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Editorial overview: Edible soft matter: Gels, colloids and interfaces

Designing edible soft matter is important, as such materials can be used to deliver components to our body, manipulate food-body interactions, and provide tasteful foods with a pleasant eating experience. This requires control and understanding of the microstructural development at different length scales, and implementation of cross disciplinary experimental technologies and approaches. Fundamental principles and characterization methods of soft matter can provide insights into the complex behavior of edible soft matter. The complex nature of such materials arise from the structure, often defined as dispersed systems, such as emulsions, foams, or suspensions. To control the macroscopic properties, it is essential to understand how the microstructure can be altered, and requires novel experimental techniques to quantify the structures on a micro scale, both in static and dynamic conditions. In this special edition on "edible soft matter", we highlight some of the latest developments in the design of new materials, and how different experimental techniques can be used to gain new insights on the structures and behavior of such materials.

Starting with foams, **Nallamilli et. al** discuss the use of complex coacervates to create foams. By including different amount of surfactants, they were able to change the hydrophobicity of these complexes, which influences the foaming ability. Also the study of **Xu et. al.** focusses on foaming ability and foam stability, but instead used nanoparticles to stabilize the interface. By controlling the electrostatic interactions between the particles, they were able to change the elasticity of the interface, and thereby increase foam stability. Nanoparticles were also used in the study of **Araiza-Calahorra** and co-workers, together with coated nanoparticles and conjugated microparticles. They used these particles to stabilize emulsions, which were loaded with active compounds. By controlling the interfacial properties, they were able to provide better protection against degradation under gastric conditions, and improve the delivery to the intestine. These studies show that is possible to control the properties of particles, and thereby alter the properties of different dispersed systems. In the study of **Ghebremedhin et. al.,** they also show that the properties of the microgel particles can be adjusted by creating them under shear. As the particles assemble during shear, the ratio between the inner core and the size of the tails as the outer core is adjusted, which influences the rheological and the tribological behavior. The resulting fluid gels can be used as texture modifiers. Next to these new particle types, casein micelles have been used already for a long time to create different fluids and solid materials. However, in the case of using reconstituted milk, the properties of the casein micelles may be affected, such as the size, which then also changes the rheological properties of casein systems. In the study of **Lie-Pang et. al.,** they use asymmetric flow field flow fractionation to gain insight in the size of the micelles. By fluorescently labelling specific casein fractions, they were also able to track the migration of these caseins from and to the serum phase which until now was not completely understood.

Next to water-continuous systems, also oil-continuous systems have been gaining a lot of attention in the last years. These systems are of relevance, as oil and fat play an important role in determining the textural properties of many edible materials. It is therefore desired to control the rheological properties, such as gel strength, plasticity, and melting behavior, of such materials. **Nicholson** and co-workers discuss how glycerolysis of liquid oils can transform them into structural fats and provide good plasticity and melting behavior. This approach can thus be used to control gel strength independent on the fat composition, which can be used to improve the fatty acid profile and increase sustainability. Such material may therefore be a healthier alternative to other solid fats. Healthier materials can also be created when they are able to deliver bioactive compounds to the body. Such compounds are often of hydrophobic nature, and degrade readily under different environmental conditions. Materials that can enclose such hydrophobic compounds may thus protect such compounds and enhance delivery. **Manzocco et. al** have designed a new hydrophobic material that would be able to enclose such compounds. They present a feasibility study of creating hydrophobic bio-aerogels using supercritical CO_2 extraction to remove oil from oleogels. They discuss how the composition and additional particles can affect the scaffold structure and properties of these aerogels. Also different strategies to create more healthier hydrophobic material is discussed by **Ewens** and co-workers. This review paper discuses different reformulation strategies for chocolate, including the use of emulsions, hydrogels, oleogels and oleofoams for the reduction of fat and sugar. In addition, the review paper also discussed the crystallization behavior of such products. The crystallization of fats is also discussed by **Rebry** and co-workers. They present a novel Rheo-NMR set-up that allows to follow the rheological properties as a result of the fat network formation as a function of shear. They discuss how shear can affect the crystal formation of different types of fat, and how this is related to a minimal percentage of solid to obtain a crystal network. Such hydrophobic materials were also used to improve the shelf-life of bakery products. **Chen et. al.** used different oleogel-based and wax-based coatings to slow down moisture transfer and retain desired textural properties over time. These hydrophobic materials are compared to other hydrophilic materials, such as protein coatings and starch coatings.

In the case of chocolate, it is not only the type of fat that influences the mouthfeel but also other factors. Next to the rheological properties, also friction or lubrication properties are relevant for mouthfeel, especially for complex attributes as creaminess and smoothness, which are

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perceived at later stages of processing when the food is mixed also with saliva. **Samaras et. al.** present a new bench test that is able to measure friction coefficients in simulated tongue-palate context; measure friction while the sample is degraded. They discuss the effect that chocolate composition has on the measured friction coefficients, such as the cocoa solid content, and the incorporation of air. To understand the relation between material structure and mouthfeel, it is therefore also important to develop new methodologies to gain insight in the dynamic changes of the structures during eating. In the study of **Srivastava** and co-workers**,** they show that ultrasound techniques can be used as a novel strategy to follow such dynamics. Using stacked layered gels with different mechanical properties, they visualize the deformation in real time, and show how different layers have a collaborative response to the deformation.

It is clear that such developments can contribute greatly to understanding how different edible materials are consumed, and how the structural organization of the foods can be changed to induce a certain sensation. With the current trends to reduce the use of solid fats, increase sustainability, and include novel ingredients from plants and waste products, it is important to understand how different ingredients influence the structure of different dispersed systems. Although this special issue provides some examples of latest developments in the field, these are still many challenges how to control properties of edible soft materials, to increase shelf-life, promote health, and to provide a pleasant eating sensation.

In Memoriam: Ashok Patel

We would like to dedicate this issue to Ashok Patel, who initiated this project. Unfortunately, Ashok passed away in 2020 before this special issue was finished. Ashok was a great colleague, and was known as a very passionate scientist. After working most of his career at Unilever and Ghent University, he became an Associate Professor at the Guangdong Technion Israel Institute of Technology in Shantou, China in 2019. During his career, he was active in the field of edible soft matter, and contributed greatly to the scientific field. It is with deep regret that we lose such a dedicated colleague in this field.

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