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Changes to fine molecular structure, hydrodynamics, and mechanical modulus of phytoglycogen nanoparticles subjected to high-shear screw extrusion

Content

In this work, for the first time, we reported changes to the fine molecular structure and nanomechanical properties that occur in phytoglycogen nanoparticles subjected to high shear extrusion, enhancing the current knowledge about the internal architecture of phytoglycogen molecules. Screw extrusion was efficient at producing size-reduced phytoglycogen nanoparticles on the multikilogram scale. Molecular weight was more susceptible to shear than particle radius, presumably indicating that a relative high number of chains (or portions) of phytoglycogen could be cleaved and removed without disintegrating the soft, deformable nano-particles. High-resolution maps of the spatial distribution of Young's modulus values within individual nanoparticles, obtained from AFM force spectroscopy images, revealed stiff inner and soft outer regions, the former potentially containing a subset of stiffer chains within the β-limit dextrin. Interestingly, extrusion at higher specific mechanical energy further disrupted the internal structure of phytoglycogen, which resulted in an overall decrease in the Young's modulus of the particles without further reductions in size. We believe that the present results will be foundational to develop an economical and scalable manufacturing process for a new class of clean label size-reduced phytoglycogen. This new material has the potential to become an attractive biocompatible nano-platform technology that is ideal for applications involving the human body, including personal care, nutrition and biomedical formulations, such as drug delivery.

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