Curcumin sub-micrometer particles by nano spray drying

Nano Spray Dryer B-90 HP:
Nano spray drying as a solution for the formulation of natural products

1. Introduction

Curcumin is a polyphenol of turmeric, derived from the rhizomes of *Curcuma longa*. In the past years it was found that *C. longa* has several proven pharmacological activities, with properties including antioxidant, anti-inflammatory or anti-tumor effects. These properties have been attributed to a group of phenolic compounds, the curcuminoids which include curcumin, demethoxy curcumin and bis-demethoxy curcumin [1].
High doses of curcumin were shown to be pharmacologically save, however, curcumin is rapidly metabolized and excreted when applied orally [2]. Due to its lipophilic characteristics, curcumin shows low systemic bioavailability and poor pharmacokinetics, which limit its in vivo efficacy [3]. Curcuminoids are also reported to be practically insoluble in acidic solutions and unstable in alkaline solutions where they break down easily in products which invalidate their use in pharmaceuticals [1].
The development of curcumin nanoparticles would be an interesting method for improving the solubility of curcumin [1].
In this application note, the possibility to produce sub-micron particles using the Nano Spray Dryer B-90 HP from a solution of curcumin will be investigated.

2. Experimental

0.1 % curcumin solutions were prepared in ethanol (EtOH) and in a mix of ethanol and acetone (ACE) (1:1). The solutions were then spray dried using the tall set up of the Nano Spray Dryer B-90 HP. The Spray Dryer was operating in closed loop mode, using the Inert Loop B-295, inert gases were circulated in the system instead of air. The gas flow rate was set up between 120 and 150 L/h, the temperature between 65 and 75 °C and the spray power at 80 %.

3. Results and Discussion

The application study demonstrated the feasibility of spray drying curcumin with the Nano Spray Dryer B-90 HP. The results obtained are summarized in Table 1 together with the used parameters.

Table 1: Parameters and results summary of curcumin spray drying.

	ETOH	ETOH : ACE (1:1)
Nebulizer	small	small
Gas flow rate	120 L/min	150 L/min
T inlet	65 °C	75 °C
T outlet	39 °C	45 °C
Spray rate	80 %	80 %
Pressure	36 hPa	55 hPa
Feed rate	10 %	10 %
Particle size	0.367-1.29 um	0.428-0.974 um

The scanning electron microscope (SEM) pictures of spray dried powder typically showed spherical morphology while pure curcumin displays a needle morphology (Figure 1). Particles from 0.367 um to 1.29 um could be obtained by spray drying curcumin.
No influence in particle size and morphology is perceived when changing the solvent, however, an improvement in throughput (from 14.8 mL/h to 20.4 mL/h) is observed when using a mix of ethanol and acetone to dissolve the curcumin powder (Table 1).

4. Conclusion

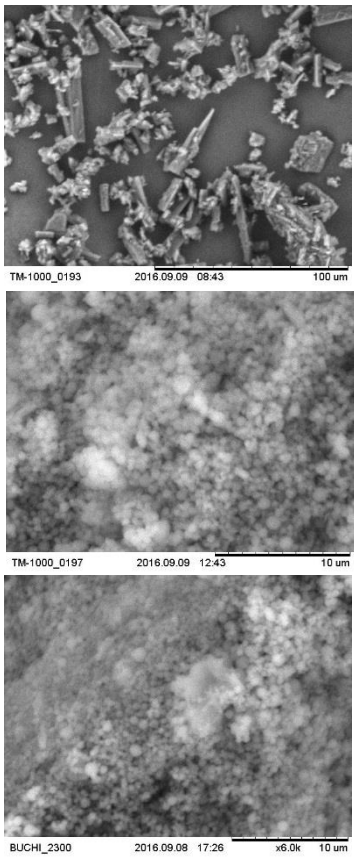

Figure 1: Curcumin particles before spray drying (top), spray dried in Ethanol (centre) and in a mix of ethanol and acetone (1:1) (low).

Sub-micron particles can be produced from a 0.1 % solution of curcumin with the Nano Spray Dryer B-90 HP. No influence on particle size can be observed by changing the solvent, however, an influence in throughput can be seen.
The given process parameters may serve as starting values for process optimization.

5. References

[1] R. M. Martins, S. V. Pereira, S. Siqueira, W. F. Salomão, and L. A. P. Freitas, "Curcuminoid content and antioxidant activity in spray dried microparticles containing turmeric extract," *Food Res. Int.*, vol. 50, no. 2, pp. 657–663, Mar. 2013.
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[3] M. M. Yallapu, B. K. Gupta, M. Jaggi, and S. C. Chauhan, "Fabrication of curcumin encapsulated PLGA nanoparticles for improved therapeutic effects in metastatic cancer cells," *J. Colloid Interface Sci.*, vol. 351, no. 1, pp. 19–29, Nov. 2010.