**Influence of kinetic and shear rate on whey protein aggregates structure: a small-angle x-ray scattering study**

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Whey proteins are of interest because of their nutritional and functional properties in food application. Heat-induced aggregation coupled with process conditions of whey proteins gives them new functional properties that can be used to impart specific structural and physical properties of food products. Then, aggregation process needs to be well understood and controlled to design specific functional whey protein aggregates.

Most of previous studies has focused on the role of the physicochemical conditions on the structure and size of protein aggregates [1], whereas process parameters have not been clearly investigated. In this study we will study the role of process parameters, i.e. shear rate, heat treatment and time on the size and structure of protein aggregates to control the aggregation process.

However, the main difficulty to understand the respective role of each parameter is to separate the kinetics of denaturation and aggregation and the flow from the thermal history. In this study, we have developed a continuous process of aggregation at small-scale (<1 mm) to have laminar flow conditions for various shear rates and a fine control of the thermal history. Thermal and flow conditions can thus be controlled independently. This feature is clearly a novelty compared to previous studies [2] in which aggregation was limited by heat transfers. This small-scale continuous process allows us to vary, in one hand, the residence time and thus to establish the kinetics of aggregation, and in the other hand, the shear rate up to 500s-1.

This set-up has been used to test the role of several process parameters on the kinetics and structure of whey protein aggregates by small angle X-ray scattering (SAXS) techniques for given physicochemical conditions (pH and ionic strength) leading to sub-micrometric aggregates. We follow the kinetics of aggregation from the protein scale (few nanometres) to the aggregate scales (< 1 µm). Structure of whey protein aggregates larger than few micrometres are also investigated by quantitative fluorescent microscopy and image analysis methodology developed for this purpose.

We show that the kinetics leads to the formation of new aggregates and not to their enlargement. Secondly, we show that the flow process has a large impact on the size and structure of the aggregates: the size of the aggregates is increased by a factor 3 when comparing the ones obtained under static conditions and the ones obtained under flow, whereas their internal structure remains unchanged. The shear rate, on the other hand, leads to an increase of the size of the aggregates without increasing their density.

References

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