Absolute and Relative Binding Affinity of Cucurbit[7]uril Toward a Series of Cationic Guests

Supporting Information

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^1H NMR spectra recorded for selected CB[7]•guest complexes

Figure S1. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **1** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **1** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **1** (0.5 mM).

Figure S2. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **2** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **2** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **2** (0.5 mM).

Figure S3. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **3** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **3** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **3** (0.5 mM).

Figure S4. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **4** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **4** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **4** (0.5 mM).

Figure S5. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **5** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **5** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **5** (0.5 mM).

Figure S6. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **6** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **6** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **6** (0.5 mM).

Figure S7. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **8** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **8** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **8** (0.5 mM).

Figure S8. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **9** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **9** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **9** (0.5 mM).

Figure S9. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **10** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **10** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **10** (0.5 mM).

Figure S10. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **11** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **11** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **11** (0.5 mM).

Figure S11. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **12** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **12** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **12** (0.5 mM).

Figure S12. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **13** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **13** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **13** (0.5 mM).

Figure S13. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **14** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **14** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **14** (0.5 mM).

Figure S14. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **15** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **15** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **15** (0.5 mM).

Figure S15. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **16** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **16** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **16** (0.5 mM).

Figure S16. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **17** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **17** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **17** (0.5 mM).

Figure S17. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **18** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **18** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **18** (0.5 mM).

Figure S18. ^1H NMR spectra recorded (D_2O , 400 MHz, RT) for: a) **19** (0.25 mM), b) a mixture of CB[7] (0.25 mM) and **19** (0.25 mM), and c) a mixture of CB[7] (0.25 mM) and **19** (0.5 mM).

Job plots by NMR experiments

The stoichiometry of host-guest complex (CB[7] with **9** or **10**) was determined by Job's methods.¹ The molar ratio of CB[7] and guest (**9** or **10**) in the resulting solution varied from 0.1 to 0.9, in which the total concentration of CB[7] and guest (**9** or **10**) was kept constant. The chemical shift ($\Delta\delta$) were multiplied by molar ratio and plotted against molar ratio to obtain the Job plot. The 1:1 nature of the complexes between CB[7] and guest **12** is determined by NMR titration.

Figure S19. Job plot (D₂O, 400 MHz, RT) for mixtures of CB[7] and **9** at a total concentration of 0.5 mM.

Figure S20. Job plot (D_2O , 400 MHz, RT) for mixtures of CB[7] and **10** at a total concentration of 0.5 mM.

Figure S21. Job plot (D_2O , 400 MHz, RT) for mixtures of CB[7] and **12** at a total concentration of 0.5 mM.

Sample Determination of K_{rel} for the Competition Between **1** and **4** for CB[7]

We use equation 1 to determine K_{rel} for the interaction of **1** and **4** for CB[7]. For this purpose, we prepared a solution containing CB[7] (283.6 μ M), **1** (2.2502 mM), **4** (325.9 μ M) and allowed it to reach equilibrium (Figure S22). Next, we determined the relative concentration of CB[7]•**4** and free **4** by integration of the appropriate resonances in the ^1H NMR spectrum (Figure S1.: CB[7]•**4**: 3.69 ppm; free **4**: 4.03 ppm). Using the concentration and the mass balance expression (equation 2) allowed us to calculate $[\textbf{4}]_{free} = 163.7 \mu\text{M}$ and $[\text{CB[7]}\cdot\textbf{4}] = 162.2 \mu\text{M}$. Equation 3 is then used to calculate $[\text{CB[7]}\cdot\textbf{1}]$ (121.4 μ M) using the known value of CB[7]•**4**. Lastly, equation 4 is used to calculate $[\textbf{1}]_{free}$ (2.1288 mM) using the known value of $[\text{CB[7]}\cdot\textbf{1}]$.

$$K_{rel} = ([\text{CB[7]}\cdot\textbf{4}][\textbf{1}]_{free}) / ([\text{CB[7]}\cdot\textbf{1}][\textbf{4}]_{free}) \quad (1)$$

$$[\textbf{4}]_{Total} = 325.9 \mu\text{M} = [\textbf{4}]_{free} + [\text{CB[7]}\cdot\textbf{4}] \quad (2)$$

$$[\text{CB[7]}]_{Total} = 283.6 \mu\text{M} = [\text{CB[7]}\cdot\textbf{4}] + [\text{CB[7]}\cdot\textbf{1}] \quad (3)$$

$$[\textbf{1}]_{Total} = 2.2502 \text{ mM} = [\textbf{1}]_{free} + [\text{CB[7]}\cdot\textbf{1}] \quad (4)$$

Substitution of the values of $[\text{CB[7]}\cdot\textbf{1}]$, $[\textbf{1}]_{free}$, $[\text{CB[7]}\cdot\textbf{4}]$, and $[\textbf{4}]_{free}$ into equation 1 gave $K_{rel} = 17.4$. These determinations were done from independently prepared stock solutions and the average values were used in the calculations of K_a and the error analysis shown below. In preparing the solutions for the above determinations we used two methods to reach equilibrium: a) A solution of CB[7] and **1** was prepared, addition of **4** gave the final equilibrium; b) A solution of CB[7] and **4** was prepared, addition of **1** gave the final equilibrium. Under those conditions the errors in $[\textbf{1}]_{free}$, are $[\textbf{4}]_{free}$ small and both $[\text{CB[7]}\cdot\textbf{1}]$ and $[\text{CB[7]}\cdot\textbf{4}]$ are kept in a good range for accurate measurement of their ratio by ^1H NMR.

Sample Error Analysis Calculation for CB[7]•**19**.

Since the binding constants in this paper are determined by several levels of ^1H NMR competition experiments referenced to an absolute K_a measured for CB[7]•**1** measured by UV/Vis titration, a proper error analysis is critical. In this section we give a sample calculation of the error analysis used to determine the uncertainty associated with the K_a value for CB[7]•**19**.

Step 1 – Estimation of the accuracy of ^1H NMR methods for the determination of guest and host•guest concentrations. We used ^1H NMR to repeatedly determine the concentration of samples of known concentration of guest and host•guest complex by monitoring guest resonances. The ^1H NMR based method was accurate with a standard deviation of $\pm 3\%$ as described previously (Liu, S.; Ruspice, C.; Mukhopadhyay, P.; Chakrabarti, S.; Zavalij, P. Y.; Isaacs, L. *J. Am. Chem. Soc.* **2005**, *127*, 15959-15967).

Step 2 – Determination of the Uncertainty Associated with a Single Level of Competition (K_{rel}).

We propagated the above uncertainty associated with the NMR determination of concentrations (e.g. $\{(\sigma_{[\text{CB[n]}\cdot\text{guest}]})/[\text{CB[n]}\cdot\text{guest}]\} = 0.03$ and $\{(\sigma_{[\text{Guest}]})/[\text{Guest}]\} = 0.03$) of using equations 5 and equations 6 – 7 (Bevington, P. R., Robinson, K. D. *Data Reduction and Error Analysis for the Physical Sciences*, 2nd. ed. McGraw-Hill: New York, 1992, pg. 61–62. eq. 4-11). Equation 6 delivers the uncertainty associated with the weighted product (x) of two values (u and v) (e.g. $x = \pm a u v$). Similarly, equation 7 delivers the uncertainty for dividing two numbers (e.g. $x = \pm (a$

u) / v). We make the assumption that the fluctuations in u and v are not correlated ($\sigma_{uv} = 0$) which when substituted into equations 6 and 7 delivers equation 8. Rearranging slightly yields equation 9 which allows us to directly use the 3% uncertainty determined for our NMR method.

$$K_{rel} = ([CB[n] \cdot G2][G1]) / ([CB[n] \cdot G1][G2]) \quad (5)$$

$$\frac{\sigma_x^2}{x^2} = \frac{\sigma_u^2}{u^2} + \frac{\sigma_v^2}{v^2} + 2 \frac{\sigma_{uv}^2}{uv} \quad (6)$$

$$\frac{\sigma_x^2}{x^2} = \frac{\sigma_u^2}{u^2} + \frac{\sigma_v^2}{v^2} - 2 \frac{\sigma_{uv}^2}{uv} \quad (7)$$

$$\frac{\sigma_x^2}{x^2} = \frac{\sigma_u^2}{u^2} + \frac{\sigma_v^2}{v^2} \quad (8)$$

$$\left(\frac{\sigma_x}{x}\right)^2 = \left(\frac{\sigma_u}{u}\right)^2 + \left(\frac{\sigma_v}{v}\right)^2 \quad (9)$$

We break the uncertainty determination in K_{rel} (equation 1) into three steps: 1) Multiplying $[CB[n] \cdot G2][G1]$, 2) multiplying $[CB[n] \cdot G1][G2]$, and 3) dividing the two results. Substituting $(\sigma[CB[n] \cdot G2] / [CB[n] \cdot G2]) = 0.03$ and $(\sigma[G1]/[G1]) = 0.03$ into equation 9 gives equation 10 and an uncertainty of 4.24% for $[CB[n] \cdot G2][G1]$ (equation 11). Similarly, the uncertainty of $[CB[n] \cdot G1][G2]$ is 4.24%.

$$\left(\frac{\sigma_{[CB[n] \cdot G2][G1]}}{[CB[n] \cdot G2][G1]}\right)^2 = (0.03)^2 + (0.03)^2 \quad (10)$$

$$\left(\frac{\sigma_{[CB[n] \cdot G2][G1]}}{[CB[n] \cdot G2][G1]}\right) = 0.0424 \quad (11)$$

With the two values of the uncertainties of $[CB[n] \cdot G2][G1]$ and $[CB[n] \cdot G1][G2]$ (4.24%) in hand we next substituted these values into equation 9 to give the uncertainty in K_{rel} (eq. 12–13) of 6%.

$$\left(\frac{\sigma_{K_{\text{rel}}}}{K_{\text{rel}}}\right)^2 = \left(\sigma \frac{\frac{[\text{CB}[n]\cdot\text{G2}][\text{G1}]}{[\text{CB}[n]\cdot\text{G2}][\text{G1}]}}{\frac{[\text{CB}[n]\cdot\text{G2}][\text{G1}]}{[\text{CB}[n]\cdot\text{G2}][\text{G1}]}}\right)^2 = (0.0424)^2 + (0.0424)^2 \quad (12)$$

$$\frac{\sigma_{K_{\text{rel}}}}{K_{\text{rel}}} = 0.06 \quad (13)$$

Step 3 – Determination of the Uncertainty in the K_a value for CB[7]•1. We obtained an uncertainty in the value of K_a for CB[7]•1 ($K_a = 20459 \pm 1168.3 \text{ M}^{-1}$) (5.71 %) from the non-linear least squares fit of the UV/Vis titration data to a 1:1 binding model.

Step 4 – Determination of K_a for CB[7]•4 by competition of 1 and 4 for a limiting quantity of CB[7]. We used ^1H NMR competition experiments to determine $K_{\text{rel}} = 7.6$ for these two guests. Substitution of $K_{\text{CB}[7]\cdot 1} = 20459 \pm 1186.3 \text{ M}^{-1}$ and K_{rel} into equation 14 gave $K_{\text{CB}[7]\cdot 4} = 3.6 \times 10^5 \text{ M}^{-1}$ (equation 15). The uncertainty in $K_{\text{CB}[7]\cdot 4}$ can be determined using equation 16. Substituting $\sigma(K_{\text{CB}[7]\cdot 1})/K_{\text{CB}[7]\cdot 1} = 0.05$ and $\sigma(K_{\text{rel}})/K_{\text{rel}} = 0.10$ [Note that we are using the even more conservative 10% error in this analysis] gives the percent error in $K_{\text{CB}[7]\cdot 4}$ (equation 17). Substituting eq. 15 into eq. 17 gives $\sigma(K_{\text{CB}[7]\cdot 4})$ (equation 18) which can be combined with eq. 15 to give a final value for $K_{\text{CB}[7]\cdot 4}$ (equation 19).

$$K_{\text{CB}[7]\cdot 4} = (K_{\text{CB}[7]\cdot 1})(K_{\text{rel}}) \quad (14)$$

$$K_{\text{CB}[7]\cdot 4} = 3.6 \times 10^5 \text{ M}^{-1} \quad (15)$$

$$\left(\frac{\sigma K_{\text{CB}[7]\cdot 4}}{K_{\text{CB}[7]\cdot 4}}\right)^2 = \left(\frac{\sigma K_{\text{CB}[7]\cdot 1}}{K_{\text{CB}[7]\cdot 1}}\right)^2 + \left(\frac{\sigma K_{\text{rel}}}{K_{\text{rel}}}\right)^2 \quad (16)$$

$$\frac{\sigma K_{\text{CB}[7]\cdot 4}}{K_{\text{CB}[7]\cdot 4}} = 0.1152 \text{ (11.52\%)} \quad (17)$$

$$\sigma K_{\text{CB}[7]\cdot 4} = (0.1152) \times (3.6 \times 10^5 \text{ M}^{-1}) \approx 0.4 \times 10^5 \quad (18)$$

$$K_{\text{CB}[7]\cdot 4} = (3.6 \pm 0.4) \times 10^5 \text{ M}^{-1} \quad (19)$$

Step 5 – Determination of K_a for CB[7]•11 by competition of 4 and 11 for a limiting quantity of CB[7]. We used ^1H NMR competition experiments to determine $K_{\text{rel}} = 2.16 \times 10^{-2}$ for these two guests. Substitution of $K_{\text{CB}[7]\cdot 4} = (3.6 \pm 0.4) \times 10^5 \text{ M}^{-1}$ and K_{rel} into equation 20 gave $K_{\text{CB}[7]\cdot 11} = 1.7 \times 10^7 \text{ M}^{-1}$ (equation 21). The uncertainty in $K_{\text{CB}[7]\cdot 11}$ can be determined using equation 22. Substituting $\sigma(K_{\text{CB}[7]\cdot 4})/K_{\text{CB}[7]\cdot 4} = 0.1152$ and $\sigma(K_{\text{rel}})/K_{\text{rel}} = 0.10$ [Note that we are using the even more conservative 10% error in this analysis] gives the percent error in $K_{\text{CB}[7]\cdot 11}$ (equation 23). Substituting eq. 21 into eq. 24 gives $\sigma(K_{\text{CB}[7]\cdot 11})$ (equation 24) which can be combined with eq. 21 to give a final value for $K_{\text{CB}[7]\cdot 11}$ (equation 25).

$$K_{\text{CB}[7]\cdot 11} = (K_{\text{CB}[7]\cdot 4})(K_{\text{rel}}) \quad (20)$$

$$K_{\text{CB}[7]\cdot 11} = 1.7 \times 10^7 \text{ M}^{-1} \quad (21)$$

$$\left(\frac{\sigma K_{CB[7]g^1}}{K_{CB[7]g^1}}\right)^2 = \left(\frac{\sigma K_{CB[7]g^4}}{K_{CB[7]g^4}}\right)^2 + \left(\frac{\sigma K_{rel}}{K_{rel}}\right)^2 \quad (22)$$

$$\frac{\sigma K_{CB[7]g^1}}{K_{CB[7]g^1}} = 0.1525 \text{ (15.25\%)} \quad (23)$$

$$\sigma K_{CB[7]g^1} = (0.1525) \times (1.7 \times 10^7 \text{ M}^{-1}) \approx 0.3 \times 10^7 \quad (24)$$

$$K_{CB[7] \cdot 11} = (1.7 \pm 0.3) \times 10^7 \text{ M}^{-1} \quad (25)$$

Step 6 – Determination of K_a for CB[7]•19 by competition of 11 and 19 for a limiting quantity of CB[7]. We used ^1H NMR competition experiments to determine $K_{rel} = 1248.5$ for these two guests. Substitution of $K_{CB[7] \cdot 11} = (1.7 \pm 0.3) \times 10^7 \text{ M}^{-1}$ and K_{rel} into equation 26 gave $K_{CB[7] \cdot 19} = 2.1 \times 10^{10} \text{ M}^{-1}$ (equation 27). The uncertainty in $K_{CB[7] \cdot 19}$ can be determined using equation 28. Substituting $\sigma(K_{CB[7] \cdot 11}) / K_{CB[7] \cdot 11} = 0.1525$ and $\sigma(K_{rel}) / K_{rel} = 0.10$ [Note that we are using the even more conservative 10% error in this analysis] gives the percent error in $K_{CB[7] \cdot 19}$ (equation 29). Substituting eq. 27 into eq. 30 gives $\sigma(K_{CB[7] \cdot 19})$ (equation 30) which can be combined with eq. 27 to give a final value for $K_{CB[7] \cdot 19}$ (equation 31).

$$K_{CB[7] \cdot 19} = (K_{CB[7] \cdot 11})(K_{rel}) \quad (26)$$

$$K_{CB[7] \cdot 19} = 2.1 \times 10^{10} \text{ M}^{-1} \quad (27)$$

$$\left(\frac{\sigma K_{CB[7]g^9}}{K_{CB[7]g^9}}\right)^2 = \left(\frac{\sigma K_{CB[7]g^1}}{K_{CB[7]g^1}}\right)^2 + \left(\frac{\sigma K_{rel}}{K_{rel}}\right)^2 \quad (28)$$

$$\frac{\sigma K_{CB[7]g^9}}{K_{CB[7]g^9}} = 0.1824 \text{ (18.24\%)} \quad (29)$$

$$\sigma K_{CB[7]g^9} = (0.1824) \times (2.1 \times 10^{10} \text{ M}^{-1}) \approx 0.4 \times 10^{10} \quad (30)$$

$$K_{CB[7] \cdot 19} = (2.1 \pm 0.4) \times 10^{10} \text{ M}^{-1} \quad (31)$$

Selected ^1H NMR spectra from the K_a and K_{rel} measurements

The following spectra are representative examples of those acquired during the determination of the various K_a and K_{rel} values. The integral is determined by deconvolution of MestRe Nova.

Figure S22. One of the ^1H NMR spectra (400 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{1}$ and $\text{CB}[7]\cdot\mathbf{4}$. $[\text{CB}[7]]_{\text{Total}} = 0.2836$ mM, $[\mathbf{1}]_{\text{Total}} = 2.2502$ mM, $[\mathbf{4}]_{\text{Total}} = 0.3259$ mM.

Figure S23. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{2}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2567$ mM, $[\mathbf{2}]_{\text{Total}} = 29.5961$ mM, $[\mathbf{11}]_{\text{Total}} = 0.3878$ mM.

Figure S24. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{3}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2518$ mM, $[\mathbf{3}]_{\text{Total}} = 12.3796$ mM, $[\mathbf{11}]_{\text{Total}} = 0.3878$ mM.

Figure S25. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{4}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2518$ mM, $[\mathbf{4}]_{\text{Total}} = 4.9216$ mM, $[\mathbf{11}]_{\text{Total}} = 0.4654$ mM.

Figure S26. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{5}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2376$ mM, $[\mathbf{5}]_{\text{Total}} = 5.2846$ mM, $[\mathbf{11}]_{\text{Total}} = 0.3591$ mM.

Figure S27. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{6}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2608$ mM, $[\mathbf{6}]_{\text{Total}} = 7.4173$ mM, $[\mathbf{11}]_{\text{Total}} = 0.4985$ mM.

Figure S28. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot 7$ and $\text{CB}[7]\cdot 11$. $[\text{CB}[7]]_{\text{Total}} = 0.2662 \text{ mM}$, $[7]_{\text{Total}} = 8.4185 \text{ mM}$, $[11]_{\text{Total}} = 1.1406 \text{ mM}$.

Figure S29. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for CB[7]•8 and CB[7]•11. $[\text{CB}[7]]_{\text{Total}} = 0.2518 \text{ mM}$, $[\mathbf{8}]_{\text{Total}} = 5.0873 \text{ mM}$, $[\mathbf{11}]_{\text{Total}} = 0.4654 \text{ mM}$.

Figure S30. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{9}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2567 \text{ mM}$, $[\mathbf{9}]_{\text{Total}} = 1.9080 \text{ mM}$, $[\mathbf{11}]_{\text{Total}} = 0.3878 \text{ mM}$.

Figure S31. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{10}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2567$ mM, $[\mathbf{10}]_{\text{Total}} = 0.7830$ mM, $[\mathbf{11}]_{\text{Total}} = 0.3878$ mM.

Figure S32. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{12}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2715$ mM, $[\mathbf{12}]_{\text{Total}} = 0.5031$ mM, $[\mathbf{11}]_{\text{Total}} = 0.4654$ mM.

Figure S33. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{13}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2608$ mM, $[\mathbf{13}]_{\text{Total}} = 0.4275$ mM, $[\mathbf{11}]_{\text{Total}} = 2.1599$ mM.

Figure S34. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{14}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2567$ mM, $[\mathbf{19}]_{\text{Total}} = 0.4109$ mM, $[\mathbf{11}]_{\text{Total}} = 2.3269$ mM.

Figure S35. One of the ^1H NMR spectra (600 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{15}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2399$ mM, $[\mathbf{15}]_{\text{Total}} = 0.3997$ mM, $[\mathbf{11}]_{\text{Total}} = 2.8995$ mM.

Figure S36. One of the ^1H NMR spectra (400 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for CB[7]•16 and CB[7]•11. $[\text{CB}[7]]_{\text{Total}} = 0.2608$ mM, $[\text{16}]_{\text{Total}} = 0.4091$ mM, $[\text{11}]_{\text{Total}} = 41884$ mM.

Figure S37. One of the ^1H NMR spectra (400 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for CB[7]•17 and CB[7]•11. $[\text{CB}[7]]_{\text{Total}} = 0.2608 \text{ mM}$, $[\text{17}]_{\text{Total}} = 0.3985 \text{ mM}$, $[\text{11}]_{\text{Total}} = 19.9415 \text{ mM}$.

Figure S38. One of the ^1H NMR spectra (400 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{18}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2608$ mM, $[\mathbf{18}]_{\text{Total}} = 0.4856$ mM, $[\mathbf{11}]_{\text{Total}} = 41.5448$ mM.

Figure S39. One of the ^1H NMR spectra (400 MHz, D_2O , 100 mM Na_3PO_4 buffer, pH = 7.4, rt) used in the determination of K_{rel} for $\text{CB}[7]\cdot\mathbf{19}$ and $\text{CB}[7]\cdot\mathbf{11}$. $[\text{CB}[7]]_{\text{Total}} = 0.2608 \text{ mM}$, $[\mathbf{19}]_{\text{Total}} = 0.3366 \text{ mM}$, $[\mathbf{11}]_{\text{Total}} = 79.5997 \text{ mM}$.

References

1. Job, P. *Ann. Chim.*, **1928**, 9, 113-203.