

## An aqueous bio-lubricant with ultra-low friction coefficients to tackle xerostomia (dry mouth condition)

Siavash Soltanahmadi, Jing Hu, Efren Andablo-Reyes and Anwesha Sarkar

s.soltanahmadi@leeds.ac.uk

Food Colloids and Bioprocessing Group, School of Food Science and Nutrition, University of Leeds, Leeds, UK

### Summary

Xerostomia is a dry mouth syndrome where the lubrication property of natural saliva is lost. The impact of complications associated with xerostomia on people suffering from that is significant. Therefore, a bio-lubricant capable of excelling the lubricity of saliva can transform the quality of life of millions of individuals, particularly elderly population where this condition is most prevalent. In this paper, a food-grade bio-lubricant is presented comprising of positively-charged proteinaceous microgels doped into a network of negatively-charged carbohydrate-based nanofibrils. The lubricant was developed by addition of laboratory-synthesized lactoferrin microgels (LFMs) into a network of  $\kappa$ -carrageenan hydrogel ( $\kappa$ CH) and exhibits a lubricity superior to that of real human saliva [1].

Keywords: oral tribology, superlubricity, biomimetic, microgel, hydrogel

### Results, discussion and conclusion

The transmission electron microscopy (TEM) and  $\zeta$ -potential measurements demonstrated electrostatic interactions between LFMs and  $\kappa$ CH. The surface adsorption properties of the LFMs,  $\kappa$ CH, and LFM-doped  $\kappa$ CH were investigated using a quartz crystal microbalance with dissipation monitoring (QCM-D) and finally the lubrication behaviour of the lubricants was studied using a Mini Traction Machine (MTM) and bespoke rheo-tribometry technique using 3D tongue-like soft textured surfaces [2]. Using TEM and  $\zeta$ -potential we show that a critical ratio of  $\kappa$ CH/LFMs exists where LFMs were fully covered by  $\kappa$ CH. The surface adsorption (examined by QCM-D) was governed by the interactions between surfaces and LFMs. The LFM-doped  $\kappa$ CH showed enhanced surface adsorption properties as compared to the individual components (Figure 1).

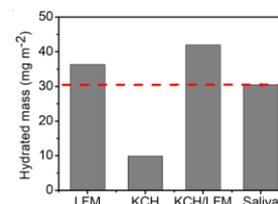


Figure 1. Surface adsorption results measured using QCM-D

Tribotesting surfaces were carried out on polydimethylsiloxane (Figure 2a) as well as on tongue-emulated surfaces (Figure 2b). These surfaces were recently developed by authors [2]. These tests confirmed that the novel microgel-doped hydrogel, developed in this work [1], excels real human saliva in lubricating orally-relevant surfaces and hence has substantial potential to be used in treating xerostomia.



Figure 2. The friction coefficient results for LFM,  $\kappa$ CH, LFM-doped  $\kappa$ CH and real human saliva on elastomeric surfaces using a) MTM and b) a modified rheo-tribometer and tongue mimicked surfaces.

### References:

- [1] Jing Hu, E.A.R., Siavash Soltanahmadi and Anwesha Sarkar. Synergistic Microgel-Reinforced Hydrogels as High-Performance Lubricants. ACS Macro Letters (Accepted) (2020).
- [2] Andablo-Reyes, E., Bryant, M., Neville, A., Hyde, P., Sarkar, R., Francis, M., et al. 3D Biomimetic Tongue-Emulating Surfaces for Tribological Applications. ACS Applied Materials & Interfaces 12:49371-49385 (2020).

**Funding:** The European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement n° 757993 and 890644)