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Characterization of Emulsions of Fish Oil and Water by Cryo Scanning Electron Microscopy

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Addition of fish oil to industrially prepared food products is attractive to the food industry because of the well-documented health effects of the omega 3 fatty acids in the fish oil [1]. Polyunsaturated Fatty Acids including omega 3 fatty acids are highly susceptible to lipid oxidation due to the many double bonds. Emulsions of fish oil in water are potential candidates for a delivery system of fish oil to food products. It has been suggested that oxidation of oil-in-water emulsions is initiated at the interface between oil and water. It has also been proposed that oxidation is to some extent dependent on the ultra structure of the emulsion; including the size of oil droplets, their distribution and the thickness of the interface between oil and water. This interface is stabilized by macromolecules such as proteins, phospholipids and hydrocolloids. The main objective of this study is to characterize fish oil in water emulsions with respect to oil droplet size, distribution, and ultimately to view the structure and thickness of the interface layer.

A freeze-fractured surface viewed at low temperatures under the scanning electron microscope is a promising strategy to reveal variations in the microstructures of the emulsions. Freeze-fractured emulsions tend to break along the oil and water interface which provides direct access to the surface of the interface layer. The interface layer can be either viewed directly or water can be sublimated from the surface to reveal more of the oil droplets. A second option is to view droplets that are broken across the interface. This will display the actual interface layer, which can be seen after etching for a short period of time.

We have found this method to show promising results for characterization of emulsions with oil droplet sizes ranging from 100 nm - 20 µm, various distribution of droplets and diverse amounts and types of emulsifiers. Here we present results for emulsions with different amounts of fish oil and different protein or milk phospholipid based emulsifiers.

We aim to refine the technique further in order to enable us to derive a correlation between the oil/water interface thickness and microstructure and the stability against oxidation of the fish oil.

References

[1] P.M. Kris-Etherton et al., Cirkulation 106 (2002) 2747.
[2] This research was supported by the Danish Food Industry Agency under the Ministry of Food, Agriculture and Fisheries.

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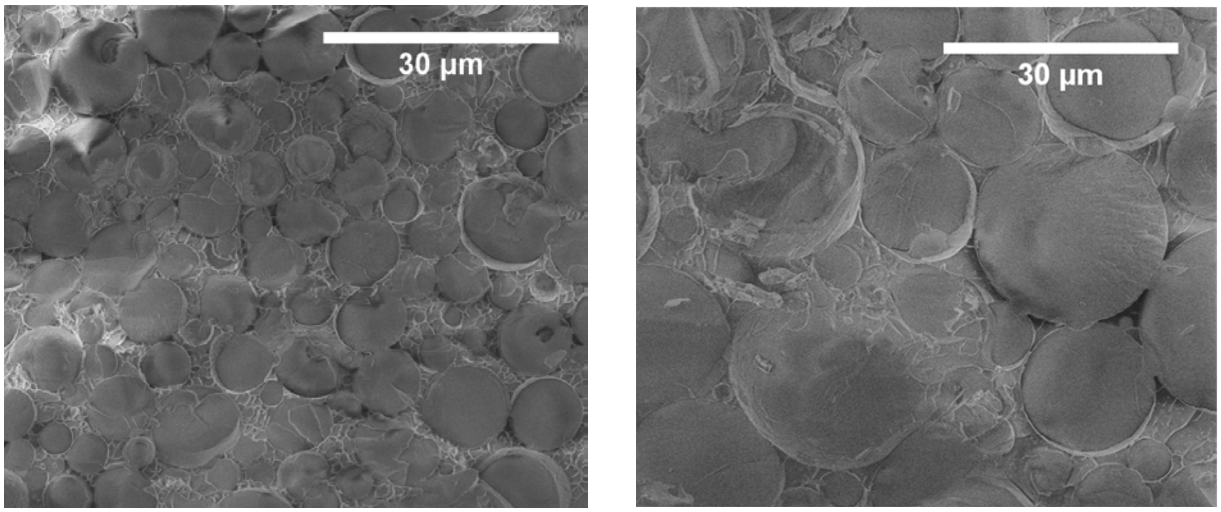
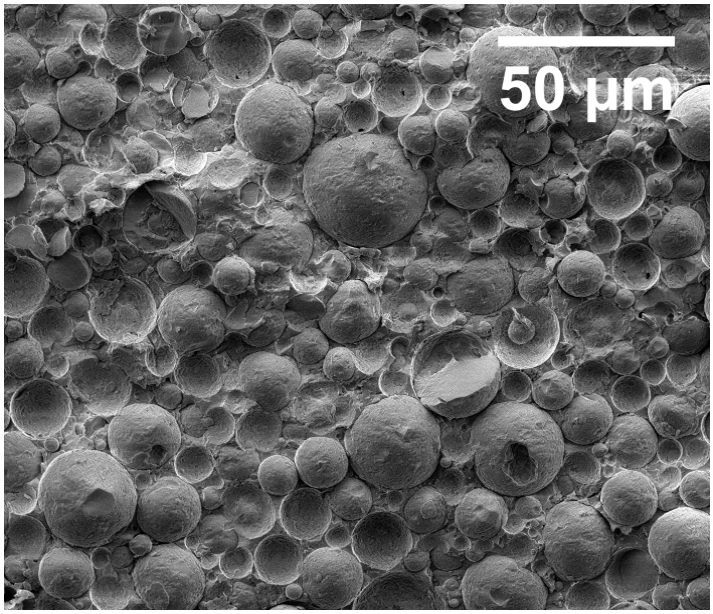


Uncoated freeze-fractured emulsion of 70% fish oil and 2,8 % casein (right) and 1,4 % casein (left). Oil droplets are mainly broken across the interface layer. Micrographs taken on Quanta 200 FEG MKII in high vacuum, 2 kV, SE mode.



Uncoated freeze-fractured emulsion of 70% fish oil and an emulsifier consisting of 75% milk phospholipids. The sample has been fractured mainly along the interface layer. Micrograph taken on Quanta 200 FEG MKII in high vacuum, 2 kV, SE mode.