4.7

Oral tribology of protein microgel particles: Influence of hydrophobicity of contact surfaces

Anwesha Sarkar *(Food Colloids and Processing Group, School of Food Science and Nutrition, University of Leeds, Leeds, LS2 9JT, United Kingdom), Brent Murray (Food Colloids and Processing Group, School of Food Science and Nutrition, University of Leeds, Leeds, LS2 9JT, United Kingdom)*

Protein-based microgel particles have attracted significant research attention owing to their enormous technological functionality (1, 2). In this study, we designed whey-protein microgel particles (WPM) (10-80 vol%) and focused on understanding their rheological, structural and tribological properties (smooth polydimethyl siloxane (PDMS) contacts, ball-on-disk set up). The WPM particles (Dh = 380 nm) displayed shear-thinning behavior and facilitated lubrication between bare hydrophobic PDMS surfaces (water contact angle 108○), leading to a 10-fold reduction in boundary friction force with increased volume fraction (≥ 65%). This was largely attributed to the close packing-mediated layer of particles between the asperity contacts acting as 'true surface-separators' and hydrophobic moieties of WPM adsorbing to the PDMS surfaces. The WPM particles are hypothesized to employ a rolling mechanism analogous to 'ball bearings', which was supported by negligible change in size and microstructure of the WPM particles after tribology. An ultra-low boundary friction coefficient, μ ≤ 0.03 was achieved using WPM between O2 plasma-treated hydrophilic PDMS contacts coated with mucin (water contact angle 47○), and electron micrographs revealed that the WPM particles spread effectively as a layer of particles even at low volume fraction (~ 10 vol%) , forming a lubricating load-bearing film. However, above close packing, μ increased in hydrophilic surfaces due to retardation of the rolling mechanism. These findings highlight aqueous lubricating properties of protein microgel particles and hold promises for fat replacements without compromising mouthfeel.

References

1. Sarkar, A. et al., Aqueous lubrication, structure and rheological properties of whey protein microgel particles. Langmuir 2017, 33, (51), 14699-14708.

2. Sarkar, A. et al.., In vitro digestion of Pickering emulsions stabilized by soft whey protein microgel particles: influence of thermal treatment Soft Matter 2016, 12, 3558-3569.

Acknowledgements The European Research Council is acknowledged for its financial support (Funding scheme, ERC Starting Grant 2017, Project number 757993) for this work.