Control of the whey protein-stabilized emulsion texture in a large range of concentration

Marie Chevallier, Thibault Loiseleux, Christelle Lopez, Catherine Garnier, Alain Riaublanc, Thomas Croguennec

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Context

- Whey proteins : Large amount available around the world

MILK → CHEESE MANUFACTURE → CHEESE / WHEY

CHEESE: ♦ 10% of the milk volume ♦ >80% of the milk proteins (caseins)

WHEY: ♦ 90% of the milk volume ♦ <20% of the milk proteins (**Whey proteins**)

From waste stream to value-added, « gutter-to-gold » *Smithers, 2008*

- Exceptional biological value (amino acid composition)
- Ligand carriers (vitamins, minerals, fatty acids)
- Bioactive proteins and peptides

Excellent for human nutrition

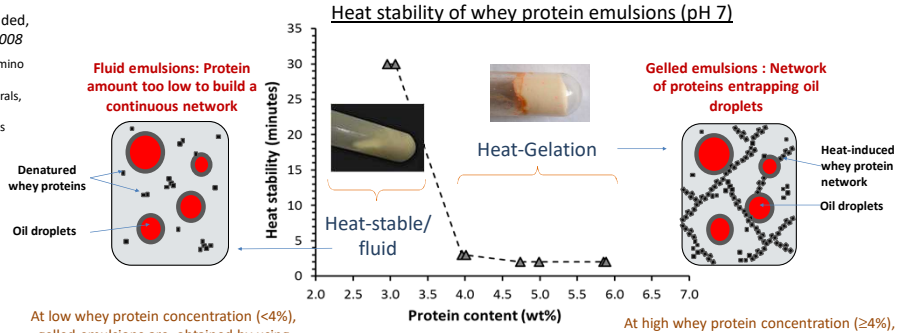
Dairy manufacturers: **add value** to dairy compounds (*e.g. aggregated whey proteins*)

- Additives are currently used to control dairy product quality (texture, heat stability, phase separation,...)
- New trends in Europe driven by consumer's expectations

- **More natural and healthier food products**
- **100% milk products** (without non-dairy additives)
- **Innovative products** (new uses and consumption habits)

- Whey proteins are - natural emulsifiers (*adsorb to oil/water interface*)
  - heat-sensitive proteins (*heat treatments are required to extent food product shelf life*)
  - → heat sensitive emulsions
  - → texturized (gelled) emulsions

Heat stability of whey protein emulsions (pH 7)



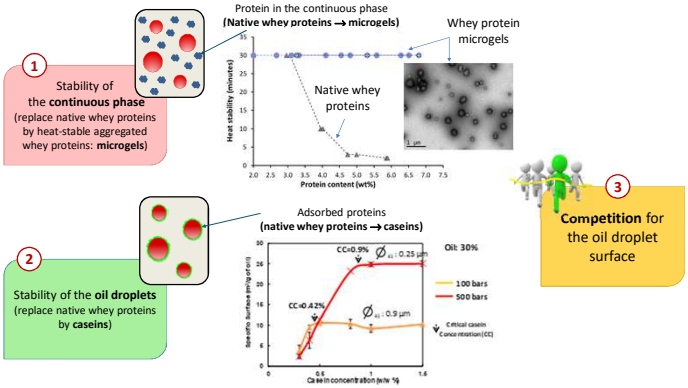
At low whey protein concentration (<4%), gelled emulsions are obtained by using non-dairy **gelling agents**

At high whey protein concentration (≥4%), fluid emulsions are obtained by using non-dairy **stabilizing agents**

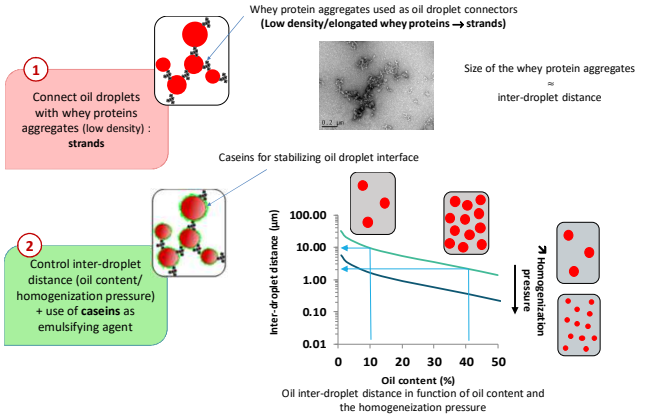
Research Questions **How to control the texture of whey protein emulsions in a large range of protein concentrations without non-dairy additives?**

Strategy

How to design whey protein emulsions at high protein concentrations that are fluid after heating in the absence of non-dairy additives?



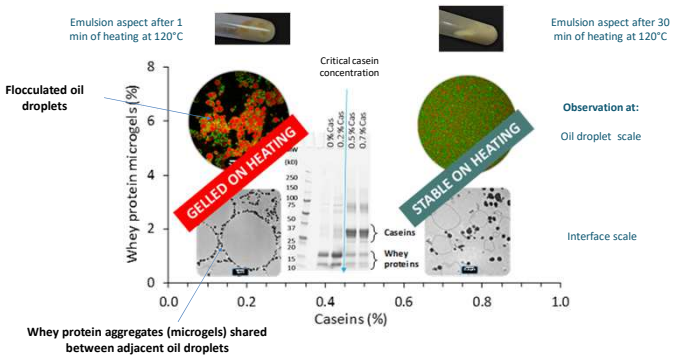
How to obtain texturized (gelled) emulsions at low whey protein concentrations without non-dairy additives ?



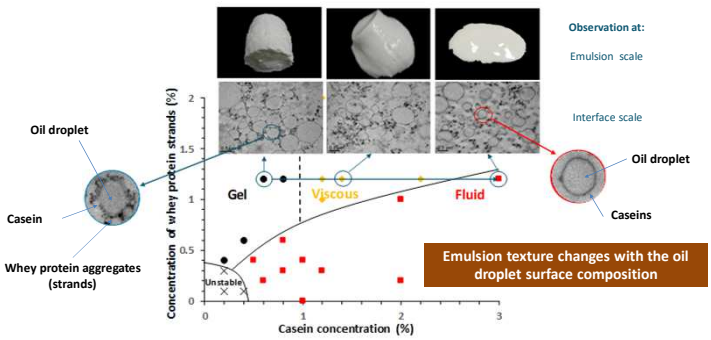
Oil inter-droplet distance in function of oil content and the homogeneization pressure

Results

Emulsion heat stability according to casein content



Emulsion texture in function of the whey protein aggregate (strands) and the casein concentrations



Conclusion

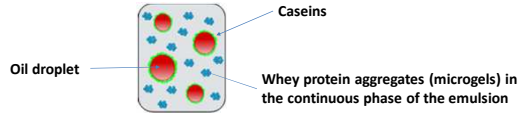
Heat stable emulsions are obtained at high whey protein concentration in the absence of stabilizing agent:

- By adding sufficient amount of caseins to cover oil droplets surface (control of the size and stability of the oil droplets

  → casein content (g) > mass of oil (g) × specific surface (m^2/g of oil) × protein interfacial load (g/m^2)
  (protein interfacial load ~ 2mg/m^2 for caseins)

Caseins → Oil droplet

- By selecting large and dense whey protein aggregates (*small number, low interfacial adsorption rate and low reactivity on heating*)

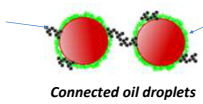


Texturized emulsions are obtained at low whey protein concentration in the absence of gelling agent:

- By selecting low density/elongated whey protein aggregates
- By using whey protein strands as « connector » at the surface of the oil droplets (size of the aggregates ~ distance between oil droplets)
- In combination with the homogenization pressure, use caseins as emulsifiers to control the size of the oil droplets (distance between oil droplets)

  → casein content (g) < mass of oil (g) × specific surface (m^2/g of oil) × protein interfacial load (g/m^2)
  (protein interfacial load ~ 2mg/m^2 for caseins)

Whey protein strands (= connecting agent)



Caseins (with homogenizing pressure, they control the oil droplet size and the distance between oil droplets)

Connected oil droplets

The number of « connectors » defines the texture of the emulsions (gel, viscous, fluid)

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