Preliminary communication

Evaluation of the binding of lanthanide shift reagents with carbohydrate derivatives

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Basic to an understanding of the ways in which a lanthanide shift reagent (*L*) induces changes in the chemical shifts of the nuclear magnetic resonance (n m r.) signals of a carbohydrate derivative (*S*), is the evaluation of the equilibrium process

$$L + nS \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} LSn,$$

in terms of the equilibrium binding constant (K_B), the stoichiometry (*n*), and the bound chemical shifts (Δ_B) An accurate measurement of the latter parameters is mandatory for conformational studies[1] We now report the first evaluations of K_B, *n*, and Δ_B values for carbohydrate derivatives

Measurements were made of the p m r spectra of a series of solutions ($[S]_0$ = 0.02 to 0 1M) of 1,2 5,6-di-*O*-isopropylidene-α-D-glucofuranose (**1**) in carbon tetrachloride containing a constant amount of tris(dipivalomethanato)europium(III) $\{$Eu(DPM)$_3$, $[L]_0$ = 4 3mM$\}$ The resultant chemical-shift data were then plotted as $1/\delta$ *versus* $[S]_0$, the resultant linear plots have[2] slope $[L]_0\Delta_B$ and y-axis intercept $-\{(1/K_B) + [L]_0\}$, and hence give the values for Δ_B and K_B. The stoichiometry can be trivially determined[3] to be 1 1. The parameters obtained for the above experiment are listed in Table I In accord with an earlier, qualitative observation[4], the Δ_B-value for H-5 is greater than that for H-3, thus, it is not necessarily the proton nearest to the donor atom that undergoes the largest shift[5].

Measurements on each individual resonance constitute independent evaluations for K_B, and the scatter of values obtained illustrates the magnitude of the experimental errors associated with the determination of K_B Unfortunately, these errors increase rapidly with increase in K_B, and hence it is not always possible to make accurate determinations of K_B for tris (2,2-dimethyl-6,6,7,7,8,8,8-heptafluoro-3,5-octanedionato)-europium(III)

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TABLE I

VALUES[a] OF BOUND CHEMICAL SHIFTS (Δ_B, p p m.) AND EQUILIBRIUM BINDING-CONSTANTS (K_B, ℓ. mole^{-1})

Substrate	*Lanthanide*	*Stoichiometry*	*Parameter*	*Proton studied*				
				H–1	*H–2*	*H–3*	*H–4*	*H–5*
1[b]	Eu(DPM)$_3$	1 1	Δ_B	4.46	6.06	15.70	8 61	22.14
			K_B	33	31	29		30
2[c]	Eu(FOD)$_3$	1 1[d]	Δ_B	3 00	2 60	3 67	7 83	14 21
			K_B	←		>100		→

[a] Measured with a Varian XL-100 instrument, at 38 8°. [b] In carbon tetrachloride. [c] In deuteriochloroform. [d] This value should be regarded with some scepticism.

[Eu(FOD)$_3$] interactions, which are known[2] to be substantially higher than those of Eu(DPM)$_3$. Even so, it is possible to evaluate accurate Δ_B-values and make a lower-limit estimate for K_B. A typical experiment involves the interaction of 1,2 3,5-di-*O*-methylene-α-D-glucofuranose (2, 0 02–0 102M) with Eu(FOD)$_3$ (5 9mM) in deuteriochloroform solution. The values of Δ_B and K_B are also listed in Table I, together with the approximate[3] stoichiometry. When the concentration range of (*S*) is sufficiently large, as in the above study, our method does not permit an accurate evaluation of the stoichiometry In agreement with theoretical behavior in this range, identical values of Δ_B were obtained when the data were treated on the basis of 2 1 binding

In the light of the many experiments we have performed, several cautionary statements may be made. It must be emphasised that the reproducibility of these data, especially with alcohol substrates, is critically dependent on the experimental care excercised in the preparation of the solutions, which should be rigorously anhydrous It is also important to control the temperature at which individual experiments are performed. It must also be pointed out that measurements of δ as a function of $[L]_0$, with $[S]_0$ held constant, are unreliable[6], for example, the Δ-values obtained in this way vary[2,7] with $[S]_0$

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