAc
13: R = Br, R^1 = Ac, R^2 = CH_2OH
14: R = Br, R^1 = H, R^2 = CH_2OH
15: R = R^1 = H, R^2 = Ph
16: R = R^1 = H, R^2 = $Me(CH_2)_7$
17: R = R^1 = H, R^2 = CH_2OH

Under these conditions the reaction of nucleosides **1** and **2** with 1-decyne (**8**) affords 3-(2-O-acetyl-3,5-di-O-benzoyl-β-*D*-xylofuranosyl)-6-octylfuro[2,3-*d*]pyrimidin-2-one (**9**) and 3-(3,5-di-O-benzoyl-β-*D*-xylofuranosyl)-6-octylfuro[2,3-*d*]pyrimidin-2-one (**10**), respectively, in good yields (Table 1).

The reaction of 2-propynyl alcohol (**11**) with nucleoside **1** is accompanied by transesterification; in this case, 3-(3,5-di-O-benzoyl-β-*D*-xylofuranosyl)-6-acetoxymethylfuro[2,3-*d*]pyrimidin-2-one (**12**), 3-(2-O-acetyl-3,5-di-O-benzoyl-β-*D*-xylofuranosyl)-6-hydroxymethylfuro[2,3-*d*]pyrimidin-2-one (**13**), and 3-(3,5-di-O-benzoyl-β-*D*-xylofuranosyl)-6-hydroxymethylfuro[2,3-*d*]pyrimidin-2-one (**14**) are formed. The possibility of acetyl migration is proved by the reaction of diol **14** with nucleoside **1** in the presence of Pd/C and CuI, which gives a mixture containing compounds **12** and **13**.

Deblocking compounds **6** and **7**, **9** and **10**, and **12—14** with 0.1 *N* MeONa in MeOH gives 3-(β-*D*-xylofuranosyl)-6-phenyl- (**15**), 3-(β-*D*-xylofuranosyl)-6-octyl- (**16**), and 3-(β-*D*-xylofuranosyl)-6-hydroxymethylfuro[2,3-*d*]pyrimidin-2-ones (**17**), respectively, in ~80% yields. The reaction of nucleoside **1** with

Table 2. UV of compounds **6**, **7**, **9**, **10**, and **12—17**

Compound	UV	
	λ_{max} (nm) (solvent)	λ_{min} (nm)
6	228.6, 280, 352.7 (MeCN)	214.6, 249.1, 315.0
7	226.6, 280, 352.5 (MeCN)	214.6, 249.5, 315.0
9	229.5, 274, 334.3 (MeCN)	217.5, 264.6, 289.2
10	229.0, 273, 332.0 (MeCN)	216.8, 266.3, 289
12	228.6, 274, 281.6, 332.3 (MeCN)	264.9, 278, 288.6
13	228.6, 274, 333 (MeCN)	209.4, 261, 311.3
14	228.9, 274, 333.2 (MeCN)	211.2, 263.5, 261.2
15	228, 277.8, 343.2 (H_2O)	216, 247.5, 310.0
16	224.3, 243.5, 330 (MeOH)	219.3, 238.5, 265.8
17	224, 245, 322 (H_2O)	213.9, 239, 264.7

Table 3. ^{13}C NMR (δ) of compounds **6, 7, 10, 12—14, 16,** and **17**

Compound	C(1')	C(2')	C(3')	C(4')	C(5')	C(2)	C(4)	C(5)	C(6)	C(7a)	C(4a)	C(8)
6	91.48	81.06	74.81	80.01	61.45	156.15	135.64	97.34	154.54	172.08	108.24	24.93
9	91.30	80.88	74.84	80.08	61.53	160.60	133.42	98.56	154.64	172.30	107.95	26.85
10	95.19	80.86	77.36	80.44	61.96	160.45	133.36	98.68	155.67	171.98	107.95	26.84
12	95.27	81.19	76.61	80.25	61.86	155.46	137.48	104.01	152.48	17186	106.76	57.80
13	91.63	81.17	74.64	80.50	61.42	158.18	136.22	100.72	154.91	172.13	107.66	57.25
14	95.13	80.95	77.31	80.40	61.90	157.57	136.63	101.01	155.48	171.92	107.48	57.43
16	93.78	85.26	74.64	80.27	59.00	157.81	137.70	99.82	153.91	171.17	105.43	26.85
17	93.87	85.38	74.50	80.20	59.00	156.82	138.96	101.18	153.95	171.27	104.95	55.95

Table 4. ^1H NMR (δ) of xylofuranosylfuropyrimidines **6, 7, 9, 10,** and **12—17**

Compound	H(1') ($J_{1,2}$)	H(2') ($J_{2,3}$)	H(3') ($J_{3,4}$)	H(4')	H(5a') ($J_{4,5}$) (J_{gem})	H(5b') ($J_{4,5}$)	H(4)	H(5)	CH_3(Ac)	OH(2')	OH(3')	OH(4')	OH(5')	Ar—H	R
6	6.24 s	5.58 s	5.71 d (3.20)	4.95 ddd (5.00)	4.86 m (2.10)	(5.00)	6.49 s	8.54 s	2.22 s	—	—	—	—	7.22—7.96 m (15H)	—
7	6.05 c	4.18 c	5.70 m	5.16 q	4.80 dd (4.15) (−12.50)	4.86 dd (6.03)	6.55 s	8.67 s		4.71 s				7.19—8.00 m (15H)	
9	6.23 d (1.04)	5.52 t (1.15)	4.68 dd (3.40)	4.92 ddd	4.80 m (−12.26)		5.92 s	8.46 s	2.20 s					7.20—8.00 m (10H)	0.90 t, 2.64 t, 1.69 m, 1.27 m
10	5.98 s	4.65 s	5.70 dd (3.50)	5.13 m	4.81 dd (6.00) (−12.35)	4.77 dd (4.20)	6.01 s	8.47 s	5.64 s					7.19—8.00 m (10H)	0.90 t, 2.62 t, 1.67m, 1.25 m
12	5.90 s	4.56 s	5.60 dd (2.00)	5.05 m	4.72 dd (5.15) (−8.50)	4.68 dd (4.10)	6.30 s	8.60 s	2.20 s	5.55 s				7.20—8.00 m (10H)	4.96 s
13	6.19 s	5.83 s	5.63 dd	4.92 m	4.80 m		6.35 s	8.51 s	2.20 s				4.63 s	7.22—8.00 m (10H)	4.63 s
14	5.80 s	4.52 d (1.47)	5.58 dd (3.73)	5.06 m	4.81 dd (4.04) (−12.43)	4.78 dd (4.30)	6.23 s	8.48 s	4.58 s			4.58 s	7.25—7.95 m	(10H)	4.58 s
15	5.84 d (4.19)	4.16 d (4.07)	4.03 t (2.83)	4.19 t.d	3.96 dd (6.00) (−7.60)	3.90 dd (5.50)	6.52 s	8.63 s	5.09 s	4.79 d	4.54 t (2.80)	(5.69)		7.20—8.00 m (5H)	
16	5.98 d (4.35)	4.12 d (4.15)	4.00 t (2.50)	4.39 t.d	3.96 dd (6.00) (−7.60)	3.90 dd (5.50)	6.58 s	8.51 s	5.77 s	5.28 s	4.89 t (2.90)	(5.70)		0.90 t,	2.72 t, 1.67 m, 1.25 m
17 4.50 s	5.79 s	4.18 s	4.13 s	4.40 m	4.39 m		6.58 s	8.61 s		5.72 s	5.24 s	4.77 t (5.20)	4.50 s		

Table 5. Melting points and elemental analysis data of compounds **6, 7, 9, 10,** and **12—17**

Compound	Mp (°C)	Found (%) / Calculated			Molecular formula
		C	H	N	
6	—	66.32 66.67	4.08 4.38	4.43 4.71	$C_{33}H_{26}N_2O_9$
7	—	67.06 67.39	4.16 4.35	4.74 5.07	$C_{31}H_{24}N_2O_8$
9	—	66.40 66.67	5.98 6.03	4.25 4.44	$C_{36}H_{38}N_2O_9$
10	—	67.05 67.35	6.09 6.12	4.45 4.66	$C_{33}H_{36}N_2O_8$
12	—	61.13 61.31	4.16 4.38	5.24 5.11	$C_{28}H_{24}N_2O_{10}$
13	—	60.97 61.31	4.16 4.38	4.83 5.11	$C_{28}H_{24}N_2O_{10}$
14	—	61.41 61.66	4.21 4.34	5.37 5.53	$C_{26}H_{22}N_2O_9$
15	129—132 (CH_3CN)	59.02 59.17	4.66 4.93	7.84 8.12	$C_{17}H_{17}N_2O_6$
16	154—155 ($CHCl_3$)	49.79 50.00	7.11 7.37	7.06 7.37	$C_{19}H_{28}N_2O_6$
17	>300 (CH_3CN)	49.94 48.32	4.38 4.70	9.16 9.40	$C_{12}H_{14}N_2O_7$

phenylacetylene **5** in a triethylamine—acetonitrile mixture in the presence of Pd/C and CuI at ~20°C for a long period (>100 h) exhibits only slight accumulation of luminescent furopyrimidine compound **6**. However, in this case an intermediate 5-alkynyl derivative was not formed either.

The structures of the compounds obtained were established on the basis of spectral data. For example, the ^{13}C NMR spectra of compounds obtained exhibit, besides signals of the carbon atom of the heterocyclic and carbohydrate residues, signals of benzoyl groups at δ 164—166 (CO) and 128—134 (Ph), acetyl groups [in **6**, **9**, **12**, and **13**; δ(CO) 168—170, δ(CH_3) ~21], and carbon atoms of the substituents at C(6): 124.0—124.9 for **6**, 14.1, 22.7, 26.8, 28.3, 29.0—29.7, 31.8 for **9** and **10**, 57.2—57.8 for **12—14**, 13.8, 22.0, 26.3, 27.3, 28.3—28.5, 31.1 for **16**, and 55.7 for **17**. The small coupling constants for the protons of carbohydrate moiety indicate the retention of the β configuration under the conditions of this catalytic reaction.

Experimental

^1H and ^{13}C NMR spectra were recorded with a Bruker AM-300 spectrometer at working frequencies of 300 and 75 MHz in $CDCl_3$ (for compounds **15**, **16**, and **17** in DMSO-d_6) with tetramethylsilane as an internal standard. UV-spectra were recorded with a Shimadzu UV 365 spectrophotometer. Optical rotation was determined with a Perkin-Elmer 241 MC polarimeter. Column chromatography was carried out on L40/100 μ silica gel in chloroform.

Synthesis of compounds 6, 7, 9, 10, and 12—14. A mixture of 1 mmol of the corresponding nucleoside (**1—4**), 1.2 mmol of alkyne, 0.042 g of 10 % Pd/C, and 0.01 g of CuI was refluxed in 2.5 mL of triethylamine and 2.5 mL of acetonitrile in argon atmosphere for a specified period of time (see Table 1). After cooling to ~20°C, the reaction mixture was filtered, and the residue was washed with acetonitrile (5 mL). The combined filtrates were evaporated to dryness, and the residue was purified by chromatography. The yields of the products and their physicochemical properties are given in Tables 1—5.

Preparation of nucleosides 15, 16, and 17. The protective groups were removed from the compounds obtained according to the above procedure by treatment with 0.1 *N* MeONa in MeOH for 24 h. The reaction mixture was neutralized by the KU-2-08 cation exchanger, the cation exchanger was filtered off and washed with methanol. The combined filtrates were evaporated to a syrup and treated with acetonitrile. The crystals precipitated were filtered out, and pure products **15—17** were obtained. Tables 2—5 summarize their physicochemical properties.

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