Spray drying behaviour and functionality of beta-lactoglobulin-/pectin-stabilized o/w-emulsions

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Abstract

During microencapsulation of sensitive (food) ingredients by spray drying, one important step is the spray drying process itself, which affects the emulsion droplet size distribution, the emulsion stability with regard to the oil droplet size as well as the structural integrity of the interface. The latter has a strong impact on the encapsulation efficiency and the physical stability of reconstituted emulsions. By interfacial engineering the barrier properties and the packing density at the oil/water (o/w) interface can be modified. The interface can be engineered by e.g. layer-by-layer-technology that involves sequential layering of polymers at the o/w-interface of an emulsion via electrostatic interactions. By that means so-called multilayer emulsions can be obtained. Studies on the characterization of these multilayer emulsions in relation to the spray drying process, especially with respect to the type of atomization and the drying behavior are lacking and literature on the oxidative stability of spray-dried multilayer emulsions is scarce.

Scope

Aim of the present study was to investigate the impact of atomization and drying on the functionality of emulsions with a modified o/w interface consisting of beta-lactoglobulin and pectins with varying degree of methylation.

Experimental Approach

Beta-lactoglobulin and pectin (low and high methylated) were used for preparation of single and multilayer-emulsions containing fish oil. Electrostatic interactions were analyzed via zeta potential measurements. Elasticity of emulsion interfaces was analyzed by droplet shape analysis. The single droplet drying behavior was characterized by acoustic levitation. Spray droplet and oil droplet size distribution were measured by laser diffraction after two-fluid-nozzle and rotary atomization at different energy inputs. Spray drying was carried out at 180/70 °C inlet/outlet temperature. The morphology of the particles was analyzed by scanning electron microscopy. The oxidative stability of the fish oil was monitored via hydroperoxide and propanal content.

Major results

The single droplet drying behavior of the differently stabilized emulsions was similar as examined by levitation. With regard to the atomization process, the emulsion spray droplet size generally decreased with increasing energy input to the atomizer. In two-fluid nozzle atomization but not in rotary atomization, the spray droplet size distribution was markedly influenced by the differences in emulsion viscosity. The spray droplet size distribution was narrower with rotary atomization compared with two-fluid nozzle atomization. The oil droplet size of the emulsions was only slightly affected by the different energy inputs during atomization. However, in the reconstituted state, the oil droplet size was higher than in the original emulsions, which can be attributed to coalescence.

The oxidative stability of the oil was influenced by both the physical state of the emulsions and the different constituents at the o/w-interface. For instance, in the liquid state the oxidative stability was higher in the original emulsions when compared to the reconstituted emulsions. Furthermore, the oxidative stability was affected by the type of pectin and thus the intensity of the oil droplet charge. It can be assumed that in liquid and spray-dried emulsions, not only the particle charge but also the constitution of the interface itself influences the oxidative stability of encapsulated oil.

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