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On relating rheology and oral tribology to sensory properties in hydrogels

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Understanding the characteristics of oral processing (chewing, lubrication) has drawn significant research attention with the focal point recently shifting from rheology to tribology. The aim of this study was to understand the relationship between the material properties (rheology, tribology) and the sensorially perceived textural attributes (quantitative descriptive analysis, QDA®) using semi-solid model foods i.e. biopolymeric hydrogels. Fracture properties and flow curves of κ-carrageenan hydrogels (κC) and mixed hydrogels containing different ratios of κC and locust bean gum (LBG), sodium alginate (NaA) or with inhomogeneity by introducing 300 or 1000 μm calcium alginate beads (CaA) at 1-4 wt% total biopolymer concentration, were evaluated. Friction coefficient (μ) of the hydrogel-boli after simulated oral processing were compared when sheared between polydimethylsiloxane (PDMS) ball/disc tribopairs with pre-adsorbed artificial salivary film at 37 °C. Nine sensory attributes were identified with a trained sensory panel (n=11) that could be related to either the chewing or lubrication related aspects of oral processing. Our results demonstrated that fracture properties were directly correlated to the chewing-related QDA attributes, such as firmness, elasticity and chewiness, as well as inversely correlated to the lubrication-related attributes pastiness and melting ($p < 0.05$). On the other hand, μ at orally relevant speeds (3-50 mm/s) was inversely correlated to pastiness for the gel bolus fluid where the large bolus fragments were filtered out. In spite of having 'ball-bearing'-mediated lubrication aspects in samples containing CaA beads, they did not show significant sensory 'smoothness' owing to their particle size exceeding the sensory threshold. Thus, our study demonstrated a unique relationship between rheology, tribology and sensory perception in aqueous hydrogels, which can open new horizons in designing new foods with tailored orally perceived textural attributes.