Droplets-based millifluidic for the establishment of protein-polysaccharide phase diagrams

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Texture, structure, taste as well as stability of food products are strongly related to its constituent's interactions. The understanding of these interactions is still a challenge in food-processing. Besides lipids or flavour, proteins and polysaccharides are widely used in food products. It is already well known that under specific conditions protein-polysaccharide mixture can lead to liquid-liquid phase separation, of segregative or associative type. To highlight the conditions of phase separation, a phase diagram is established. However, such a study, generally performed in bulk is time and raw material consuming. Therefore alternative strategies for rapid phase diagram determination using microfluidics recently emerged. Microfluidic enables a large reduction of engaged volume, a precise control over experimental conditions and mixed systems composition as well as an acceleration of reaction time. Nevertheless, these techniques were only described for segregative phase separated systems [1], [2]. In the present work we developed a droplets-based millifluidic device for rapid phase diagram building of associative phase separated system [3]. Binodal curve was determined by turbidity measurements within the droplets using image analysis. Cloud points, corresponding to the onset of phase separation, were defined as the composition corresponding to a 10% increase in turbidity compared to the original reference solution. The first part of the study was dedicated to the proof of concept using a colloidal suspension of titan dioxide. We evidenced proportionality between the turbidity measured in bulk using spectrophotometry and those determined within the droplet by image analysis. The second part of the study was devoted to establish the phase diagram of an associative phase separated system: β-lactoglobulin (BLG) / Gum Arabic (GA), first in bulk and then using the more innovative droplets-based millifluidic approach where the composition and total concentration were finely tuned by flow rates variation (Figure 1). Considering the high similarities obtained at both scales, we now plan to extend the method to several protein-polysaccharide mixtures.

[1] J. Leng, M. Joanicot and A. Ajdari. Microfluidic exploration of the phase diagram of a surfactant/water binary system. Langmuir, **23,** 15-17 (2007).
[2] D. Silva, A. Azevedo, P. Fernandes, V. Chu, J. Conde and M. Aires-Barros. Determination of aqueous two phase system binodal curves using a microfluidic device, J.Chromatogr. A*.,* **1370,** 115-120 (2014).
[3] C. Amine, A. Boire, J. Davy, M. Marquis and D. Renard, Droplets-based millifluidic for the rapid determination of biopolymers phase diagrams, Food Hydrocolloids **70**, 234 (2017)

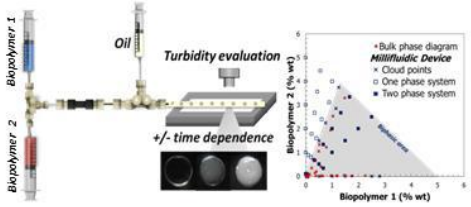

Figure 1. Droplets-based millifuidic device to rapidly map phase diagrams of biopolymers mixtures