**The Tale of a Shear-thickening Biomacromolecule from the New Zealand Black Tree Fern**

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**Abstract**

The industrial demand for minimally processed natural ingredients has motivated the search for biopolymers with unique functionalities such as shear-thickening behaviour (*i.e.,* increase in viscosity on applying shear). Biomacromolecules with shear-thickening behaviour are uncommon and rarely reported in the literature. Thus, here we present a one-of-a-kind shear-thickening polysaccharide extracted from the New Zealand black tree fern (*Cyathea medullaris*). Black tree fern polysaccharide (BTFP) is a long-chain water-soluble glucuronomannan polymer with a repeating backbone of -4)-*β*-D-GlcpA-(1→2)-*α*-D-Manp-(1→. Investigation into the rheological properties revealed that BTFP exhibits Newtonian, shear-thickening and shear-thinning behaviour depending on concentration and applied shear rate. However, the shear-thickening behaviour is found to be sensitive to the harvesting age of the fronds at the farm. It was previously shown that the BTFP could delay the emptying of food from the stomach into the small intestine (*i.e.,* delay gastric emptying) by significantly altering the wall activity of the rat stomach (Lentle, Janssen, Goh, Chambers, & Hulls, 2010; Wee, Lentle, Goh, & Matia-Merino, 2017). This suggests that the shear-thickening behaviour of BTFP can be explored to design novel food products that could facilitate safe swallowing for people with dysphagia, satiety management and reduced glycaemic index for people with diabetes and obesity. However, during industrial manufacturing, BTFP may be subjected to treatments such as high-shear and temperature which could adversely affect the structural and rheological properties, thereby its physiological effects. In this work, we observed that BTFP is sensitive to both temperature and high-shear treatments. The temperature treatment disintegrated the backbone of BTFP into smaller fragments (molecule weight-*Mw*: control = ~3.9x106 Da, 115°C = ~0.6x106 Da), which caused a reduction in viscosity and the extent of shear-thickening. Similar rheological trends were observed post-high-shear treatment, however, there was no evidence of depolymerisation as *Mw*, constituent monosaccharide composition and NMR spectra (1H and 13C) were unaffected. It is suggested that the changes in rheological behaviour after high-shear treatment could be due to changes in the packing of BTFP molecules, which leads to a compact structure with stronger intramolecular interactions. The results, therefore, indicate that the harvesting age of fronds and modification of BTFP during the industrial process should be considered as it may adversely affect the texture of the product and the expected physiological benefits.

**Keywords**: New Zealand black tree fern, shear-thickening, rheology, high-shear sensitivity, temperature sensitivity, gastric emptying

**Reference**

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