In situ gas foaming of plant-based dispersions into porous food structures

Simon Müller, Patrick A. Rühs

Laboratory of Food Structure Engineering, Institute of Food, Nutrition and Health, ETH Zürich

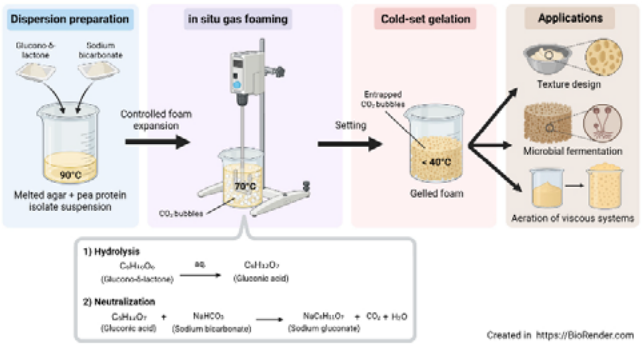
simon.mueller@hest.ethz.ch

Porous food materials are central to texture perception, mass transfer, and cell growth in both food and bioprocessing applications. Conventional foaming methods, which rely on mechanical aeration and interfacial stabilization, are highly effective for low-viscosity and surface-active systems but fail when applied to highly viscous or poorly surface-active dispersions. This limitation constrains the design of dense, plant-based matrices into functional porous structures. Here, we propose in situ gas foaming as a novel approach to aerate viscous food dispersions through controlled gas generation within the material itself. Although in situ gas foaming is well established for structuring polymer melts into microcellular materials, its potential as a colloidal templating mechanism for foaming viscous food dispersions remains largely unexplored.

Gas generation was induced in situ via a food-grade acid-base reaction between glucono-ð-lactone and sodium bicarbonate, producing CO_2 within melted agar-pea protein isolate dispersions. This process enabled foaming across a broad viscosity range and showed a trade-off between foam expansion and structural stability. Low-viscosity dispersions showed the highest initial expansion but also the greatest collapse during gelation, whereas highly viscous systems formed denser yet more stable foams. The highest post-gelation expansion occurred at intermediate viscosity, indicating an optimal balance between bubble growth and viscous resistance.

In this work, we demonstrate the potential of in situ gas foaming as a colloidal structuring approach for generating porous structures in viscous food dispersions. This opens new opportunities for designing functional materials in food and bioprocessing applications.

Keywords:
Foaming, in situ gas foaming, plant protein dispersions, rheology, foaming properties, porous materials



Schematic representation of in situ gas foaming as a colloidal structuring approach for viscous food dispersions. Gas is generated in situ through a food-grade acid-base reaction between glucono-ð-lactone and sodium bicarbonate, producing CO_2 within melted agar-pea protein dispersions. Upon cooling,