

Design of an innovative technological route using fractal whey protein aggregates instead of texturising agents to create clean label dairy products

Ali Kerjouh, Julie Ebongué, Florence Rousseau, Marie-Hélène Famelart, Thomas Croguennec, Alain Riaublanc, Cécile Rannou, Carole Prost, Marielle Harel-Oger, Gilles Garric

▶ To cite this version:

Ali Kerjouh, Julie Ebongué, Florence Rousseau, Marie-Hélène Famelart, Thomas Croguennec, et al.. Design of an innovative technological route using fractal whey protein aggregates instead of texturising agents to create clean label dairy products. https://www.icef14.com/en/committees/6. The 14th edition of the International Congress on Engineering and Food (ICEF14), Jul 2023, Nantes, France. , 2023. hal-04150248

HAL Id: hal-04150248 https://hal.inrae.fr/hal-04150248v1

Submitted on 4 Jul 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.





Liberté Égalité

Fraternité







A. Kerjouh¹, J. Ebongué¹, F. Rousseau¹, M.H. Famelart¹, T. Croguennec¹, A. Riaublanc², C. Rannou³, C. Prost⁴, M. Harel-Oger¹, G. Garric¹

- 1: INRAE, Institut Agro Rennes-Angers, UMR1253 STLO, Rennes, France
- 2: INRA, BIA, Rue de la Géraudière, BP 71627, 44 316 Nantes Cedex 3, France
- 3: UMR CNRS GEPEA 6144, Oniris, Nantes, France
- 4: Lunam University, Oniris, UMR CNRS 6144 "GEPEA Flavour Group", Nantes, France

CONTEXT & AIM

✓ In France, consumers and public authorities increasingly request healthy and safe products with as few ingredients as possible [National Program on Nutrition and Health-PNNS 4 and Loss leader pricing law (EGALIM3)].



Ingrédients Lait entier, sucre, crème fraîche, amidon transformé de maïs, fructose, arôme, gélifiant : carraghénanes, colorant : rocou, protéines de lait, lactose.

- ✓ The main aim of this work was to study how to replace the texturising agents usually used in dairy products (modified starches, carrageenans, etc.) with whey protein assemblies.
- ✓ Products must meet consumer's expectations including the use of processes that are simple and sustainable.

STRATEGY:



STLO

®

plateforme

LAIT

The strategy of this project consisted in

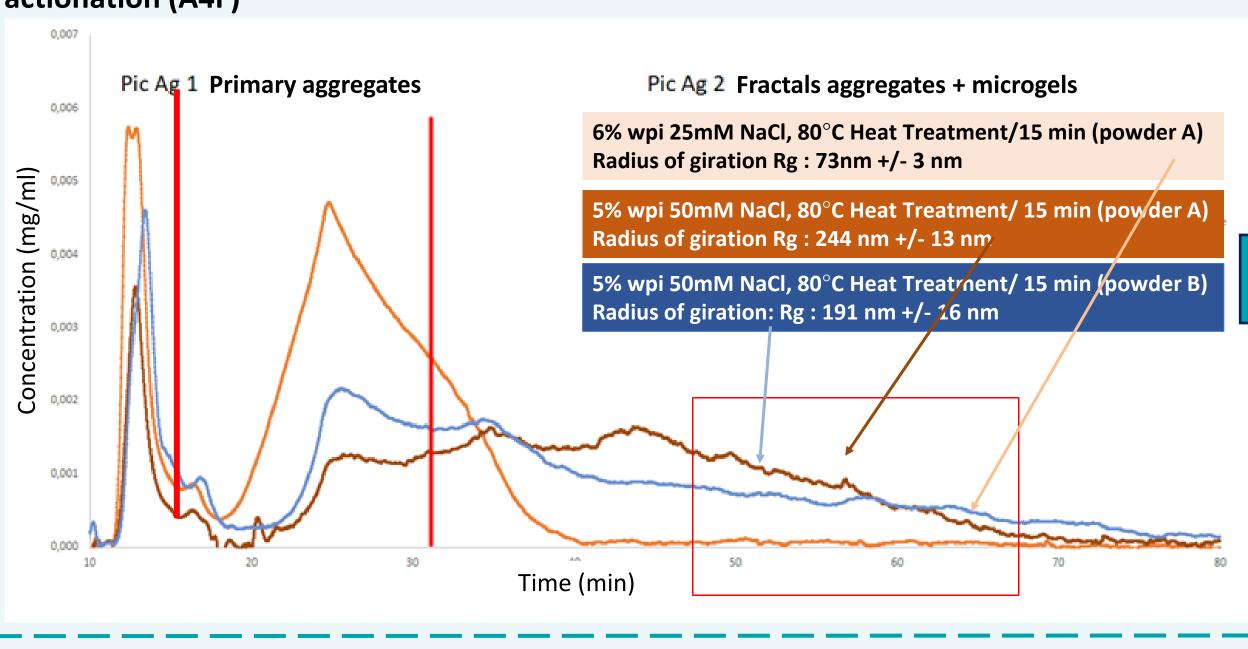
- 1. Identify protein aggregates exhibiting good texturing properties for cream dessert at bench scale (fractals, microgels, fibrils, mixed),
- 2. Determine the best homogenization treatment to size the diameter of the fat globules to the dimensions of the selected aggregates (around 200 nm) to connect the fat globules to the protein assemblies and thus texturize the cream dessert,
- 3. Develop the simplest, most sustainable technological process possible, first on a bench scale and then on a pilot scale,
- Test the consumer acceptability of the new dessert cream by a hedonic test.

Throughout the project, biochemical and rheological analyses enabled us to characterize the products, in particular to compare them with market products.

Some of the results of this work build on findings of **PROFIL** (Functionalized Proteins for Dairy Industry) 2014 - 2018 project, in particular those obtained by T. Loiseleux (PhD thesis, Nantes University): Interfacial competition between soluble and aggregated proteins: droplet connectivity and texture of dairy emulsions



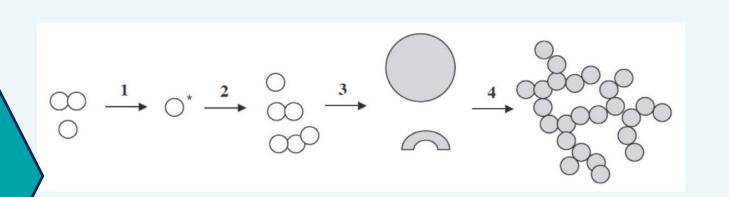
1. Determine the process for obtaining the selected protein aggregates with a size of around 200 nm in diameter from 2 WPI powders: A and B by: Assymetric Flow Field-Flow Fractionation (A4F)



RESULTS

1. The selected protein aggregates were obtained by: 5% Whey protein Isolate (WPI), 25 mM NaCl, pH 7.0, heat treatment: 80°C/15 min, intermediate flow regime: 3500 Reynolds (Re),

2. The optimum homogenizing pressure achieved in a single pass is at least 700 bar for a 7% FM cream.





WPI solution before and after heat treatment

Large aggregates: not

determine

Proteins agregate: 4,4 %

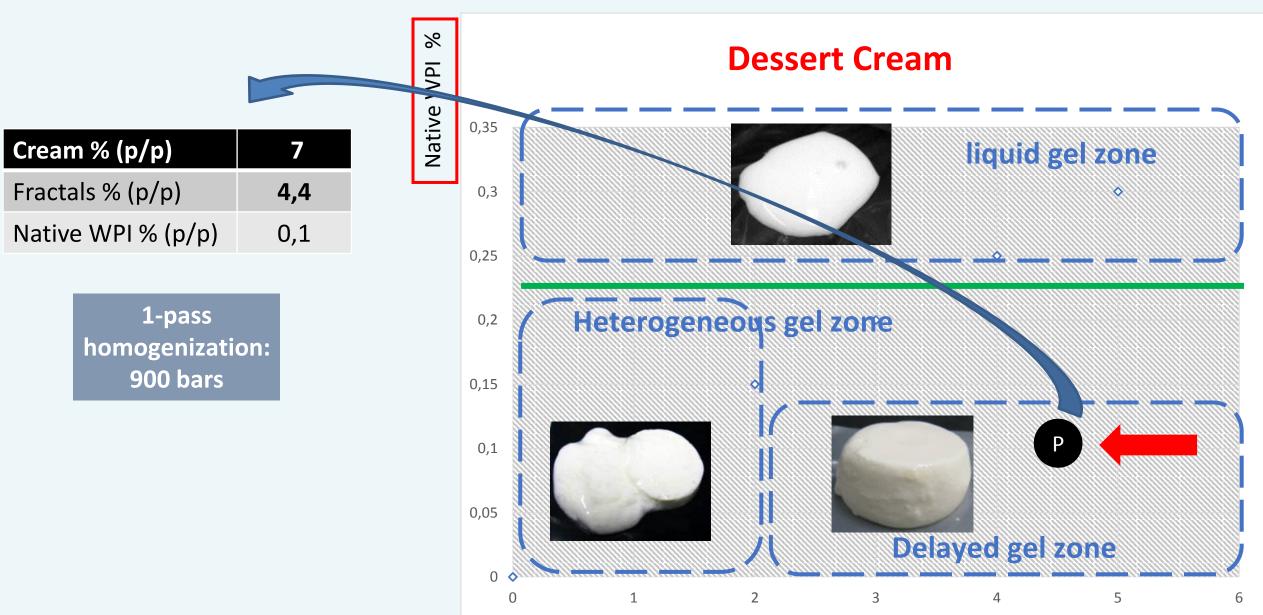
Selected protein aggregates composed of fractal aggregates and a small proportion of microgels

β-LG aggregation process for pH 7

very dense, branched ~200 nm/diameter) Small aggregates Microgels

Transmission Electronic Microscopy (MET)

2. Determine the best homogenization scale to obtain droplet diameters of the same order of magnitude as the diameters of the assemblies.



3. Transfer the process from bench (~ 2kg) to pilot scale (~ 100 Kg) in a continuous process

30%

State diagram of emulsions containing fractal aggregates, produced at 900 bar with 7% MGLA and stored at 4°C.

% Fractals aggregates

Really too much

Just About Right

Really not enough

Too much

Not enough

butteroil volume fraction % Native Whey protein • Modeling the effect of homogenization and fat

----500 bars

volume on the distance between fat droplets and gel texturing: 7% Fat matter, 4,4% aggregates, 0,1% native WPI and a 700 bar single pass to obtain the best structure

Modeling the effect of Butter oil volume fraction and homogenization pressure on the distance between droplets Fat globules **Denatured Whey protei Emulsion** aggregates

the texture Fractal aggregates Non micellar casein **Gelified emulsion**

Dessert Cream with Proteins

route are as follows

3. The optimized technological parameters of the

 Native WPI: 0,1% aggregates • Fat: 7% Raw materials Sugar: 10 % • Vanilia: 1% Mix solubilisation 50°C- 1H Homogenization 60°C - 700 bars **Continious Heat Treatment** 80°C - 1 min

4. The final product has a soft, pleasant texture and a viscosity comparable to that of commercial products at 4°C and 1 s⁻¹ (DHR2 rheometer crosshatched plate-form geometry).

Cooling and storage



4°C

Confocal microscopy (Objective x 60 Nikon microscope)

PROFIL knowledge book home page

The final product!

CONCLUSION & PERSPECTIVES

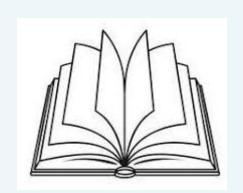
✓ Fractal aggregates have a high functional potential: they can replace texturizing agents under certain conditions.

Percentage for « Just About Right » level

- ✓ They should not be thought of as additives or technological aids, but rather at the heart of the process. ✓ Their use in dairy, mixed and vegetable products is yet to be designed.
- ✓ Production of a **knowledge e-book** for the project's academic and industrial partners









INRAO Boo Pays de la Loire



4. Consumer's acceptability

Percentage response for each

hedonic note (54 panelists)

Note hédonique

• Average = 6,54/9

• scores range from 4 to 9









