Balancing oil and protein content: antifoam regimes of foamed protein-based emulsions

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The presence of liquid oil droplets in protein foams can reduce foaming functionality through antifoam activity. However, no systematic study on the regimes of antifoam activity at different protein and oil contents is currently available for foamed food emulsions. A (soy) protein solution that was nearly completely free from aggregates and an emulsion (sunflower oil) with controlled droplet size distribution were used. Mixing these [1].
Antifoam activity was drastic at low and moderate protein contents (<0.7 wt%) and was not observed at high protein contents (>1 wt%). Oil contents as low as 0.006 wt% caused notable foamability reductions. Remarkably, recovery of foamability functionality was observed at oil contents above 0.1 wt%, with full restoration of foamability functionality at high oil contents above 10 wt% (fig. 1.). The same regimes of antifoam activity as a function of protein and oil content were also observed for multiple other protein types besides the used soy (skim milk, egg white, and potato) and different oil types besides sunflower (rapeseed and corn) [1].
Only foamability, and not foam stability, was affected by the presence of oil droplets in whipped foams, indicating the dynamic nature of the antifoam effect [1]. In line with the low timescales typically associated with dynamic antifoams, a correlation between fast protein adsorption kinetics (rising bubble tensiometry) of certain protein types (milk) with reduced antifoam activity at relatively lower protein contents was observed. Furthermore, the role of a characteristic time for adsorption at the bubble air-water interface [2] was further substantiated in single bubble lifetime tests where longer bubble rise times (i.e. adsorption time) resulted in lower antifoam activity. Additionally, the relatively low antifoam activity for protein types (egg white) that form highly viscoelastic air-water interfaces highlights the unique role of protein viscoelasticity and electrostatic repulsion to prevent antifoam activity. This was further substantiated by observations of complete prevention of oil droplet entry at a protein-stabilized air-water interfaces at relatively low protein contents.
In conclusion, we have established generic trends as a function of protein and oil content. We have shown that the effect can occur at very low oil contents, which can make it an overlooked factor in protein foaming research. Our research highlight the drastic nature of antifoam activity, especially for plant-based protein systems. Finally, we provide first insights in the unique interfacial and capillary dynamics of antifoam activity for protein-stabilized foamed emulsions.

Keywords:
antifoam, emulsions, foams, protein, plant-based

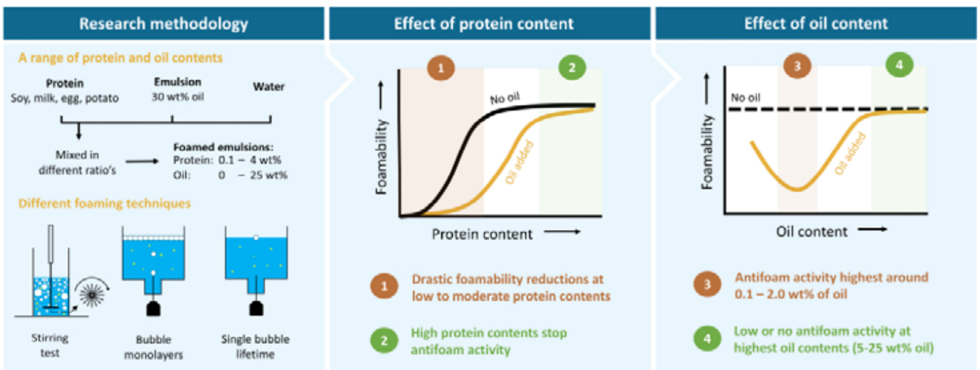

Figure 1: graphical abstract of used methods and results found in [1]

References:

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