Investigating Sucrose and D-trehalose in AOT Reverse Micelles

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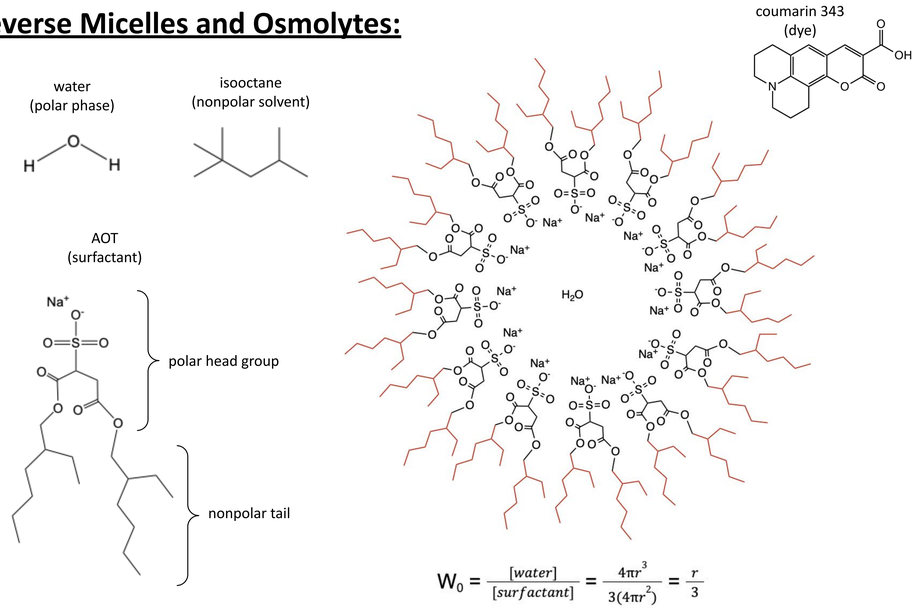
Summer 2023

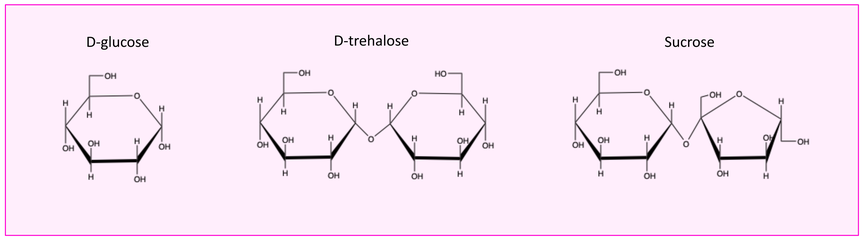
Abstract:

Reverse micelles are nanosized structures that encapsulate small water pools and allow us to investigate the fundamental interactions of small organic molecules in nanoconfinement. The behavior of small organic molecules, sometimes referred to as osmolytes, differs in bulk solution and confinement. Because reverse micelles are a good model for biological nanoconfinement, investigating osmolytes in reverse micelle systems can help us to better understand the role they play in biological systems. Optical spectroscopy such as UV-Vis, Fluorescence, and Red Edge Excitation (REES) was used to probe the environment of the reverse micelles. Three small organic molecules were studied: a monosaccharide, d-glucose, and two disaccharides, d-trehalose and sucrose. Spectroscopy results indicate that nanoconfinement affects the interactions had by the osmolytes. Dynamic Light Scattering was used to determine the size of the reverse micelles. Size data results suggest that size increases as w_0 increases, and as concentration of saccharide added decreases, the variability of size increases.

Reverse Micelles and Osmolytes:



$$W_0 = \frac{[water]}{[surfactant]} = \frac{4\pi r^3}{3(4\pi r^2)} = \frac{r}{3}$$



Methods:

Sample Preparation:

- 0.1M AOT in isooctane stock solutions
- 120:1 and 180:1 water to sugar stock solutions
- Sonicate 10 plus minutes, BRANSON 3200
- 750 uL saturated Coumarin 343 in methanol

Excitation and Emission (1-3), Size (4), NMR (5):

1. Vernier SpectroVis Plus and Logger Pro software
2. CLARIOstar and MARS data analysis software
3. Edinburgh FS5 spectrofluorometer (150 W Xenon Lamp)
4. Dynamic Light Scattering (DLS)
5. JEOL 400 and Delta 6.0.0 software (H NMR, ^{13}C NMR, 2D NMR)

Optical Spectroscopy:

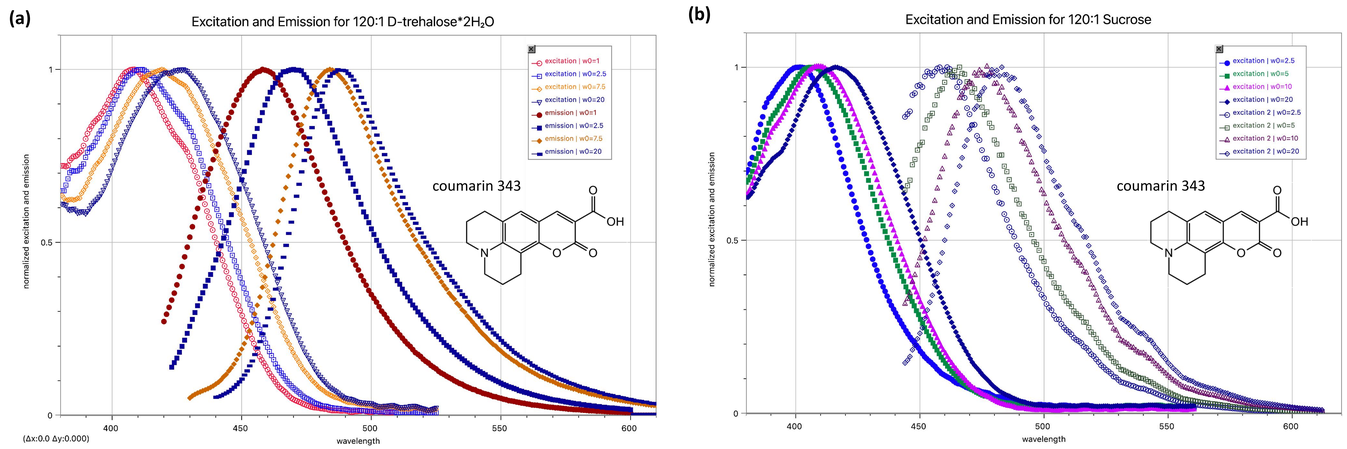


Figure 1a and 1b. *Excitation and Emission for 120:1 concentrated disaccharides.* Shifts of excitation and emission scans for increasing w_0 value indicate that the environment of the reverse micelles changes as w0 changes. This reinforces the need to study the osmolytes in nanoconfinement.

Size:

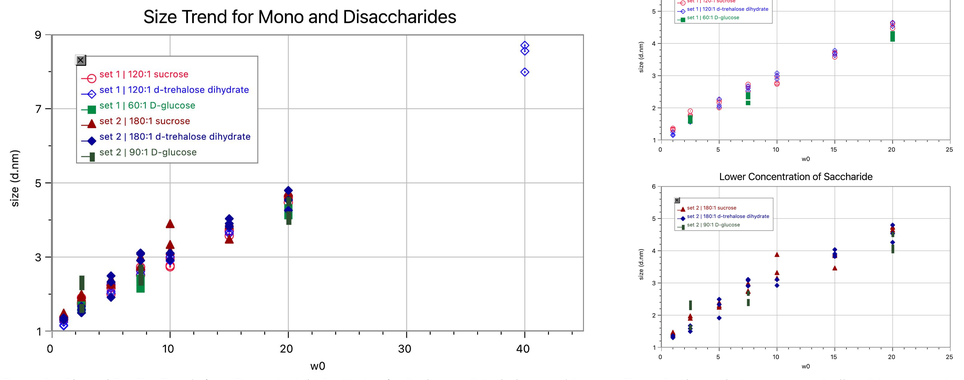


Figure 2a, 2b, and 2c. *Size Trends from Dynamic Light Scattering for D-glucose, D-trehalose, and Sucrose.* Figure 2a shows that as reverse micelle w0 increases, size increases. A comparison of Figures 2b and 2c show that a lower concentration saccharide leads to a greater variability of reverse micelle size.

Future Work:

- Calculate and compare stoke shifts from excitation and emission data
- Analyze REES data
- Analyze current 2D NMR data
- Develop a clear method to compare NMR data

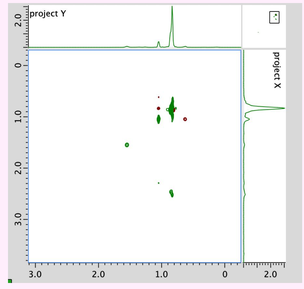


Figure 3. *2D NMR of w_0=5 120:1 D-trehalose*2H$_2$O.* This type of NMR allows us to see which protons are interacting with each other. Having this information means that a position where the osmolytes occupy space can be determined within the reverse micelle, whether that be in the water domain, at or near the interface of the water pool and surfactant polar headgroups, or in the nonpolar regions.

Acknowledgements:

Thank you to the National Science Foundation for financial support (Award #1956198 and #1956323) and to Professor Gourley for her great mentorship, support, and encouragement.