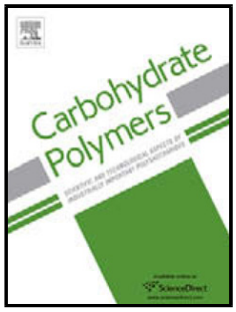

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Probing Hydrogen Bond Interactions in a Shear Thickening Polysaccharide using Nonlinear Shear and Extensional Rheology

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Abstract

Mamaku gum is a polysaccharide extracted from the fronds of the black tree fern found in New Zealand. The cooked pith has traditionally been used for various medicinal purposes and as a food source by the Māori people of New Zealand. It has potential applications as a thickener in the food industry and as a palliative for patients with dysphagia. Studies on the shear rheology of Mamaku gum have revealed that the gum exhibits shear thickening at a critical shear rate due to a transition from intra- to inter-molecular chain interactions upon shear-induced chain elongation. In this paper we demonstrate that these interactions are primarily due to hydrogen bonding. We perform extensional rheology on mixtures of Mamaku gum and urea (a known disruptor of hydrogen bonds) to quantify the nature of these interactions. Capillary Breakup Extensional Rheometry (CaBER) performed on the pure Mamaku gum solutions yield plateau values of the Trouton ratio as high as $\sim 10^4$, showing that the viscoelasticity of the gum in uniaxial elongation is much higher than in shear. For all Mamaku concentrations tested, the extensional viscosity decreases upon increasing urea concentration. Furthermore, the relaxation time decreases exponentially with increasing urea concentration. This exponential relationship is

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