Macedonian pharmaceutical bulletin, 69 (Suppl 1) 29 - 30 (2023)
Online ISSN 1857 - 8969
DOI: 10.33320/maced.pharm.bull.2023.69.03.014
Short communication

Spray drying process parameter optimization for co-processed materials

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Introduction

Spray drying is an inspiring bottom-up technique in particle engineering for the pharmaceutical and food industry. Spray drying transforms liquids into dry, generally amorphous or partly amorphous powder with spherical particles. The liquid feed is atomized into droplets that come in contact with hot chamber air. A solvent or dispersing agent evaporates from the droplets, and the droplets form a dry powder. The method generates powders with tailor-made characteristics depending on the process parameters, feed composition, and environmental conditions. Co-processing excipients with spray-drying can produce an excipient with optimized features compared to the individual ones.

The study aimed to optimize the spray drying process parameters for lactose, an important excipient as a drug carrier in dry powder inhalation (DPI) preparations and common filler in the tableting process. Optimized production process parameters can produce the excipient with improved characteristics, such as flow properties, moisture content, and particle morphology. Additionally, excipients with different chemical and physical characteristics (glass transition temperature, solubility, molecular weight, viscosity, film-forming ability) were tested to produce a co-processed excipient with improved traits.

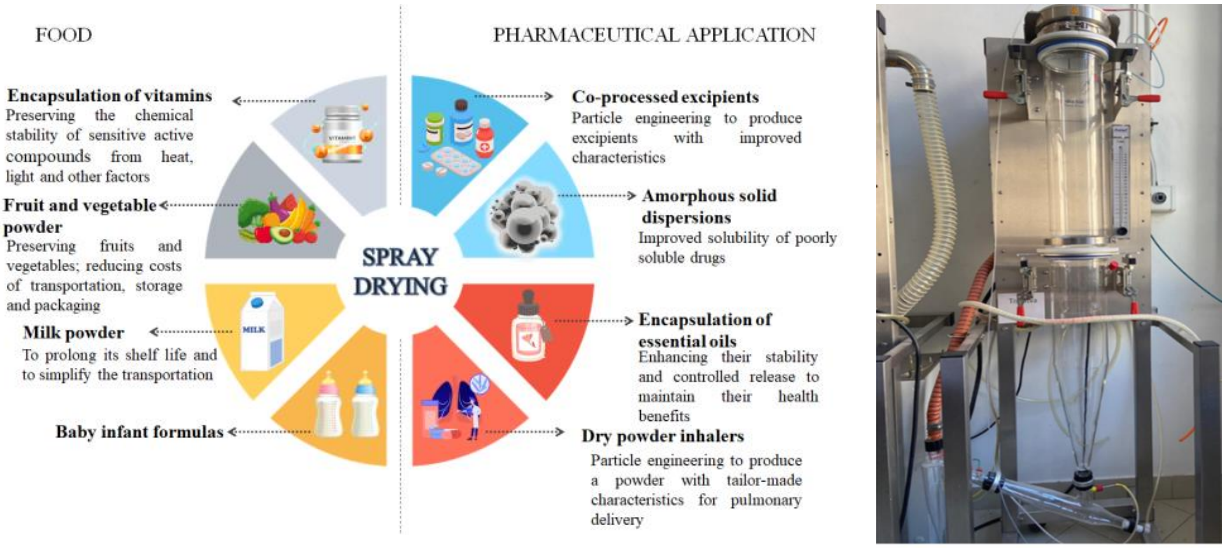

Fig. 1. Application fields of spray drying (designed by FreePik) and ProCepT 4M8-Trix spray dryer

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Materials and methods

ProCepT 4M8-Trix spray dryer (ProCepT, Belgium) was used in the experiments. We tested the influence of spray drying process parameters such as inlet air temperature, pump speed, atomization air pressure, and nozzle size on the powder characteristics. We analyzed the morphology of the particles with image analysis based on microscopic pictures taken with Keyence VHX 970F Digital Microscope (Keyence, Japan). Also, we tested the moisture content by the Karl-Fischer method (Metrohm, Switzerland). The powders' rheology characteristics were tested. Glass transition temperature and crystal/amorphous ratio of powders were also investigated by Differential Scanning Calorimetry (DSC) (Seiko Exstar 6000/6200 type (SEIKO Instruments Inc., Japan) and XPRD (X'pert Pro MPD X-ray diffractometer, Malvern PANalytical, Malvern, UK) respectively.

Table 1. Test parameters

Changing parameters		Output parameters
Temperature (°C)	Feed rate (%)	moisture content (Karl-Fisher)
90	10	morphology (image analysis)
110	30	
130	50	crystallinity (XRD, DSC)

Results and discussion

The influence of spray-drying process features on the characteristics of the powder was analyzed to optimize the spray-drying process parameters for lactose (Fig. 2). After spray drying, the co-processed excipients were studied to test their modified and improved characteristics. Figure 3 shows that the characteristic desolvation endotherm at around 140°C and melting endotherm at approximately 217°C of lactose monohydrate are entirely reduced in the case of co-processed material. The co-processed excipient minimized the stickiness of the sugar-based materials used in spray drying (Fig. 4).

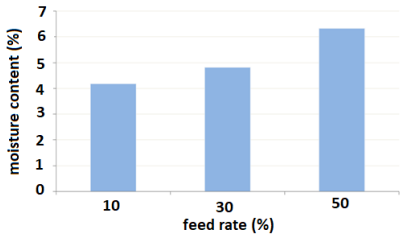

Fig. 2. Effect of feed rate on the moisture content of spray-dried lactose (T_{inlet}:130°C)

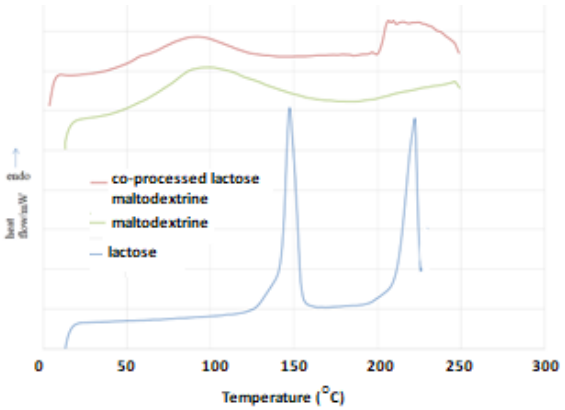

Fig. 3. DSC thermogram of lactose, maltodextrin and spray-dried co-processed lactose-maltodextrin

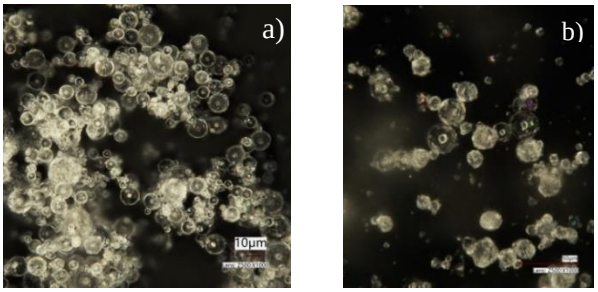

Fig. 4. Comparison of images taken with a Keyence VHX 970F digital microscope of lactose (a) and co-processed excipient 10:15 % (w/v) of the lactose-maltodextrin concentration (b)

Conclusion

We have successfully produced spherically shaped carbohydrate-based micron-sized particles that can be used as excipients for drug delivery systems.

Acknowledgements: Stipendium Hungaricum supported the study.

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