Dairy proteins create new textures

How high-moisture extrusion turns milk proteins and starches into sustainable, meat-like fibrous structures for the future food industry.

Creating foods with a "bite" similar to meat requires precise engineering. This project used high-moisture extrusion (HME), a process that uses heat and mechanical pressure to transform ingredients into dense, fibrous structures. We hypothesized that dairy proteins, specifically Milk Protein Concentrate (MPC), could act as a scaffold to hold plant starches in a way that mimics animal muscle fibers. This technique is energy-efficient and allows for the creation of a wide variety of textures by simply adjusting the recipe or the machine settings.

The perfect starch mix

Not all starches behave the same way under pressure. Our research showed that the "architecture" of starch - how it is built - is vital for a good result. We tested six different types of starch. We discovered that high-amylose maize starch and crosslinked potato starch are the winners for creating stable fibers. These starches don't swell too quickly, which allows the dairy proteins to align properly into long, strong fibers that stay firm even after 15 days of storage.

The secret of hydration

A major breakthrough in the project was the pre-hydration study. Usually, when starch and protein are mixed, the starch "steals" the water, preventing the protein from forming fibers. By pre-hydrating the milk protein before it enters the extruder, we ensured both ingredients had enough water to work together. This resulted in beautifully layered, "lamellar" structures and much better texture. This approach also proves that we can process liquid dairy streams directly, skipping the expensive and energy-intensive step of turning them into powder first.









BY BUSRA GULTEKIN SUBASI, RESEARCHER, AARHUS UNIVERSITY;
SHYAM KRISHNA SUWAL, SENIOR R&D MANAGER, ARLA FOODS;
MILENA CORREDIG, PROFESSOR, AARHUS UNIVERSITY;
MARIO M. MARTINEZ, ASSOCIATE PROFESSOR, AARHUS UNIVERSITY

ABSTRACT

The STRING project, supported by the Milk Levy Fund, investigates how to turn milk proteins into meat-like, fibrous food structures using high-moisture extrusion. By combining dairy proteins with plant starches, researchers successfully created new textures that could replace meat or offer innovative snacks. The study found that specific starches, like high-amylose maize, and a unique "pre-hydration" technique are key to making these fibers stable and high-quality. These results offer the Danish dairy industry new ways to use liquid side-streams and create sustainable, value-added products.

PROJEKT OVERVIEW

Title: STRING: Extrusion of dairy proteins into novel anisotropic foods

Project manager: Mario M. Martinez, Aarhus University

Participants: Aarhus University (Department of Food Science) and Arla Foods

Project period: August 2023 – August 2025

Objective: To design novel food structures with adjustable textures using dairy proteins and plant polysaccharides, and to understand the molecular processes that create these structures during extrusion.

PROJECTS RELATED TO THE DANISH DAIRY RESEARCH FOUNDATION

How can the industry benefit from this research?
The Danish dairy industry stands to gain significantly from these findings in three main ways:

- **Energy savings:** By using liquid protein concentrates directly in the extruder, companies can bypass water-removal steps, saving massive amounts of energy.
- **New market opportunities:** The ability to create "hybrid" products (dairy mixed with plants) allows the industry to lead the way in the growing market for sustainable meat alternatives.
- **Circular economy:** This research turns dairy by-products and side-streams into high-value, functional food ingredients, improving the overall sustainability of production.

This project confirms that Danish dairy ingredients are perfect building blocks for the next generation of sustainable, textured foods. ●



Figure 1. Making meat-like fibers from milk protein. (a) A finished piece pulled apart by hand where you can see the soft, meat-like strands inside, (b) The product coming out of the machine as one long strip, shaped by heat and pressure, (c) A look inside different recipes: giving the milk protein water before mixing turns a crumbly texture into neat, meat-like layers.