The structure of omega3 food emulsions

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The structure of omega3 food emulsions.

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Fish oil is rich in polyunsaturated omega-3 fatty acids (omega-3 PUFAs) which are generally recognized as being beneficial to the health [1]. The addition of fish oil to food products is attractive to both the consumers and the food industry. Indeed, these components will improve nutritional value and add product value. Omega-3 PUFAs are rich in double bonds in their fatty acid chains and this attribute renders them highly susceptible to lipid oxidation. Omega-3 PUFAs can be added to food products as neat oil or as a delivery system such as oil-in-water emulsions. In this last configuration, the oil is surrounded by an emulsifier e.g. proteins, phospholipids or hydro-colloids. This emulsifier layer is important and may protect the oil inside the droplets against prooxidants in the surrounding water phase; the emulsifier should act as a physical barrier between the omega-3 PUFAs and the prooxidants. But this protective aspect is a really complex process and it is dependent on the food matrix to which the oil is added [2]. Oxidation is presumed to be initiated at the emulsifier layer, i.e. the interface layer between the oil and water where the oil is most likely to come into contact with the prooxidants in the water phase. Hence the structure, thickness and composition of the interface layer is expected to have a great impact on the oxidative stability of the emulsion. These layers are consisting of food grade emulsifiers such as milk phospholipids, casein and whey protein and are estimated to be in the range of a few nm which is why we used several electron microscopy techniques to visualize and characterize them.

For this work we compare chemical fixation/ room temperature embedding in resin, cryofixation/ freeze substitution and cryofixation/cryo imaging (freeze-fracture cryo-SEM) on several oil-in-water emulsions. Concerning chemical fixation, we adapted conventional protocols for preserving the emulsions, by developing agar pockets for encapsulation or embedding in capillary tubes (figure 1). Indeed to use chemical fixation with these samples is challenging because we need to minimize alterations of the samples while ensuring at the same time that the samples are stabilized so they do not collapse when the water is removed, e.g. milk encapsulated in agar capsules [3]. These new protocols give an interesting view of the emulsions and the organisation of the interface layer surrounding the oil droplets. With cryofixation we could image more details of this interface and we observed that cryo substituted material seems to correspond very well to images of freeze fractured frozen samples in cryo-SEM where protein aggregates seems to be visible in the water phase, see figure 2.

With this work, we want to demonstrate the importance of combining different microscopic approaches to access the ultrastructure of the oil-in-water emulsions due to their complexity and instability [5].

References

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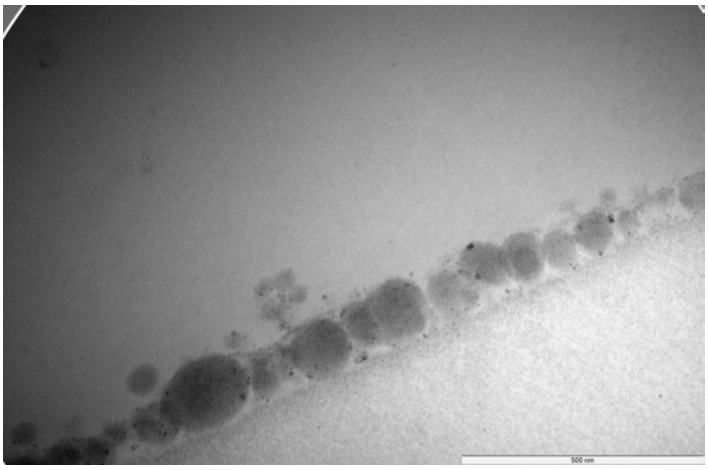

Figure 1. *Capillary tubes embedded and chemically fixed of emulsion with 10 % fish oil and whey protein.*

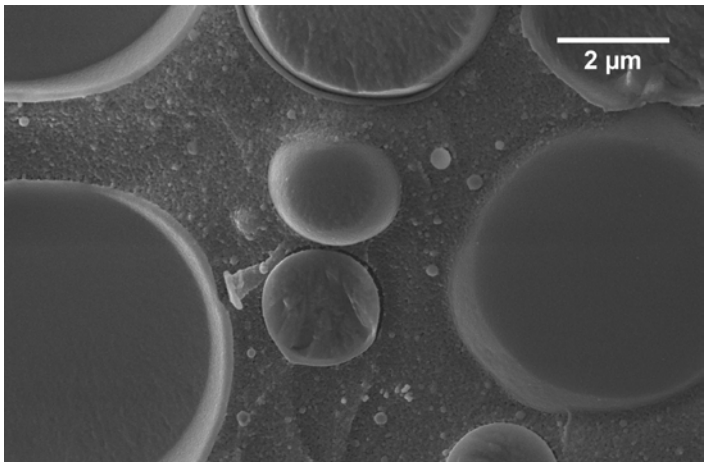

Figure 2. *Freeze-fracture cryo-SEM of emulsion with 70 % fish oil and 1.4% sodium caseinate.*