World Academy of Science, Engineering and Technology
International Journal of Animal and Veterinary Sciences
Vol:17, No:11, 2023

Study of Operating Conditions Impact on Physicochemical and Functional Properties of Dairy Powder Produced by Spray-drying

Authors : Adeline Meriaux, Claire Gaiani, Jennifer Burgain, Frantz Fournier, Lionel Muniglia, Jérémy Petit

Abstract : Spray-drying process is widely used for the production of dairy powders for food and pharmaceuticals industries. It involves the atomization of a liquid feed into fine droplets, which are subsequently dried through contact with a hot air flow. The resulting powders permit transportation cost reduction and shelf life increase but can also exhibit various interesting functionalities (flowability, solubility, protein modification or acid gelation), depending on operating conditions and milk composition. Indeed, particles porosity, surface composition, lactose crystallization, protein denaturation, protein association or crust formation may change. Links between spray-drying conditions and physicochemical and functional properties of powders were investigated by a design of experiment methodology and analyzed by principal component analysis. Quadratic models were developed, and multicriteria optimization was carried out by the use of genetic algorithm. At the time of abstract submission, verification spray-drying trials are ongoing. To perform experiments, milk from dairy farm was collected, skimmed, froze and spray-dried at different air pressure (between 1 and 3 bars) and outlet temperature (between 75 and 95 °C). Dry matter, minerals content and proteins content were determined by standard method. Solubility index, absorption index and hygroscopicity were determined by method found in literature. Particle size distribution were obtained by laser diffraction granulometry. Location of the powder color in the Cielab color space and water activity were characterized by a colorimeter and an aw-value meter, respectively. Flow properties were characterized with FT4 powder rheometer; in particular, compressibility and shearing test were performed. Air pressure and outlet temperature are key factors that directly impact the drying kinetics and powder characteristics during spray-drying process. It was shown that the air pressure affects the particle size distribution by impacting the size of droplet exiting the nozzle. Moreover, small particles lead to more cohesive powder and less saturated color of powders. Higher outlet temperature results in lower moisture level particles which are less sticky and can explain a spray-drying yield increase and the higher cohesiveness; it also leads to particle with low water activity because of the intense evaporation rate. However, it induces a high hygroscopicity, thus, powders tend to get wet rapidly if they are not well stored. On the other hand, high temperature provokes a decrease of native serum proteins, which is positively correlated to gelation properties (gel point and firmness). Partial denaturation of serum proteins can improve functional properties of powder. The control of air pressure and outlet temperature during the spray-drying process significantly affects the physicochemical and functional properties of powder. This study permitted to better understand the links between physicochemical and functional properties of powder to identify correlations between air pressure and outlet temperature. Therefore, mathematical models have been developed, and the use of genetic algorithm will allow the optimization of powder functionalities.

Keywords : dairy powders, spray-drying, powders functionalities, design of experiment
Conference Title : ICADS 2023 : International Conference on Animal and Dairy Sciences
Conference Location : Reykjavik, Iceland
Conference Dates : November 20-21, 2023