ENCAPSULATION IN DOUBLE EMULSIONS - FUNDAMENTAL ANALYSIS OF STABILITY

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Double emulsions show great potentials for the encapsulation of hydrophilic components such as enzymes, vitamins, or crop protection agents. Thereby, the active ingredient is formulated in a water phase (W_1), which is emulsified in the oil phase (O) protecting the active. The inner emulsion is again emulsified in the outer water phase (W_2) for different aqueous applications in cosmetic, food or agricultural industries. Due to stability issues, only a few products based on double emulsions are currently available on the market. For instance, during storage, the inner water phase and consequently the active ingredient is lost in most systems. Underlying instability mechanisms like coalescence and diffusion, however, are still not completely understood and need further analysis.

Regarding stability, the selection of the emulsifier systems is important and is therefore discussed in detail, as part of this study. To stabilize the inner water droplet (W_1) a hydrophobic emulsifier is needed. Additionally, the W_1/O-droplets need to be stabilized by a hydrophilic emulsifier. Concerning coalescence between the inner and the outer water phase not only the type and the concentration of emulsifier is important, but also the interaction between the hydrophobic and hydrophilic emulsifier. For example, very small amounts of a hydrophilic emulsifier stabilizing the W_1/O-droplets lead to interfacial instability and coalescence of inner W_1-droplets.

Innovative analytical approaches are adapted or further developed to determine and describe instability mechanisms and corresponding influencing parameters. To investigate coalescence and diffusion, single drops are analysed by imaging techniques. Nonlinear spectroscopy is used to describe the interfacial properties of emulsions, focusing especially on the structure and alignment of emulsifier molecules. Next to that, the distribution of the emulsifier molecules is determined via molecular modelling. The aim of the work is the identification of structure/property-relationships in double emulsions to select appropriate formulation and process conditions for making stable (W_1/O/W_2)-emulsions.

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