

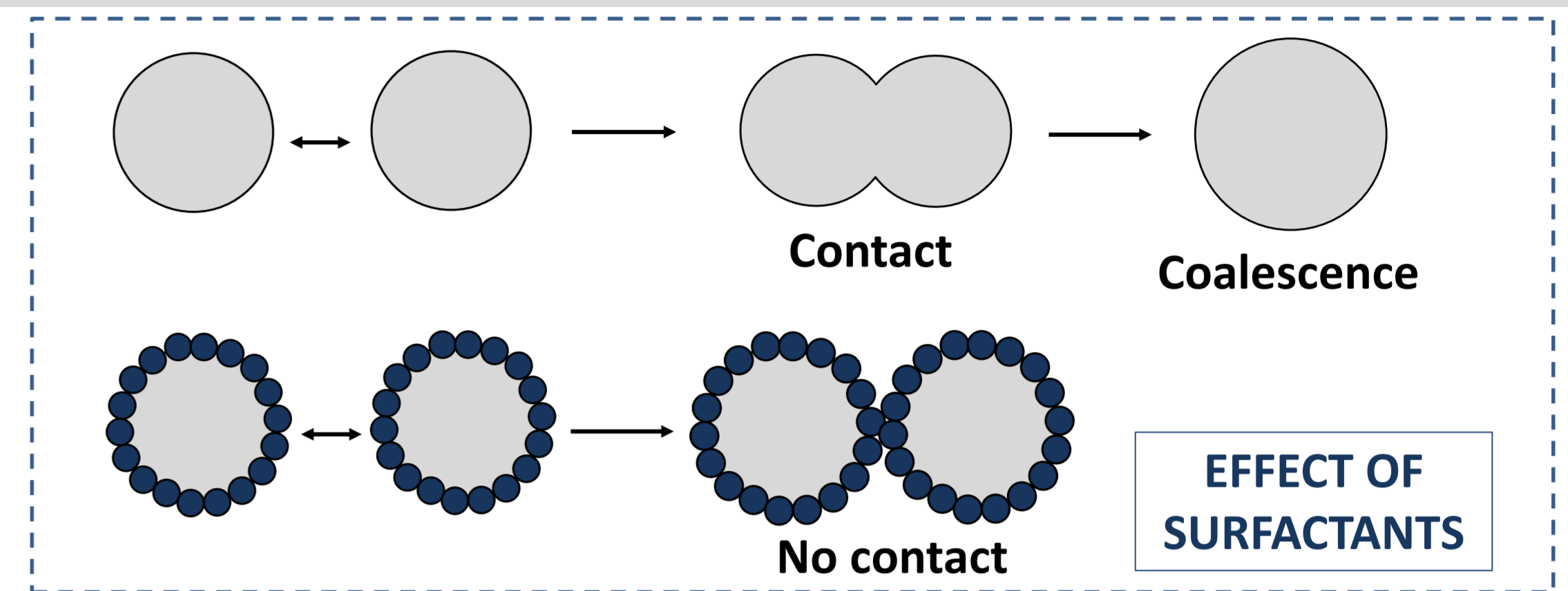
# Formation and stability of foams in complex media

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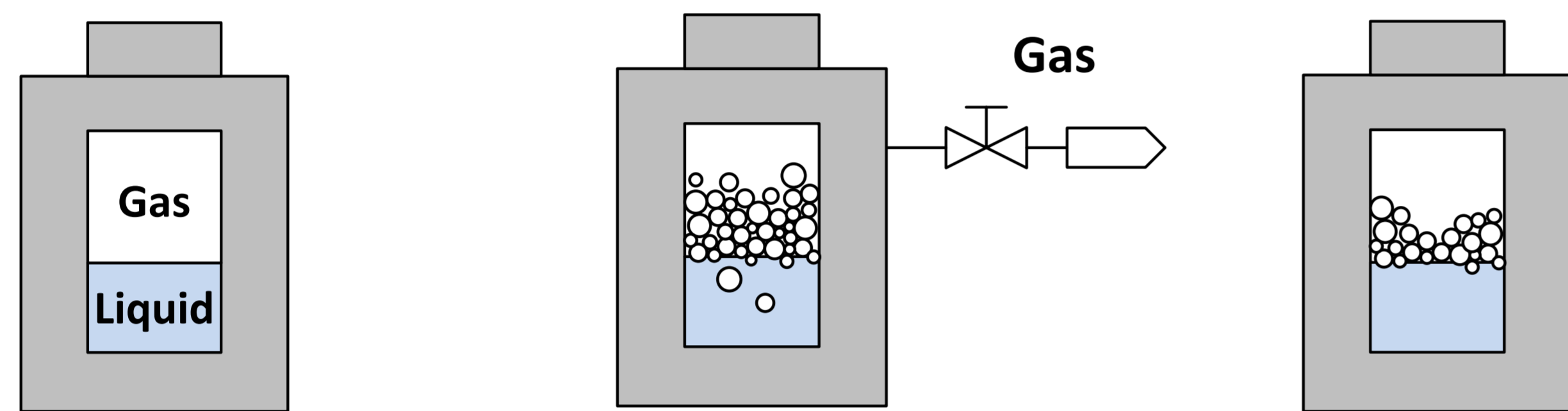
## Introduction and Research aim

- Foam on food products is a feature that strongly drives consumer preference. Some effects can be controlled by the foam formation and stability (Labbe et al., 2016). However, foams are thermodynamically unstable and tend to collapse to a liquid that is the lowest energy state.
- Food products contain surfactants that are preferably located at the gas-liquid interface and play an important role in foam properties (Boos et al., 2013). However, no systematic chemical and physical studies have been devoted to better comprehend such complex systems.
- **The aim:** to establish a sound scientific understanding of the interfacial properties of food systems as well as of the solubility and sorption kinetics of food grade gases under different conditions in food matrices.



## Foam formation upon depressurization

- Formation of a foam requires the introduction of a gas into a liquid.
- They can be formed by **releasing the gas from a supersaturated solution** due to a pressure drop.



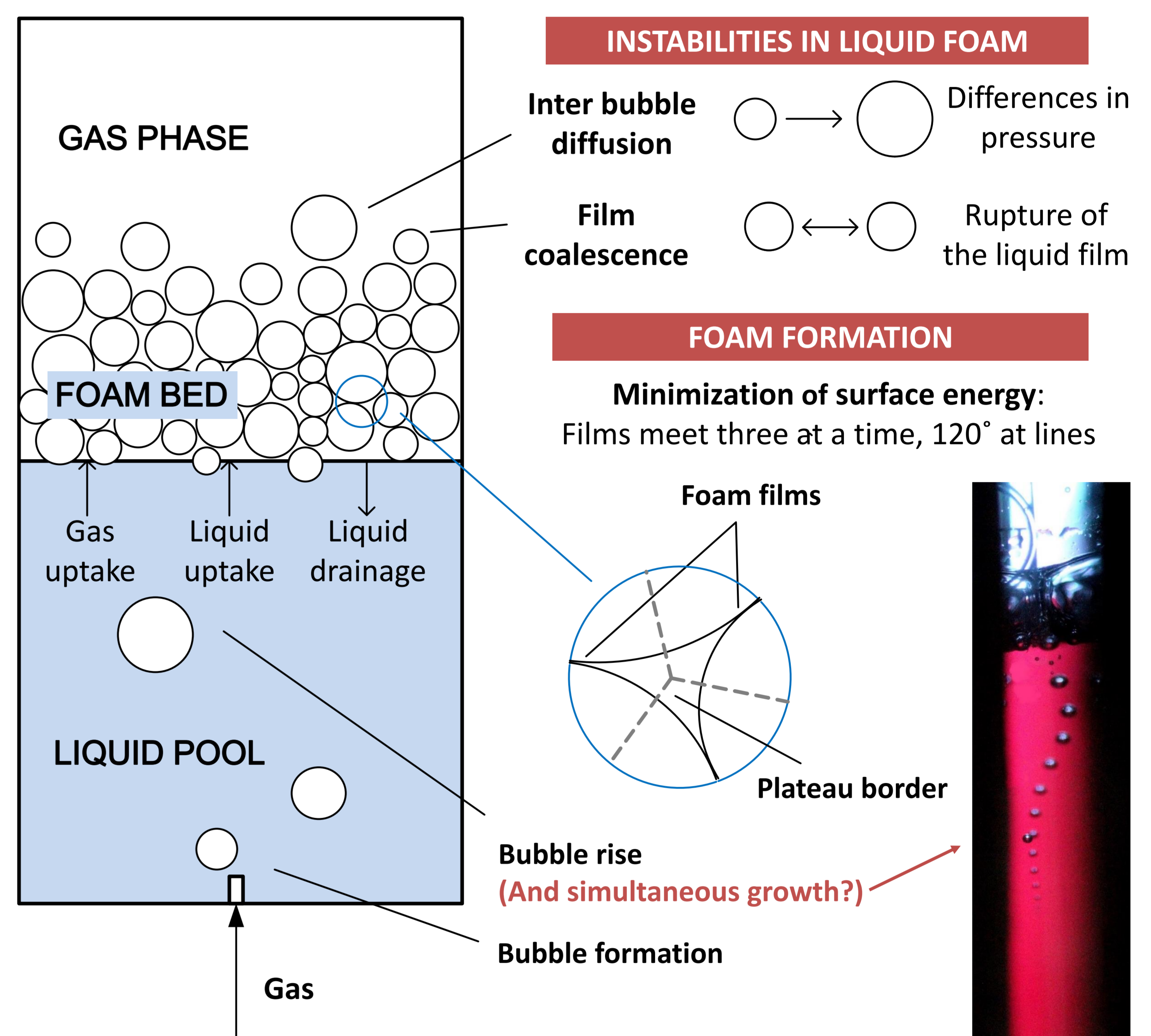
**P = const. Gas solubilization**  
Gas solubilized in the liquid phase at elevated pressures

**↓P ; ΔP > 0 Foam formation**  
No longer soluble gas releases at the surface **forming** the foam

**ΔP = 0 Foam stability**  
Foam is thermodynamically **unstable** and begins to decay over time

- Depending on the nature of the compounds present on the liquid phase, the foamability and stability of the foam will be affected:
  - **Foamability:** Maximum foam volume that the solution is able to achieve
  - **Stability:** Time it takes for the foam to achieve the half of the height

## Phenomena that occur in a foam column (Exerowa & Kruglyakov, 1998)

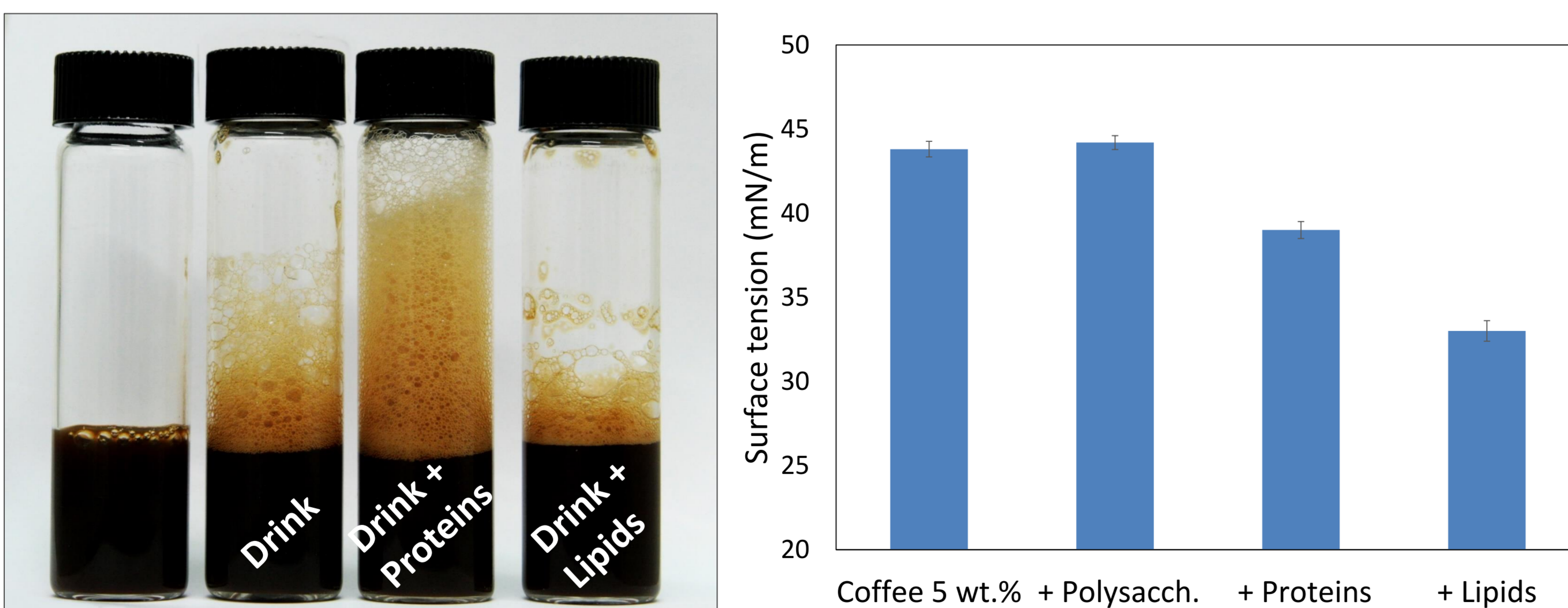


## Effect of surface active compounds

- Food products already contain **biopolymers and natural surface active compounds** that will participate in the formation and stabilization of liquid films.

- **Polysaccharides:** Increase the stability
- **Proteins:** Increase the foamability
- **Lipids:** Decrease the foamability

Surface tension studies:  
**COMPETITIVE ADSORPTION**



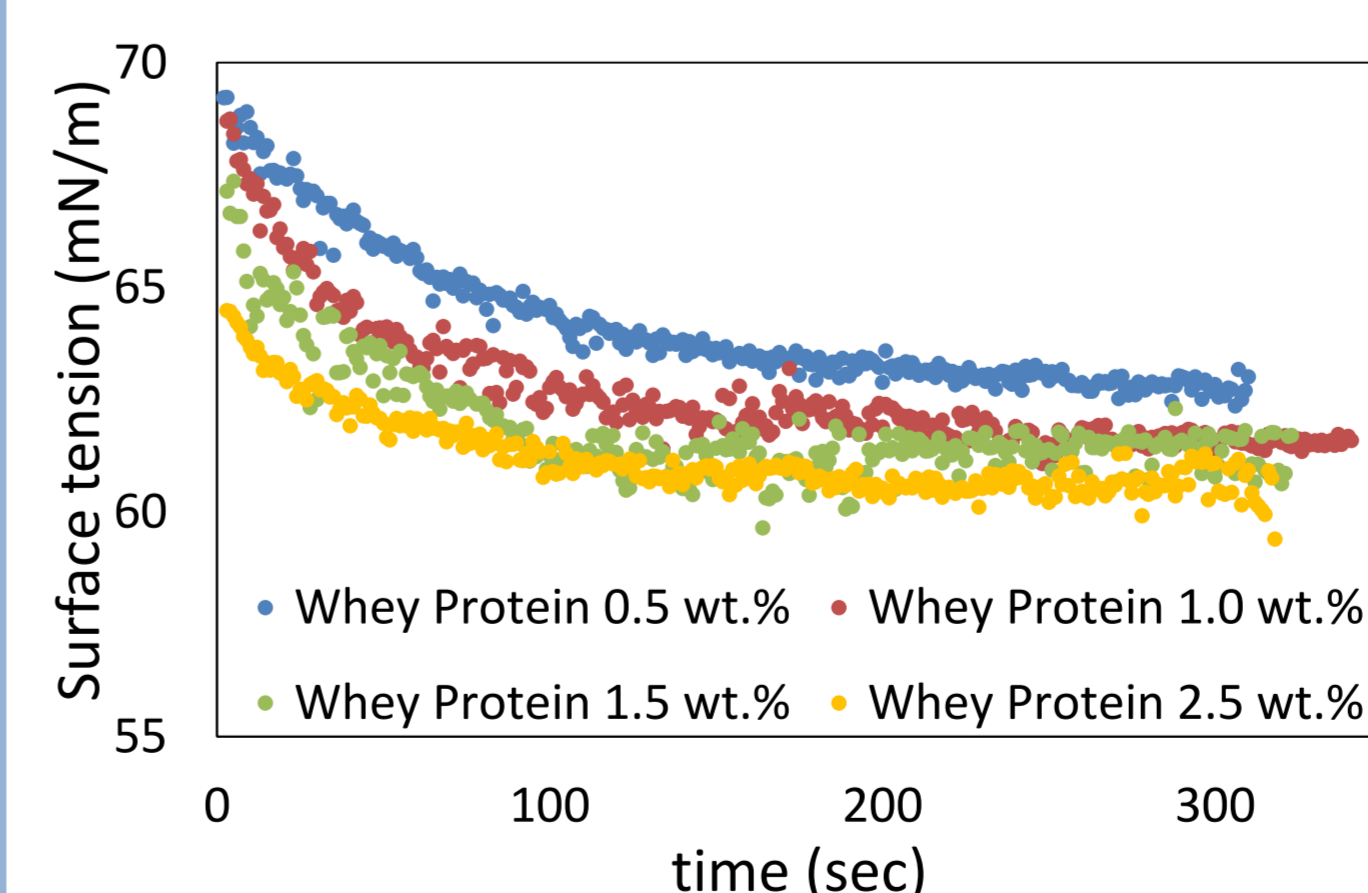
**No direct correlation between the foaming power and equilibrium surface tension when more surface active compounds are present** (Kitabatake & Doi, 1988)

## Properties of the interface

### Adsorption of proteins

Surface tension decreases over time:

- Time-dependent adsorption
- Changes in molecular arrangement because of denaturation of the protein at the gas-liquid interface



### Further analyses needed

Some other analyses are needed to comprehend the foam formation and stability of food systems:

- Competitive adsorption of different compounds at the interface
- Diffusion of surface active compounds
- Solubility of gases and kinetics of dissolution
- Interfacial shear rheology
- Effect of the density, pH and ζ-Potential
- Depressurization rate
- Nucleation, growth and coalescence of bubbles
- Evolution of the foam structure

## Search

- Foam structure analysis
- Oscillating drop method

## Offer

- Interfacial tension measurements (dynamic and under pressure)
- Supercritical Fluid Chromatography (SFC)

### Literature:

- D. Labbe et al. (2016). Food Res. Int., vol. 82, pp. 53–58.  
 J. Boos, W. Drenckhan and C. Stubenrauch (2013). J. Surfactants Deterg., vol. 16, no. 1, pp. 1–12.  
 D. Exerowa and P. M. Kruglyakov (1998). Foam and Foam Films: Theory, experiment, application (Vol. 5).  
 N. Kitabatake and E. Doi (1988). J Food Sci., 53(5), 1542–1545.