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A mathematical model of the bolus formation of starch-based foods during oral processing

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Food oral processing is one of the many digestive processes in the body but is less understood due to its complexity and variation across people. A mechanistic approach, such as a mathematical model, is a tool that can be used to understand food oral processing. It can be used to visualise the mechanisms and governing principles of oral processing when food is consumed in the mouth. Similarly, the models could be used to identify food structures aimed at providing palatability with increased protein, reduced sugar or salt products. Therefore a successful outcome of the mathematical model can provide understandings to food engineers to design foods that can tailor to consumer preferences.

It is known that food oral processing involves various small batch operations, including mechanical shear, heat transfer, enzymatic reactions and many others. In this research, these operations were compared with the unit operations currently existing in the food and chemical engineering industry to offer insights and a basis for the development of a mathematical model. For example, food particle reduction by the teeth is paralleled to crushing a rock ore using a jaw crusher in the engineering industry. The mathematical model predicts starch-based food (such as rice, biscuits and potato chips) bolus properties which are known to have an impact on swallowing, digestion and palatability. The modelled properties are the particle size distribution of the bolus, the bolus continuous phase viscosity, the concentration of tastant and aroma compounds inside the bolus and the bolus cohesiveness. The study is divided into three principal stages; first is the development of a conceptual model to provide a framework of the key rate processes involved in oral processing, second is the development of a working mathematical model integrating these essential processes and lastly validating the mathematical model with in-vivo experimental data.