

P-018 Wall material selection to encapsulation by spray drying

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INTRODUCTION AND OBJECTIVES

Dried microcapsules represent a very interesting system to the industry as they avoid some inconvenience associated to the high level of water, as microbiological contamination, degradations and also by reducing the storage and transport costs. During the spray-drying process, the atomized feed solution joins the air at a high temperature, and the solvent is evaporated rapidly from the surface, forming a highly concentrated layer on the outer surface of the droplet. A suitable polymer for serving as wall material in encapsulation processes should have a tendency to form a thin and dense network during drying, but also have a high emulsifying activity and should not permit lipid separation from the emulsion during dehydration (Imagi 1992).

The present work makes a short analysis of the characteristics and behaviour of the several polymers to evaluate their efficacy for serving as an encapsulating material and as a substitute for gum Arabic. The polymers and their blends were characterized by the drying kinetics, capacity of oil incorporation and stabilize it.

MATERIALS AND METHODS

Materials Maltodextrin (MD), equivalent dextrose DE=10, (Mor-rex 1910, Corn Products, Brazil), whey protein concentrate (WPC) (Alibra, Brasil), soy protein isolate (IPS) (Tovani, Brazil) and gum Arabic (GA) (IRX49345, CNI, Brazil) were used as wall materials. Commercial soybean oil (Soya) was used to determine emulsifying capacity.

Dispersion preparation The wall materials, GA, MD and WPC, were hydrated in deionized water at a 30% w/w concentration and stored overnight. IPS was hydrated in 50°C deionized water at a 10%w/w, due to the high viscosity of this protein. Total solids of mixtures of IPS:MD were 20%w/w (IPS 25), 15% w/w (IPS 50) and 12%w/w (IPS 75) and the number in front of IPS indicates the proportion of protein to the MD.

Rheological measurements The rheological properties of the solutions above prepared were measured using a Physica MCR 301 rheometer (Ostfildern, Germany) with a double gap concentric cylinder measurement cell. Suspensions were placed in the temperature-controlled measurement vessel and allowed to equilibrate up to 25°C for 5 min prior to measurement. The shear stress

was recorded as a function of shear rate range from 0.1 to 100 s⁻¹.

Drying curves Isothermal (150°C) drying curves for aqueous dispersion of MD, GA, WPC, IPS and different proportions between IPS:MD and WPC:MD were developed. One gram aliquots of these suspensions were pipetted into aluminum pan liners (6081-00/OHAUS- 12cm diameter) in duplicate and dried in a infrared balance (OHAUS-MB200) for 1h.

Emulsifying capacity The emulsification capacities (EC) of the wall materials were determined based on De Katerewicz (1987) method. Dispersions of 1%w/w of sample were combined with soybean oil and homogenized, in different proportions and total weight as 50g. Saturation (emulsion breaking) was determined visually by the sudden phase separation of the mixture. To the proportion just before breaking, increments of oil was added with a burette at 2ml/min. Homogenization was made in a Ultra Turrax T-25 homogeneizer (IKA - Laborthechnik) at 10000rpm and the emulsion was maintained in an ice bath. The EC was calculated by the maximum amount of oil incorporated per gram of protein.

RESULTS AND DISCUSSIONS

The drying characteristics of the solution of biopolymers were evaluated from the data of moisture loss with respect to time. Figure 1 shows the plot of moisture content, in dry basis, versus time. In Figure 1a, all materials, initially at 30%w/w, had its water content reduced to the half in approximately 8 minutes (500s), but the reduction to the minimum was different for each polymer. Samples of GA and WPC reached the minimum water content in about 1500 seconds (25minutes), whereas the MD needed the double of the time. Also, the level of MD in the WPC-MD mixtures changed the drying final time. Although of this time cannot be compared to the time used to dry the particles, due to influence of the droplet surface formed by the atomizer, the isothermal drying rate is governed by the diffusion rate of water during drying, and the drying rate may reflect the characteristics of the sample matrix: the thinner and denser the matrix, the lower the drying rate (Imagi 1992). When the internal diffusion becomes limiting to the drying, a critical moisture content is eventually reached before the surface becomes impenetrable. The slight difference between the polymers GA, MD and WPC is due to the porous structure and the pore size formed during the drying. These

materials, after dried, became as a film or a shrinkage membrane. Regarding the curves of IPS (Figure 1b), the mixture of IPS:MD containing a high proportion of IPS (IPS50 and IPS 75) has dried faster than the isolated polymer and IPS 25, attained a minimum water content in 700s. Adding 25% of IPS in relation to the MD do not change the drying profile of MD.

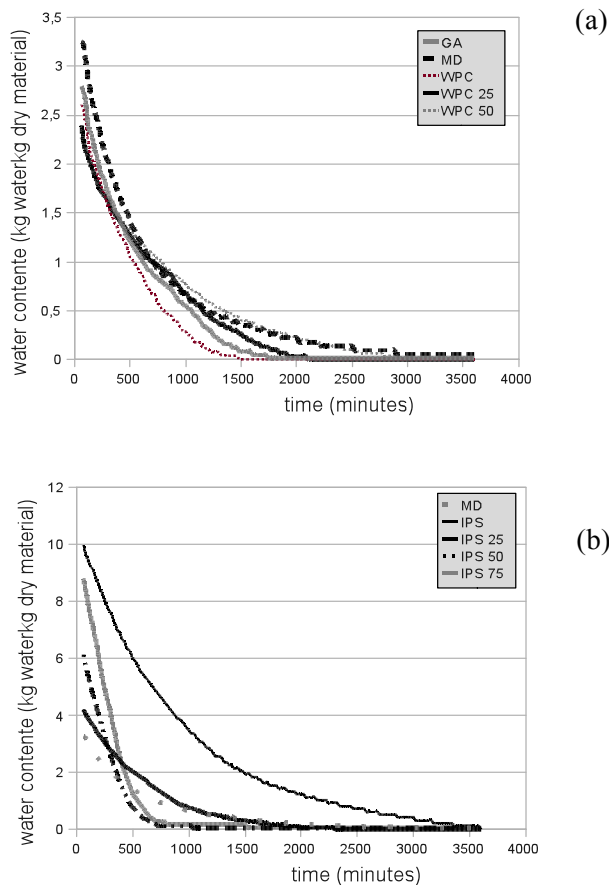


Figure 1: Drying curves of the biopolymers and their blends. a) GA: gum Arabic; MD: maltodextrin; WPC: whey protein concentrate. Blends are mixtures of protein plus MD. b) IPS: soy protein isolate; MD: maltodextrin; Blends are mixtures of protein plus MD.

Figure 2 shows the rheological assays to the polymers. Tixotropic effects were observed for all mixtures between MD-IPS. MD reduces the viscosity of IPS but the non-newtonian behavior is not changed. Newtonian behavior was observed to MD and WPC solution 30%w/w.

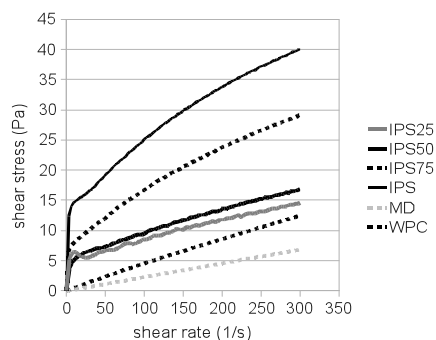


Figure 2. Viscosities of biopolymers solution.

GA is one of the most commonly used food hydrocolloids in encapsulation due to its exceptional surface-active and rheological properties (McNamee 1998). However, many researches have been conducted over the years to find an alternative polymer, due to fluctuations in supply and price of GA. Studies about the molecular structure of the gum suggested a glycoprotein as responsible by its the emulsifying capacity (Dror 2006).

Proteins aid in the formation of emulsions, mainly by decreasing interfacial tension between the water and oil, and also by helping to stabilize the emulsion by forming a physical barrier at the interface. The analysis of emulsifying capacity has shown that WPC is more efficient emulsifying agent than soy protein isolate (Table 1). Furthermore, a substantial reduction on oil incorporation by the protein could be observed with IPS-MD mixtures, indicating that hydrophobic groups became unavailable.

Table 1: Emulsifying capacity of the biopolymers.

	EC (g oil/ g sample)
IPS	101.62 ± 5
IPS 25	8.48 ± 2
IPS 50	14.66 ± 2
IPS 75	35.53 ± 3
WPC	605.95 ± 24
MD	1.26 ± 0.3

CONCLUSIONS

The characterization of the polymers before producing the particles is very important to reduce the assays number and also for explaining properties of resulting particles. At the experimental conditions used, a probable interaction between IPS and MD which reduces significantly its emulsifying capacity. However, WPC-MD seems to be a potential substitute for the GA by providing a required oil-water activity and low viscosities.

REFERENCES

- Dror et al. (2006) *Structure of Gum Arabic in Aqueous Solution* Journal of Polymer Science: Part B 44 (22) 3265-3271.
- De Kanterewicz et al. (1987) *Water-oil absorption index: A simple method for predicting the emulsifying capacity of food proteins.* Journal of Food Science 52 (5) 1381-1383.
- Imagi et al. (1992) *Retarded oxidation of liquid lipids entrapped in matrixes of saccharides or proteins.* Bio-science, Biotechnology and Biochemistry 56 1236-1240.
- McNamee et al. (1998) *Emulsification and microencapsulation properties of gum arabic.* Journal of Agricultural and Food Chemistry 46 4551-4555.