Issue N° 8 - December 2024

IDF

DAIRY SUSTAINABILITY OUTLOOK

Research progress | Global insights | Expert opinion

DAIRY PROCESSING

SPECIAL EDITION

PREFACE

MESSAGE FROM THE IDF DIRECTOR GENERAL

Our series, IDF Dairy Sustainability Outlook, spotlights initiatives implemented by the global dairy sector to contribute to the UN Sustainable Development Goals (SDGs). This special issue is dedicated to dairy processing. We have collected a range of case studies that showcase how the dairy sector around the world works for sustainable systems.

In this report, we delve into the diverse landscape of dairy processing, exploring innovative strategies and initiatives from around the world. From France to Australia, from Canada to India, dairy processing facilities are embracing cutting-edge technologies and sustainable practices.

From reducing food waste and increasing efficiency to harnessing the power of renewable energy and promoting economic and social sustainability, the dairy sector is at the forefront of driving positive change. Through collaboration, innovation, and a shared commitment to sustainability, we have the opportunity to transform the dairy processing landscape for the betterment of our planet and future generations.

Join us on this journey as we explore the transformative potential of dairy processing for a more sustainable and resilient future.

Laurence Rycken
IDF Director General

MESSAGE FROM THE CHAIR OF THE TASK FORCE ON PROCESSING

Dear Reader,

Dairy processing plays a pivotal role in the global dairy sector, transforming raw milk into a wide range of nutritious and safe products that meet diverse consumer needs. From increasing shelf life to enhancing nutritional profiles and ensuring food safety, processing is essential for maximizing the value of milk and supporting the sustainability of the sector.

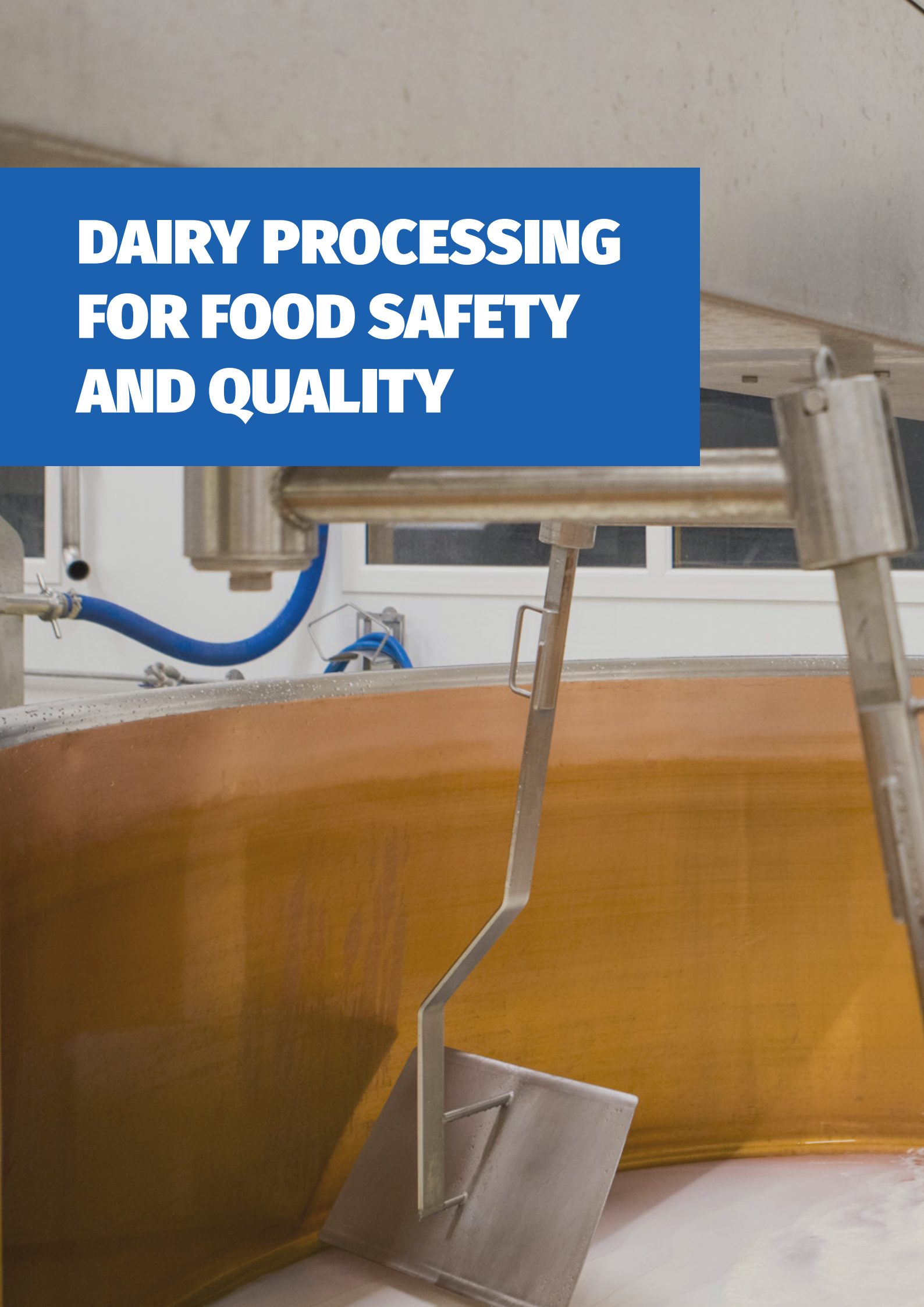
Dairy processing contributes to several United Nations Sustainable Development Goals (SDGs) by improving food security, promoting sustainable agriculture, and enhancing health. Through efficient processing technologies, dairy helps reduce food waste by extending shelf life and improving the nutritional value of products. By creating diverse dairy products that cater to different dietary needs, it supports good health and well-being (SDG 3). Sustainable dairy processing practices, such as energy-efficient production and waste reduction, contribute to responsible consumption and production (SDG 12). Additionally, the sector's role in providing livelihoods for millions of farmers and workers aligns with ending poverty (SDG 1) and promoting decent work and economic growth (SDG 8).

The IDF has been at the forefront of advancing dairy processing practices worldwide. IDF has helped shape the global dairy landscape, ensuring that processing technologies are not only effective but also sustainable.

For more information about the benefits of processing in dairy, I invite you to read the factsheet developed by the IDF Task Force on Processing (access here).

Piercristiano Brazzale
Chair of the IDF Task Force on Processing

CONTENTS



DAIRY PROCESSING FOR FOOD SAFETY AND QUALITY

FRANCE

Safe and nutritious fermented food products: food cultures in dairy

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ALIGNMENT WITH SDGS

DAIRY PROCESSING THROUGH FERMENTATION

Fermentation has been closely linked with the early stages of pastoralism, tracing back to the earliest steps of human history. Very little was known about the true role of microorganisms until the 19th century. Recently, fermented food products have been recognized for their high nutritional value and health benefits to consumers. In the field of fermented food products, the dairy sector has been leading the scientific demonstration and relevance for tackling food waste, food safety, and nutrition. Among many initiatives, one notable project started in 2002 with the Inventory of Food Cultures, a task the International Dairy Federation (IDF) is still working on 20 years later.

THE IDF INVENTORY OF FOOD CULTURES AIMS TO PROVIDE THE SCIENTIFIC BASIS FOR THE REGULATION OF FERMENTED FOODS

The initiative recognizes the role of various microbial species used in traditional fermented food products. It provides authorities with a scientific basis to build regulations and support the international trade of fermented food products, including dairy and other food matrices.

The work brought together dairy technologists, with their expertise and knowledge of various dairy fermented food products, and food safety microbiologists, more familiar with pathogens of concern and hygienic indicators. This collaboration ensures the establishment of the safety demonstration of microbial food cultures with technological use, updating the original 2002 initiative in 2012, 2018, and 2022.

"Making the best of food cultures to tackle food waste"

François Bourdichon

IDF AS A LEADER IN FOOD FERMENTATION AND THE USE OF MICROBIAL FOOD CULTURES

In order to gain recognition beyond the dairy community, the work was published in a peer-reviewed paper in 2012, which remains one of the most downloaded papers and has garnered numerous citations. It has been acknowledged by various official bodies for its authority in the field, establishing IDF as a leader in food fermentation and the use of microbial food cultures.

The outcomes of this work, supported by IDF experts, have been utilised on several occasions to resolve disputes in international trade concerning fermented food products. Moreover, the initiative has expanded beyond the dairy sector to encompass all types of indigenous foods, addressing both the global challenges of food waste and promoting healthy food choices.

SAFE, NUTRITIOUS FERMENTED FOODS ADVANCE SDGS

This initiative offers a scientific basis for the safe consumption of both dairy and non-dairy fermented foods with traditional use, as well as a framework for developing new fermented food products. This includes considering the use of new microbial species or species typically isolated from other food sources. By employing this approach, consumers are guaranteed safe and nutritious food, while the food sector can enhance fermentation efficiency to align with various Sustainable Development Goals (SDGs), notably Zero Hunger (#2) and Good Health and Well-being (#3).

ONGOING ENDEAVORS

IDF is continuing its efforts to expand and maintain the inventory of food cultures to include non-dairy fermented food products, considering the wide variety of indigenous fermented foods.

This is a joint work of the IDF Standing Committees on Microbiological Hygiene/ Dairy Science and Technology and Nutrition and Health.

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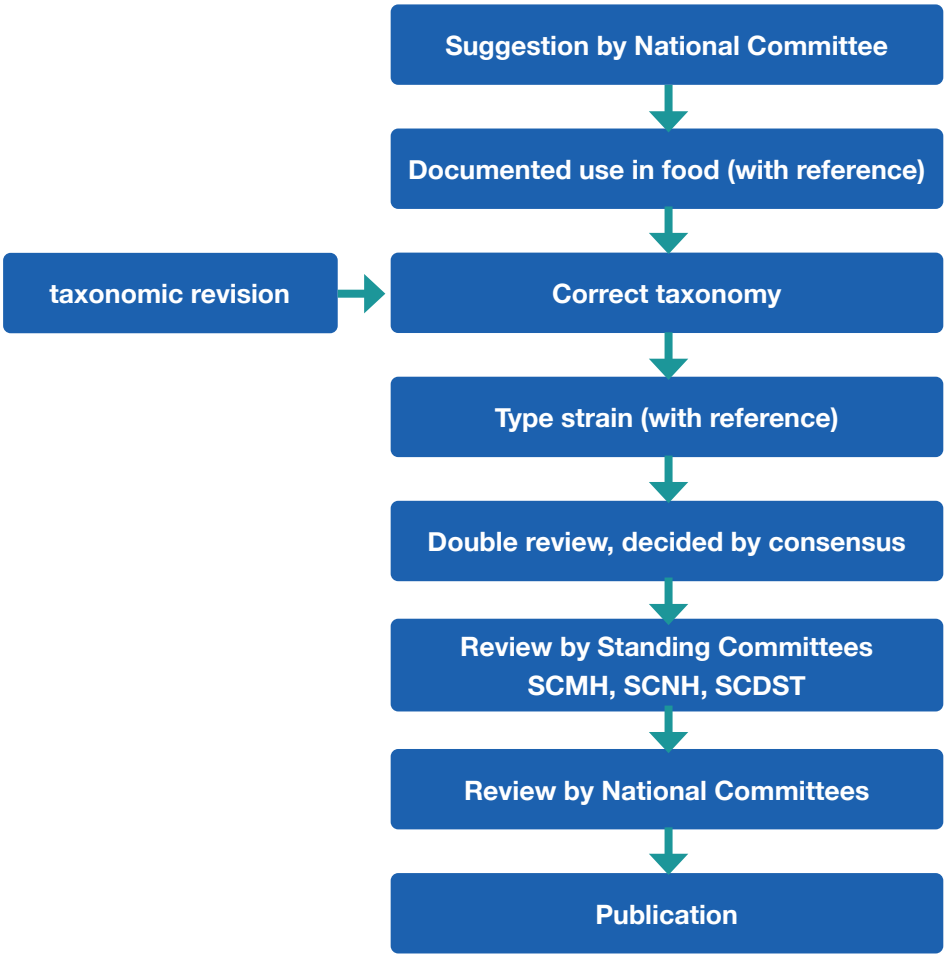

Figure 1. Process for microbial species inclusion. Adapted from the Bulletin of the IDF N° 514/2022.

UNITED STATES

Digital approaches to reducing food waste and increasing sustainability of the dairy industry

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ALIGNMENT WITH SDGS

ACCURATE PREDICTION OF SHELF-LIFE COULD REDUCE DAIRY WASTE AND LOSS

Dairy products are among the top three food groups being lost and wasted, with fluid milk being responsible for two thirds of the volume attributed to dairy products. Ability to accurately predict the shelf-life of each package or bottle of dairy product and assess dairy spoilage systematically would open the door to solutions that could reduce the waste and loss of dairy products and contribute to sustainability of the entire dairy sector.

MATHEMATICAL MODELS CAN PREDICT DAIRY SPOILAGE AND ITS IMPACT ON SHELF LIFE

Some of the key groups of microorganisms responsible for the spoilage of fluid milk, cheese, and yogurt were isolated and identified to define individual representatives within each group and determine the frequency at which these representatives are involved in the spoilage of different dairy products. Representatives from each of these groups were characterised to determine parameters that define their growth in dairy products. Finally, the obtained information was used to develop different Monte-Carlo simulation models that can simulate the growth of spoilage organisms and predict the shelf-life of these products based on raw milk quality and conditions encountered during processing, storage, and distribution.

A CENTRAL HUB FOR DIGITAL TOOLS THAT IMPROVE DAIRY PROCESSING AND PRODUCTS AT CORNELL UNIVERSITY

The path from concept to final use of these models followed four basic steps: (i) development, (ii) validation, (iii) deployment, and (iv) piloting the use within the dairy industry. The validation process included microbiological testing of commercial pasteurized milk during refrigerated storage and showing that there are no statistical differences between these actual and predicted values. The final models were deployed by integrating them with user-friendly interfaces that were made publicly available on-line. The final models were also pilot tested in real dairy processing environment; for example, to evaluate the impact bactofugation has on extension of fluid milk shelf-life.

PROCESSING AND RETAILING BENEFITING FROM PREDICTED SHELF LIFE

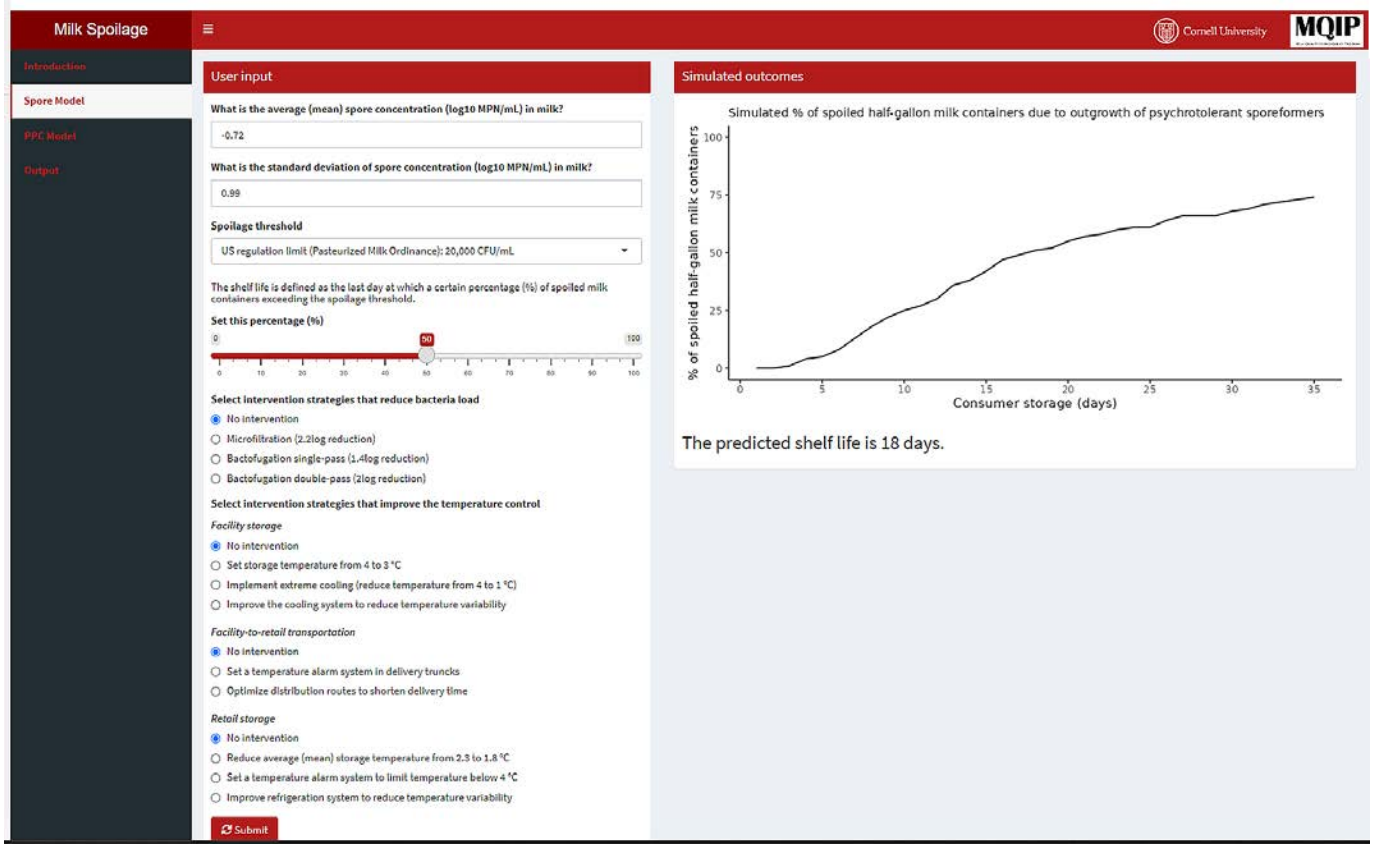
The benefits of predictive simulation models we developed can be applied to both dairy processing and retailing. (i) The models can be used by dairy processors as decision-making tools that can test the benefits of different interventions in a virtual space without the need for large time and resource investments. (ii) The models offer a way of providing more accurate information on shelf-life that can be specific to individual batch or even unit of product instead of static shelf-life information determined during product development.

"Predictive modelling is always one step ahead of spoilage."

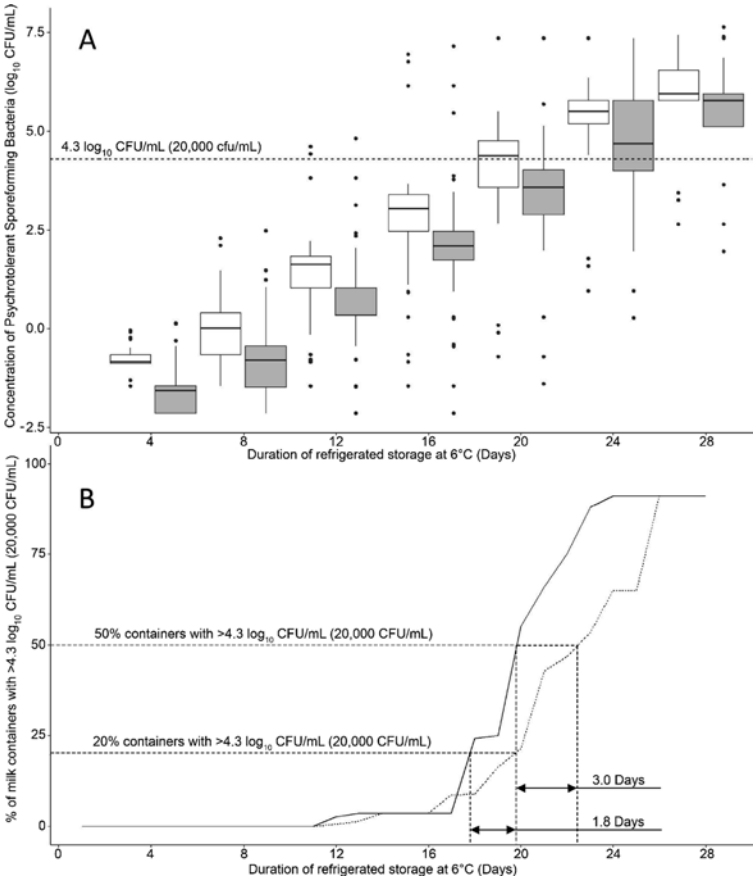
Aljosa Trmcic, Cornell University

OPPORTUNITIES FOR DYNAMIC PRICING APPLICATION

Using modelling to provide more accurate information on shelf-life at a batch or unit level offers opportunities for implementation of dynamic pricing of perishable dairy products. Dynamic pricing is based on the reduced price of product with shorter shelf-life and price-premiums of product with the longest shelf-life. The next step of our project is to focus on fluid milk and evaluate in the real retail environment if this type of dynamic pricing can be implemented to increase the sale of product with reduced shelf-life and reduce the amount of product being wasted while maintaining a revenue neutral balance for the retailer.



User-friendly interface of Fluid Milk Spoilage Model - © Aljosa Trmcic, Cornell University.



Growth of psychrotolerant sporeforming bacteria in pasteurized skim milk during refrigerated storage (6°C) predicted by Monte Carlo simulation model. (A) Gray boxes represent predicted values when bactofuge is used and white boxes represent predicted values when bactofuge is not used in the processing flow. Dashed line represents the Pasteurized Milk Ordinance limit of 20,000 cfu/mL, used as the limit at which fluid milk is considered spoiled. (B) Dotted line represents predicted values when bactofuge is used, and solid line represents predicted values when bactofuge is not used in the processing flow. Dashed lines represent the difference in storage days when 20 or 50% of milk containers reach the limit of 20,000 cfu/mL. - ©Griep-Moyer et al., 2022.

Dynamic pricing model applied to milk in a retail store. - © Aljosa Trmcic, Cornell University.

Dynamic pricing model applied to milk in a retail store. - © Aljosa Trmcic, Cornell University.

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CHINA

The processing of a new probiotic but ambient yoghurt: AMBPOMIAL AMX

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ALIGNMENT WITH SDGS

A SHELF STABLE. AMBIENT YOGURT FOR MARKETS WITH LOW REFRIGERATION POSSIBILITIES

Traditionally, yogurt requires refrigeration to maintain probiotic viability, posing challenges in distribution and storage. Low-temperature yogurt demands strict temperature control, leading to high energy consumption and increased waste due to spoilage. These requirements restrict distribution, especially in regions with limited refrigeration infrastructure. The need for constant refrigeration not only limits market reach but also contributes to significant energy use and environmental impact. Developing shelf-stable, ambient yogurt with active probiotics addresses these challenges by enhancing convenience, reducing waste, and expanding distribution possibilities, ultimately supporting the growing demand for probiotic-rich foods and improving global health outcomes.

SIGNIFICANT INNOVATION IN THE DAIRY SECTOR

This ambient yogurt with active probiotics aims to eliminate the need for refrigeration, making it more convenient to consume while maintaining the probiotics' activity and preserving the original nutritional characteristics.

Each unit contains 1 billion colony-forming units (CFU) of *Lactobacillus rhamnosus* (LGG) active probiotics. Using aseptic downstream inoculation technology and a carbohydrate-specific combination formula, ambient probiotic yogurt achieves a higher live probiotic rate. This innovative system precisely injects LGG probiotics into room-temperature yogurt in a sterile environment before the filling process. This method ensures that probiotics added after yogurt sterilization remain active, prevents the excessive reproduction of unwanted bacteria, and maintains product safety and quality.

OFFERING PRACTICAL, ECONOMIC AND HEALTH-RELATED BENEFITS

This innovation enhances consumer convenience, reduces reliance on cold chain logistics, and expands market reach, especially in regions with limited refrigeration infrastructure. Additionally, it supports the increasing demand for probiotic-rich foods, known for their health benefits. By making probiotic yogurt more accessible and convenient, this advancement can significantly improve global health outcomes while providing economic and environmental benefits to the dairy industry.

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Packaging of the product AMBPOMIAL AMX. - © Yili Group

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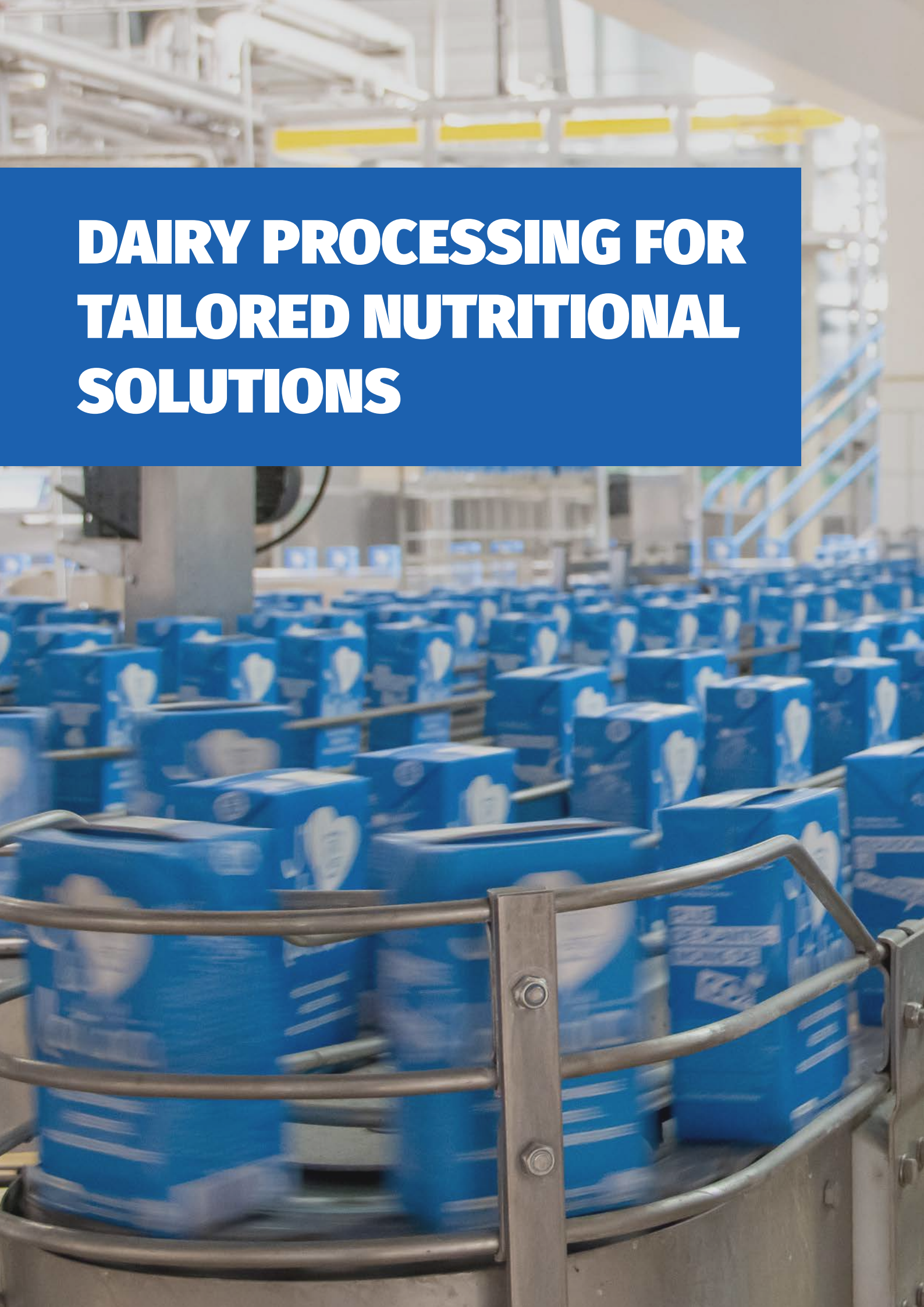
"Ambient yogurt with active probiotic"

Steve Tan

DAIRY PROCESSING FOR TAILORED NUTRITIONAL SOLUTIONS



AUSTRALIA

Improving the processing of high protein yoghurts with a novel application of hydrolysed milk protein

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ALIGNMENT WITH SDGS

ELDERLY AND DYSPHAGIC CONSUMERS HAVE ACCESS TO PRODUCTS WITH NOVEL TASTES AND FLAVOURS

The market for high-protein yoghurts has shown strong growth in recent years and is forecast to continue to grow in the future. Exciting new segments are emerging for novel textures and flavours, including those targeted specifically toward elderly and dysphagic consumers. This has led to an industrial need for new processing strategies to allow for greater manipulation of product firmness and viscosity, whilst maintaining nutritional value, flavour, sustainability and affordability. As the "naturalness" of these products is also important, such changes should ideally be achieved through process innovation, rather than the use of non-dairy additives.

FROM UNDERSTANDING THE BIOCHEMISTRY AND FUNCTIONAL EFFECTS OF HYDROLYSED MILK PROTEINS TO PRODUCT DEVELOPMENT

Firstly, we aimed to understand more about the biochemistry and functionality effects of hydrolysed milk proteins in experimental yoghurt systems. Secondly, we aimed to apply these findings in an industrial setting, to develop new, science-based strategies for the sustainable manufacture of high-protein yoghurts with novel textures and good flavour attributes.

A multidisciplinary project was developed in collaboration with local dairy companies and Dairy Australia. Initial lab-based studies focussed on physical and biochemical analyses in conjunction with model food systems. Two pre-fermentation fortification approaches were compared – the addition of hydrolysed milk proteins to yoghurt milk vs. *in situ* enzymic hydrolysis of yoghurt milk containing added whey protein. Critical parameters explored in a multifactorial approach included casein : whey protein ratios, different peptides and protease systems, and pasteurisation and cooling regimes. These results were used to guide a smaller number of food-grade factory trials to produce larger samples for physical, biochemical and sensory analysis.

"It's very satisfying to work with Australian industry on innovative research that aims to achieve positive sustainability and health outcomes."

Greg Martin

FROM EASILY POURABLE YOGURT TO THE SPOONABLE TYPES

From lab studies, a wealth of new information was established regarding dairy peptide biochemistry and functionality in model yoghurt systems containing up to 15% total protein. Sensory analysis of products from selected treatments replicated at pilot scale allowed us to identify optimum formulation and processing combinations for products, containing hydrolysed milk proteins, with acceptable flavour and texture. By manipulation of casein : whey ratio and pasteurisation temperature, as well as judicious choice of protease system or peptide source, we were able to generate stable viscosities ranging widely from easily pourable to the more familiar, firmer, spoonable types (see Figure 1).

IMPROVING WHEY PROTEIN USE FOR CHEESE PRODUCTION

Significant new knowledge about dairy peptide biochemistry and functionality was generated and will be published in international journals for the benefit of the wider dairy science and dairy manufacturing communities.

Some important new, science-based processing and formulation levers were developed to facilitate the manufacture of new types of high-protein yoghurt, including low-viscosity products for new markets.

Some of the best results were obtained by fortification with whey-based ingredients, potentially improving the utilisation of undervalued whey protein and enhancing sustainability aspects of the cheese industry.

Figure 1. Stable viscosities ranging from easily pourable to firmer, spoonable types in model yoghurt systems containing up to 15% total protein. - © Enrico Hadde, The University of Melbourne.

Elderly and dysphagic consumers, in particular may benefit from these novel, low-viscosity / high-protein yoghurts.

LOOKING AT IMPROVING YOGHURT PRODUCTION

Industrial trials are continuing to fully evaluate the commercial potential of these new yoghurt types, with particular interest in lower-viscosity products.

We are also looking at the potential of some of these new yoghurt manufacturing strategies to reduce the amount of protein discarded in acid whey, thereby providing an additional opportunity for improved sustainability.

This approach also has the potential to be applied in the manufacture of some other dairy products, such as soft cheeses.

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CHINA

Yili creates Satine Active Lactoferrin Organic Pure Milk to safeguard consumers' immunity

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ALIGNMENT WITH SDGS

THE BIG PICTURE

The active lactoferrin is extremely rare as it is retained at a very low level after UHT sterilization. Yili has overcome the technical bottleneck and adopted the innovative process of 'separation extraction - individual sterilization - aseptic mixing' to protect lactoferrin before UHT sterilization. This breakthrough achieves a high retention rate of 90% active lactoferrin in ambient temperature milk. In addition, Yili has successfully created the world's first Satine Active Lactoferrin Organic Pure Milk, containing 16 mg of active lactoferrin per box - 8 times more than the amount in ordinary ambient temperature milk. On October 18, 2024, Satine Active Lactoferrin Organic Pure Milk was awarded the IDF Dairy Innovation Award for New Product Development by the International Dairy Federation.

THE PROMISE

The creation of the world's first organic pure milk with active lactoferrin in ambient temperature addresses the nutritional shortfall faced by consumers who are unable to obtain relatively high levels of lactoferrin in ambient temperature pure milk. This breakthrough resolves a key consumer concern and enhances the nutritional and health value of the product through advanced technological innovation.

MOVING THE WHEEL

Yili achieved its goals through three innovative approaches: On the product front, Yili developed organic pure milk enriched with active lactoferrin for ambient temperature storage. On the process front, Yili established a cutting-edge technological solution for lactoferrin, involving 'separation extraction - individual sterilization - aseptic mixing', ensuring a high retention rate of active lactoferrin in ambient temperature pure milk. On the equipment front, Yili independently designed an automated production demonstration line for ambient temperature lactoferrin pure milk, achieving a globally leading breakthrough. Finally, the innovation was transformed into products, which were successfully introduced to the market and welcomed by consumers.

> Health is not only about a survival condition, but also one of the basic needs of human beings. But this basic need is sometimes a scarce resource for people in different parts of the world. Therefore, we together, oriented by quality and powered by innovation, undertaking responsibilities jointly and sharing achievements with the world, can realize the dream of "World Integrally Sharing Health"."
>
> **Mr. Pan Gang, Chairman and President of Yili Group**

Based on the development of undenatured lactoferrin detection technology in milk and dairy products by the research team of the Chinese Academy of Agricultural Sciences, methods for the separation, concentration, and purification of undenatured lactoferrin were formulated, and a group standard titled 'Determination

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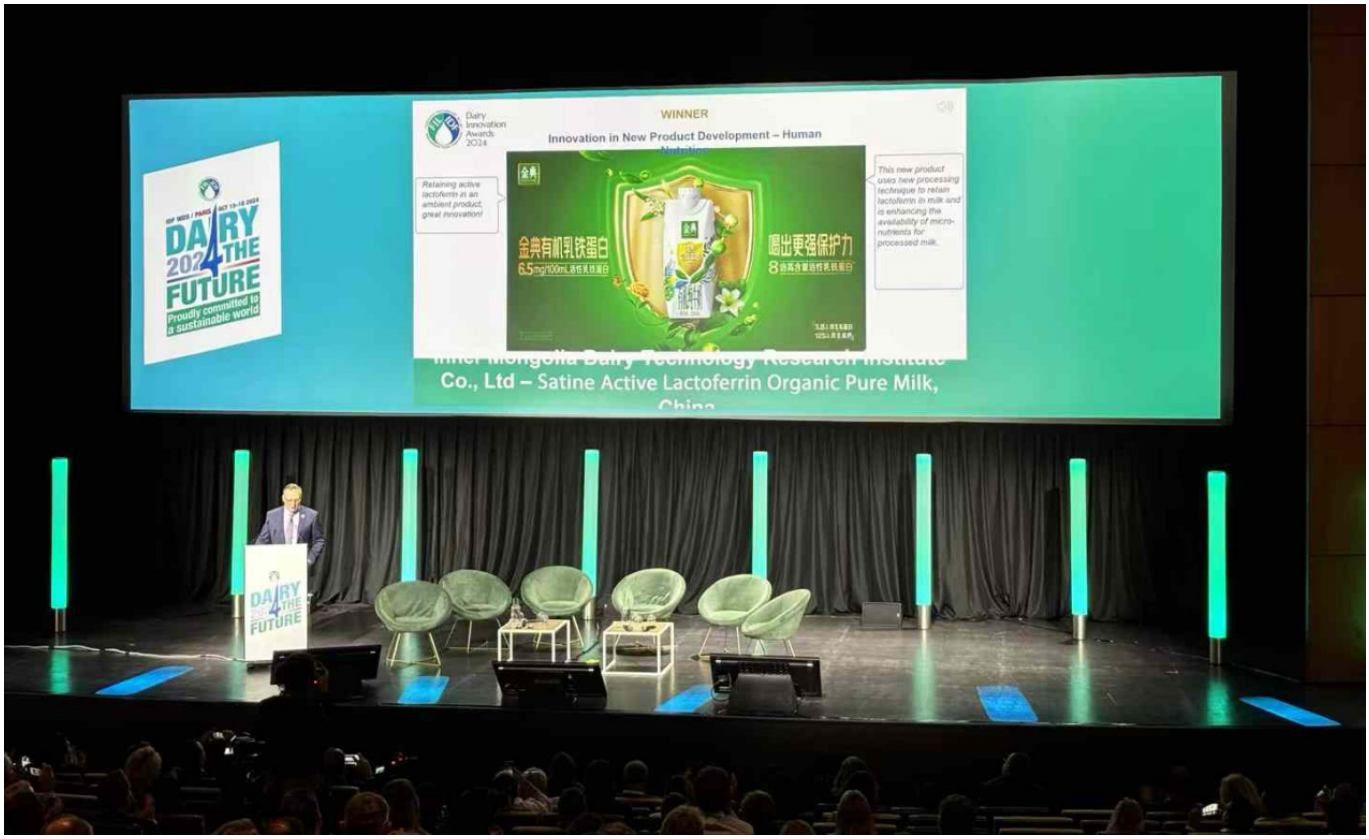

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of lactoferrin in milk and dairy products - Liquid chromatography method' (T/TDSTIA 006-2019) was established. Through the isolation and purification of undenatured lactoferrin, followed by high-performance liquid chromatography detection, the determination of undenatured lactoferrin content was achieved. Based on this detection method, this project conducts lactoferrin monitoring throughout the research and production process, ensuring that the products labelled with undenatured active lactoferrin during production and on the shelves. Therefore, this project pioneered the production of pure milk products with a high preservation rate of active lactoferrin nutrition in the sterilized milk category.

THE HISTORY OF SUCCESS

This project integrates a series of highly efficient lactoferrin chromatography separation processes, multi-stage microfiltration cold sterilization methods, and aseptic mixing processes, innovations that have not been reported in any other research, either domestically or internationally. Satine Active Lactoferrin Organic Pure Milk stands out as the first product in the sterilized milk category to employ an internationally pioneering process technology, achieving retention of over 90% of the active lactoferrin present in raw milk. Furthermore, each pack of Satine Active Lactoferrin Organic Pure Milk contains at least 16mg of lactoferrin—8 times the active lactoferrin found in ordinary milk

THE VALUE OF THE INITIATIVE

This initiative addresses a critical consumer need for convenient access to high levels of lactoferrin, a nutrient essential for immunity and overall health. This innovation particularly benefits consumers, providing convenient access to enhanced nutrition and immunity support and meeting the rising demand for functional, health-focused foods.

This breakthrough enriches public health while elevating the global dairy industry, showcasing Yili's commitment to nutrition and technological excellence.

NEW OPPORTUNITIES

Yili will continue to prioritize consumer needs, integrate global quality resources, and enhance innovation and R&D efforts to meet the nutritional and health requirements across all scenarios, populations, and life stages. As a Yili brand, Satine will remain committed to understanding consumers' aspirations for a higher quality of healthy living, driving continuous technological advancements. As a pioneer and leader in China's organic dairy industry, Satine aims to shape the future of innovation and quality in organic products.

GERMANY

Revolutionizing gut health through sustainable dairy innovation

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ALIGNMENT WITH SDGS

THE BIG PICTURE

The dairy industry faces increasing pressure to innovate sustainably while addressing global health challenges. One significant issue is digestive health, with constipation affecting one in six people worldwide, particularly the elderly. This prebiotic whey-based drink pioneers a solution by harnessing an innovative production process to create a sustainable, health-promoting product. By repurposing whey—a dairy by-product—into a functional beverage, it not only supports gut health but also contributes to a circular economy. This initiative represents a practical, scalable model for aligning health-focused nutrition with sustainable dairy practices, setting a benchmark for industry innovation.

THE PROMISE

This initiative aims to improve digestive health by offering a low-dose, effective prebiotic beverage that prevents constipation and enhances gut microbiota. Simultaneously, it promotes sustainability within the dairy industry by valorizing whey, a by-product, into a functional and eco-friendly product.

MOVING THE WHEEL

The development process at the University of Hohenheim focused on refining the transformation of whey into a prebiotic drink. Various whey compositions, enzymes, and membrane types for the filtration were tested to achieve the ideal nutritional profile and product efficacy. A double-blind, randomized study demonstrated the product's efficacy in improving stool consistency and promoting beneficial gut bacteria. The entire process is protected under European and New Zealand patents, ensuring innovation exclusivity and scalability across global markets. Through this iterative approach, the process was optimized to deliver a high-quality, functional beverage, aligning innovation with environmental responsibility.

> "The enzymatic transformation of lactose to lactulose demonstrates how whey, a dairy by-product, can be transformed into a valuable prebiotic food product, highlighting the synergy between sustainability and health-focused innovation."
>
> **Prof. Dr.-Ing. Jörg Hinrichs – University of Hohenheim**

THE HISTORY OF SUCCESS

A pilot study with 30 participants over 14 days confirmed the product's positive effects on intestinal flora and bowel movements. It significantly improved stool consistency and increased levels of beneficial bacteria, such as Bifidobacteria and Lactobacilli, by 10%. These outcomes were measured using the Bristol Stool Scale. Beyond health benefits, this innovation demonstrates the successful transformation of dairy by-products, reinforcing the economic and environmental value of circular production methods within the dairy industry.

THE VALUE OF THE INITIATIVE

This project addresses critical needs in consumer health and dairy sustainability. Its primary beneficiaries are individuals suffering from constipation, healthcare systems aiming to reduce associated costs, and the dairy industry seeking sustainable practices. By converting whey or whey permeate into a high-value product, it offers an economic incentive for dairy processors while reducing environmental waste. Consumers benefit from a convenient, scientifically-backed solution for gut health, and the industry moves closer to a circular production model. This initiative exemplifies how health-focused innovation can align with environmental responsibility.

NEW OPPORTUNITIES

The next steps include scaling production, conducting a large-scale clinical trial with EIT-Food co-funding, and expanding distribution networks. Future opportunities involve exploring diverse markets, particularly in aging populations and health-conscious consumers. Research into additional functional applications of lactulose and other whey-derived compounds could further enhance the product range. Moreover, collaborations with dairy producers globally would definitely facilitate widespread adoption of its sustainable production process, setting new standards for circularity and functionality in the dairy sector.

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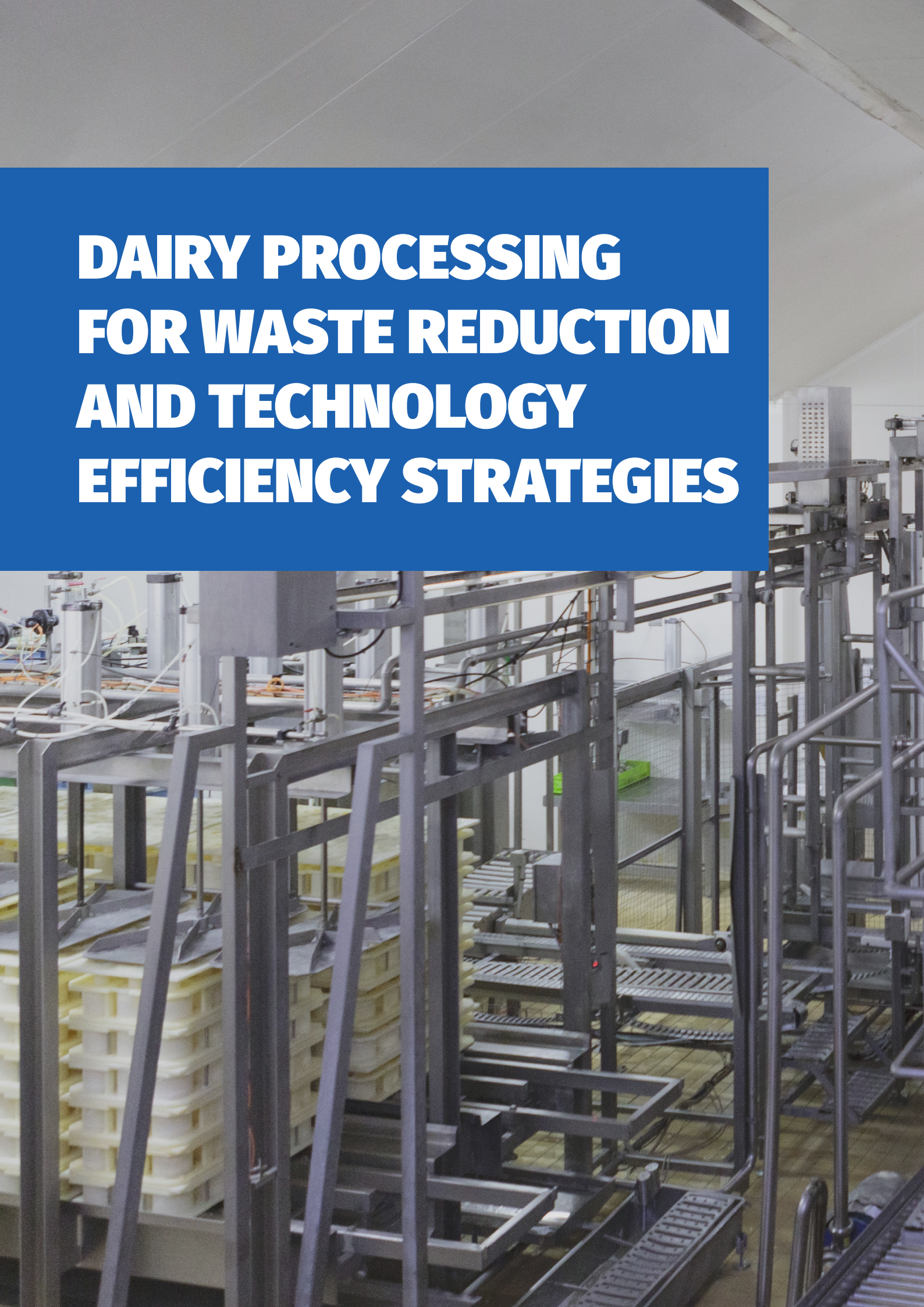
DAIRY PROCESSING FOR WASTE REDUCTION AND TECHNOLOGY EFFICIENCY STRATEGIES



CANADA

State-of-the-art wastewater treatment plant at the largest cheese processing facility in Canada

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ALIGNMENT WITH SDGS

MODERNIZATION OF THE WASTEWATER AT A CHEESE PRODUCTION FACILITY

Prior to the commissioning of the modernized Wastewater Treatment Plant, Lactalis Canada, stored organic materials from the plant's effluent in open-air lagoons located north of Winchester. Once at capacity, the organic material was emptied from the lagoons and pumped by pipeline to farming fields 2 km from the plant for application as fertilizer. While this process helped maintain soil productivity, reduce erosion and add valuable nutrients to the fields for crops, it contributed to wastewater pollution, electricity consumption and disruptive odours and noise in the community.

Following consultation with the community and local stakeholders, a plan to mitigate the odours associated with this practice was put into action, including a major four-year project to implement a new Wastewater Treatment Plant at the facility. The $18 million project, completed in 2020, features state-of-the-art infrastructure.

PROJECT HIGHLIGHTS

- Implementation of a separator system that concentrates and dries organic material present in the facility's wastewater effluent through a process entirely contained in a closed, climate-controlled building to mitigate odours in the surrounding community;
- Installation of a clarifier system to further clean water discharged; and,
- Addition of a new concrete bioreactor tank system that features greater capacity to manage temperature and oxygen for treating wastewater.

> "Lactalis Canada's core purpose is to Enrich and Nurture the Lives of Canadians. Integral to this purpose is building and fostering a sustainable future through responsible business practices that have a positive impact on the wellbeing of our communities and planet through all that we do."
>
> **Gilles Froment**

MAKING POSITIVE IMPACTS

Environmental - The implementation of this new facility has resulted in:

- Reduced odours and noise in the community
- Reduction in electricity consumption by 35%
- Enhanced wastewater treatment process, improving the water quality of wastewater

Economic - A key pillar of our sustainability program is to empower our communities to thrive economically. With 300+ employees in Winchester, Lactalis Canada drives the local economy by supporting farmers and the agricultural community; creating jobs with competitive wages and benefits that provide economic stability for many residents.

Community Relations - This project facilitated direct engagement between Lactalis Canada and Winchester community members.

CREATING A MODEL TO FOLLOW

Major investments such as this wastewater treatment plant will drive positive impacts in the Winchester community and surrounding region by laying the framework for a sustainable future and continued prosperity. This project offers a model for how Lactalis plans to improve wastewater quality in plants and communities, both in Canada and globally.

In 2021, Lactalis Canada won the inaugural Canadian Grocer Impact Award in the Sustainability category for the Wastewater Modernization Project. These Awards recognize initiatives introduced by retailers, suppliers and solution providers that are making a meaningful difference in a range of areas from helping the planet to supporting employees and communities.

Illustration of the wastewater modernization project in Winchester, Ontario - © Lactalis, Canada.

INDIA

Plastic Neutral Dairy - A Mother Dairy India's initiative on plastic waste management

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ALIGNMENT WITH SDGS

LEADING THE CHANGE TO PLASTIC NEUTRAL PROCESSING

The plastic industry in India has grown at a CAGR of around 10-12% in volume and is expected to grow exponentially. However, this growth has fueled the accumulation of plastic waste. Every minute, more than one million plastic bags are thrown away after an average use of just 15 minutes, posing a significant threat to the environment.

In response to this crisis, a global movement has emerged, involving policymakers, large industries, and consumers. It has become imperative for businesses to join these efforts to mitigate the myriad risks associated with plastic.

ACHIEVEMENT OF NET ZERO PLASTIC WASTE MANAGEMENT

Mother Dairy is committed to meeting Extended Producer Responsibility (EPR) compliance to ensure effective management of plastic waste. Mother Dairy holds the distinction of being the first dairy industry to obtain Central Pollution Control Board (CPCB) Registration in November 2018, in accordance with PWM Rules for the implementation of EPR.

The aim of this initiative is to take a step forward towards our country's long-term goal of achieving 'Net-Zero' plastic waste management through Extended Producer Responsibility, including 'Reduce, Reuse & Recycle'.

HIGHLIGHTED ACTIONS

- Mother Dairy's Token Milk has been reducing plastic usage since 1974, saving approximately 4.2g per liter of milk (see Figure 1).
- Initiating a research program, the company aims to replace plastic trays for curd cups with eco-friendly packaging paper trays (see Figure 2, 3 and 4).
- Transitioning towards sustainability, all plastic spoons for ice cream and dairy products have been replaced with wooden spoons, and plastic straws with paper ones since 2018 (see Figure 5 and 6).
- Engaging in consumer awareness campaigns, Mother Dairy spreads the message on plastic pollution, partnering with leading NGOs and CPCB (see Figure 7).

THE TONS OF WASTE SAVED ARE THE TRIUMPH

Mother Dairy sets an industry benchmark by demonstrating a 'Zero Plastic Model' for delivering commodities like fresh milk safely.

- Bulk Vended Milk Model: Saving 4.2g of plastic per liter, Mother Dairy's initiative results in approximately 700 metric tons of plastic reduction annually.
- Eco-Friendly Tray for Dahi (Curd) Cups: Implementing this eco-friendly tray eliminates 100 metric tons of plastic from the system each year, contributing to a greener environment.
- Replacement of Plastic Spoons & Straws: Since 2018, all plastic spoons have been replaced with wooden ones. In 2023-24 alone, 106.72 million wooden spoons and 12.53 million paper straws were utilized.

> "Mother Dairy's remains committed to achieving and maintaining its plastic neutral status in its overall quest towards sustainable dairy practices"
>
> **Meenesh Shah**

BENEFITING ENVIRONMENT AND CONSUMERS

Mother Dairy has spearheaded a Multi-Layered Plastic (MLP) and Single-layered Plastic (SLP) waste collection and recycling program. The company's EPR journey began in one state of India in 2018 and has now been scaled up Pan-India with 100% EPR implementation.

The company has sustained its 'Plastic Neutrality Status' by collecting and sustainably managing more than 36,000 tonnes of plastic waste till 2023-24. This has resulted in a reduction of 22,000 MT of carbon emissions, equivalent to the planting of a thousand mature trees.

Additionally, Mother Dairy incentivizes consumers with a lower price point for purchasing Bulk Vended Milk (Plastic-free Milk) compared to packaged milk.

Figure 7. The Plastic Ravan (Depiction of a Demon)'

CONTINUOUS EFFORTS TO ACHIEVE FREE PLASTIC WASTE

Sustainability is at the heart of Mother Dairy's ethos, driving the company's commitment to reducing its environmental impact through responsible management and conservation practices. Mother Dairy is dedicated to effectively managing plastic waste and striving towards a plastic-waste free F&B sector.

Ongoing initiatives include the sale of Bulk Vended Milk (Plastic-free), the use of 100% recyclable plastic packaging, and extended producer responsibility/ recycling of post-consumer multi-layer and single-layer plastic.

Mother Dairy will continue to explore innovative ways to incentivize consumers to choose Bulk Vended Milk, investigate alternate eco-friendly packaging options, and promote EPR/recycling efforts.

Figure 1. Bulk Vended Milk (BVM) – Plastic Free Milk Model

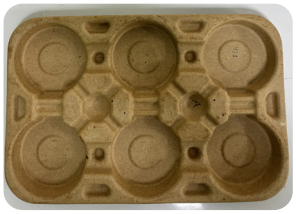

Figure 2. Paper Tray

Figure 3. Plastic Tray

Figure 4. Placement of Dahi (Curd) Cups in Paper Tray

Figure 5. Replacement of Plastic Spoons with Wooden Spoons

Figure 6. Replacement of Plastic Straws with Paper Straws

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ITALY

Dairy packaging processing: thinking about green strategies for recycling

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ALIGNMENT WITH SDGS

USE OF BIODEGRADABLE MATERIALS OR BY-PRODUCTS FOR PACKAGING

Between 4 and 11 million tons of dairy waste is annually disposed, posing environmental risks due to its high organic content. Dairy products with a short shelf life (1-2 weeks) largely contribute to this waste. The European Union emphasizes sustainability across the food chain, while the Food and Agriculture Organization aims for "zero waste." These ethical drives motivate research toward eco-friendly destinations for dairy waste. Biodegradable materials derived from natural biopolymers, sourced from waste or by-products, are prioritized, aligning with a circular economy model. This approach seeks to mitigate environmental harm of plastic while promoting sustainable packaging practices.

WE HAVE CREATED PACKAGING FILMS FROM WASTE PROTEIN FRACTIONS

The research seeks to upcycle dairy waste into food packaging films. It investigates green approaches to modify the properties of protein fractions recovered from waste in order to develop films with appropriate performances. The suitability of the resulting films for packaging applications is assessed as thermal, mechanical, and barrier properties.

INNOVATIVE TECHNOLOGIES FOR ENHANCING FILM PERFORMANCE

The research focuses on the casein fraction recovered from expired pasteurized milk having different fat content. Different green modifications to caseins were studied in order to improve performances of the derived films. Thermal treatments, non-thermal technologies (ultrasonic treatment, pulsed electric fields), chemical or enzymatic cross-linking, oxidizing agents, were tested in order to obtain useful changes of structure and behaviour of casein. Film-forming solutions were developed using the modified casein preparations. Different film production techniques such as solution casting, spreading or extrusion were experimented. A comprehensive evaluation of the films will be carried out.

"The study is carried out within a PhD activity (Food System- Integrated green strategies for the management, recovery, and recycling of waste in a dairy factory), managed by University of Milan (Department of Food, Environmental and Nutritional Sciences) with the support of Lactalis Italy."

Figure 1 shows a schematic process of film production from dairy waste.

THE HISTORY OF SUCCESS

Using laboratory-prepared sodium caseinate solutions resulted in films (see Figure 2) with mechanical properties that were influenced by the content of residual fat present within the film, following the protein recovery treatment. Mechanical properties were determined by a texture analyser with special clamps. An increase in plasticity at the expense of tensile strength was observed as the fat content increased. Medium to high oxygen barrier properties were found in casein films, while the greatest weakness of this biopolymer is the susceptibility to water vapour. A permeabilimeter was used to analyse the barrier properties of the films.

Furthermore, this work has been presented in several conferences (7th National Dairy Conference AITeL- Cremona 2023, Italy, 9th International Conference on Food Chemistry and Technology, Paris 2023, France) and won the award for originality and scientific validity of the research at the 7th National Dairy Conference AITeL and the international award for the best oral presentation at the Food Chemistry and Technology congress, Valencia 2024.

CONVERTING DAIRY WASTE INTO VALUABLE MATERIALS

This project aims to exploit the concept of circular economy by proposing to reuse and valorise waste generated by the dairy industry that would otherwise be downcycled or disposed of, thus causing considerable environmental impact. This waste can be converted into new raw materials. Furthermore, the current work responds to the urgent need to identify alternative methods for the production of materials that have a reduced environmental impact, in terms of both production and disposal; but, at the same

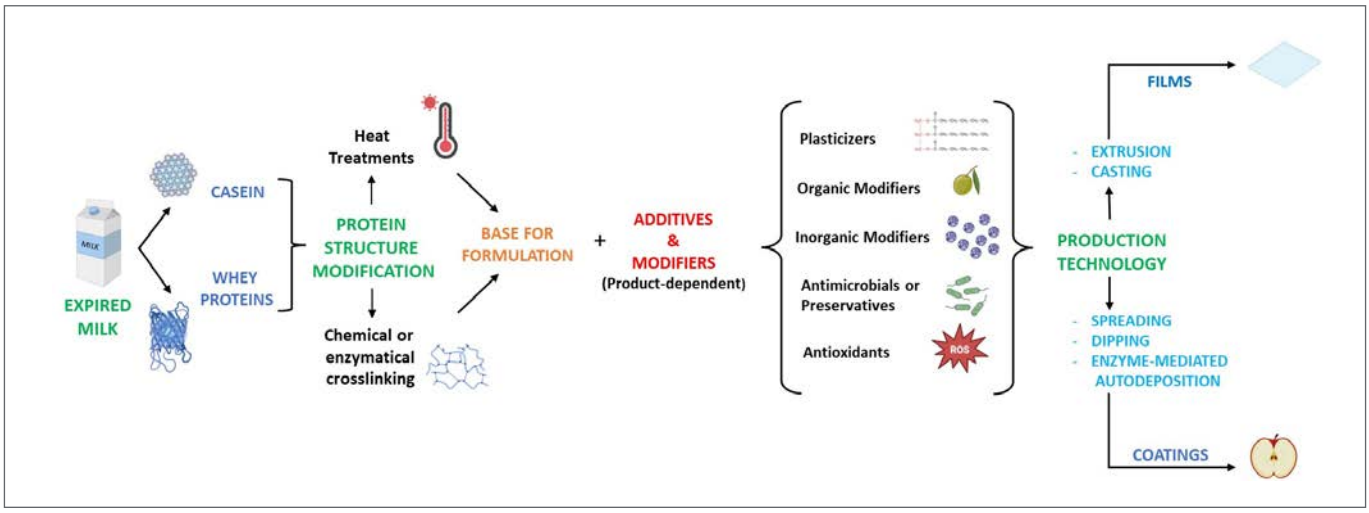

Figure 1 Schematic representation of the production of films from dairy waste. Extracted from Gerna, et al. 2023

time, they shall guarantee performances at least comparable to those of the materials currently in use for packaging.

TAILORING BIOMATERIALS PROPERTIES FOR SPECIFIC FUNCTIONS

Although the developed biomaterial has good properties, there is still room for improvement. Regarding the starting caseinate, different approaches can be used to promote cross-linking between casein molecules, such as the exposure to UV light in presence of photosensitising molecules, or the use of conditions promoting isopeptide bonds between side groups of amino acids. With regard to film, selected molecules of lipidic nature (e.g. linseed oil, beeswax, oleic acid) can help to reduce the susceptibility of the biopolymer to water vapour, while preserving the mechanical properties. Finally, the choice of an appropriate destination for the film will be crucial to direct future research towards obtaining a film optimised for that specific function.

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Figure 2 Illustration of a flow pack obtained from casein fraction recovered from expired milk

AUSTRALIA

Minimising waste in dairy processing

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ALIGNMENT WITH SDGS

WHAT COULD WE DO WITH WHEY WASTE STREAMS?

The dairy industry has become extremely proficient in recovering value from sweet whey. However, the fate of other whey streams remains a problem. Acid whey contains valuable lactose and protein but spray drying is not possible unless the concentrations of calcium and lactic acid can be reduced. Salty whey and other salt-rich effluent streams create problems for effluent treatment. High concentrations of sodium chloride are a particular issue for processing facilities a long way from the coast, as there is nowhere for this salt to go. The use of evaporation ponds is becoming increasingly difficult, due to increasing regulation and sustainability requirements.

INNOVATIVE RECOVERY AND CONVERSION OF COMPONENTS FROM ACID WHEY

We aimed to recover the protein and lactose from acid whey using nanofiltration, a conventional pressure-driven process. An electromembrane process (i.e., electrodialysis) was also employed to target the removal of charged species (e.g., lactate and salt ions). We then aimed to convert the salt in salty whey into useful chemicals using an advanced electromembrane process involving bipolar membranes. (Figure 1)

Supported by funding from Dairy Innovation Australia Limited, we found that nanofiltration (NF) was a cost-effective method to remove around 30% of the lactic acid and 40-60% of the salt from acid whey. Further reductions required electrodialysis (ED). We tested a combined UF-NF-ED approach at pilot scale. The use of NF as an intermediate step reduced the size of the final ED unit,

> "Membrane separation systems can value-add to dairy by-products. "
>
> **Dr George Chen**

thus resulting in lower capital and energy costs. The resulting concentrate was readily spray dried to provide a non-sticky powder with an ash and moisture content of less than 4%.

We used a technique known as electrodialysis with bipolar membranes (EDBM) to convert salt into sodium hydroxide and hydrochloric acid, both are chemicals that can be utilised by dairy processors (see Figure 2).

EFFICIENT RECOVERY AND CHEMICAL PRODUCTION

We successfully demonstrated the use of NF and ED at pilot scale to allow for the recovery of both the protein and the lactose in acid whey as spray dried products. However, the ED approach remains capital intensive and this cost needs to be offset by a significant sales price for these products.

EDBM successfully removed at least 70% of the sodium in a salty whey stream, producing high quality hydrochloric acid and sodium hydroxide. Detailed business case studies were conducted to evaluate the potential of the technology. A key consideration was the need to balance demand for both acid and base. Consumption of one without the other, would lead to significant waste disposal issues.

EXPLORING ENERGY-SAVING METHODS IN FACTORY OPERATIONS

We continue to seek new methods to further reduce energy and water demand within the factory. This includes

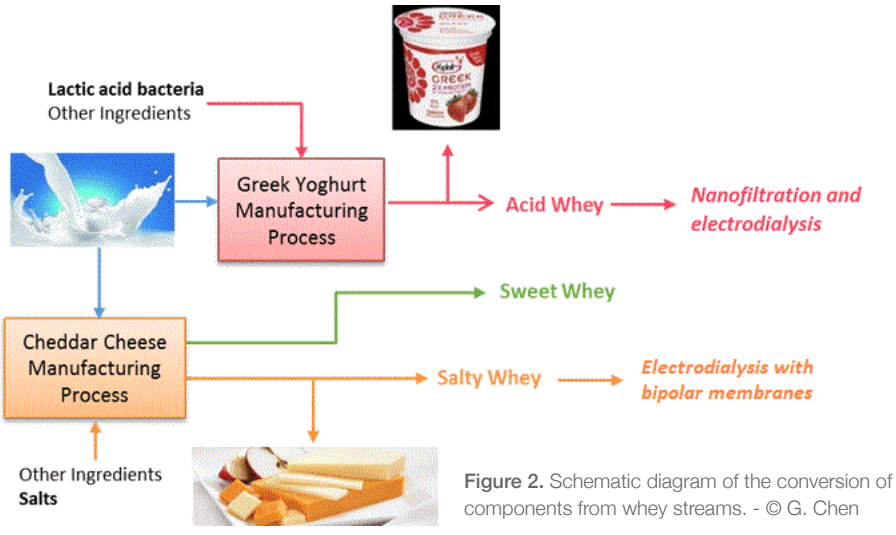

Figure 2. Schematic diagram of the conversion of components from whey streams. - © G. Chen

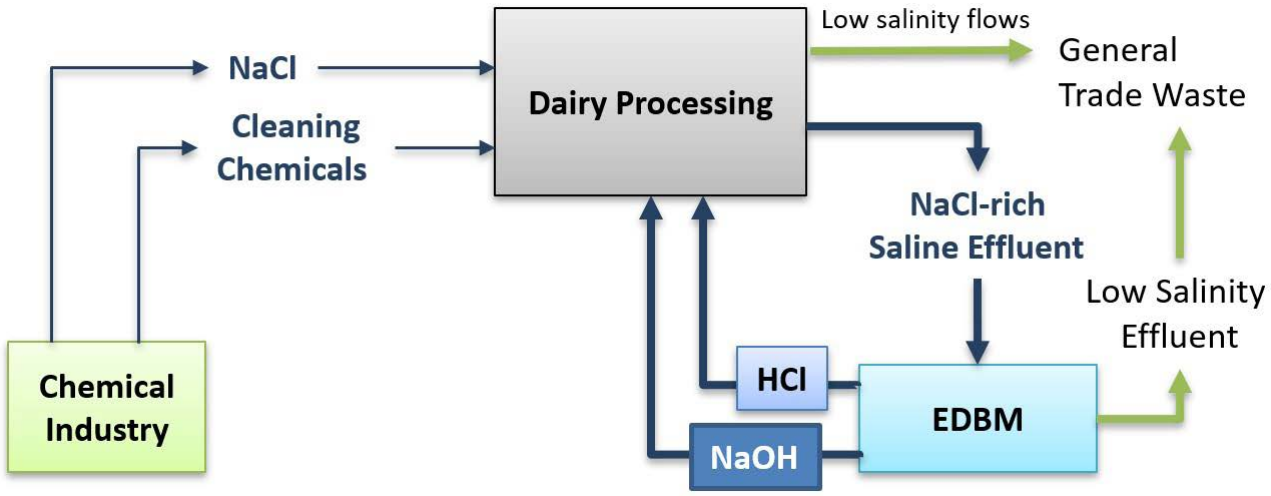

Figure 1. Schematic diagram of the process of electrodialysis with bipolar membranes. - © G. Chen

consideration of pressure exchangers and turbochargers, commonly used in desalination facilities, to recover pressure energy from nanofiltration and reverse osmosis processes. We have considered forward osmosis as a further mechanism to reduce the energy costs associated with product concentration and evaporation. We are also considering membranes emerging on the market that are made from optimised materials that can result in greater flux for a given transmembrane pressure.

Finally, we believe that further optimisation of whey processes could provide opportunities for valorisation of the potassium, calcium and phosphate present, for use in other industries.

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INDIA

Use of solar as thermal and electrical energy source for dairy processing

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ALIGNMENT WITH SDGS

"Mother Dairy's initiative in adoption of solar energy use for dairy processing will help catalyse propagation of alternate energy across dairy sector in India"

Meenesh Shah

THE BIG PICTURE

Considerable attention is given to enhancing efficiency to minimize energy costs in dairy processing. Mother Dairy, India, goes further by embracing renewable energy sources for processing, aiming not just for cost reduction but also positive climate action. Their adoption of Concentrated Solar Thermal for hot water generation and Solar Photovoltaic (PV) Model for electricity production saves 1 million units (KWH) annually. Dairy processing stands as the most energy-intensive stage in the dairy value chain. Therefore, replicating and scaling up Mother Dairy's renewable energy initiative across the Indian dairy sector is paramount for sustainability.

THE PROMISE

The aim of the initiative was to reduce recurring energy costs and carbon footprint of dairy processing by adopting suitable renewable energy applications within the constraints of space, capacity, and capital costs, among others. Additionally, it aimed to create a reference model ready for adoption by the Indian Dairy Industry.

MAIN APPROACHES

- Concentrated Solar Thermal Technology (CST) for Hot Water Generation: CST systems were installed in the dairy plant, concentrating sunlight on a small area to generate significant heat. This heat is utilized for heating water used in washing, CIP (Cleaning-in-Place), and other processes in the dairy plant. See Figure 1 and 2.
- Solar PV for electricity generation: Solar PV systems (see Figure 3) are installed to generate power, which is transferred to the LT Panel to reduce the overall electric power consumption of the plant. The total PV installation capacity is 1 MW across five locations, with an additional 500 kW in the process of being set up at another location.

SOLAR POWER GENERATION IN NUMBERS

Usage of solar power generation system with total power generation of 10, 25, 629 KWh units in FY 2023-24 in five milk manufacturing units.

DAIRY'S RENEWABLE ENERGY SUCCESS STORY

The initiative has become a reference for other dairies looking to adopt renewable energy in dairy processing. While Mother Dairy took the lead, it also addressed challenges encountered during the process, resulting in a robust solution and standardized model ready for replication across various parts of India.

Since installation, the dairy has benefited from reduced energy costs by about Rs.140 million and has also decreased its carbon footprint by 10 million tonnes CO2e. Monetizing these savings will ultimately benefit farmers with better prices and returns. The reduced carbon footprint is the dairy sector's contribution to climate action.

SOLAR EXPANSION: DAIRY'S COMMITMENT IN INDIA

Mother Dairy is committed to expanding solar installations at its dairy plants wherever space permits. Solar energy will be a key component in all upcoming plants. Mother Dairy will also explore possible incentives through carbon emission reduction in future plants.

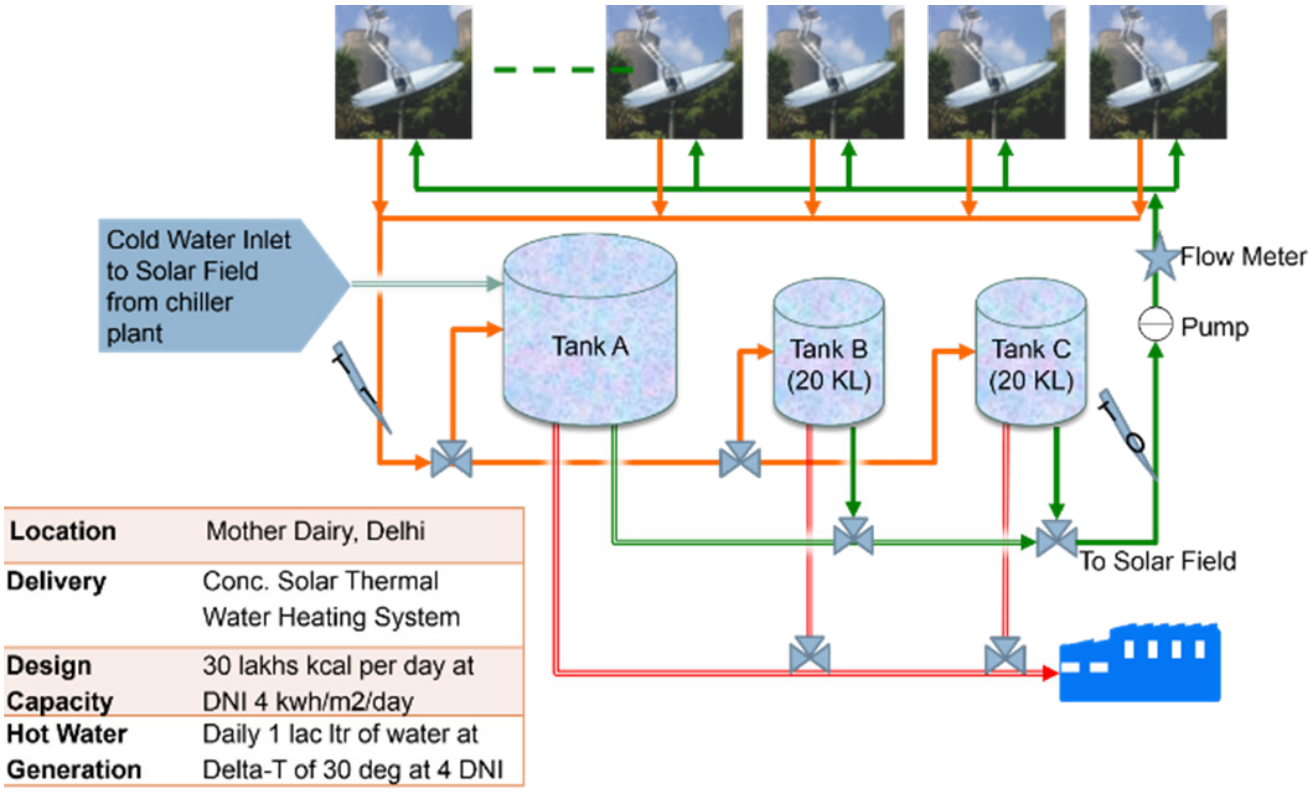
Drawing from the success of this initiative, NDDB, the parent organization of Mother Dairy, is promoting the use of alternative energy sources for dairy processing across the cooperative dairy sector. This initiative serves as a reference for policymakers to incentivize the dairy sector for adopting solar energy.

Solar Power Generation at Mother Dairy Fruit & Vegetable Pvt. Ltd.

S.No.	Mother Dairy Manufacturing Unit	Solar Power Generation in KWh
1	Patparganj Unit, Delhi (CST + PV Model)	3,35,187
2	Pilkhuwa Unit, Uttar Pradesh	58,525
3	Etawah Unit, Uttar Pradesh	89,967
4	Balaji Unit, Andhra Pradesh	5,21, 374
5	Bhiwandi (Maharashtra)	20,576
	TOTAL	**10, 25, 629**

Figure 1. Concentrated Solar Treatment Plant

Figure 3. Solar Grid, Mother Dairy, Patparganj Unit, Delhi (India).



Location	Mother Dairy, Delhi
Delivery	Conc. Solar Thermal Water Heating System
Design Capacity	30 lakhs kcal per day at DNI 4 kwh/m2/day
Hot Water Generation	Daily 1 lac ltr of water at Delta-T of 30 deg at 4 DNI

Figure 2. Schematic Diagram of Hot Water Generation System.

DAIRY PROCESSING FOR ECONOMIC AND SOCIAL SUSTAINABILITY

INDONESIA

Localization of production in Indonesia to create more than 5,000 direct and indirect job opportunities

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ALIGNMENT WITH SDGS

"Explore globally and operate locally"

Steve Tan

THE BIG PICTURE

Localization in the dairy sector, encompassing production, raw material sourcing, talent acquisition, and management, holds paramount significance for fostering sustainable growth and fostering community engagement. By integrating local market experiences and expertise, dairy companies can align their operations with regional needs, preferences, and regulations. This approach not only enhances operational efficiency but also fosters economic development by creating job opportunities and stimulating local businesses. Moreover, localized operations promote cultural exchange and social integration, establishing stronger ties between dairy companies and the communities they serve, thereby contributing to long-term success and mutual prosperity.

THE PROMISE

In its international endeavors, Yili integrates the expertise of its local teams with daily operations to advance production, raw material sourcing, talent acquisition, and management localization. The aim is to promote the localization of production, raw material procurement, talent, and management, bringing economic benefits to the local area and achieving win-win results.

MOVING THE WHEEL

Over 97% of Yili's Indonesian dairy production base employees are locals. Upon completion of the initial and subsequent phases, over 5,000 direct and indirect jobs will benefit the local populace. Moreover, Yili has partnered with 100+ high-quality suppliers in Indonesia, augmenting local procurement and fostering economic growth, thereby achieving mutual prosperity.

THE VALUE OF THE INITIATIVE

The value of localization in the dairy sector extends beyond operational efficiency to encompass economic, social, and cultural benefits. By sourcing materials locally, hiring local talent, and adapting management practices to local contexts, dairy companies foster sustainable development and community empowerment. The main beneficiaries of localization efforts are the local communities themselves, who gain access to employment opportunities, economic growth, and improved livelihoods. Additionally, localization enhances collaboration with local suppliers, promotes cultural exchange, and strengthens social ties, contributing to a more inclusive and resilient dairy industry that benefits both producers and consumers alike.

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Colleagues from Yili's Indonesian dairy production base

JAPAN

Meiji Co., Ltd. moves to maximize sustainability in Eastern Hokkaido operations through rationalization of existing facilities and construction of new state of the art facilities

AUTHOR
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Meiji Co., Ltd. • Japan

ALIGNMENT WITH SDGS

A ten-year project, new plant construction and consolidation of production in the Eastern Hokkaido region will result in a projected 33% reduction in CO2 emissions by 2028. This process will involve the consolidation of six facilities to three more efficient facilities. As part of this process, the construction of one new factory and the retirement of two older factories will result in an estimated 60% reduction in CO2 emissions and reduce water usage by 50%.

THE BIG PICTURE

Sustainable dairy production is essential for minimizing Meiji's environmental impact. By adopting innovative technologies, Meiji can enhance operational efficiency, reduce waste, and lower greenhouse gas emissions. New technologies will allow Meiji to optimize resource use, reduce waste, and lower environmental impacts, ensuring our operations are both economically viable and environmentally responsible.

In a major overhaul to production in Eastern Hokkaido, Meiji will consolidate and improve the efficiency of operations which had previously been carried out at six different locations. The result will be three locations including a new state of the art facility built with a focus on reduced CO2 emissions.

The aim of this initiative is to increase efficiency in our operations while transitioning to more sustainable production.

HIGHLIGHTED ACTIONS

Actions included in the initiative include the following:

1) consolidating production from six to three facilities,

2) construction of one state of the art facility to replace two ageing facilities,

3) introduction of biomass processing equipment and the utilization of previously discarded whey permeate,

4) conversion to use of LNG gas,

5) employment of solar and green energy to reduce Scope 2 CO2 emissions, and

6) employment of membrane permeate water to reduce overall water usage by half at the new state of the art facility (as compared with the two facilities being retired).

ONGOING PROJECT

This multi-stage process started in 2017 and is projected to be fully implemented by 2027. To date, operations which were previously conducted at six facilities have been consolidated to four facilities, and utilization of biomass has been introduced to utilize previously discarded whey permeate. In addition,

STATE OF THE ART FACILITIES ENHACING SUSTAINABILITY

By 2027, a new production facility will replace two current ageing facilities. The new operations will improve efficiency by employing LNG gas and solar power at different points in the process and supply chain. Improvements related to reduced transportation and efficient production at the new state-of-the-art facility are projected to reduce CO2 emissions by 33%. In addition, construction of one new facility and the retirement of two older facilities will result in a 60% reduction in CO2 emissions and a reduction by half in the use of water in the affected production. Finally, biomass is being considered for use in a related factory in the same area.

> "Meiji is committed to sustainable dairy production and will continue to improve operations by implementing the latest technologies."
>
> **Richard Walton**

SETTING A HIGH STANDARD FOR DAIRY PRODUCTION

The resulting operations will set a high standard for dairy production for our company. In the future, Meiji will continue to make improvements and implement the latest technologies in pursuit of efficient and sustainable production.

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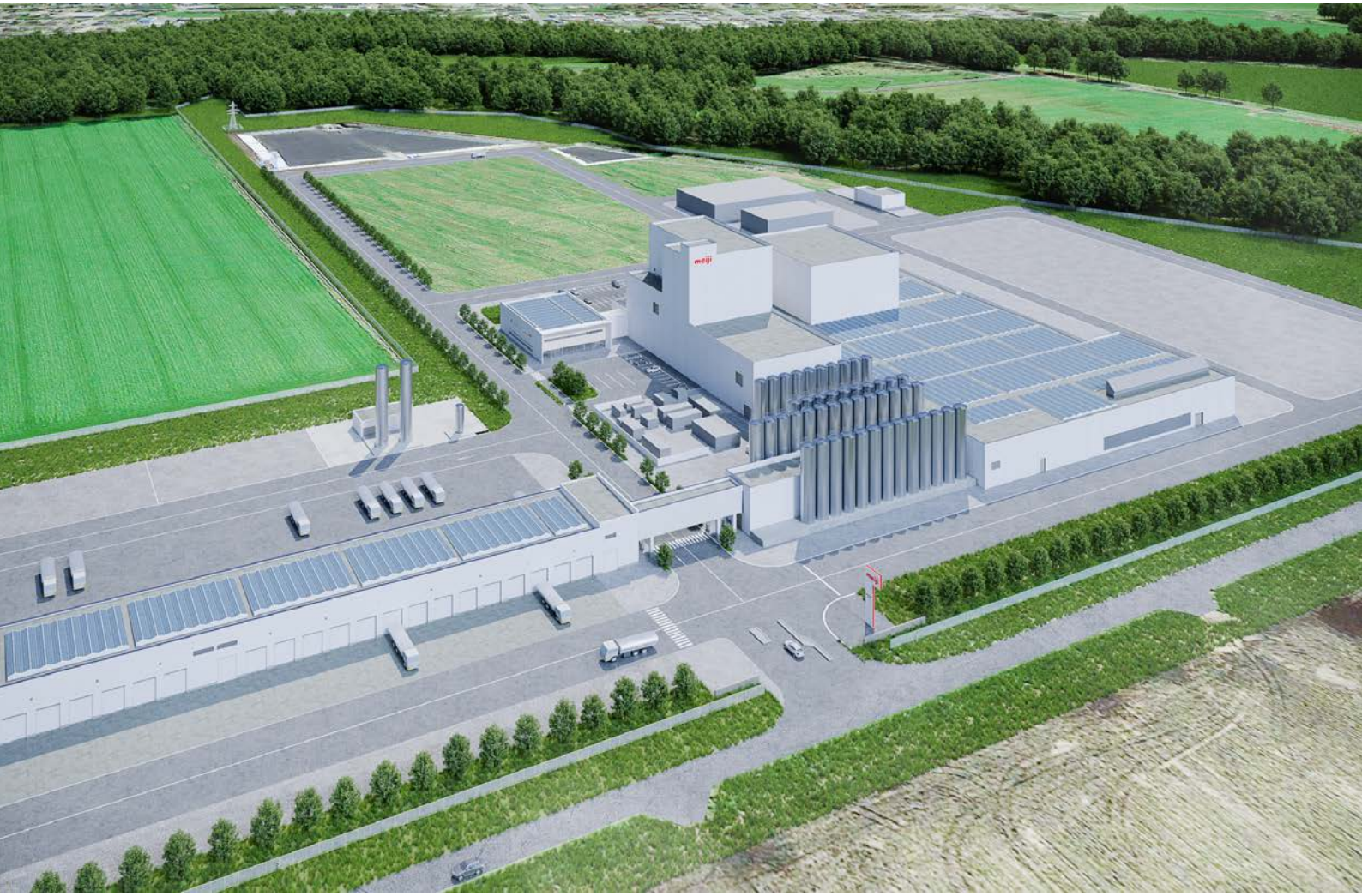

Visualisation of new plant construction.- ©Meiji Co., Ltd.


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HELPING NOURISH THE WORLD WITH SAFE AND SUSTAINABLE DAIRY

The IDF is the leading source of scientific and technical expertise for all stakeholders of the dairy chain. Since 1903, IDF has provided a mechanism for the dairy sector to reach global consensus on how to help feed the world with safe and sustainable dairy products.

A recognized international authority in the development of science-based standards for the dairy sector, IDF has an important role to play in ensuring the right policies, standards, practices and regulations are in place to ensure the world's dairy products are safe and sustainable.

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