How interfacial rheology can help to understand process-related modifications of whey proteins

Besides their nutritional value, proteins have many properties, that make them desirable in food formulations. Due to their techno-functional properties they are able to stabilize foams, emulsions and gels. Mostly those properties are linked to their structure. During isolation and formulation food ingredients can undergo several processing steps like heat or pressure treatments. These steps can affect their structure and hence their functional properties. Therefore, it is crucial to understand the process-related modifications to the functional properties of proteins.

A parameter that is often associated with foam stability is the elastic modulus *E'* derived from the pendant drop oscillation experiment. During that experiment the volume of a pendant drop containing the protein or surfactant is changed periodically by a small amount. This leads to a constant change in the available surface area. Depending on the properties of the protein or surfactant the interfacial tension changes as well and the elastic modulus *E'* as well as the viscous modulus *E''* can be furnished from an oscillating drop measurement.

Baier *et al.* investigated the influence of high pressure – low temperature (HPLT) treatments on the functionality of whey proteins. Previous studies already demonstrated, that a HPTL treatment induces changes in the structure of milk proteins. However, it remained unclear how the structural changes affect the functional properties. Thus, interfacial rheology was used to determine the interfacial tension as well as the elastic and viscous modulus of a 2 %

(w/w) solution of whey protein isolate (WPI) after high pressure treatment at room temperature (RT) and -35 °C (PAF, pressure assisted freezing), respectively. In comparison to an untreated WPI solution the interfacial tension and viscous modulus E'' did not change much, but the elastic modulus E' was significantly increased (**Figure 1**). As expected, the stability and density of foams produced with the treated WPI was increased compared to foams with untreated WPI.

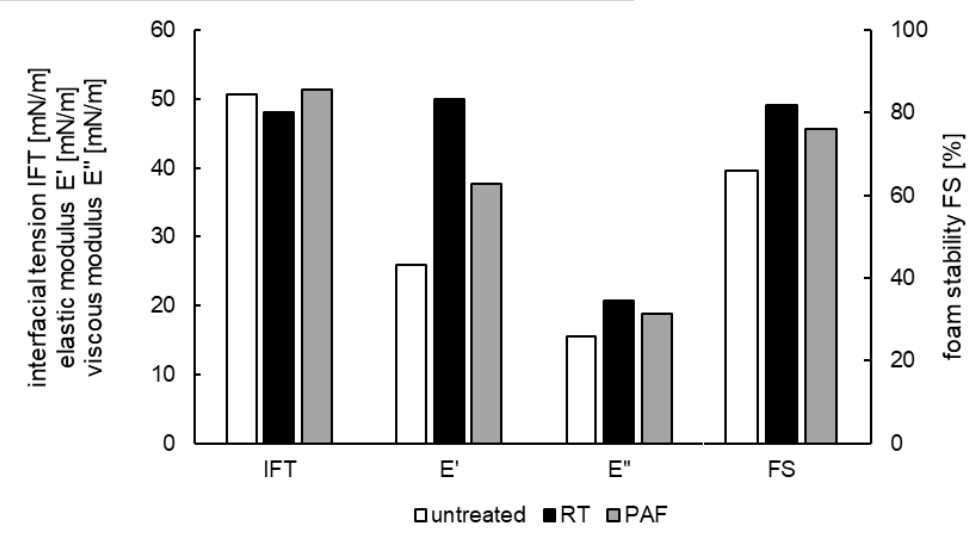

Figure 1: *Average interfacial tension, elastic and viscous modulus and resulting foam stability of WPI solutions (2 % w/w) after high pressure treatment at room temperature (RT) and -35 °C (PAF), respectively.*

In conclusion, the pendant drop oscillation experiment provides results, that can be used to evaluate possible modifications of techno-functional properties occurring during the processing of food.

Pendant Drop Oscillation Experiment: Viscoelastic Modulus E*

The viscoelastic modulus E* indicates how fast surface-active molecules can respond to a change in interface area. For the measurement, a pendant drop is suspended from a cannula surrounded by air (or an outer liquid phase) and its volume is periodically changed. With the volume also the interface area is changed which leads to an alteration of the interfacial tension over time. The speed of the interface tension change is depending on how fast the surface-active molecules can reassemble to cover the newly formed interface. A characteristic value for the speed of this surfactant rearrangement is the viscoelastic modulus E*. The complex viscoelastic modulus E^*. It consists of an elastic part E' and a viscous part E''.

$$E^* = E' + iE''$$

An optical contour analysis system OCA equipped with an oscillating drop generator ODG20 (DataPhysics Instruments GmbH, Germany) was used in this research.

If you want to know more about the content of the article, you can directly view the literature information below.

Changes in functionality of whey protein and micellar casein after high pressure - Low temperature treatments; D. Baier, C. Schmitt, D. Knorr; Food Hydrocolloids **2015**, 44, 416-423; https://doi.org/10.1016/j.foodhyd.2014.10.010

Contact DPI for more information on the measurement of interfacial rheology or visit our webpage under https://www.dataphysics-instruments.com/us/knowledge/understanding-interfaces/interfacial-rheology/ for an introduction.