Ultrasonic vs. clasical nozzles in probiotics encapsulation applications

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INTRODUCTION

The benefits of consuming probiotics and farmabiotics containing live lactic bacteria have been considered well known, from the start of our studies. Functional aspects of this food supplements like improving of colon health state, prevention of colon cancer or decreasing of the cholesterol level in blood are considered modern themes of discussion and of research in the last 30 years.
One of the main problems the the probiotic and farmabiotic industry has, in this stage of development, is the decrease of viability of the ingested bacterial products when passing through the intestinal tractus.

During the last years methods of improving the viability of the probiotic bacteria have been taken into consideration, starting from simple microbiological methods and reaching the tops of genetics, for developing genetically modified microorganisms. We consider genetics as being the future as long as we would be able to completely understand and control the mechanisms implied.
A simpler and safer method was considered to be the protection of lactic bacteria using the microencapsulation technology. This study focuses on the methods of encapsulating Bifidobacterium Bb-12 using a spray drier with ultrasonic atomization nozzle and on comparing this method with the more traditional methods: spray drying with centrifugal and with stationary dual-fluid nozzles.

MATERIALS AND METHODS

The studies started with the techniques most used today at industrial level: spay drying using centrifugal nozzle. The equipment used was a semi industrial NIRO spray-dryer. The bacterial suspension used had the following composition: ¼ Ringer solution, Bifidobacterium Bb-12 (11%), sodium alginate (1%), maltodextrin (2%) The drying was made at the inlet air temperature of 175°C ± 10°C and outlet temperature 75°C ± 10°C. The inlet solution's flow rate was 100ml/min.
The second equipment used was a Büchi B290, with a two fluid stationary nozzle. The bacterial suspension used had the same composition as described above. The inlet temperature was 150°C ± 5°C and the outlet temperature 78°C ± 3°C. The diameter of the nozzle orifice was 0,7mm, and the flow rate of the peristaltic pump was set to 6 ml/min.

The third trial was made on a SonoDry750. This equipment is designed for working both with a two fluid nozzle (with a peristaltic pump) and with ultrasonic nozzle (with syringe pump). In our experiment we used the ultrasonic nozzle having an operating frequency of 120 kHz. The inlet temperature was 150°C ± 5°C and the outlet temperature 85°C ± 5°C. The power applied to the nozzle was 5,5 watt and the flow rate of the syringe pump was set to 4 ml/min. Same composition of the bacterial suspension as in previous trials was used.

The methods of analysis used were chemical (dry matter, water activity, viscosity), microscopical (optical and SEM), as well as a simulation of intestinal tractus.

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Figure 1. Semi industrial NIRO atomizer

Figure 2. SonoDry750 atomizer

RESULTS

In case of spray drying using the semi industrial Niro atomizer the medium diameter of obtained capsules was 36.2 µm, but with very large dimensions' distribution.

Relatively big particles can also be considered the one obtained with Büchi B290. In this case the medium diameter was 27.8 µm.

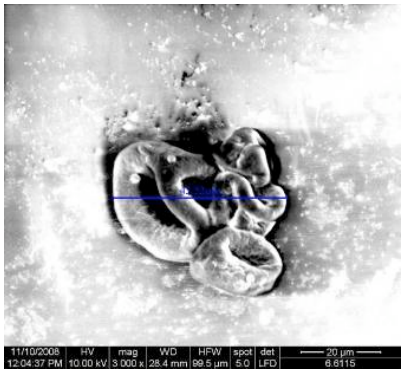

Figure 3. Microcapsules obtained using Niro semi industrial atomizer

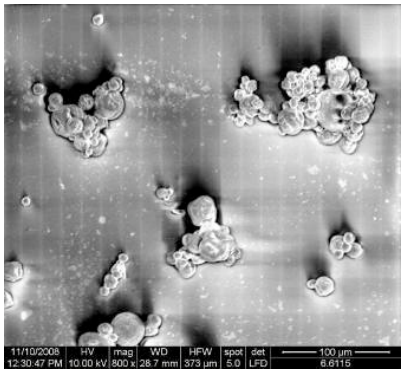

Figure 4. Microcapsules obtained using Büchi B290

Best results were achieved with SonoDry750, using an ultrasonic nozzle with the frequency of 120kHz. The medium diameter of these microcapsules was 9.6 μm, but none of the measured particles exceeded 20μm.

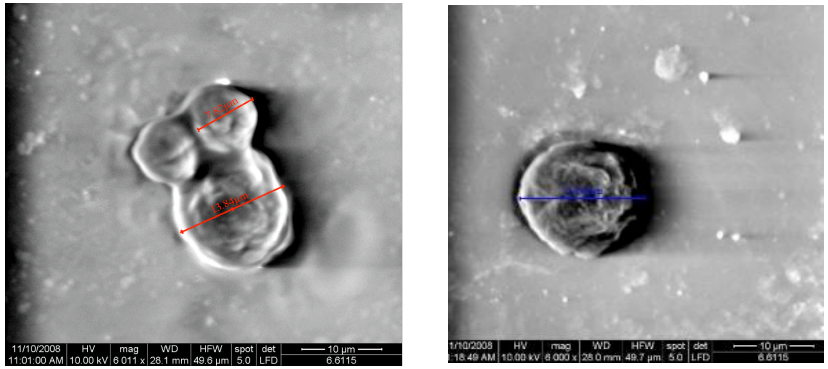

Figure 5. Microcapsules obtained using SonoDry750

The results of measuring the dimensions of the particle and viability of the encapsulated bifidobacterias are shown in table 1.

Equipment	**Semi industrial NIRO**	**Büchi B290**	**SonoDry750**
Nozzle type	centrifugal nozzle	two fluid stationary nozzle	ultrasonic nozzle
Inlet air temperature	175°C ± 10°C	150°C ± 5°C	150°C ± 5°C
Outlet air temperature	75°C ± 10°C	78°C ± 3°C	85°C ± 5°C
Particles' aspect	"Donut" aspect, not agglomerated	"Golf ball" aspect, agglomerated	Spherical shape, not agglomerated
Particle medium diameter	36.2 μm	27.8 μm	9.6 μm
Dimensions' distribution	large	large	narrow
Before process Bifidobacterium CFU	2.8×10^{10}	3.3×10^{9}	1.6×10^{11}
After process Bifidobacterium CFU	9×10^{7}	3×10^{7}	2.1×10^{9}
BPBC/APBC	311	110	76

Table 1. Comparative table of the microencapsulation methods used

CONCLUSIONS

The best results, from the authors' point of view, were obtained using the ultrasonic nozzles. The main advantages of this technology come from the way in which the liquid drops are obtained with

this technology, resulting smaller and more uniform drops comparing to the traditional spray drying process.

The decrease of the Bifidobacterium CFU was also the smallest, in case of the usage of ultrasonic nozzles, but also the results of the other two tests can be considered acceptable.

Unfortunately, we have to mention two big disadvantages of the ultrasonic nozzle: it implies a very elaborative process of setting up all the necessary parameters and it is still very hard to scale up to industrial level.

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