More than dairy substitutes

Using plant proteins to innovate new possibilities in dairy product development.

Combining plant and dairy sources in food formulations isn't a new concept in the dairy industry – it's been a key tool for modifying product functionality and reducing costs for years. Take butter, for example, where the addition of vegetable oil has long been used to create softer, more spreadable consistencies. However, what was once primarily a cost-saving measure has evolved into an exciting frontier for sustainable innovation.

Today, research on combining dairy proteins, such as whey, with a diverse range of plant proteins – from popular sources like soy and pea to more novel sources like rapeseed and lupin – has gained momentum. This approach not only preserves the nutritional benefits of dairy but also aligns with the growing demand for climate-friendly food production. The project "Proflex" (2020-2023) aimed therefore at deriving generic principles on the behavior of plant-dairy mixtures using "model systems" to accelerate the innovation on plant-whey protein formulations.

Processing challenges in plant-dairy protein formulations

The potential of combining plant and dairy proteins is well-known and documented. Research on plant-whey proteins has shown that similar qualities can be achieved by supplementing whey protein with plant protein ingredients. For example, it has been demonstrated that it is possible to supplement whey proteins with plant proteins in emulsions and achieve similar or in some cases even better stabilities. However, for the industry to gain from this potential there are technical challenges to overcome, particularly in processing. Whey proteins, derived from milk, are highly soluble and disperse easily in liquid systems, making them a versatile ingredient in many dairy-based formulations. However, plant proteins, extracted from dry sources such as yellow peas or lupin seeds, behave quite differently. These powdered ingredients tend to be more difficult to disperse in liquids due to their unique structure compared to whey proteins.

The varying solubility and dispersibility of plant proteins can complicate their incorporation into traditional dairy processing systems, which have long depended on soluble and dispersible protein ingredients. Ad-

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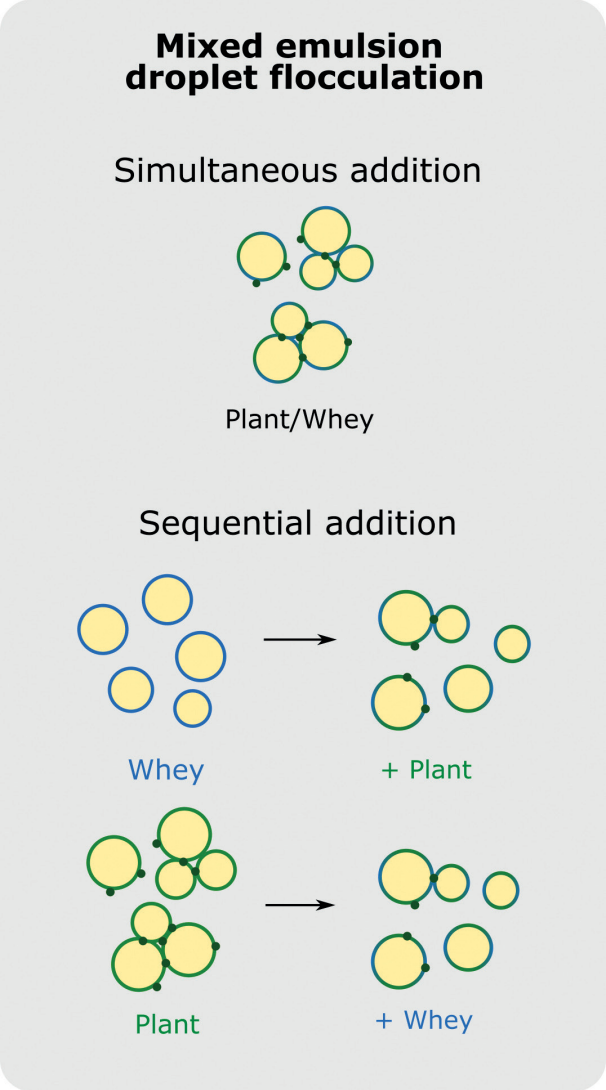
ABSTRACT

To create more sustainable solutions that optimize resources and provide affordable options while ensuring high functionality and nutritional quality, we must rethink food formulation. One approach is to combine dairy proteins with plant proteins. Dairy proteins are widely used for their high quality, but adding plant proteins can lower a product's carbon footprint. Research has demonstrated that this combination is possible while maintaining a similar quality. However, plant proteins don't easily fit into current dairy processing systems. This project explores how to incorporate plant proteins into these processes, showing that optimized processing conditions can enhance the texture and functionality of plant-dairy protein emulsions, leading to innovative products.

Figure 1.



dressing these challenges is key to unlocking the full potential of hybrid protein products in the dairy sector, and thus a large focus of this project. Current dairy formulations and processes are tailored to the unique functional properties of dairy proteins, meaning that integrating plant proteins often requires rethinking both formulations and processing steps. This project highlights the potential for such adaptations, allowing for better integration of plant proteins and expanded hybrid product offerings in the dairy industry.

Emulsion foods designed around dairy

Various strategies can enhance the incorporation of plant proteins into dairy foods. Pre-treatments, like mild heating during ingredient dispersion or pre-homogenisation, have been shown to improve the solubility of plant proteins, making them easier to incorporate into food formulations. However, in this project, it was found that in emulsion-based foods, where homogenisation is already a key step, no additional pre-treatment was necessary, as homogenisation alone was sufficient to disperse the plant protein particles.

Interestingly, while pea and lupin protein ingredients were able to produce emulsions with similar droplet sizes to whey protein-stabilised emulsions, the plant protein ingredients caused clustering of oil droplets. Unlike whey-stabilised emulsions where droplets remained dispersed, plant protein particles tended to connect multiple droplets together resulting in larger droplet flocs. Therefore, formulations containing plant proteins may be particularly well-suited for applications where droplet flocculation enhances texture or mouthfeel, such as creamy textures in spreads or sauces.

The emulsion properties could also be modified by the order of protein addition, i.e. if whey and plant proteins were added simultaneously or stepwise (Figure 1). Adding both plant and whey proteins before homogenisation led to flocculated droplets. Alternatively,

Figure 2.

Emulsion protein source + Gel matrix protein source

adding plant proteins first, followed sequentially by whey proteins after homogenisation, reduced flocculation and increased stability. This opens new possibilities to modify emulsion textures to meet specific needs in dairy applications by simply controlling the point of protein addition.

This tailored approach was further demonstrated in a high-protein, pudding-like product, where lupin protein was first added to stabilise the emulsion, creating flocculated droplets. Whey protein was then sequentially incorporated for its gelling properties. Following heat treatment and cooling, this approach produced a homogeneous, pudding-like product with a softer, creamier texture due to the lupin-induced droplet flocs while keeping the characteristic properties of a whey gel (Figure 2). This highlights the versatility and potential of plant-dairy protein combinations to create a wide range of textures tailored to different dairy food applications.

How can the industry benefit from this research?
Using blends of plant and dairy protein ingredients offers the dairy industry an innovative pathway to expand their product offerings and meet modern consumer demands. By integrating plant proteins with dairy, it is possible to create new textures and flavors that appeal to flexitarian and eco-conscious consumers. This approach invites dairy experts to rethink product development, viewing plant proteins as valuable components that complement whey's nutritional profile while adding a broader range of functional benefits. Thereby, the principles developed in this project provide inspiration to new processing solutions, which drives innovation and positions dairy producers to lead with products that are both environmentally conscious and diverse in taste and texture. ●

PROJECT OVERVIEW

Title: Mastering structure design in model foods containing dairy proteins for flexitarian diets (PROFLEX)

Project manager: Milena Corredig

Participants: Aarhus University, Arla Foods Ingredients, Southern Denmark University

Project period: October 2020-September 2023

Objective: The aim of the project is to study the behavior of plant-dairy protein blends in relevant food systems containing oil and water phases to contribute to the knowledge in the creation of hybrid plant-dairy emulsion-based foods.

PROJECTS RELATED TO THE DANISH DAIRY RESEARCH FOUNDATION