

## **STEAM-JET AGGLOMERATION OF SKIM-MILK POWDERS: INFLUENCE OF THE RAW MATERIAL PROPERTIES AND PROCESS PARAMETERS.**

**M. Person<sup>12</sup>, B. Cuq<sup>2</sup>, A. Duri<sup>2</sup>, C. Le Floch-Fouéré<sup>1</sup>, R. Jeantet<sup>1</sup> & P. Schuck<sup>1</sup>**

<sup>1</sup> *STLO, UMR1253, INRA, Agrocampus Ouest, 35000, Rennes, France*

<sup>2</sup> *IATE, UMR1208, INRA, Supagro Montpellier, Université Montpellier 2, CIRAD, 34060 Montpellier, France*

*E-mail of the corresponding author: [mathieu.person@inra.fr](mailto:mathieu.person@inra.fr)*

### **Abstract:**

Steam-jet granulation is a process used in the dairy industry to produce instant agglomerated milk powder. The agglomerate growth process includes wetting of the particle surface, collisions of sticking particles and consolidation of the agglomerates by drying. The aim of this study was to evaluate the influence of the raw material properties (initial particle size and humidity) and processing conditions (liquid/solid ratio and post-drying conditions) on the growth mechanisms and agglomerates properties. Skim milk powders were granulated using steam-jet granulation pilot and characterized *via* the in-size distribution, water content, structure, thermodynamical and functional properties. The water content and the post-drying time were identified as key process parameters to control in order to obtain instant agglomerated milk powders.

**Keywords:** Steam-jet granulation skim-milk agglomerates instant rehydration

### **Introduction**

Steam-jet granulation is a process used in the dairy industry to produce instant agglomerated milk powder. Agglomerated instant powders exhibit improved wettability and instant rehydration behaviour, which are essential attributes for coffee whiteners applications. Although there is a growing interest for research in this area [1,2], the steam-jet granulation process has been little studied to date and the quality control at industrial scale remains experimental and empirical. Moreover, the multi-factorial causes at the root of the agglomerates rehydration properties make it difficult to identify the key process parameters that should be controlled to meet the quality requirements. The present study investigated how different raw materials properties and process parameters interact and contribute to the production of skim milk agglomerates with improved rehydration properties.

### **Materials and Methods**

Skim-milk powders with different water content and particle size were obtained from spray-drying on a research pilot workshop; they were agglomerated using a steam-jet granulation pilot plant developed in our laboratory. Two process parameters, the liquid/solid ratio (from 300 to 700 g/kg for example) and the post-drying conditions (from 5 to 15 min at 90°C), have also been studied (Fig.1). Both the native raw materials and the agglomerated powders were characterized by laser diffraction, dynamic vapour sorption, differential scanning calorimetry and X-ray micro-tomography, to respectively assess granule size, moisture sorption isotherms, glass transition temperature and compactness. Instant properties were also characterized through wetting time measurements. A multivariate data analysis was

used to identify correlations between the raw material properties, the process parameters and the physicochemical and functional properties of the agglomerates.

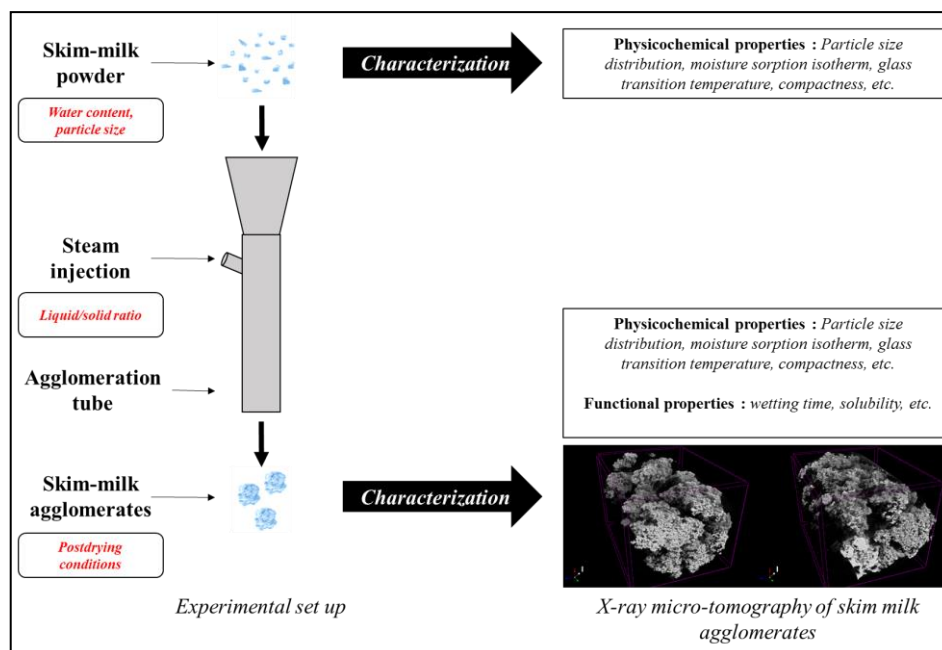


Fig. 1. Research strategy

## Results and discussion

The steam jet granulation pilot prototype made it possible to obtain agglomerated powder with satisfactory reproducibility ( $\pm 10\%$  whatever the parameter considered) and to highlight significant differences between agglomerates obtained with varying conditions. The water content of the native raw material and the post-drying time were found to be critical in controlling the humidity and thermodynamical properties (glass transition temperature) of the agglomerates. These properties were correlated to the wetting time and showed significant influence on the instant rehydration behaviour of the agglomerates. Moreover, the compactness of the agglomerates was found to be critical in order to obtain instant powders with required wettability and rehydration behaviour.

## Conclusions

This study paves the route for a better understanding of agglomeration mechanisms involved in dairy powder granulation. Moreover the characteristics of the agglomerates obtained in this study were found to be close to that of industrial agglomerated powders. Thus, recommendations concerning raw materials specifications as production parameters are given to avoid conform rehydration behaviour in industrial agglomerated skim milk powder.

## References

- [1] Barkouti A., Turchiuli C., Carcel J.A., Dumoulin E.: Milk powder agglomerate growth and properties in fluidized bed agglomeration, *Dairy Science & Technology*, (2013), 93, pp. 523–535.
- [2] Ji J., Fitzpatrick J., Cronin C., Maguire P., Zhang H., Miao S.: Rehydration behaviours of high protein dairy powders: The influence of agglomeration on wettability, dispersibility and solubility, *Journal of Food Engineering*, (2016), 189, pp. 1–8.