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Perspective

Tribology Behavior in Polysaccharide Hydrocolloids

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DESCRIPTION

Xanthan gum and scleroglucan, two rod-shaped polysaccharide hydrocolloids, are compared using a wide range of instrumental techniques and methods steady shear flow, small amplitude oscillatory shear, first normal stress differential, capillary rupture, and soft contact tribology. Aqueous solutions of these two hydrocolloids with similar flow and viscoelastic profiles show distinct differences in capillary degradation time and apparent extensional viscosity. This result correlates with the difference in the first normal stress difference and, to a lesser extent, with the behavior of the Stribeck curve. Formulating the hydrocolloids in a concentrated sucrose solution (40% by weight) shifts the relaxation profile to a longer time and significantly reduces differences in rheological and smearing behavior. Except for the capillary breakage test, other methods showed no statistically significant differences between polysaccharides dissolved in viscous matrices. The toolbox of techniques is also applied to study the interaction of xanthan gum and scleroglucan with whole human saliva and bovine submandibular mucin. No specific interactions between hydrocolloids and salivary proteins have been reported, and we propose that cumulative effects must result from a specific set of linear and nonlinear rheological properties of saliva/hydrocolloid mixtures.

Many tasks in food study and development require the selection of instrumental techniques to characterize the flow and lubrication behavior of food biopolymers and study their interactions with other constituents and biological interfaces. The combination of different instrumental techniques represents a powerful approach that can capture different aspects of biomacromolecular behavior over different lengths and timescales. However, in the context of food development, the combined approach can pose many practical challenges. Complexity of experimental design, difficulty in implementation and data interpretation, and equipment availability and significant time commitments may limit broad acceptance and hinder practical application. To address this issue and allow easy comparison of instrumental technology, we studied the shear flow, viscoelasticity, and smearing behavior of two very similar hydrocolloid thickeners, xanthan gum and scleroglucan. It tried different techniques which are expected to exhibit selective sensitivity to different aspects of viscoelastic behavior. Furthermore, in addition to previous studies by analytical ultracentrifugation, there is study interaction of these two hydrocolloids with salivary proteins using rheological and tribological tools.

Over the past decade, great progress has been made in developing experimental techniques to characterize food biopolymers and their behavior during oral processing. A recent examination by several investigation teams highlights the historical evolution of food characterization techniques, from deeply rooted approaches to flow profiling and rheological oscillatory techniques (small and large amplitude oscillatory shear rheometry) to extended measurement capabilities. There are next generation methods which include thin-gap, high-shear, rheometry and nanorheology using atomic force microscopy, extended rheological approaches such as capillary disruption, tribology and lubrication. In particular, we focus on soft contact tribology as one of the most effective techniques for food.

CONCLUSION

Although the choice of technique is determined by the examination question, rheometer-based techniques are a common method in many food development tasks that require evaluation of thickener rheological properties, as well as capture of liquid mouth feel and textural properties and semi-liquid diet. However, many applications require the evaluation of complex flow behavior and the recording of interactions between product components and microstructures and saliva. These factors play an important role in determining the oral processing of food and have a significant impact on the organoleptic properties of the product. For distressed consumers, for example, simple spoon or drinkable hydrocolloid formulations may require careful consideration to ensure a safe product. Two formulation strategies commonly used for this type of product include the use of high molecular weight rod thickeners such as xanthan gum or lightly cross linked systems such as carrageenan to induce gelling. Mineral salts are added for the specific choice of thickener system which is determined by rheological properties(spooning, squeezing), textural properties and stability under different environmental conditions.

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