

Experimental report

19/12/2023

Proposal: 1-20-74

Council: 10/2022

Title: Foam stabilized by Food grade albumins

Research area: Soft condensed matter

This proposal is a new proposal

Main proposer: Ruifen LI

Experimental team: Leonardo CHIAPPISI
Julien LAMOLINAIRIE
Gokhan Ugur ATIL
Ruifen LI
Milena CORREDIG

Local contacts: Leonardo CHIAPPISI

Samples: Albumins solution
Whey proteins solution

Instrument	Requested days	Allocated days	From	To
D33	1	1	02/07/2023	03/07/2023
D22	1	0		

Abstract:

Aqueous foams are important in creating appealing structures in food. Recent studies on the foaming properties of plant proteins is still very limited. This proposal will allow us for the first time the use of neutron scattering to the study of the foaming properties of pea albumins in their both native and aggregated state, and compare them to the more known whey proteins. These albumins are the most abundant protein in the side streams from the isolation process of the pea protein isolate. The latter is currently an emerging protein ingredient, increasingly used in food formulations for vegetarian food products. We will be able to use the novel device developed at the ILL, combining in-situ small-angle neutron scattering (SANS) with conductivity and macrophotography. The (de)stabilization of foams can then be followed at all relevant length scales on their mechanisms, and relate the findings to our molecular studies of albumin at the interfaces, with rheological, and macroscopic drainage measurements.

Experiment N.: 1-20-74 Instrument: D33 Local contact: Leonardo Chiappisi

Experiment Title: Foam stabilized by Food grade albumins

Aqueous foams are important in creating appealing structures in food, but appealing foams with plant-derived proteins are not yet well developed. Studies on the foaming properties of plant proteins are needed. The foaming properties of pea-derived albumins were first measured using neutron scattering on the D33 diffractometer beamline. The structural information of their micellar solution were also conducted on foaming solutions in a quartz cuvette of 2 mm thick on the D22 diffractometer at the same time. The plan was successfully executed to study their foam aging process in their both native and aggregated state with promising results.

In this experiment, we used the device of quartz column to generate liquid foam, which is transparent for neutrons. It was designed on the model of the FOAMSCAN from Teclis Scientific (France). Using this design, we could also obtain both the conductance of foams at different heights and capture foam images at the same time during foam drainage. Then we could compare these data with SANS data to understand the foam drainage mechanisms of plant-derived albumins in their native and aggregate states when subjected to the processing conditions of different pH and heat treatment changes. After data analysis, the foam properties from the models of SANS scattering intensity, such as liquid fraction, specific surface area of the Plateau borders and inter-bubble films, and thin film thickness, could be correlated well with the liquid fraction and bubble sizes obtained from conductance and image analysis, respectively.

This work shows how with this multiscale approach it is possible to understand the underlying foam destabilization mechanisms of albumins and the links of foam coarsening with the microscopic, chemical composition of an aqueous protein foam, which leads to the macroscopic appearance and stability. The study material, albumins, present in the side stream extracts of plant protein have shown promise as functional foaming ingredients to replace animal-based proteins.

Lastly, we would like to sincerely thank the ILL staff, especially my local contact/ collaborator Dr. Leonardo Chiappisi, who helped our experiment throughout the beamtime, supported us to explore experimental possibilities and further data analysis after beamtime. We also appreciate the warm help from his PhD student Julien Lamolinairie throughout our beamtime.