**Effect of continuum shear rheology on the oral tribology of protein microgels**

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Biocompatible microgels based on starch and whey proteins have been recently demonstrated to act as suitable lubricants for high demanding physiological applications1,2. However, the role of the rheological properties of these microgels in the tribological limit is not yet well understood. Moreover, these tribological studies have been limited to dispersions of microgels in simple aqueous media, neglecting the important influence of other components, such as polysaccharides. In this work, the lubrication performance of whey protein microgels (10 wt% or 15 wt% protein content) dispersed in Newtonian (phosphate buffer and 50 – 75 wt % corn syrup solutions) or complex non-Newtonian (0.5 - 1 wt% xanthan gum solutions) continuum was studied. Microgel particle diameter was estimated by dynamic light scattering to range from 80 to 120 nm. Shear viscosity of microgel dispersions and continuum was investigated using rotational rheology (cone-plate geometry) in a range of shear rates from 0.1 to 1000.0 s-1. Experimental temperature was fixed at 37 °C. Viscosity data was fitted using the Cross model in order to extrapolate the high shear rate plateau values (**∞) in cases where this region was not observed in the experimental window. Values of **∞ for microgel dispersions in continuum with **∞< 10 mPa s, showed a monotonic behaviour up to 10 fold increase with increase in protein concentration in the microgels. However, microgel dispersions in continuum with **∞> 40 mPa s, showed a non-monotonic dependence of **∞ with the concentration of protein in the microgels. Microgels with 10 wt % protein content had values of **∞ of only half with respect to that of the continuum, while 15 wt % protein microgels approximated the rheology of the continuum. Soft lubrication performance of the microgel dispersion was studied using a silicon ball on disc set-up under rolling-sliding conditions with normal load of 2 N. Friction coefficient was measured on a range of entrainment speeds (*U*) from 1.0 to 300.0 mm/s covering the mixed and hydrodynamic lubrication regimes. Microgels in continuum with **∞< 10 mPa s showed up to a 70 % decrease in friction in comparison to the continuum. However, increasing the continuum viscosity, resulted in an increase of friction by 80% for 10 wt % protein microgels respect to the continuum, while 15 % wt protein microgels showed similar lubrication properties to the continuum. The qualitative behaviour shown by **∞ and friction coefficientwas similar for both, corn syrup and xanthan gum solutions. Connection between rheological and tribological properties of the dispersions was established by representing the friction coefficient as a function of the fluid drag force (**∞*U*). Collapse of the friction curves and shifting of the hydrodynamic lubrication onset indicated that the lubrication properties of microgels are due to their thickening or thinning effect depending on the rheological properties of the continuum.

*References:*

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