

Note

P.m.r. spectral assignments for *O*-methyl groups in mono-methylated D-hexoses

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During the course of our studies on the syntheses of *O*-methyl derivatives of monosaccharides¹, it was observed that, in the p.m.r. spectra of mono-*O*-methyl derivatives of D-glycopyranoses, the signals for the *O*-methyl groups appeared to be dependent on position. Previous reports of *O*-methyl resonances for partially² and fully methylated³ monosaccharides either did not report complete data for all the methoxyl groups, or involved solvents that did not allow an unambiguous identification of a particular *O*-methyl resonance. Recently, the p.m.r. spectra of poly-*O*-methylated D-glucoses have been measured, and the methoxyl group signals have been identified by correlations with the position and the orientation of the substituents⁴, or by synthesis of derivatives that were specifically deuterated in individual methoxyl groups⁵. We now report on p.m.r. analyses of six mono-*O*-methyl derivatives of D-glucose, five mono-*O*-methyl derivatives of D-galactose, and three mono-*O*-methyl derivatives of D-mannose. The data are recorded in Tables I–III.

The H-1 resonances were readily identified as doublets to lower field than δ 4. They always appeared as doublets; the determination of the anomeric configuration was easily ascertained by the value of the apparent coupling constant¹⁵ $J_{1,2}$. The *O*-methyl resonances, displayed between δ 3.40 and 3.65 as sharp singlets superimposed on the non anomeric ¹H signals, were directly assigned.

From the data in the Tables, the following observations can be made. (a) The position of the H-1 signals and the magnitude of the $J_{1,2}$ values are consistent with the *CI*(D) conformations. (b) The chemical shift of a particular O-Me resonance is independent of its axial or equatorial orientation but is dependent on the configurations of the adjacent groups (OH or CH₂OH). (c) The only exception to (b) arises when the O-Me group is at C-1. In this case, the methoxyl resonance occurs in the range δ 3.44 and 3.60 (compounds 1, 2, 11, and 20). (d) When both adjacent hydroxyl groups are equatorial, the resonance of the O-Me group occurs at δ 3.62–3.65 (compounds 4–6, 13, and 22). (e) When one of the adjacent hydroxyl groups is axial and the other is equatorial, the O-Me group resonates at δ 3.47–3.48 (compounds 3, 12, 14, 15, and 21). (f) When one of the adjacent equatorial groups is CH₂OH, the O-Me group resonates at δ 3.55–3.57 (compounds 7, 8, 16, and 17). (g) When the O-Me group is at C-6, it

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TABLE I

CHEMICAL SHIFTS IN δ (P.P.M.) OF MONO-*O*-METHYL-D-GLUCOSES^a

Compound	<i>H</i> -1 (doublet)		<i>O</i> -Me (δ)	Ref.
	δ	$J_{1,2}$		
Methyl α -D-glucopyranoside (1)	4.83	3	3.45	6
Methyl β -D-glucopyranoside (2)	4.41	7.5	3.60	7
2- <i>O</i> -Methyl- α -D-glucose ^b (3)	5.50	3.5	3.48	9
2- <i>O</i> -Methyl- β -D-glucose ^b (4)	4.70	7.5	3.62	
3- <i>O</i> -Methyl- α -D-glucose ^b (5)	5.25	3	3.64	10
3- <i>O</i> -Methyl- β -D-glucose ^b (6)	4.63	7.5	3.65	
4- <i>O</i> -Methyl- α -D-glucose ^b (7)	5.23	3	3.57	9
4- <i>O</i> -Methyl- β -D-glucose ^b (8)	4.63	7.5	3.57	
6- <i>O</i> -Methyl- α -D-glucose ^b (9)	5.23	3.5	3.40	
6- <i>O</i> -Methyl- β -D-glucose ^b (10)	4.68	7	3.40	

^aIn D₂O at 38°. ^bThe values were obtained after allowing the anomeric equilibrium to be reached.

TABLE II

CHEMICAL SHIFTS IN δ (P.P.M.) OF MONO-*O*-METHYL-D-GALACTOSES^a

Compound	<i>H</i> -1 (doublet)		<i>O</i> -Me (δ)	Ref.
	δ	$J_{1,2}$		
Methyl β -D-galactopyranoside (11)	4.34	7.5	3.60	8
2- <i>O</i> -Methyl- α -D-galactose ^b (12)	5.55	3.5	3.48	9
2- <i>O</i> -Methyl- β -D-galactose ^b (13)	4.65	7.5	3.62	
3- <i>O</i> -Methyl- α -D-galactose ^b (14)	5.29	3.5	3.47	11
3- <i>O</i> -Methyl- β -D-galactose ^b (15)	4.62	7	3.47	
4- <i>O</i> -Methyl- α -D-galactose ^b (16)	5.29	3	3.55	1
4- <i>O</i> -Methyl- β -D-galactose ^b (17)	4.59	7.5	3.55	
6- <i>O</i> -Methyl- α -D-galactose ^b (18)	5.28	3	3.40	12
6- <i>O</i> -Methyl- β -D-galactose ^b (19)	4.60	7	3.40	

^aIn D₂O at 38°. ^bThe values were obtained after allowing the anomeric equilibrium to be reached.

TABLE III

CHEMICAL SHIFTS IN δ (P.P.M.) OF SOME MONO-*O*-METHYL-D-MANNOSES^a

Compound	<i>H</i> -1 (doublet)		<i>O</i> -Me (δ)	Ref.
	δ	$J_{1,2}$		
Methyl α -D-mannopyranoside (20)	4.80	1.5	3.44	6
2- <i>O</i> -Methyl- α -D-mannose ^b (21)	5.35	2	3.47	13
2- <i>O</i> -Methyl- β -D-mannose ^b (22)	4.93	2	3.63	
6- <i>O</i> -Methyl- α -D-mannose ^b (23)	5.25	1.5	3.40	14
6- <i>O</i> -Methyl- β -D-mannose ^b (24)	4.95	1.5	3.41	

^aIn D₂O at 38°. ^bThe values were obtained after allowing the anomeric equilibrium to be reached.

resonates at δ 3.40–3.41 (compounds **9**, **10**, **18**, **19**, **23**, and **24**). (*h*) In those spectra where the signal for the methyl group attached to the anomeric oxygen atom could be attributed to a methoxyl group placed at another carbon atom of the pyranoid ring, the problem can be resolved by taking into account the resonance value and the coupling constant of the H-1 doublet; the signal for H-1 appears at higher field when the anomeric oxygen atom is substituted (compounds **1** and **3**, **2** and **4**, **11** and **13**, and **20** and **21**). The fact that the anomeric oxygen atom is substituted could also be ascertained by the lack of mutarotation, *e.g.*, the presence of only one signal⁹ for H-1.

Each Table should be utilised individually. When the parent monosaccharide is known, the data may be helpful in establishing the position of the methoxyl group in partially methylated glycopyranoses. They could also be used in connection with previous studies of this subject^{3–5} and of mass spectrometry of methylated aldohexoses^{16–18}.

EXPERIMENTAL

P.m.r. spectra were measured at $\sim 38^\circ$ with a Varian A-60 spectrometer for 6–8% solutions in D₂O containing $\sim 1\%$ of 2,2-dimethyl-2-silapentane-5-sulphonate as internal standard. Chemical shifts are on the δ -scale, and were taken from the chart recording; they are accurate to ± 0.02 . Coupling constants are reported in Hz, and are apparent coupling values determined from the chart. These measured spacings do not give the true value of $J_{1,2}$, although they serve to differentiate between diaxial and axial-equatorial orientations.

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