**Influence of elasticity on performance of sustainable biopolymeric microgels**

Daisy Akgonullu a, Brent Murray a,Simon Connellb, Yuan Fangc, Bruce Linterd, Anwesha Sarkara

*a Food Colloids and Bioprocessing Group, School of Food Science and Nutrition, University of Leeds, Leeds, LS2 9LY, UK*

*b Molecular and Nanoscale Physics Group, School of Physics and Astronomy, University of Leeds, LS2 9LY, UK*

*cPepsiCo, Valhalla, New York, NY, USA*

*dPepsiCo International Ltd, Leicester, UK*

Microgels are particles of cross-linked solvated polymers, with unique deformability which enables them to provide viscoelasticity to bulk media1. In addition, some proteinaceous microgels possess excellent interfacial properties,2 such that they are partially wetted by both oil and water phases and so have the ability to act as Pickering stabilisers. Due to the increasing demand for biocompatible, clean-label ingredients with minimal environmental impact, a greater understanding of the behaviour of biopolymeric microgels originating from plant-based, sustainable sources is required.

This study particularly focuses on understanding the performance of plant protein microgels by changing their degree of internal crosslinking and size. Potato protein (PoP) was used to produce microgels of sub-micron diameter via a top-down approach of thermal crosslinking followed by high-shear homogenisation of the bulk gel. The modulus of the microgels was altered via varying the protein concentration in the bulk ‘parent’ gel: 5, 10 and 15 wt%, to produce microgels with diameters between 200 and 300 nm, as observed via dynamic light scattering and atomic force microscopy. Measurements of: bulk rheology; interfacial shear viscosity (i) and interfacial tension (g); surface pressure - area isotherms of microgel monolayers at the air-water (A-W) interface; atomic force microscopy of adsorbed films, were combined to assess the role of microgel deformability on bulk and interfacial film properties.

It was shown that PoP microgels were capable of lowering  at an oil-water interface to values ≈ 13 mNm-1, similar to those of native PoP. Whilst the bulk viscosity of dispersions (50% concentration) of microgels produced from 10 and 15 wt% gels showed pronounced shear thinning, the apparent viscosity decreasing by an order of magnitude over the shear rate range 10 to 1000 s-1, in contrast to the native PoP, which displayed Newtonian behaviour at equivalent PoP concentrations. Preliminary results from interfacial shear rheology and monolayer experiments show the importance of the deformability and size of the microgels in terms of packing at the A-W interface, suggesting that an optimal level of microgel mobility may promote resilience of microgels at interfaces and thus aid in emulsion stability.

These findings offer new knowledge on how biopolymeric microgel performance can be tuned via altering the modulus of the bulk parent gels to aid the development of sustainable Pickering emulsions as a suitable template for developing new soft materials tackling a multitude of industrial challenges within food, agrochemical, and biotechnological sectors.

Acknowledgements

Authors gratefully acknowledge the Engineering and Physical Sciences Research Council (EPSRC) funded Centre for Doctoral Training in Soft Matter for Formulation and Industrial Innovation (SOFI2), Grant Ref. No. EP/S023631/1 for financial support.

References

1. Andablo-Reyes, E.; Yerani, D.; Fu, M.; Liamas, E.; Connell, S.; Torres, O.; Sarkar, A., Microgels as viscosity modifiers influence lubrication performance of continuum. *Soft Matter* **2019,** *15* (47), 9614-9624.
2. Zhang, S.; Holmes, M.; Ettelaie, R.; Sarkar, A., Pea protein microgel particles as Pickering stabilisers of oil-in-water emulsions: Responsiveness to pH and ionic strength. *Food Hydrocolloids* **2020,** *102*.