Energy-efficient process for the manufacture of dairy powders using superconcentration and granulation

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Although spray-drying is the gold standard to manufacture dairy powders, it is an extremely energy intensive process. Previous studies showed that replacing spray-drying by superconcentration and granulation could lead to reduced energy footprint provided that critical parameters of the disruptive process were determined. The aim of this work was to identify the operating parameters controlling the process and to follow up the evolution of the physical properties of dairy products throughout superconcentration and their behaviour during granulation. In this way, relevant tools and techniques were developed at lab-scale and applied to dairy streams of different composition (in particular protein and lactose contents): skim milk, fat-filled milk, whey permeate and demineralized whey.
Results evidenced that a dry matter (DM) dependent highly cohesive (sticky) phase limited the extent of superconcentration, whereas the minimum dry powder recirculation for effective granulation was related to the end of this cohesive phase. The onset of cohesive phase was marked by a sharp rise in viscosity and yield stress. Besides, the composition of dairy products showed a great influence on the location of the cohesive phase: higher protein contents induced an earlier onset of this phase whereas higher lactose content delayed it. The cohesive phase started thus at about 62 % DM for skim milk and up to 80 % DM for whey permeate.
While higher protein contents negatively impacted the superconcentration step due to higher cohesiveness of superconcentrates, granulation of the paste was surprisingly more efficient using whey protein powder as a substrate. This result was associated to a higher water holding capacity of this type of powder. It opens then new perspectives for formulated products as different powders could be mixed with superconcentrates to prepare ingredients of targeted composition. The next steps of this work are to validate the outcomes from this lab-scale study at pilot-scale and go further in the optimization of the process and product properties.