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Switchable foam stability by Janus-like plant protein particles.

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Protein foams, in applications like a cappuccino, need to be sufficiently stable, whereas in large-scale production processes, such as protein extractions, stable foams are not desired. Therefore, in an ideal situation, the foam stability of proteins should be tuneable. We found that proteins from rapeseeds, known as napins, have a unique Janus-like amphiphilic particle structure with a diameter of 5 nm, which, when they are not charged, form stable foams similar to those of whey and egg proteins. However, a slight increase in their surface charge (-15 mV) through a pH change resulted in a rapid foam collapse. Through ellipsometry and atomic force microscopy, it was revealed that napins, when they are not charged, form dense, superhydrophobic viscoelastic monolayers on the surface. Increasing their charge to -15 mV enhanced the repulsion between protein particles and altered their interfacial arrangement to a less dense monolayer, resulting in a more liquid-like surface structure. Using the thin film balance, we found that the pressure at which the bubbles coalesce is twice as high when the napins have no surface charge in comparison to when the surface charge is at -15 mV. We demonstrated that the behaviour of napins as amphiphilic Janus-like particles is highly dependent on the repulsive electrostatic forces. This behaviour allows us to control the foam stability and enables a broad use of napins in foam-based applications and processes.

Keywords:
Foams, napins, interfacial rheology, thin film dynamics, Janus-like particles