STRUCTURE AND HYDRATION OF PHYTOGLYCOGEN NANOPARTICLES: NATURE'S DENDRIMER

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Nature offers amazing examples of nanostructured molecules and materials. I will focus on phytoglycogen, a highly-branched polymer of glucose produced in the form of dense, monodisperse nanoparticles by some varieties of plants such as sweet corn. The particles are chemically simple, but have a special dendrimeric or tree-like structure that produces interesting and unusual properties such as extraordinary water retention, and low viscosity and exceptional stability in water. These properties point to a wide variety of potential applications from cosmetics to drug delivery, yet these applications need to be enabled by a deeper understanding of the unique structure of the particles and their interaction with water. To achieve this, we have used a wide range of techniques. Neutron scattering has revealed that the nanoparticles have uniform size and density and are highly hydrated, with each nanoparticle containing about 250% of its mass in water [1]. Surface-sensitive infrared absorption measurements on phytoglycogen films show that the high degree of branching in phytoglycogen leads to a well ordered "network" structure of the hydration water within the particles [2]. Rheology measurements have revealed weak interactions between the particles, allowing loading of the particles into water up to 20% w/w before significant increases in viscosity are observed, showing that this is an interesting model system for studying soft colloid physics [3]. Taken together, these studies provide new insights that are key to fully understanding and exploiting these materials in new technologies and therapies.

[1] J.D. Nickels, J. Atkinson, E. Papp-Szabo, C. Stanley, S.O. Diallo, S. Perticaroli, B. Baylis, P. Mahon, G. Ehlers, J. Katsaras and J.R. Dutcher. Structure and Hydration of Highly-Branched, Monodisperse Phytoglycogen Nanoparticles, Biomacromolecules 17, 735-743 (2016).

[2] M. Grossutti and J.R. Dutcher. Correlation Between Chain Architecture and Hydration Water Structure in Polysaccharides, Biomacromolecules 17, 1198-1204 (2016).

[3] H. Shamana, E. Papp-Szabo, J. Atkinson, C. Miki and J.R. Dutcher. Phytoglycogen Nanoparticles in Water: A Model Soft Colloid System, in preparation