MICROENCAPSULATION OF SUPERCRITICAL CO_2 EXTRACTED RICE BRAN OIL IN PEA PROTEINS

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INTRODUCTION

Rice bran oil is source of bioactive molecules such as sterols, tocols, γ-oryzanols and unsaturated fatty acids [1,2] which show strong antioxidant activity. In order to preserve it, rice bran oil must be encapsulated.

Among the different encapsulation materials, vegetable proteins are trendy, due to their properties (emulsifying easiness, high nutritional value and non-allergenic characteristics) and the possibility to be used in pharma, cosmetics and food industries.

AIM

The aim of this work is to study the microencapsulation process of rice bran oil (extracted using supercritical CO_2 (SC-CO_2), according to Benito-Román et al. [3]) using mixtures of pea protein and maltodextrin as wall material in two steps:

1. using RSM–Box Behnken to study and optimize the emulsion formation process by high pressure homogenization
2. studying the particle formation when drying the emulsion obtained in the optimal conditions using three different drying methods

EXPERIMENTAL APPROACH: 2 STEPS

1. EMULSION FORMATION

HIGH PRESSURE HOMOGENEIZATION

- **Advantages**
  - ✓ Industrial application due to flexibility to control the emulsion droplet size (EDS)
  - ✓ Ability to produce emulsions from a variety of materials
- **Experimental device**
  - Microfluidics LM-20 (interaction chamber F20Y)
  - Maximum working pressure: 200 MPa
- **Aim:**
  - To find the combination of the experimental parameters that minimize the EDS

EXPERIMENTAL FACTORS

- **Pressure**: from 60 to 150MPa
- **Carrier material**: mixtures of pea protein (PPI) & maltodextrin (MD); 50-90% of PPI
- **Carrier to oil ratio**: from 2 to 4

- 15% of solids in the emulsion
- 7 homogenization cycles
- Box-Behnken experimental design (15 runs)

OPTIMAL CONDITIONS

114 MPa; 60% of PPI; ratio carrier to oil of 3.2
EDS: 180±5 nm

OPTIMAL CONDITIONS AND RESULTS

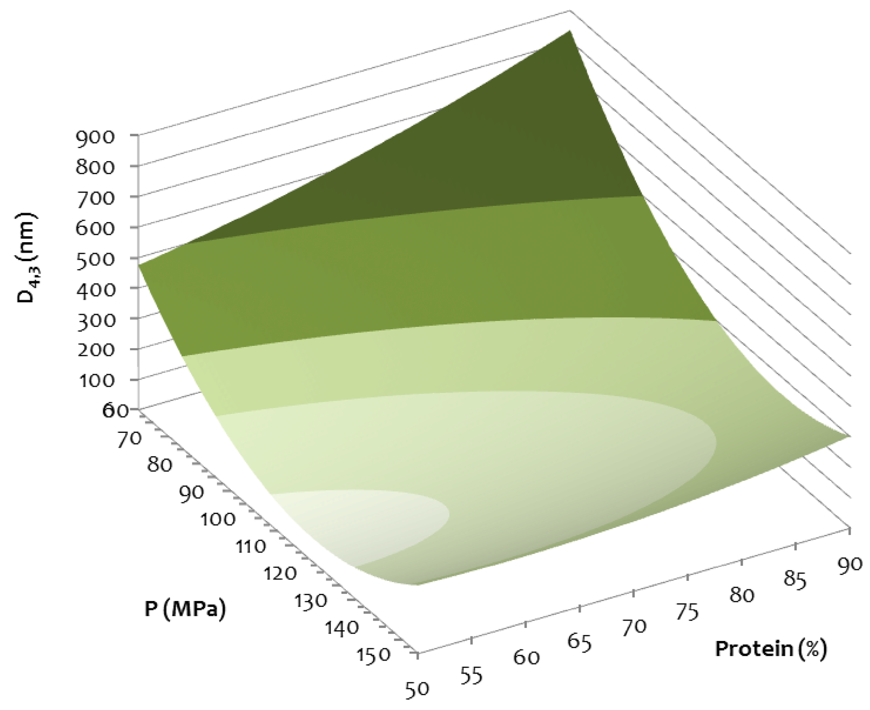

Figure 1. Effect of the working pressure and protein content in the carrier material on the EDS

2. OPTIMAL EMULSION DRYING

SPRAY DRYING

- Buchi B-290 mini
- T: inlet, 155°C; outlet, 92-96°C
- Emulsion flow rate: 3 g/min

Encapsulation Efficiency: 73%
Average particle size: 18 µm
Dented particles

PGSS DRYING

- SC-CO_2; P: 10MPa
- T: outlet, 55°C; Static mixer, 105 °C
- GPR: 30 g CO_2/g emulsion

Encapsulation Efficiency: 52%
Average particle size: 11 µm
Spherical particles

FREEZE DRYING

- Labconco freeze drier
- 0.15 mbar

Encapsulation Efficiency: 99 %
Amorphous particles

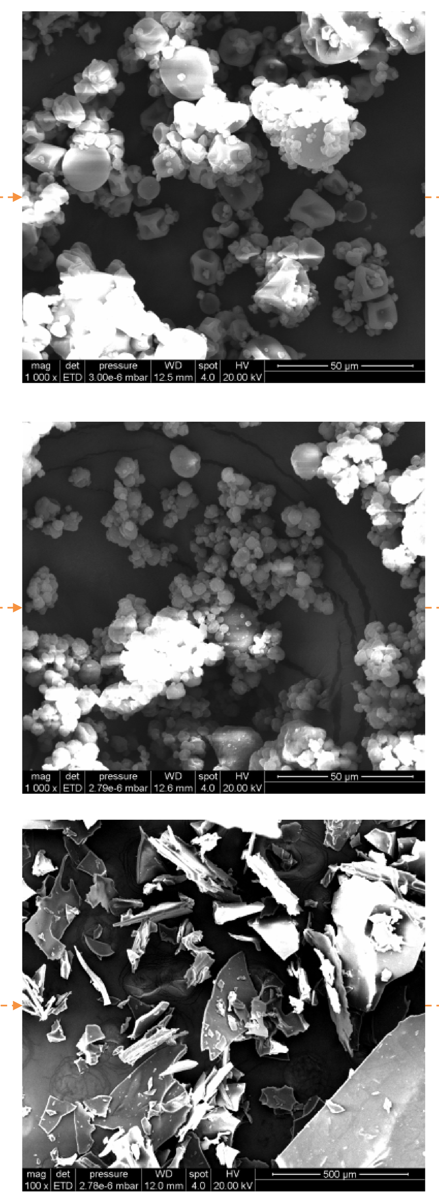

Figure 2. SEM pictures of the obtained particles

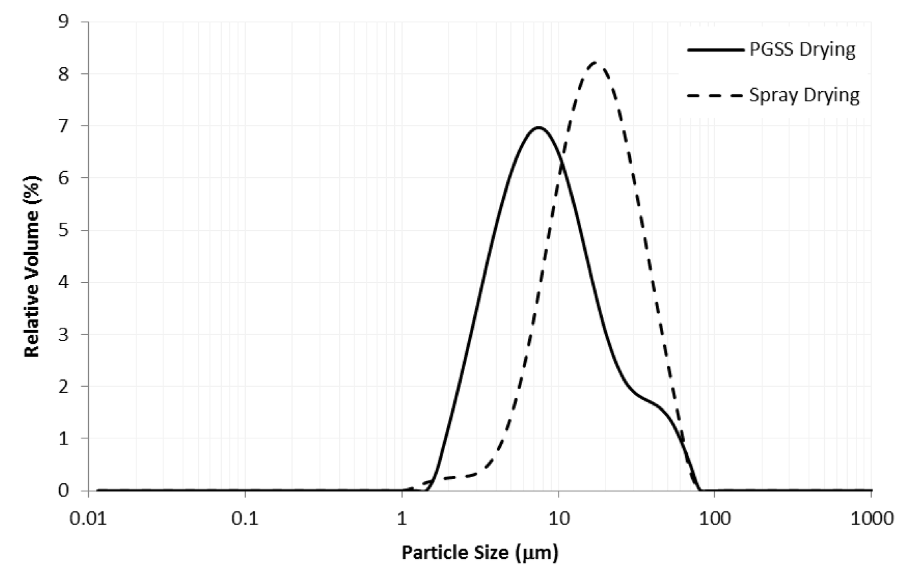

Figure 3. Particle size distribution of particles obtained by spray drying and PGSS drying

Figure 4. Particles obtained from PGSS drying

CONCLUSIONS

- **EMULSION FORMATION:** in order to minimize the EDS, moderate pressures (114 MPa), a carrier composed mainly by PPI (60%) and carrier to oil ratios equal to 3.2 are required. Important interactions between the experimental factors were also observed.
- **EMULSION DRYING:** All the drying techniques yielded dry powders, which resulted in different morphologies and encapsulation efficiencies. Freeze drying yielded the higher encapsulation efficiencies and more stable powders when stored at 4 °C, whereas spray-dried and PGSS-dried powders increased the amount of free oil after two weeks of storage.

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