EXPERIMENTAL MICROSCOPY OF FOOD SYSTEMS

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Foods are complex products, which must fulfill at least two requirements: be stable and have acceptable sensory properties (flavor, texture), corresponding to the consumer' s acceptance.

Obviously, the stability and the textural properties of food products are strongly influenced by the functionality of the ingredients and their interactions during the process. It is also well known that these interactions result in a structuration of the food product, thereby creating their textural properties.

During mixing and along processing, ingredients interact at a nano-scale and, often due to thermo-dynamic incompatibilities leading to phase separations, build up micrometric structures whose mechanical properties have a critical impact onto the global mechanical properties of the bulk.

However, by creating these micro particles, numerous interfaces are also generated. The mechanical responses of these interfaces to mechanical factors, such as shearing, contribute also importantly to the global mechanical properties of the bulk. One can also easily deduce that these interfaces create more or less permeable barriers having also a profound influence onto the chemical and thermo-dynamic properties of the product and, its stability. The stability of these interfaces is critical for the product and is governed by thermodynamic compatibilities/imcompatiblities.

Subsequently, understanding the mechanisms sustaining the structuration/de-structuration of these interfaces, is an essential issue for the food sciences and, hence, the food industry. This explains why food science is now moving and focusing more and more toward the science of interfaces.

Interfaces play an essential role in two important structural components of food products: foams and emulsions, both important partners of highly appreciated products such as ice creams. This explains the amount of work devoted to this subject in the food science literature. However, as food products are extraordinarily complex, a clear understanding of the basic phenomena grounding food structuration/de-structuration cannot be achieved on finished products and simplifications are needed via the constructions of models of food and appropriate devices adapted to the microscopy of this models.

Numerous analytical techniques are available to investigate and understand food properties. Among these, imaging, at resolution ranging from the macrometric to the nanometric scale (macroscopy, light microscopy, Scanning electron microscopy, transmission electron microscopy, Atomic force microscopy, SNOM etc…), play a still growing key role in this issue, not only due to the resolution increase, but also because, more and more microscopy techniques are integrating highly specific tools guiding microscopy closer and closer to microchemistry and micro-physic.

Among these microscopy techniques, Confocal Scanning Laser Microscopy (CSLM) occupies a place of choice because it allows high resolutions in the 3 and 4 dimensions. Combined to the possibility of tagging ingredients with fluorescent probes, a very specific localization of the ingredients during the structuration process extends further the unique capabilities of this instrument. Moreover, applying these tools to simple models gives new insight into the basic phenomena which occur during the structuration/destrcuturation of the interfaces. By increasing the complexity of these models of foods, going closer and closer to the real target product, following a very structured approach, our understanding of food structuration/destructuration increases rapidly, resulting in a better control of food structure and texture.

The scope of this presentation is to review the place of the possible imaging approaches in the field of food processing.

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Based on the literature and our own work, we will demonstrate the advantage of combining diffferent techniques (macroscopy, conventional epifluorescene, CSLM, micro-rheoloy) with different models of food and simplified versions of foos systems (flat films, bubbles) to understand better protein-polysaccharides interactions leading to segregative or associative phase separations in bulk and their behavior at interfaces, leading to the creation of interfacial films. The correlation of the information provided by these models with the structures observed in complex systems close to real products, such as ice-creams using cryo-fluorescence techniques, will be presented and discussed.

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