**The development of agar fluid gels for fat reduction in high-sugar bakery fillings.**

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Fats are important dietary components providing 25–30% of our daily energy intake. However, fats can also be controversial, with excessive consumption of trans- and saturated fats (in particular) being linked to conditions/pathologies that are detrimental to human health. Saturated fats are largely responsible for the mouthfeel and textural performance of many formulated food products, and so reduction in food products poses a serious technical challenge.

This work focusses on the development of fluid gels for the reduction of saturated fats in high-sugar bakery fillings such as custard, chocolate filling and whipped cream. Fluid gels are concentrated suspensions of gelled particles, formed when gelation of a biopolymer occurs under shear. Their combination of lubricating ability, paste-like rheology and deformable micron-scale microstructures has led to the suggestion that fluid gels may be suitable for fat replacement in food products. However, the presence of sugar in bakery fillings poses a problem, since the material properties of hydrocolloid gels are sensitive to such co-solutes1,2. While research exists in the context of quiescent gels, there is limited literature exploring the effect of sugar on fluid gel formulations. Thus, development of a fluid-gel based bakery filling requires exploration of the effect of sugar on the material properties of fluid gels, and translation into the practical implications this would have for mimicking fatty mouthfeel.

A combination of texture analysis, rheology and phase contrast microscopy have been used to explore the effect of sucrose (up to 60 wt%) on agar fluid gels produced in a cup and vane rheometer geometry, as well as a pin stirrer. Sucrose is found to increase the physical strength and stiffness of the gel network up to a critical concentration, possibly through enhanced stabilisation due to more pronounced hydrogen bonding between water, the used hydrocolloid and equatorial OH-groups present on the sugar. The mean fluid gel particle size is shown to decrease with sucrose addition, likely due to a combination of effects arising from an increased viscosity during gelation. An increase in viscosity and yield stress but reduction in elastic modulus is observed, which can be related to changes in the particle textural properties and microstructure.

Application of current models for predicting mouthfeel from rheological behaviour suggests that the presence of sucrose in these formulations may be beneficial for enhancing creaminess perception. This work confirms that the established view that the properties of fluid gels can be manipulated through variations to the processing conditions used for their manufacture, still persists in the presence of sugar, and demonstrates there is also the possibility to further tune fluid gel properties by changing the order of sucrose addition; i.e. addition prior or post fluid gel formation. Overall, this research presents both a fundamental and practical approach for developing fat-reduced formulations for high-sugar products using fluid gels.

*References:*

1. M. Watase K. Kohyama, K. Nishinari*.* (1992).Effects of sugars and polyols on the gel-sol transition of agarose by differential scanning calorimetry*. Thermochimica Acta* 208, 163–173 (1992).

2. P. Lopez-Sanchez, N. Fredriksson, A. Larsson, A. Altskär, A. Ström. (2018). High sugar content impacts microstructure, mechanics and release of calcium-alginate gels. *Food Hydrocolloids* 84, p26-33.