# Ingredient microencapsulation

Microencapsulation has been investigated as a potential method to reduce consumer exposure to undesirable compounds formed during food processing without affecting food quality or microbiological safety. Microencapsulation is not only a convenient way to protect hydrosoluble molecules from water, but it is also a smart approach able to prevent reactions with other compounds present in food products, specifically in the Maillard reaction. Microencapsulation strategies were applied to two food models: biscuits (microencapsulation of sodium chloride) and infant formula (microencapsulation of ascorbic acid, mineral blends containing iron, and polyunsaturated fatty acid). Three microencapsulation techniques, adaptable at industrial scale, namely fluid bed coating, prilling (also known as spray-cooling) and spray-drying, were selected.

Fluid bed coating, a microencapsulation process where a coating material is sprayed onto particles of a fluidized compound was applied to sodium chloride (particles size ≈ 500 µm; NaCl content > 750 mg/g), with the objective to avoid chemical reactions during the baking of biscuits, which could increase amounts of HMF and acrylamide, and the formation of 3-MCPD esters.

The ability of three selected coatings (fatty acids blend, candelilla wax and carnauba wax) to prevent dissolution of NaCl in water was assayed by conductivity measurement (monitoring of NaCl release). Figure 1a highlights the efficiency of the coatings. The particles coated with carnauba wax released less than 15 % of NaCl after 2 hours under stirring in water. Figures 1b and c show respectively the general aspect of NaCl particles coated with carnauba wax (optic microscopy) and a detail of the smooth coating obtained (scanning electron microscopy). Microencapsulated sodium chloride was compared to pure sodium chloride in the biscuit model. After incorporation in biscuit dough and subsequent baking, the HMF content of the biscuits was assessed by chromatographic analysis. HMF content decreased according to the melting point of the coatings (Figure 1d); data demonstrated that the more heat-resistant the lipid-based coating was, the more pronounced was the reduction of HMF formation, and the best result was obtained with the carnauba wax. In addition, sensory analysis revealed that the salty taste was still present in the biscuits; NaCl was released after melting of the coating in the late stage of baking.

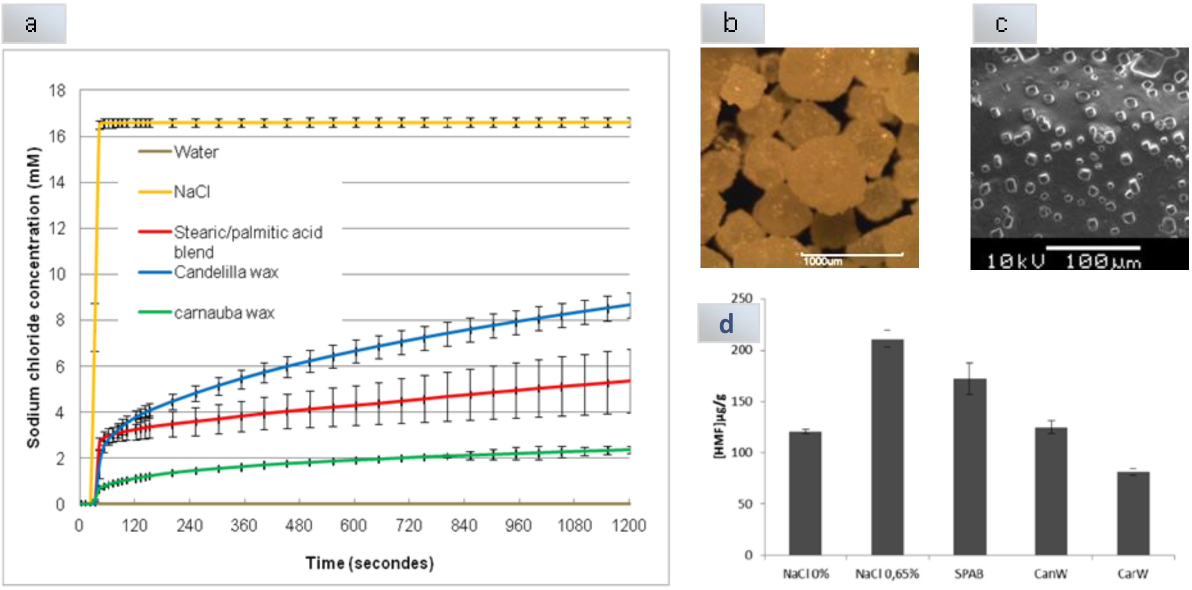


Figure 1. Properties of the microencapsulated particles.

Prilling is a microencapsulation technology where the compound is dispersed or solubilized into a melted material. The formulation is then pulverized, and the micro-droplets formed are converted into microparticles by solidification. Prilling was applied to the microencapsulation of ascorbic acid, iron sources and mineral blends, in order to mitigate the formation of contaminants during the sterilization process of infant formula. The actives were dispersed as fine powders in the encapsulation material (microparticles size ranging from 100 to 500 µm, active content up to 400 mg/g). The powder particles entrapped inside the microspheres produced were clearly visible under optical microscope (Figure 2e). Prilling technology allowed a close control of the size and size distribution of the microspheres, whatever the encapsulated active ingredient (Figure 2f: mineral blend; Figure 2g: iron fumarate). A subsequent fluid bed coating of the microparticles was also performed to further limit the dissolution in water.

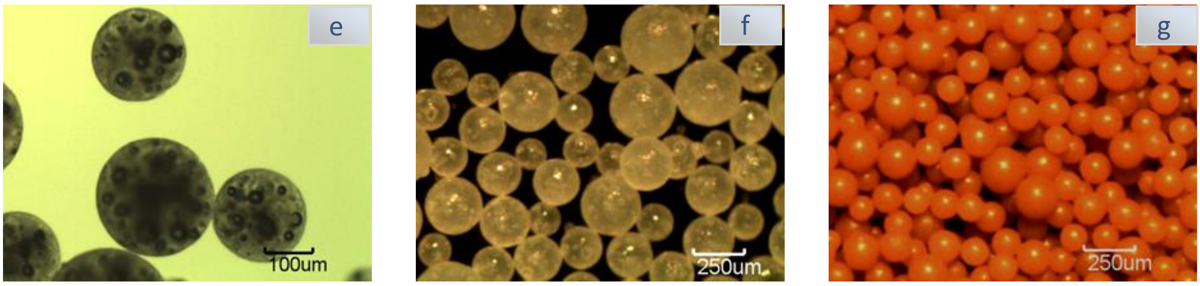


Figure 2. Microscope images of the microparticles

Spray-drying technology allows the combination of atomization and drying of solutions. This technology was applied for the microencapsulation of polyunsaturated fatty acids, which were first emulsified in presence of whey proteins and maltodextrin. The resulting emulsion was spray-dried and a fine dry powder was obtained (particle size < 50 µm, active content up to 250 mg/g).

To conclude, three technologies (namely, fluid bed coating, prilling and spray-drying) were evaluated to protect actives compounds from heat induced reactions during the manufacture process of two food models (namely, biscuit and infant formula). Microencapsulation allows limiting of substrate availability for process contaminants formation. The most significant effect was obtained with the encapsulation of sodium chloride in biscuits. The selected microencapsulation processes are fully available at the industrial scale, with production capabilities up to hundreds of tons per year of encapsulated actives (microparticles with an active content ranging from 200 to 750 mg/g, are typically incorporated between 0.1 and 5 % in final product mass). In this extent, such microencapsulation processes were found particularly relevant to mitigate the formation of contaminants in industrial food processes.

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