The physics of conching chocolate

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Abstract

Chocolate conching is the process in which an inhomogeneous mixture of fat, sugar, and cocoa solids is transformed into a homogeneous flowing liquid. We have shown that two of the main roles of conching are the mechanical breakdown of aggregates and the reduction of interparticle friction through the addition of a dispersant.

Project Description

The mixing of a powder of 10- to 50-μm primary particles into a liquid to form a dispersion with the highest possible solid content is a common industrial operation. Building on recent advances in the rheology of such "granular dispersions," we study a paradigmatic example of such powder incorporation: the conching of chocolate, in which a homogeneous, flowing suspension is prepared from an inhomogeneous mixture of particulates, triglyceride oil, and dispersants. Studying the rheology of a simplified formulation, we find that the input of mechanical energy and staged addition of surfactants combine to effect a considerable shift in the jamming volume fraction of the system, thus increasing the maximum flowable solid content. We discuss the possible microscopic origins of this shift, and suggest that chocolate conching exemplifies a ubiquitous class of powder–liquid mixing.

Key Results:

- Mechanical agitation (conching) causes a shift in the jamming volume fraction, ϕ_m. When a sample has volume fraction $\phi > \phi_m$ the system is jammed (images above, A – F). These samples granulate[1].
- This shift in ϕ_m caused by mechanical action is due to changing the degree to which primary particles are aggregated.
- The jamming point ϕ_m can also be altered by mixing in a surface active agent, usually lecithin.
- Lecithin acts to reduce interparticle friction, thus reducing the constraints to motion imposed on the system[2].

[1] https://arxiv.org/abs/1907.10980

[2] https://doi.org/10.1103/PhysRevLett.121.128001

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