Oxygen Based Diffusion Modeling of Oxidation Behaviour of Encapsulated Lipids

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Abstract

Encapsulation is an established technique to protect sensitive materials from environmental factors such as oxygen and light. Nutritionally beneficial fatty acids like omega 3 fatty acids are susceptible to oxidation and are therefore encapsulated by drying an oil in water emulsion. It is assumed that the wall matrix, that is surrounding the lipid droplets, acts as an oxygen diffusion barrier. The study investigates the impact of the oxygen diffusion barrier on the oxidative stability of encapsulated oil using simulation as well as experiments.

In order to simulate the formation of hydroperoxides in the encapsulated lipid, the reaction kinetic of lipid oxidation is determined by measuring the hydroperoxide formation of lipids stored at atmospheres of different oxygen concentrations.

The oxidation behavior of the encapsulated lipids in the distributed oil droplets is simulated using COMSOL Multiphysics®. The model geometry of a particle containing oil droplets is generated using LiveLink™ for MATLAB®. The oxygen diffusion and hydroperoxide formation are simulated using the Chemical Reaction Engineering Module, specifically with the Transport of Diluted Species and Chemistry interfaces. Parametric studies are used to evaluate the impact of the physical properties of the wall matrix and of particle properties.

The simulation is evaluated experimentally by measuring the oxidation of a model system. The oxygen diffusion path is modified by adjusting the oil content, droplet- and particle size.

It is expected that oxygen solubility and diffusivity in the wall material as well as the particle properties have a significant effect on the hydroperoxide formation in encapsulated lipids. The stability of encapsulated oil can be increased by adjusting the particle properties.

Figures used in the abstract

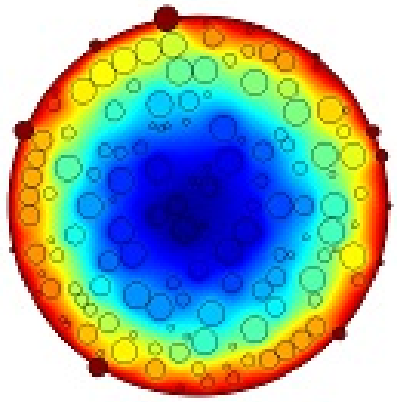

Figure 1