Spray drying skim milk, concentrated milk, full cream milk

Mini Spray Dryer B-290, Rotavapor® R-300
Yield and total yield determination in spray dried milk

1. Introduction

Spray dryers are used to transform a liquid, i.e. solutions, suspensions or emulsions into dried powders. It is a quick, gentle and single step drying process.

A major application is the production of milk powder. In general, liquid milk is easily denaturized and difficult to store for a long time. To prolong its shelf life and to simplify transportation milk is spray dried to milk powder.

2. Experimental

Instrumentation: Mini Spray Dryer B-290; Rotavapor® R-300.

Samples: All the materials were purchased from a supermarket in Beijing. The composition of milk sample (% solids) is shown in Table 1.

- Natural skim milk was used as purchased in liquid form.
- Concentrated milk from powder was made by mixing 82.4 g milk power (either skim or full-cream) with 117.6 g distilled water, which was dissolved at 50 °C.
- The concentrated full-cream milk was prepared in a Rotavapor® R-300. 700 mL of liquid milk was concentrated to 200 g by evaporating 500 g of water.

3. Spray drying parameters

Spray drying experiments were performed at three different inlet temperatures, 120°C, 160 °C and 200 °C, while letting the other parameters unchanged, as listed in Table 3. The outlet temperature cannot be set, it is a function of the inlet temperature, the aspirator performance, the feed rate, and the spray gas flow rate.

Table 1: Spray drying parameters.

Inlet Temperature(°C)		200	160	120
Outlet Temperature (°C)	Natural skim	83	50	41
	Skim concentrate (powder)	103	92	71
	Full-cream concentrate （powder）	115	102	66
	Full-cream concentrate	110	85	60
Aspirator (%)		100	100	100
Feed rate (mL/min)		8	8	8
Spray gas flow (mm)		40	40	40

Equation (1) describes the yield calculated from the collected dry mass in the collecting vessel divided by the processed solid matter. The total yield, calculated according to equation (2) takes into account the powder in the collecting vessel and the powder sticking on the glass cylinder of the instrument.

$$\text{Yield} = \frac{M_{\text{powder from collecting vessel}}}{M_{\text{processed solid matter}}} \quad (1)$$

$$\text{Total Yield} = \frac{M_{\text{powder from collecting vessel and cylinder}}}{M_{\text{Processed solid matter}}} \quad (2)$$

4. Results

Table 2: Spray drying results.

Inlet T	Recovery	A	B	C	D
120 °C	Yield	65 %	47 %	37 %	17 %
	Total Yield	94 %	78 %	73 %	51 %
160 °C	Yield	78 %	54 %	43 %	51 %
	Total Yield	96 %	76 %	78 %	92 %
200 °C	Yield	73 %	59 %	40 %	28 %
	Total Yield	88 %	83 %	85 %	78 %

A：Natural skim; B：Skim concentrate (powder);
C：Full-cream concentrate（powder）; D：Full-cream concentrate

5. Conclusion

The recoveries of dry powders from different milk products were determined on the BUCHI Mini Spray Dryer B-290. The influence of the inlet temperature on yield and total yield was investigated on four different kind of milk.
The advantages are that the drying condition can be repeated, runs are easy to control and optimize for a higher recovery.
The data collected in this study could also serve as a basis for optimizing industrial spray drying processes.

6. Reference

For more detailed information and safety considerations please refer to the Application Note No. 218/2016