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Preliminary communication

Stereospecific addition of a phosphinate and of phosphonates to methyl 6-deoxy-2,3-*O*-isopropylidene-α-L-*lyxo*-hexopyranosid-4-ulose

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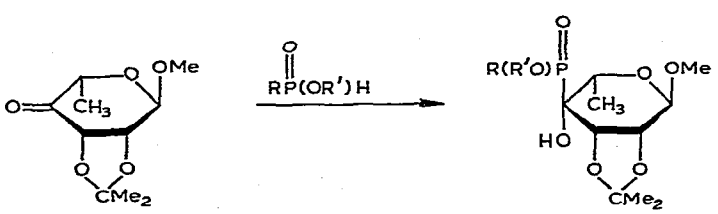
As an alternative method for preparing sugar derivatives having a phosphorus atom as the ring heteroatom[1], attempts to introduce a carbon–phosphorus bond were made by using the addition reaction of phosphorus compounds to glycosiduloses. It is known that reaction of carbonyl compounds with dialkyl phosphonates affords α-hydroxyphosphonates[2], and the reaction of glyculoses with dialkyl phosphonate under Abramov conditions has also been reported[3]. We now report a stereospecific addition reaction of phosphorus compounds to a glycosid-4-ulose.

Methyl 6-deoxy-2,3-*O*-isopropylidene-α-L-*lyxo*-hexopyranosid-4-ulose[4] (**1**, 2 g) was treated with methyl phenylphosphinate (1.5 g), in the presence of triethylamine (1 mL) as the catalyst, for 10 h at 70–80°. The yield of crude product was almost quantitative, and the ^{1}H-n.m.r. spectrum of the reaction mixture showed the existence of only one stereoisomer. The product was recrystallized from methanol, to give pure compound **2a** in 45% yield, m.p. 179–180°, $[\alpha]_D^{20}$ −82.3° (*c* 1.0, $CHCl_3$); ν_{max}^{KBr} 3320 (OH), 1210 (P=O), 751, and 696 cm^{-1} (Ph); ^{1}H-n.m.r. ($CDCl_3$): δ 1.04



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2a R = Ph, R' = Me
2b R = OMe, R' = Me
2c R = OEt, R' = Et

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(d, 3 H, *J* 7.0 Hz, Me-5), 1.36 (s, 3 H, C-Me), 1.52 (s, 3 H, C-Me), 3.33 (s, 3 H, OMe-1), 3.65 (d, 3 H, J_{POCH} 11.0 Hz, P-O-Me), 4.00–5.00 (m, 4 H, H-1,2,3,5), and 7.30–8.10 (m, 5 H, Ph); mass spectrum: *m/e*, 372 (M^+).

Anal. Calc. for $C_{17}H_{25}O_7P$: C, 54.84; H, 6.76. Found: C, 54.70; H, 6.86.

Compound **2a** was hydrolyzed with 4M hydrochloric acid at 50°, giving compounds **3α** and **3β** in the ratio of 9:1. Compound **3α** was treated with acetone in the presence of copper(II) sulfate for a week at room temperature, to give compounds **4** and **2a** in the ratio of 1:1 (based on the ^{1}H-n.m.r. spectrum). Compound **4** had m.p. 166–167°, $[\alpha]_D^{17}$ −127.5° (*c* 1.0, $CHCl_3$); ν_{max}^{KBr} 3400 (OH) and 1210 cm^{-1} (P=O); ^{1}H-n.m.r. ($CDCl_3$): δ 1.08 (d, 3 H, *J* 6.8 Hz, Me-5), 1.10 (s, 3 H, C-Me), 1.45 (s, 3 H, C-Me), 3.40 (s, 3 H, OMe-1), 3.68 (d, 3 H, J_{POCH} 11.0 Hz, P-O-Me), 3.90–5.00 (m, 4 H, H-1,2,3,5), and 7.30–8.10 (m, 5 H, Ph); mass spectrum: *m/e* 372 (M^+). Therefore, compound **4** had the α-L-*talo* configuration, and compound **2a** was methyl 6-deoxy-2,3-*O*-isopropylidene-4-*C*-[(methoxy)phenylphosphinyl]-α-L-talopyranoside.

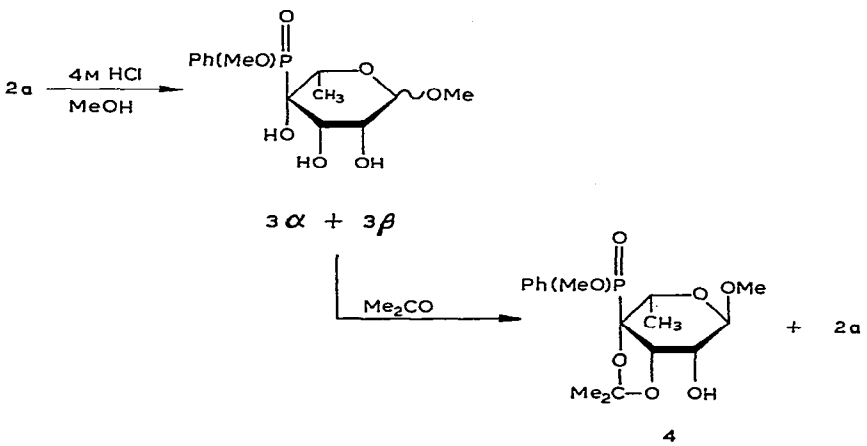


TABLE I

REACTION OF KETONES **1** AND **5** WITH PHOSPHINATE AND PHOSPHONATES

Ketone	*Phosphorus compound*	*Reaction temp. (°C)*	*Time (h)*	*Product*	*Yield (%)*	*M.p. (°C)*
1	Ph(MeO)P(O)H	70–80	10	**2a**	45	179–180
1	$(MeO)_2P(O)H$	70–80	10	**2b**	45	134–135
1	$(EtO)_2P(O)H$	70–80	10	**2c**	45	125–126
5	$(MeO)_2P(O)H$	room temp.	72	**6a,b**	quantitative[a]	—

[a]Crude yield.

TABLE II

SPECTRAL DATA FOR COMPOUNDS[a] **2b** AND **2c**

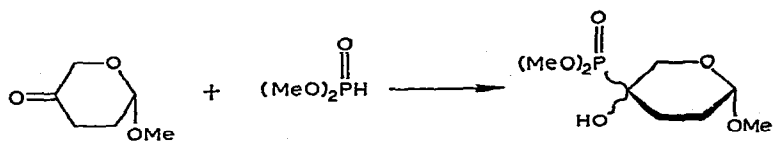
Compound	*Mass spectrum* (m/e, M^+)	$[\alpha]_D^{17}$[b] *(degrees)*	*^{1}H-N.m.r.* (δ; $CDCl_3$)	ν_{max}^{KBr} *(cm^{-1})*
2b	326	−38.2	1.40 (s, 3 H, Me), 1.45 (d, 3 H, *J* 6.7 Hz, Me-5), 1.59 (s, 3 H, Me), 3.40 (s, 3 H, OMe-1), 3.83 (d, 6 H, *J* 11.0 Hz, POMe), 4.0–5.0 (m, 4 H, H-1,2,3,5)	3340 (OH) 1230 (P=O)
2c	354	−40.6	1.30 (t, 6 H, *J* 7.1 Hz, CH_2Me), 1.40 (s, 3 H, Me), 1.68 (s, 3 H, Me), 1.72 (d, 3 H, *J* 6.0 Hz, Me-5), 3.39 (s, 3 H, OMe-1), 3.98–5.2 (m, 8 H, $POCH_2$, H-1,2,3,5)	3300 (OH) 1220 (P=O)

[a]Elemental analysis gave satisfactory results (C, ±0.37%; H, ±0.14%). [b]In chloroform, $c = 1.0$.

Stereospecific addition-reactions were also observed on treatment of glycosidulose **1** with dimethyl and diethyl phosphonate, respectively, under the same conditions (see Tables I and II).

On the other hand, reaction of ketone[5] **5** with dimethyl phosphonate for 3 days at room temperature afforded two diastereoisomeric products, **6a** and **6b**, in the ratio of 1:1 (based on the ^{1}H-n.m.r. spectrum), and in almost quantitative yield. One of the diastereoisomers had m.p. 79–81°; ^{1}H-n.m.r. ($CDCl_3$): δ 1.0–2.5 (m, 4 H, H-2,3), 2.9–4.9 (m, 3 H, H-1,5), 3.45 (s, 3 H, OMe-1), 3.83 (t, 6 H, J_{POCH} 10.8 Hz, P-O-Me), and 4.33 (s, 1 H, OH).

Anal. Calc. for $C_8H_{17}O_6P$: C, 40.00; H, 7.12. Found: C, 39.53; H, 7.12.



5 6 a,b

These findings suggest that the substituents on the skeletal carbon atoms of a cyclic ketone determine the direction of attack by the phosphorus atom on a carbonyl group, and that chiral phosphorus compounds should be readily preparable from such ketones.

REFERENCES

1 M. YAMASHITA, Y. NAKATSUKASA, M. YOSHIKANE, H. YOSHIDA, T. OGATA, AND S. INOKAWA, *Carbohydr. Res.*, 59 (1977) C12–C14.
2 V. S. ABRAMOV, *Dokl. Akad. Nauk SSSR*, 95 (1954) 991–992; *Chem. Abstr.*, 49 (1955) 6084*d–f*.
3 H. PAULSEN AND W. GREVE, *Chem. Ber.*, 106 (1973) 2124–2139.
4 J. YOSHIMURA, K. SATO, AND H. HASHIMOTO, *Chem. Lett.*, (1977) 1327–1330.
5 M. YAMASHITA, M. YOSHIKANE, T. OGATA, AND S. INOKAWA, *Tetrahedron*, 35 (1979) 741–743.