Tetrahedron Letters No. 48, pp 4879 - 4882, 1972. Pergamon Press. Printed in Great Britain.

# A $^{13}C$ NMR CHEMICAL SHIFT STUDY OF trans-FUSED BICYCLIC HEXOPYRANOSIDE DERIVATIVES

(Miss) Eileen Conway and R.D. Guthrie

(School of Molecular Sciences, University of Sussex, Brighton BN1 9QJ, U.K.)

S.D. Gero, G. Lukacs and (Mlle.) A.-M. Sepulchre

(Institut de Chimie des Substances Naturalles, C.N.R.S., 91-Gif-sur-Yvette, France)

and Edward W. Hagaman and Ernest Wenkert

(Department of Chemistry, Indiana University, Bloomington, Indiana 47401, U.S.A.)

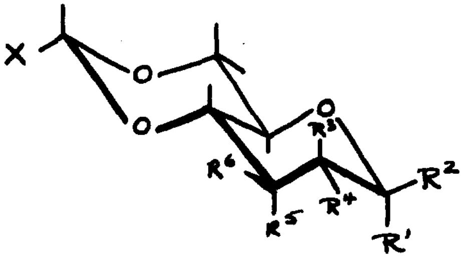
(Received in UK 11 October 1972; accepted for publication 26 October 1972)

Natural abundance $^{13}C$ nmr spectroscopy offers a new tool for the study of carbohydrates. Several papers[2] on free aldoses and their glycosides have shown that structural correlations can be made; only one paper [2a] briefly mentioned other derivatives.

As part of a general $^{13}C$ nmr study of monosaccharides and their derivatives we have investigated the spectra of the conformationally more stable, trans-fused methyl 4,6-O-benzylidene-D-aldohexopyranosides and report in this Letter on diols, amino-alcohols and mono- and di-deoxy derivatives (see Figure). The pyranose ring in these systems has been demonstrated by pmr[3], ir[4] and other analytical methods[5] to be in the Cl(D) conformation, as shown. These compounds therefore enable an investigation of the variations of chemical shift with stereochemical change to be made with confidence.

Noise-decoupled spectra were recorded for thirteen benzylidene compounds and one ethylidene derivative (14). The assignment of $\delta$ values (see Table) is based on application of chemical shift theory[2,6-8], and spectral comparison of structurally related compounds. Single-frequency off-resonance spectra of compounds (1), (6) and (12) were used to differentiate between carbons of close chemical shifts. The essentially constant shifts of the aromatic carbons of compounds (1) - (13) were 136.8 (substituted carbon), 128.7 (para), 127.8 and 125.8 ppm.

Figure



for (1)-(7) X = Ph,
for (14) X = Me

| Compound | Hexose Configuration | $R^1$ | $R^2$ | $R^3$ | $R^4$ | R | $R^6$ |
|---|---|---|---|---|---|---|---|
| (1) | α -*allo* | OMe | H | H | OH | OH | H |
| (2) | α -*altro* | OMe | H | OH | H | OH | H |
| (3) | β - *altro* | H | OMe | OH | H | OH | H |
| (4) | α - *gluco* | OMe | H | H | OH | H | OH |
| (5) | β- *gluco* | H | OMe | H | OH | H | OH |
| (6) | α -*manno* | OMe | H | OH | H | H | OH |
| (7) | 2, 3-dideoxy-α- *erythro* | OMe | H | H | H | H | H |
| (8) | 3-deoxy-α-*arabino* | OMe | H | OH | H | H | H |
| (9) | 3-deoxy-α-*ribo* | OMe | H | H | OH | H | H |
| (10) | α-*gluco* | OMe | H | H | OH | H | $NH_2$ |
| (11) | α-*altro* | OMe | H | OH | H | $NH_2$ | H |
| (12) | α-allo | OMe | H | H | OH | $NH_2$ | H |
| (13) | α-manno | OMe | H | OH | H | H | $NH_2$ |
| (14) | β-gluco | H | OMe | H | OH | H | OH |

## TABLE

$^{13}$C Nmr Shifts[a] of Compounds (1) - (14)

| Compound | C-1 | C-2 | C-3 | C-4 | C-5 | C-6 | C-7 | OMe |
|---|---|---|---|---|---|---|---|---|
| 1 | 100.2 | 67.9 | 68.8 | 78.1 | 56.9 | 68.8 | 101.5 | 55.7 |
| 2 | 101.6 | 69.6 | 68.8 | 76.0 | 57.8 | 68.8 | 101.8 | 55.0 |
| 3 | 99.4 | 70.8 | 68.6 | 76.5 | 62.8 | 68.6 | 101.8 | 56.4 |
| 4 | 99.9 | 72.4 | 70.5 | 80.8 | 62.0 | 68.5 | 101.5 | 54.9 |
| 5 | 104.2 | 74.2 | 72.9 | 80.3 | 65.9 | 68.3 | 101.5 | 56.8 |
| 6 | 101.7 | 70.6 | 68.0 | 78.5 | 62.9 | 68.4 | 101.7 | 54.4 |
| 7 | 98.1 | 29.0 | 23.5 | 77.9 | 64.5 | 69.1 | 101.6 | 54.2 |
| 8 | 100.5 | 67.4 | 31.4 | 73.5 | 64.6 | 68.9 | 101.8 | 54.3 |
| 9 | 98.9 | 67.0 | 32.6 | 76.1 | 63.4 | 68.9 | 101.3 | 54.6 |
| 10 | 99.4 | 72.1 | 52.4 | 81.0 | 62.2 | 68.7 | 101.5 | 55.0 |
| 11 | 101.6[b] | 69.4 | 52.0 | 75.9 | 57.6 | 68.8 | 101.8[b] | 54.8 |
| 12 | 100.8 | 67.5 | 52.1 | 78.3 | 56.7 | 68.9 | 101.3 | 55.6 |
| 13 | 102.0 | 70.0 | 50.3 | 79.4 | 63.4 | 68.5 | 101.6 | 54.5 |
| 14[c] | 104.1 | 74.2 | 72.9 | 79.8 | 65.9 | 67.7 | 99.4 | 56.7 |

[a] Spectra of 4:1 deuteriochloroform-methanol solutions determined on a Fourier transform spectrometer at 15.08 MHz; chemical shifts in parts per million downfield from TMS; $\delta^{\mathrm{TMS}} = \delta^{\mathrm{CDCl_3}} + 76.9$ ppm.

[b] Values may be interchanged.

[c] $\delta$(C-7 Me) = 19.6 ppm

Acetalation of the C-4 and C-6 oxygens of the aldohexopyranosides leads to expected deshielding of C-4 and C-6 compared with the unsubstituted glycosides[2]. Being unaffected by stereochemical changes, C-6 and C-7 varied little in chemical shift through the whole series. The assignment of C-6 was confirmed from the spectrum of the $6,6'$-$d_2$ analogue of compound (4); this spectrum was identical to that of (4) except that the signal at 68.5 ppm was missing.

The C-5 signal of all fourteen compounds was dramatically upfield of its position in unsubstituted glycosides[2]. While greater in magnitude in the present series this shift is analogous to the observed effect of ring oxygens on C-.2 and C-4 of aldohexopyranosides[2b] and on C-5 of 1,3-dioxanes[9]. The greater effect in (1)-(14) may be due to their rigid stereochemistry, relative to the analogies quoted. Substituent parameters of the acetals are nearly identical with those of the methyl aldohexopyranosides, as indicated by the effects on C-1 and C-2.

## REFERENCES

1 Part (X) in a series on $^{13}$C nmr analysis by G.L. *et al*. [Part (IX) G. Lukacs, S.D. Gero, D.A. van Dorp, E.W. Hagaman and E. Wenkert, J.Amer.Chem.Soc., in the press].

2 (a) L.D. Hall and L.F. Johnson, Chem.Comm., 1969, 509; (b) A.S. Perlin, *et al*, Tetrahedron Letters, 1969, 2921; Canad. J.Chem., 1970, 48, 2596, 2639; Carbohydrate Res., 1970, 15, 403; (c) D.E. Dorman and J.D. Roberts, J.Amer.Chem.Soc., 1970, 92, 1355; (d) W. Voelter, E. Breitmaier, G. Jung, *et al*, Angew Chem.Int.Ed., 1971, 10, 935; $^{2}$Chimica, 1971, 25, 168, $^{3}$362; 1972, 26, $^{4}$136, Chem.Ber., 1971, 104, 1147; (e) D.Doddrell and A. Allerhand, J.Amer.Chem.Soc., 1971, 93, 2777.

3 a R.D. Guthrie, *et al*, J.Chem.Soc., 1961, 4166, b Tetrahedron, 1968, 24, 4517, c Carbohydrate Res., 1969, 9, 99; B. Coxon, Tetrahedron, 1965, 21, 3481.

4 H. Spedding, Adv. Carbohydrate Chem., 1964, 19, 23.

5 R.D. Guthrie, *et al*, J.Chem.Soc.(C), 1967, 1194, b Tetrahedron, 1970, 26, 3653, c Carbohydrate Res., 1969, 11, 53, d 565; e 1970, 13, 199; f 1971, 18, 373.

6 G.C. Levy and G.L. Nelson, "Carbon-13 Nuclear Magnetic Resonance for Organic Chemists", Wiley-Interscience, 1972.

7 D.K. Dalling and D.M. Grant, J.Amer.Chem.Soc., 1967, 89, 6612.

8 D.W. Cochran, Ph.D. Dissertation, Indiana University, 1971.

9 A.J. Jones, E.L. Eliel, D.M.Grant, M.C. Knoeber, and W.F. Bailey, J.Amer.Chem.Soc., 1971, 93, 4772.