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HYDROGELS PREPARED FROM OVOMUCINS: AN EASY-TO-ACCESS MODEL FOR MUCUS TRIBOLOGY

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ABSTRACT

Animal tissues locating at the interface, such as epithelium of tracheobronchial, gastrointestinal and reproductive tracts, are lubricated with viscoelastic mucus hydrogels. The unique gel-like properties of mucus are provided mainly by the network formation of a highly complex glycoprotein mucins. Even though the research on the lubricating properties of macromolecular mucins has been conducted to a certain extent [1,2], corresponding lubrication studies on mucus are much rarer to date. This is primarily due to the lack of mucus or mucus models that are easily accessible and prepared. Commercially available mucins can be one source to formulate mucus models. However, they are known to lack gel-forming properties even at physiological concentration, presumably due to certain steps involved in mucin isolation and preparation process that impair sufficient aggregation of mucins to form mucus gels.

Recent studies on hydrogels generated with extracted ovomucin (OVM) from hen egg white, termed as OVM gel (OVMG), have indicated that their rheological properties are similar to those of pig gastric mucus [3], which inspired us to extend the scope of the study to tribological properties of OVMG. Given the extremely low film thickness at biological tissues (mucus film thickness < 1 mm), the lubricity of OVMG was characterized with in a thin layer in ambient environment as opposed to flooded lubrication. Rheological studies have shown that OVMG prepared from dissolving 1% in distilled water showed typical physical hydrogel properties in dynamic viscoelasticity and shear-thinning properties. Meanwhile, heating OVMG up to 90°C led to an irreversible increase of the viscoelasticity. Based on the model mucus gels prepared from OVM, a primary question that we address in this study is to identify the type of solid interfaces it can effectively lubricate by employing many tribopairs varying in surface chemistry and mechanical properties, including a) HDPE-HDPE representing hard-hydrophobic interface, (b) HDPE-PDMS, representing soft-hydrophobic interface, (c) steel-PDMS, representing soft-half hydrophilic interface, and (d) steel-glass, hard-hydrophilic interface. Variation of surface hydrophilicity of the tribopair and mechanical properties revealed that OVMG is most effective in its lubricity as thin film at soft-hydrophilic tribological interface, as presented for the case of steel/PDMS pair in Fig. 1. The wetting and anchoring of OVMG onto the interface appear to be a most critical parameter to determine its lubricity.

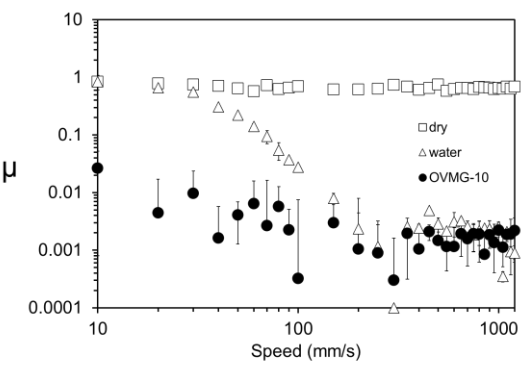

Fig.1 μ vs. speed plots for steel ball/PDMS disc pair lubricated with a thin layer of OVMG: Measurements with mini-traction machine (MTM), 5N, 10% SRR

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