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SPECIAL "PLANT BASED ALTERNATIVES"

magazine

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Dear Readers,

Across Europe, plant-based milk alternatives have established themselves as a relevant and steadily growing segment within the milk and beverage category. Following a period of rapid market expansion, the sector is increasingly entering a phase of stable, moderate growth. Oat-based drinks continue to dominate the segment, while soy, almond and more protein-rich raw materials such as pea or fava bean are gaining importance depending on the application.

This development is closely linked to changing consumption patterns. Growth is no longer driven exclusively by vegan consumer groups, but increasingly by flexitarian usage, in which plant-based and conventional dairy products are used alongside each other in everyday consumption. As a result, expectations regarding taste, texture, nutritional profile and technological performance of plant-based milk alternatives continue to rise.

Technological advancement plays a central role in this context. Progress in processing and equipment technology, new processing methods and functional ingredients are contributing to significant improvements in sensory quality, nutritional value and application stability. These technological improvements enhance the suitability of products for everyday use – and thus consumer acceptance, which ultimately determines long-term market success.

We wish you an engaging read and hope that the articles provide practical insights and inspiration for your daily production operations.

Your IDM editorial team

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Plant-based milk alternatives

Processing technology

The dairy industry is currently shaped by several global trends. As dairy markets become increasingly saturated, product innovations, such as plant-based milk alternatives, play a pivotal role for dairies looking to gain market share and drive growth. Segments including organic dairy products, high-protein offerings, and milk alternatives continue to expand, with sustainability remaining a key motivator for both producers and consumers. Both manufacturer brands and private labels are essential in delivering product innovation to the market. While manufacturer and own brands concentrate on developing new products, private labels are often at the forefront of driving trends and segment growth. From an innovation perspective, technology and process excellence are especially relevant for private-label manufacturers. Additionally, artificial intelligence and machine learning are gaining importance across the entire value chain, enhancing efficiency and productivity, and fostering further product innovation.

Handtmann is a solutions provider for production processes of plant-based milk alternatives. Processing steps are grinding, heating, and mixing systems for producing the base masses, as well as modular and flexibly deployable system solutions for portioning, forming, co-extrusion, dosing, or pumping. Depending on the application, these can be compact system solutions, automated line solutions with synchronized interfaces to upstream and downstream process steps, or customized process plants. This is realized through the flexible combination of a vacuum filler as a pump with various attachments for specific functions. The production solutions offer room for vegan trend products and innovations in the drinking milk and milk drinks sector.



Handtmann Inotec emulsifier

For production of vegan base masses, Handtmann offers both process automation units and universal process units that can be used for simultaneous heating, mixing, grinding, and emulsifying, as well as mixing technology. The two process options for wet milling plant-based milk alternatives of dry, uncrushed, and unground raw materials without pre-swelling: In the first method raw materials such as cereals, pseudo-cereals, pulses, seeds, and water are continuously wet-milled and emulsified in a single pass using perforated disk mills and advanced grinding, and emulsifying technology.

In the second method, all types of nuts like vegan almond, hazelnut, cashew, pistachio, walnut or kernels, and water are wet-milled and emulsified in a recirculation system via perforated disk mills with an automatic, compact and closed complete processing unit. The challenge in producing plant-based milk alternatives is the optimal fine grinding of chunky nuts, pistachio or almonds and the combining of components with different consistencies, such as liquid, chunky, powdered, and crystallizing. This is achieved with a compact, closed Handtmann process automation unit from the BC-it series. In the process container, chunky raw materials are pre-ground and mixed with dry ingredients and liquids.



Handtmann Inotec Process Unit BC-iT

The mixture can be heated by direct steam injection or optionally heated or cooled indirectly with a double jacket. An additional vacuum system allows for the deaeration of the product mixture and the suction of liquids or dry ingredients. During or after the cooking process, the product can be run through the multi-stage, modularly constructed fine grinder. This serves to emulsify, homogenize, pump, and transfer to subsequent filling systems. An example of this process is the production of almond, macadamia, or cashew milk. Water, nuts/almonds, sugar, and powdered ingredients are optimally homogenized in the wet grinding process, from pre-grinding to cooking with an adjustable cooking temperature of up to 99°C and pumping. The BC140-iT process automation unit and the BC175-iT universal process machine, designed for heavy-duty industrial continuous operation, are available in different sizes with various hopper sizes and a capacity of up to 3,000 kg/h. They are perfect as standalone machines in the production process of milk and cheese alternatives but also suitable for integration into existing process plants.

For both process types, downstream steps may be fermentation, separation, homogenization, UHT treatment, and filling.

Vegan milk alternatives such as almond, hazelnut, cashew, pistachio, walnut or coconut milk including varieties with chia seeds and more are possibly processed using Handtmann technology (photos: Handtmann)



Alternative with technological potential

Faba bean protein

At the Afternoon Tea with BENEIO in October 2025, the faba bean took center stage. The company presented its latest research findings and applications related to faba protein – an ingredient that is increasingly gaining attention in the food industry. The growing interest in plant-based protein sources that combine nutritional quality with sustainability provides the backdrop.

Growing demand for plant-based protein

The market for plant-based proteins is expanding rapidly. According to current analyses, it is expected to grow by nearly eight percent annually through 2030. Around two-thirds of consumers, based on international surveys, are interested in plant-based protein sources. The faba bean is considered particularly promising, as it is perceived as both nutritious and environmentally friendly.



Faba bean protein can be used in numerous product categories (photo: alexzrv_shutterstock)



Versatile applications

Faba bean protein can be used in a wide range of product categories – from baked goods and snacks to dairy alternatives. At the event, BENEEO showcased several examples, such as gluten-free protein biscuits and plant-based smoothies.

The protein exhibits good emulsifying and foaming properties and can partially replace egg or dairy ingredients. When combined with rice protein, it provides a complete amino acid profile, making it attractive for high-protein products as well.

Faba beans are grown in Europe and require neither artificial irrigation nor nitrogen fertilizers (photo: Dennis Möbus_Südzucker)

Raw material with a favorable environmental footprint

Faba beans are cultivated in Europe and require neither artificial irrigation nor nitrogen fertilizers. They improve soil structure, contribute to biodiversity, and fit well into crop rotations. At BENEEO's facility in Offstein, processing is carried out through dry fractionation – a method that uses no water or chemical auxiliaries and is powered entirely by renewable energy.

Nutrient profile and health benefits

Faba beans contain around 60 percent protein (based on dry matter) as well as dietary fiber, B vitamins, iron, and zinc. This makes them an appealing basis for developing foods aimed at meeting the rising demand for protein – beyond animal sources. The combination of nutrient density and functional properties makes this legume attractive for both conventional and plant-based product concepts.

From alternative to essential: The rise of dairy alternative milk



Author: Louisa Parrillo,
strategic marketing lead – dairy and alternatives EMEA, Ingredion

Dairy alternative milk is no longer a niche; it's becoming the default for millions of health-conscious consumers. This article discusses how beverage brands can keep up with rising consumer trends and seize the opportunity to explore dairy alternative options that cater to health trends, without compromising on taste.

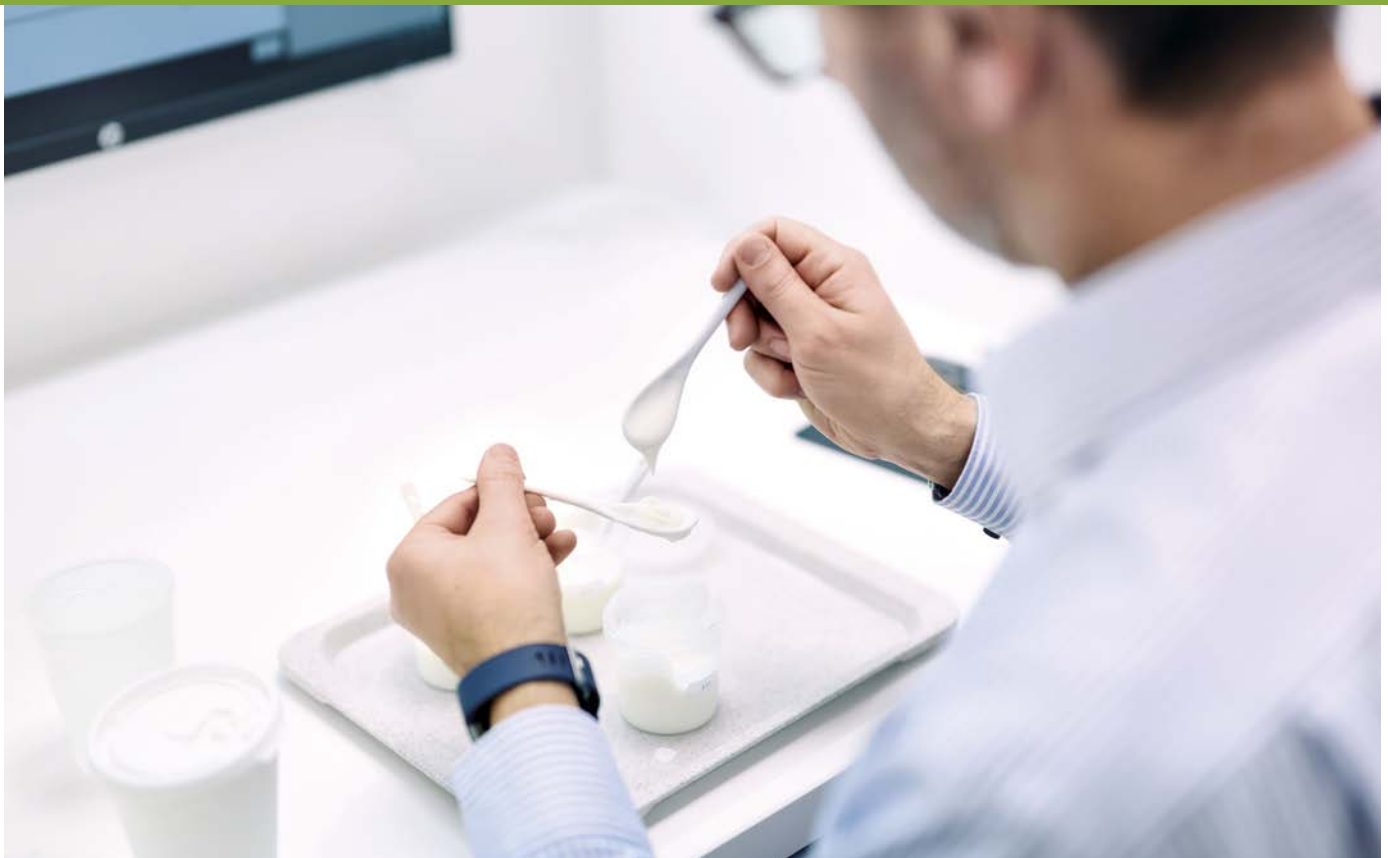
Across Europe, dairy remains embedded in daily consumption habits, with 39% of consumers reporting they drink milk every day.¹

However, as sustainability concerns and dietary trends such as flexitarianism and veganism snowball, consumers are increasingly switching out traditional dairy products for dairy alternative milk options, which, as a category, has grown by 8%.¹

This provides an opportunity for manufacturers to develop dairy alternative products that have consumer demand. Investing in the development of dairy alternative milk also allows food and beverage companies to enhance their offering, for example, through the addition of plant protein or vitamins.

However, when developing and trialling dairy alternative milks, several factors need to be carefully considered, such as achieving a desirable taste and familiar textural experience, the level of processing and balance of additives required, and the cost of reformulation.

So how can manufacturers develop dairy alternative products without sacrificing important elements of taste and texture, which maintain purchase loyalty?



Importance of taste

While health perception is the largest factor motivating buyers to purchase dairy alternatives, for existing consumers of the category, taste is a clear priority. When asked which factors most affect the alternative milk dairy they choose to purchase, buyers ranked taste in first place at 86% most important, followed by considerations like natural formulation (71%) and low sugar content (68%). To meet the demands of modern-day consumer expectations, therefore, avoiding formulation problems that negatively impact taste is crucial.

Some plant ingredients commonly used in dairy alternative milks can leave lingering tastes that disrupt the traditional taste consumers have come to expect from dairy. For example, soy can bring beany or earthy notes linked to compounds such as lipoxygenase, while almond milks sometimes exhibit a bitter aftertaste. Strong or unexpected flavours from ingredients such as peanuts can also disillusion consumers who prefer a neutral taste profile.

As such, there's a growing demand for flavoured options such as chocolate, vanilla, and even seasonal flavours like pumpkin spice or sweet bakery. Flavoured options cater to consumers looking for variety and indulgence, whilst also helping to mask plant flavours.

Difficulty replicating a desirable, or familiar, texture is another common problem that crops up in dairy alternative formulations. Consumers who are accustomed to the smooth, creamy sensation of dairy milk are disappointed by alternatives that fail to replicate the same experience, particularly in luxurious products such as milkshakes. Some nut and grain-based milk can present an unsatisfying gritty or chalky texture due to insoluble particles.

Additionally, achieving the right viscosity presents a challenge. While some products become too thin and watery, others have the opposite problem, resulting in a gummy mouthfeel, with the danger of straying too far from the traditional properties of milk.

To ensure the functionality of the product, the acidity of dairy alternative milks must be carefully balanced to avoid curdling when added to hot drinks like coffee or tea.

All of these challenges can lead to a negative taste experience, which could potentially stop a buyer from repeatedly purchasing a product. Therefore, it's essential for manufacturers to deliver consistent and enjoyable dairy alternatives above all else.



Health-conscious consumers

The desire to reduce sugar intake is a particularly strong motivation for consumers and something that's reflected on the supermarket shelves. In 2023 alone, over half of NPDs (New Product Developments) in the alternative dairy drink category featured a sugar-related health claim.¹

Since consumers perceive products that showcase reduced sugar claims as healthier than those without, around 70 % of global consumers actively seek reduced-sugar products, with 46 % identifying sugar as the single ingredient they are most actively reducing in their diets as a whole.²

As such, around two-thirds of consumers are willing to pay more for products featuring reduced-sugar, no-added-sugar, or zero-sugar claims.³ Indeed, there is urgency for brands to develop lower sugar or sugar-free alternative milk options, all without compromising on flavour, in order to stay competitive in such a health-conscious market.

Clean label expectations are also becoming commonplace. Buyers are looking for transparency, favouring short, recognisable ingredient lists and avoiding artifi-

cial additives or preservatives. This demand for simplicity, combined with a desire for nutritional enrichment such as added protein or fibre, is pushing the boundaries of product development in the category.

Smarter ingredient solutions

Consumers want to feel good about what they are putting into their bodies, but not at the cost of compromised taste or an unpleasant sensory experience. Careful consideration is needed when incorporating clean label formulation, enhanced nutrition, or reduced sugar into product development. Luckily, innovation in both plant ingredient solutions and performance has paved the way for an easier formulation process.

Reducing sugar without losing the sweetness that consumers crave is a central challenge. Ingredion's Pure-Circle stevia-based sweeteners are a no-calorie, plant-derived option that deliver satisfying sweetness in flavoured dairy alternatives.

Stevia sweeteners have improved significantly since they were first developed. By using processes such as bioconversion and fermentation to obtain higher quantities of the Rebaudioside M (Reb M) molecule, known for its superior sugar-like taste, compared to earlier stevia

sweeteners, the products now available have minimal bitterness and a more familiar taste.

To address broader flavour problems, flavourings with modifying properties (FMPs) can be added to mask bitter or earthy notes, whilst simultaneously enhancing creaminess and other desired taste profiles.

To simulate the indulgent, rich experience of animal milk, starch-based texturisers are a successful alternative that replicates a thick and creamy texture. What's more, specialised starches derived from corn, potato, rice, and tapioca can all deliver viscosifying and co-texturing benefits that improve mouthfeel.

Citrus fibre can boost fibre content whilst also acting as an innovative, clean-label emulsifier that is particularly useful for improving product performance where curdling is a concern. For example, Ingredion's FIBERTEX® CF 100/500 uses recycled citrus fibre to stabilise acidified dairy beverages from sedimentation and improve mouthfeel.

Additionally, protein content can be enriched through pulse products like pea isolate, and soluble corn fibre supports nutrition claims.

Attracting consumer attention

The perception of dairy alternatives has switched. Dairy products using alternative milk are no longer seen as niche or experimental, but rather are mainstream choices expected to replace traditional dairy in both taste and function. Unsurprisingly, then, the bar for quality is high.

Brands have the opportunity to help shape the future of this ever-growing market. Using differentiated ingredient solutions to stand out against competitors is not only strategic but essential.

- 1 *Ingredion proprietary insights.*
- 2 <https://www.ingredion.com/na/en-us/news-events/news/breakthrough-ingredion-stevia-solution-unmatched-in-consumer-testing>
- 3 <https://www.ingredion.com/na/en-us/be-whats-next/2023-consumer-food-preference-trends>

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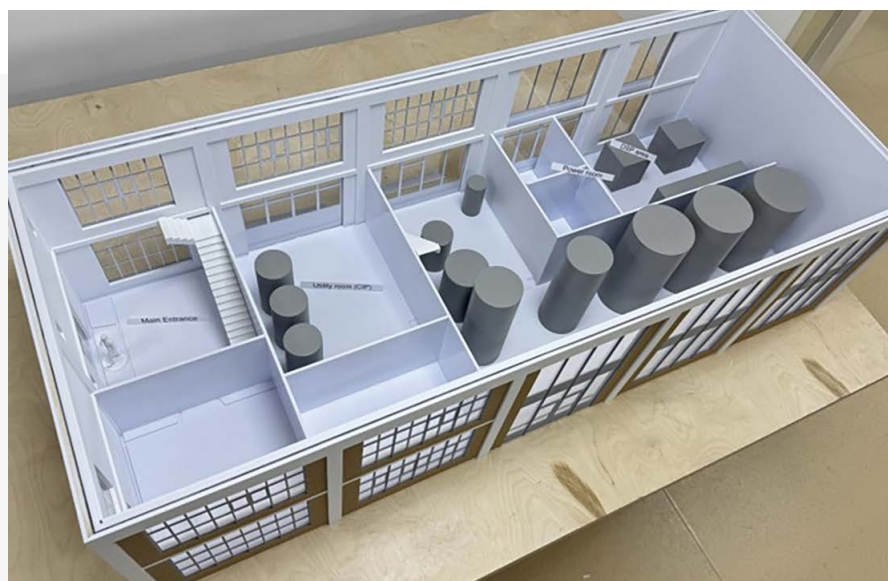
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GEA to equip BFF's food-grade line for precision and biomass fermentation

Installation in 2026 – pilot operations from 2027

GEA has been selected to deliver and commission a precision and biomass fermentation upscaling line for Biotechnology Fermentation Factory (BFF), an open-access site on the NIZO Food Innovation Campus in Ede, Netherlands. The facility gives food and ingredient companies a food-grade infrastructure to test, validate and scale products such as animal-free dairy proteins, egg-white proteins, specialty enzymes, flavors and fragrances, and other functional biomolecules. Installation is scheduled for 2026, with pilot operations targeted from 2027.

Frederieke Reiners, Vice President New Food, GEA: "Open-access capacity is the critical development link many innovators have been missing. By delivering BFF's line, we help teams validate their processes faster under food-grade conditions – and as the logical next step from our GEA New Food Application & Technology Center (proof-of-concept) this pilot environment enables application-ready material and decision-grade data sets that de-risk the move toward commercial manufacturing. It also advances Mission 30, where biotechnology meets scalable industrial production."



3D visualization of the BFF facility showing the indicative layout of the precision- and biomass-fermentation pilot line. (photo: NIZO/BFF/Royal Haskoning)

Closing the missing link with an open-access model

Many precision and biomass fermentation projects stall between lab proof-of-concept and the first commercial investment decision. BFF's model addresses this gap with a single, coherent validation environment that de-risks tech transfer, accelerates time-to-validation and supports Europe's move toward biotechnology-enabled food production.

BFF operates as an open-access facility, offering a bookable fermentation upscaling capacity, process expertise and quality procedures to run pilot campaigns and generate decision-grade data without the need to build a facility of its own. Operating under food-grade standards, BFF produces trial volumes suitable for sensory evaluation and application testing, giving product teams material they can use in subsequent end-product development.

Capacity and integrated workflow that support credible decisions

Anchored by both a 1,000 liter and a 10,000-liter main fermenter, GEA is delivering an integrated upstream-to-downstream line for food-grade operations – from media preparation and controlled fermentation to cell harvest and a filtration train for recovery and polishing – with commissioning and validation support to produce decision-grade data sets while keeping organisms, recipes and commercial figures confidential.

This setup complements BFF's existing pre-pilot assets and its biomass fermentation lines and directly connects to the downstream processing (DSP) pilot plant at NIZO on the same campus. Teams can run fermentation, primary recovery and professional-scale concentration and purification in one place. Together, this creates one of Europe's most complete mid-scale, food-grade validation environments for precision and biomass fermentation.



Exterior view of the building that will host BFF's open-access pilot facility. (photo: NIZO/BFF)

Smart starts in every glass

Omega-3s in Plant-Based Dairy Alternatives for Children



Authors:

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The global demand for plant-based dairy alternatives designed specifically for children is growing rapidly. A new generation of parents is raising children on vegan, vegetarian, or flexitarian diets, driven by health concerns, sustainability ambitions, ethical considerations, and a desire to pass on their own eating habits. These consumers are highly engaged: they read labels carefully, compare claims, and expect more from the products they bring home to their families.

What began as a lifestyle choice for a niche audience has evolved into a mainstream movement. As the category matures, expectations are rising accordingly. Today's consumers want products that deliver great taste and strong nutritional value. They look for clean labels, natural ingredients, and benefits backed by credible science. For manufacturers of plant-based dairy alternatives, this creates both an opportunity and a responsibility to innovate.

Moving beyond basic fortification

Over recent years, brands have made major progress in improving the nutritional profile of plant-based dairy alternatives. Many products are now fortified with calcium, vitamin B12, vitamin D, and other essential micro-nutrients to help narrow the nutritional gap versus conventional dairy.



Yet while these steps are important, they represent only the starting point. Parents are increasingly looking for products that go beyond baseline nutrition and offer functional benefits that support long-term health and development. This is where fortification with essential nutrients such as long-chain omega-3 fatty acids, EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), can make a meaningful difference.

Omega-3s are ranked among the top three most familiar nutrients for consumers, after vitamins C and D¹ and this is complemented by 40,000 scientific papers and 400 clinical trials. However, despite this strong awareness and scientific foundation, most consumers globally still do not achieve the recommended intake², highlighting a persistent and significant nutrition gap.

For children, the importance of omega-3s is particularly well established. Often described as “food for the brain,” DHA supports the growth and function of the brain and plays a role in cognitive development, learning ability, memory formation, and healthy vision during the early years³, when children are rapidly growing and exploring the world around them.

The benefits of EPA and DHA extend far beyond childhood. These essential nutrients support cardiovascular, cognitive, and visual health across the lifespan³, making them relevant for every family member.

Addressing the nutritional omega-3 gap in plant-based diets

Today, a significant part of the population, including children, vegetarians, vegans, and non-fish consumers, has no-to-low fish intake. This makes it difficult for them to reach the minimum recommended daily intake of omega-3 (250mg, or more, of EPA and DHA) needed to deliver the health benefits³.

While plant sources such as flaxseed and chia seed contain the omega-3 fatty acid ALA (alpha-linolenic acid), the body converts only a very small proportion of ALA into EPA and DHA³. As a result, many consumers following plant-based diets fail to achieve sufficient levels of these essential long-chain omega-3 fatty acids.

Fortifying plant-based dairy alternatives with EPA and DHA helps close this nutritional gap and provides brands with a powerful point of differentiation. For parents,



it offers a practical way to integrate these nutrients into their children's daily diets, without the need to rely solely on supplements, and ensures nutritional support through products children already love to consume.

Going straight to the source with algal omega-3s

Beyond nutrition, sustainability remains a core purchasing driver. Nearly two-thirds of consumers globally are trying to have a positive environmental impact through their everyday actions, and almost 60% believe their individual choices can make a difference⁴.

For decades, fish has been the primary dietary source of long-chain omega-3 fatty acids. However, fish do not produce omega-3s themselves; they accumulate them by consuming microalgae. By going directly to the source, algal omega-3s provide a natural, renewable, and highly sustainable solution that aligns perfectly with plant-based lifestyles.

Omega-3 fatty acids are sensitive products that need to be handled carefully to preserve stability and ensure the sensory quality consumers expect. Maintaining this balance between nutritious credentials and indulgent appeal is not an easy task. This is why dsm-firmenich has developed the life's® family of algae-derived long-chain omega-3 fatty acids. This innovative portfolio builds on a proud heritage as pioneers in algal oils, a legacy of trust that began in the early 1980s at NASA.

Derived from marine microalgae and cultivated in tightly controlled environments, these premium-quality, in-

herently pure oils are extracted using water-based processes and formulated into best-in-class delivery forms designed for superior stability, bioavailability, and performance in food and beverage applications.

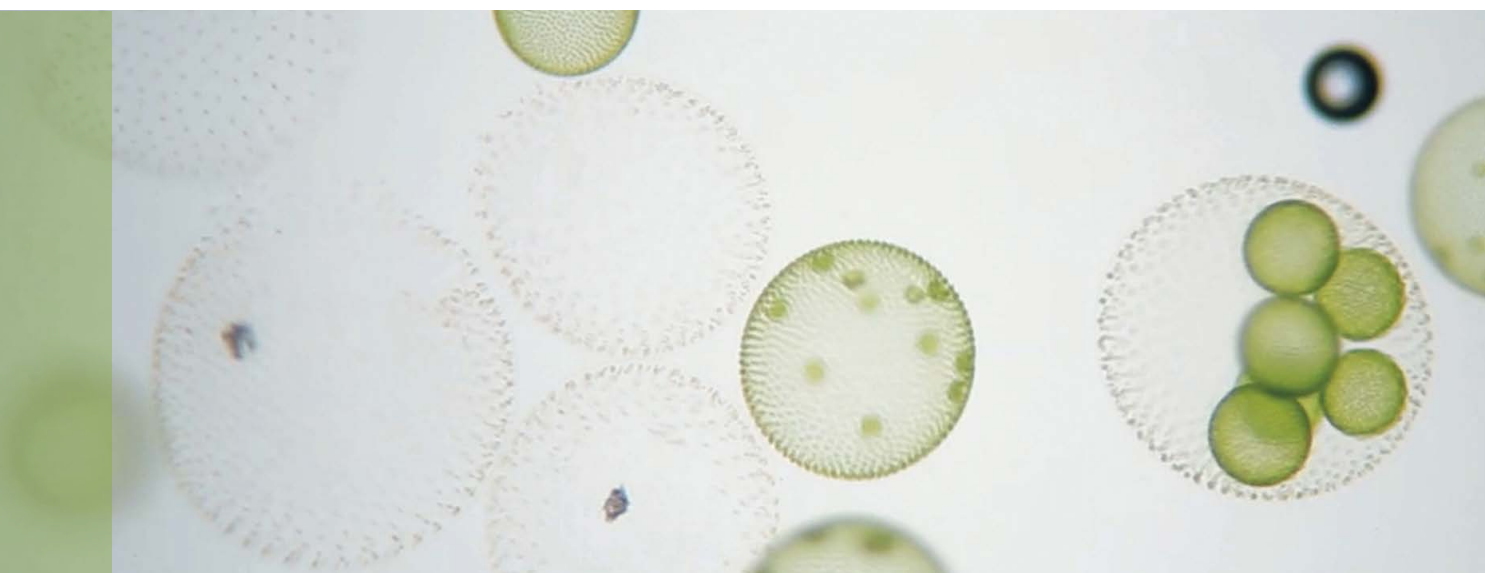
By integrating life algal omega-3s into plant-based dairy alternatives, manufacturers can meet consumer demand for omega-3 fortification in a way that is fully plant-based and with no impact on fish population. The result is a dual benefit: nutritional excellence for people and a more sustainable solution for the planet.

Balancing Nutrition and Taste

Parents know that even the most nutritious product will fail if children refuse to drink it. Sensory experience is therefore critical for success.

dsm-firmenich combines the high quality of life' algal omega-3s with formulation and application expertise to support the development of products in which nutritional benefits are maintained without compromising sensory performance. This makes it possible to fortify products with omega-3 fatty acids while preserving an appealing taste.

This approach offers a broad range of options for product development. In combination with dsm-firmenich's flavor portfolio, manufacturers have various tools available to adapt products to different consumer preferences. Familiar flavors such as vanilla and strawberry continue to play an important role, while more distinctive options, including fruit blends or novel flavor concepts, can be used to create differentiated products.



Fortifying plant-based dairy alternatives with omega-3s enables brands to combine functional nutrition with sensory quality, offering products that meet children's taste expectations while also addressing parents' interest in nutritional value.

Partnering for Success

firmenich's teams collaborate closely with manufacturers, combining technical expertise, application know-how, regulatory guidance, and consumer insight. This end-to-end support helps ensure that health and functional claims comply with regional requirements and that innovations translate successfully from concept to commercial reality.

With life algal omega-3 fatty acids, brands can create products that are nutritionally robust, sustainably sourced, and appealing to children, while meeting the expectations of modern parents. The combination of science, sustainability, and sensory excellence positions omega-3 fortified plant-based dairy alternatives as a compelling growth opportunity for the next generation of consumers.

- 1 *dsm-firmenich Global Health Concerns Study 2023, EMEA results*
- 2 *Schuchardt et al. Prog Lipid Res 2024*
- 3 *The Joint WHO/FAO expert consultation on fats and fatty acids in human nutrition Report of an expert consultation 2008; EFSA Journal 2010*
- 4 *Euromonitor Voice of the Consumer, Sustainability Survey, 2024*

FIVE YEARS OF PLANTENEERS

Plant-based solutions for changing diets

Five years ago, Planteneers was founded with the ambition of establishing plant-based foods as a permanent part of everyday nutrition. "Five years ago 'Plant-based as the New Normal' was our vision. Now it's more and more a reality," says Dr. Matthias Moser, Managing Director of the Food Ingredients Division of the Stern-Wywiol Gruppe. Since then, the company has developed an international footprint: around 50 employees work at sites on three continents, developing plant-based convenience solutions. Customers can choose from more than 1,200 formulations covering a wide range of product segments.

The starting point was the conviction that plant-based raw materials play a central role in more sustainable diets. Building on experience in the plant-based sector since 2013, Planteneers was established as an independent specialist within the group. The aim

was – and remains – to develop plant-based products that deliver convincing sensory quality while also being economically viable.

The portfolio includes functional systems for plant-based alternatives to meat, sausage, fish and dairy products, as well as cheese and deli foods. Developments include structured meat alternatives, innovations in the field of fish alternatives, and a plant-based sliced cheese alternative with elastic texture and increased protein content. Sensory quality, nutritional profiles and clean-label approaches are key areas of focus. To meet these requirements, Planteneers continues to invest in research and development. The company addresses new raw materials and technologies at an early stage, including mycelium and alternative binding systems designed to reduce ingredient lists. Close collaboration with companies from the meat and dairy in-



The portfolio includes functional systems for plant-based alternatives to dairy products and cheese (photo: Planteneers).

dustries plays an important role in this process.

Looking ahead, Planteneers expects continued growth in alternative proteins derived from plants, fermentation and cellular agriculture. Topics such as clean label, raw material diversity, health and convenience are likely to gain further importance. At the same time, the company is expanding its international presence, including a subsidiary in the United States and a technology center in Singapore.

Rising to the challenge of plant-based cheese alternatives



Author: Dr. Ali Sedaghat Doost
Food R&D Scientist – Food R&D department of FAM STUMABO

The global market for plant-based dairy alternatives is expanding rapidly, driven by key growth drivers, including the growing adoption of vegan and flexitarian diets, rising lactose intolerance, ethical concerns about animal welfare, and environmental considerations associated with conventional dairy. At the same time, accelerating population growth is increasing the need for sustainable, scalable food sources, further boosting interest in plant-based dairy alternatives. However, the pace of growth varies significantly across regions. Europe and North America are mature markets, with high awareness and strong retail presence, but expansion in some segments may be slower than in emerging markets.

Over the past two years, the market has shifted from novelty-driven growth to a phase of critical consumer evaluation. Early launches focused primarily on highlighting that a product was dairy-free. Today, consumers ask more nuanced questions: Does it taste right? Is

the texture appealing? Is it truly natural and healthy, or ultra-processed? In response, formulators are exploring new ingredients and preparation methods, such as precision fermentation. They must also address desired functionalities, such as melt and stretchability, while successfully replicating the rheological and sensory properties of conventional dairy products.

Consumer motivations are diverse. Many are drawn to plant-based dairy alternatives for perceived potential health benefits, such as lower saturated fat (although due to textural limitations, some formulations contain a portion of saturated fats), lactose-free composition, and alignment with broader wellness goals. Sustainability and ethical concerns are also significant, while lactose intolerance makes plant-based options a practical necessity for others. The result is a diverse consumer base: some choose these products for health alone, others for ethics, convenience, or intolerance, and many for a mix of reasons.



photos: FAM STUMABO

The science of replicating dairy products

Developing plant-based cheeses involves navigating complex challenges for processors. Achieving the desired functionalities like melt, texture, and stability in a plant-based system is far from straightforward. Dairy proteins exhibit unique properties, and replicating them with plant-origin proteins, starches, emulsifiers, and other functional components requires sophisticated formulation and lengthy R&D.

In recent years, processors have increasingly moved away from relying solely on soy and pea proteins, exploring new protein sources, blended systems, and novel fats, starches, and fibers to meet evolving demands. Manufacturers use alternative lipid structures, starch and hydrocolloid systems, and fiber additions to replicate dairy's body, melt, and mouthfeel, while also supporting nutritional value and cleaner labels. These choices are further complicated by sustainability and cost considerations.

Adapting legacy processing lines to plant-based slurries, protein-fat-and-fiber blends, and novel emulsions is another hurdle that often requires investment in new equipment and a thorough re-evaluation of process stability, scale-up, hygiene, allergen cross-contamination, and cleaning regimes.

Recent research highlights additional technical nuances. High-protein plant-based cheeses require precise cutting mechanics focused on shear forces and controlled processing conditions to maintain clean particle geometry. Starch-based alternatives, on the other hand, are easier to shear-cut cleanly, but it highly depends on whether they are for shredding or dicing, as starch-based formulations can be diced more uniformly. Starch-based vegan cheeses, in particular, undergo significant textural changes during storage due to starch retrogradation, which alters their shreddability. Therefore, a comprehensive understanding of these formulation aspects is fundamental to effective scale-up and



photos: FAM STUMABO

consistent product quality, as they directly influence the machinability behavior of these cheese alternatives. Consequently, formulation development must be systematically monitored and scientifically guided to ensure robust, reproducible size reduction outcomes.

Shaping the future of plant-based cheese alternatives

To address these challenges, FAM STUMABO ensures its machines remain adaptable to the continuous innovation in plant-based formulations by combining advanced material-science research with modular machine design and a “together we build your success” approach. A dedicated R&D team and global knowledge center monitor evolving product attributes and collaborate with customers and food science institutes to test analog formulations. New cutting technology, interchangeable blades, variable-speed and temperature controls, and easy-to-clean, hygienic frames allow the equipment to be precisely adjusted for new plant-based cheeses, rather than requiring replacement.

Sustainability remains at the heart of innovation in plant-based cheese production. Energy efficiency, waste reduction, and material optimization are considered at every stage. Precision cutting and high-accuracy blades and machine systems reduce off-spec pieces and fines. Easier cleaning minimizes energy and water use.

Having said that, producing consistently high-quality plant-based cheese alternatives requires careful attention to formulation, processing, and texture. At FAM STUMABO’s Food R&D department, material science and cutting technology are studied in parallel to optimize product machinability and address the unique challenges of plant-based formulations. By collaborating with manufacturers and food scientists, FAM STUMABO contributes knowledge and practical solutions that help the industry scale innovative products efficiently, consistently, and sustainably.

Fermenters and Bioreactors

Holistic concepts for market-ready products



Author:

Jürgen Schütze, Management Board, Ruland Engineering & Consulting

The European market for fermentation products has been growing dynamically for years, yet remains volatile. The success of vegan protein alternatives to meat, fish, or dairy products is closely linked to quality, economic viability, and the skillful formulation of familiar sensory attributes. As a supplier of process plants for liquid processing, Ruland Engineering & Consulting considers the relevant technological, process-related, and economic aspects.

Whether precision fermentation for the production of enzymes, active substances, and functional ingredients, or biomass fermentation, there are many promising approaches for the use of fermenters and the development of in-house production capacities. In its most recent report “State of the Industry: Fermentation”, GFI Europe estimated total investment volume in the sector for 2024 at USD 275.0 million (approx. EUR 237.2 million). Of this amount, USD 139.0 million (approx. EUR 119.9 million) was invested in Germany¹. Looking ahead, the global market volume of the fermentation industry (meat, dairy, eggs, seafood) is forecast to reach at least USD 15.0 billion (approx. EUR 12.9 billion) by 2030. In the best-case scenario, it could reach up to USD 74.0 billion (approx. EUR 63.8 billion) – a market² that is highly attractive, yet also technically demanding.

The overall plant system determines success

Industrial production facilities for highly complex fermentation processes require far more than just the bioreactor itself. The bioreactor is always only a key component of the overall plant and must be integrated into a sequence of upstream and downstream process steps. For this integration, measurement and control technology (MCT) must be considered from the outset. This is just as essential for a stable, economical manufacturing process with consistently high product quality as hygiene, sustainability, and energy efficiency. Under these conditions customers can fully utilize their plant capacity and design efficient production workflows.

Understanding products and considering relevant parameters

At the beginning of every project, engineering partners must develop a thorough understanding of the product and the parameters that influence its quality and yield. On this basis, the plant manufacturer can optimally design the individual modules of the system and incorporate quality-relevant physical parameters from the very start. A pilot plant is often required, as products and production processes frequently behave differently at

laboratory scale than at industrial scale. This is especially relevant for innovative products as a pilot plant provides clarity for scale-up and helps prevent wrong decisions on the process. During the pilot phase, producers test the process steps and assess the economic viability of the later production. The insights gained from pilot trials enable the plant manufacturer to develop an intelligent plant design for which he chooses all components carefully and integrates a comprehensive automation concept. In this way, scale-up to larger production volumes can be implemented reliably while maintaining process stability.

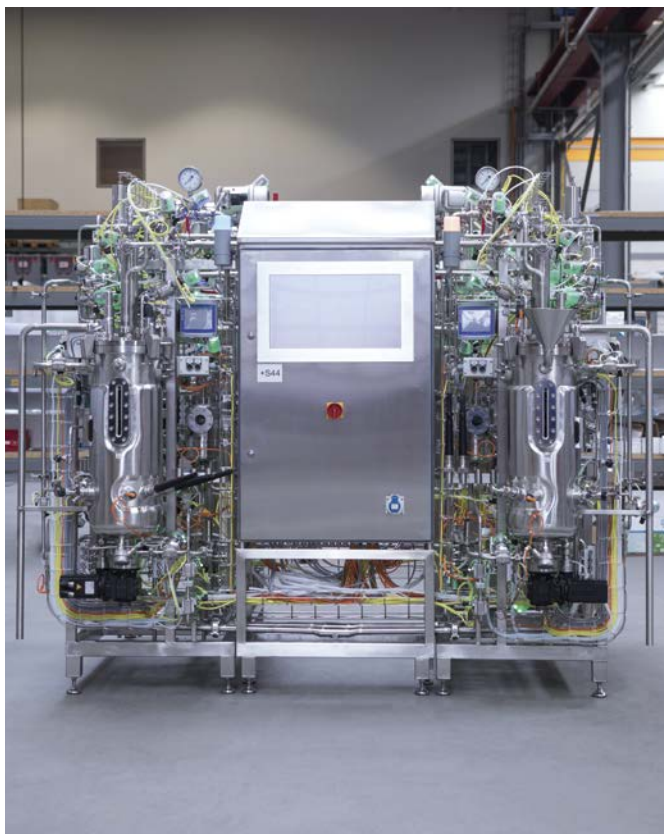
Clean planning for hygienic production

Every production process depends fundamentally on raw materials. Their provision and processing therefore require careful consideration, design, and planning. In the food and dairy industries, products are often highly sensitive, meaning that raw materials must be delivered and stored under hygienically flawless or even aseptic conditions. To prevent bottlenecks in the production process – particularly during fermentation – the supply of raw materials must be precisely planned so that the right quantity is fed at the right time. Modern automation systems such as the Ruland Process Management System (RPMS) support this process by ensuring complete recording and processing of raw material, production and operating data, as well as by controlling the entire workflow automatically. The RPMS also generates logs and evaluations to document the manufacturing process.

Creating optimal process conditions

Numerous influencing variables must be precisely controlled in fermentation processes. This is the way to provide optimal conditions to the metabolism of the respective microorganism strain. Especially in closed systems, it is crucial that parameters such as temperature, pH value, density, and oxygen supply are regulated with high precision in order to carry out precision fermentation in a controlled manner. For products that require

Carefully selected measurement and control technology ensures optimal monitoring and control of fermentation processes (photos: Ruland Engineering & Consulting)



a specifically adapted process, the importance of a suitable plant design becomes evident. A coordinated balance between agitator speed, agitator design, and oxygen input in the fermenter significantly contributes to increasing the energy efficiency of the process and reducing the consumption of materials and operating resources. At the same time, foam formation in the fermentation vessel can be better controlled. There are no off-the-shelf solutions here. With carefully selected measurement and control technology and a plant design tailored to the process, Ruland ensures optimal monitoring and control of the customer's process.

Correct cascading – Balancing risk and yield

In large-scale industrial production, multiple fermenters are often operated in cascade to achieve the required volume of fermentation medium. Fermenter cascades can be flexibly adapted to different requirements, ranging from laboratory fermenters with minimal volumes to large-scale fermenters with capacities of up to 150 m³. Optimally dimensioned size ratios achieve the best pos-

Nutrients and substrates supplied in the right dosage at the right time are just as important for precision fermentation as physical parameters



Integrated control technology and data record link fermenter cascades from the smallest to the largest volumes and allow for a continuous production



sible balance between product yield and process time. Process risk is also an important factor when selecting fermenter size. An experienced plant manufacturer provides support through consulting on process optimization, energy efficiency, and technical feasibility. For safety reasons, it may be advisable to distribute unstable or still-developing processes across two fermenters. In addition, it often becomes apparent that individual process steps that function without problems at laboratory scale can become uneconomical at very large vessel volumes. In such cases as well, functionality, energy demand, and economic efficiency must be realistically evaluated for the client of the fermentation line. The design of the complete process naturally includes downstream processing of the fermentation products. This involves heating, disintegration, and separation systems, as well as filtration systems such as ultrafiltration and nanofiltration, before the purified proteins, enzymes, active substances, or ingredients are temporarily stored in tank farms for further processing, filled on downstream systems, or converted into powder through customized drying steps.

Future-proof positioning with fermentation processes

The future potential of fermentation technology lies not only in the economical production of innovative products such as alternative proteins for the food and dairy industries. As it relies on renewable raw materials, reduces waste, and drives the transition to innovative processes, it can make a significant contribution to sustainable production. It is essential to consider the entire manufacturing process and to align plant technology accordingly. Solutions that are designed for flexibility and scalability from the outset reduce risks and ensure a reliable, cost-efficient, and market-ready production facility with consistently high product quality.

- 1 <https://gfi.org/wp-content/uploads/2025/06/State-of-the-Industry-Fermentation-for-meat-seafood-eggs-dairy-and-ingredients-GFI.pdf>, S. 14-15
- 2 *ibid.*, S. 52

Plant-based drinks after the hype

Why nutritional excellence and quality consistency will define category leaders



Authors:

Dr. Latika Bhandari, Global Market Segment Manager for Dairy & Ice Cream (Plant-based Dairy) at Döhler
Jil Moser, Global Product Manager for Cereals, Nuts, and Pulses at Döhler

Plant-based milk alternatives have moved well beyond their early niche. Across Europe and globally, expectations are rising as the category matures. It is increasingly defined by quality and product maturity, with products expected to deliver on more demanding applications such as barista-style, functional and high-protein concepts. For companies across the value chain, from manufacturers to ingredient suppliers, availability is no longer the competitive edge. What matters is a differentiated choice of raw material bases, outstanding taste, credible nutritional value, reliable functionality, clearly recognisable sensory profiles and trustworthy sustainability performance.

The global plant-based milk market reached around 10.5 million t in 2024 and is forecast to grow to about 11.5 million t by 2030 (Fig. 1), with an expected CAGR of roughly 1.8% for 2026–2030. In parallel, competitive intensity is increasing: private label has strengthened,

brands are consolidating, and newer players are under pressure. As the category matures, winning will depend on being consistently better.

From dairy “look-alike” to a category with its own identity

The first wave of innovation focused on mimicking cow’s milk as closely as possible: neutral taste, a familiar white colour, predictable viscosity and similar behaviour in coffee. As the market evolves, the strategy is changing. Brands increasingly recognise that long-term value lies in leveraging the strengths of plant bases, not masking them. They are building clearer roles for different bases and use cases: barista-style performance, high protein, low sugar, cooking and on-the-go formats. This pushes the category away from a one-size-fits-all approach towards sharper differentiation and more targeted positioning.



Oat remains highly relevant, and can increasingly be combined with other protein sources such as pea and faba bean to improve nutrition and texture. This evolution is not only about positioning – it reflects a technical reality. Plant-based beverages are not a simple transfer of dairy technology. Raw material variability, nutritional composition, enzymatic activity, particle behaviour and protein functionality differ. Suppliers can ease this challenge through state-of-the-art R&D: Döhler helps translate pilot results into consistent performance in industrial production.

Supplier support to ease new challenges

To keep pace, manufacturers and retailers increasingly rely on suppliers to remove complexity from both development and scale-up. This includes innovation support: new concepts, trend input and samples that help shape pipelines, especially in retail where speed and differentiation matter. Döhler covers this space and is also known for being able to provide manufacturers with integrated ingredient systems and all-in-one solutions rather than single components – products that bring taste, colour, texture and stabilisation together and are tuned for specific applications. Where simplicity is es-

sential, standardised, shelf-stable formats such as their concentrates or powders can improve consistency and shelf life while enabling faster time to market.

Nutritional credibility is now the trust currency

As the category matures, consumers increasingly expect plant-based drinks to be nutritionally plausible. The following areas matter most:

- » Protein quantity and protein quality: Protein enrichment is becoming increasingly important. The key is to make targeted use of the different functional properties of plant-based raw materials and combine them in a way that delivers a balanced amino acid profile.
- » Micronutrients as a baseline expectation: Calcium, vitamin D and B vitamins are now established elements of fortification in many markets. Looking ahead, iodine and vitamin B12 are likely to matter more as manufacturers aim to build long-term credibility. The key question is not only whether products are fortified, but how: bioavailability, stability across shelf life and clean taste without metallic notes are decisive for repeat purchase.

Fig. 1:
Global plant-based
milk market volume
(2020–2030F,
thousand tonnes).
Source: Euromonitor

Geography	Category	Data Type	Unit	2020	2021	2022	2023
World	Plant-based Milk	Total Volume	kt	9526,5	10298,8	10658	10472,5
World	Plant-based Yoghurt	Total Volume	kt	236,8	267,7	276,4	272,6
World	Plant-based Cheese	Total Volume	kt	71,4	79,3	86,7	84,5

» Fibre: “Plant-based” increasingly overlaps with broader health positionings. Fibre enrichment, prebiotic concepts and sugar reduction add value for better-for-you products – provided taste, texture, stability and labelling remain coherent.

Formulation and processing: where ambition meets reality

The most underestimated issues appear where multiple goals must be achieved at once: clean label, high protein, stable emulsions, reliable frothing, heat stability, long shelf life and cost efficiency. From a manufacturer’s perspective, three tension points stand out:

1. Off-notes and raw material variability: Pea and faba bean can introduce green or beany notes, while oat can vary towards cereal notes or bitterness depending on the raw material and enzyme management. Addressing this typically requires a combination of raw material selection, process control (including enzymatic steps and temperature profiles), targeted taste modulation and, where appropriate, flavour design.
2. Stability under functional pressure: More protein does not automatically mean better performance. Without the right dispersion and homogenisation strategy, sedimentation, grittiness and phase separation



2024	2025	2026	2027	2028	2029	2030	CR 2024-25	CAGR 2020-2025	CAGR 2026F-30F
10.470,7	10.553,0	10.693,3	10.864,4	11.059,8	11.276,5	11.502,4	0,8%	2,1%	1,8%
289,2	296,2	303,9	312,7	322,5	332,9	343,3	2,4%	4,6%	3,1%
83,8	83,9	84,4	86,0	88,2	90,7	92,9	0,1%	3,3%	2,4%

ration become likely. Shelf-stable formats such as UHT, DSI and downstream homogenisation add another layer: heat stability must be repeatable across production and the full supply chain. The interaction between proteins, fats, emulsifiers, hydrocolloids and particle management is what determines success – or complaints.

3. Clean label versus process security: Shorter ingredient lists remain a strong purchase trigger but often conflict with technical minimum requirements. Reducing stabilisers or emulsifiers means alternative routes are needed, for example through protein blends, optimised particle size, enzymatic modulation or process windows that stabilise texture more naturally. This demands development time, pilot work and tight alignment between R&D, procurement and production.

Emerging technologies: what is already delivering value

New technologies are starting to deliver practical impact. Precision fermentation can enable functional proteins that improve foamability, emulsification and mouthfeel in targeted ways. Adoption is likely to grow first where performance justifies a clear premium, especially in barista and high-protein segments. AI-supported formulation tools can accelerate development by exploring recipe spaces more systematically and identifying stability risks earlier. Composite proteins and multi-base systems are also gaining relevance: they can reduce off-notes, improve protein quality and stabilise texture without making ingredient lists unnecessarily long. The bottleneck remains scale: raw material availability and its standardisation, regulatory classification, investment needs and resilient supply chains will determine how widely these technologies spread over the next five to ten years.

Inclusivity and sustainability are now design parameters

Allergen-aware design is increasingly part of mainstream development pipelines. Soy-free, nut-free and gluten-free concepts respond to a broader set of dietary needs and can simplify listing across retail and foodservice. At the same time, they create formulation trade-offs: avoiding soy often leaves a protein gap, while avoiding nuts can remove key texture drivers. This pushes manufacturers towards system approaches rather than ingredient silos.

Sustainability has also become more technical. Brands and retailers increasingly expect robust data on carbon footprint, water use and land use, as well as traceable sourcing. Packaging expectations are tightening, too. Sustainability therefore needs to work in tandem with quality and cost – otherwise it remains a claim rather than a market advantage.

Outlook to 2030: leadership comes from the complete package

Plant-based beverages will continue to grow globally, but the success logic has changed. The category is moving towards clear quality markers: convincing taste without off-notes, credible nutrition with well-integrated fortification, robust processing for chilled and shelf-stable formats, and sustainability backed by measurable evidence.

The companies that integrate these dimensions will reduce development complexity, shorten time to market and deliver products that perform in real life – on shelf, at home and in the coffee shop. In a mature category, consistent excellence becomes the most reliable differentiator.

New plant-based sliced cheese

Elastic texture with attractive protein content

Plant-based cheddar cheese cubes (photos. Planteneers)



Plant-based cheddar cheese side

The market for plant-based milk and cheese alternatives is growing steadily and will continue to offer growth potential going forward. This is particularly the case for cheese alternatives. Planteneers is now setting a new bar – with a stabilizing and protein system from the fiildDairy CH series, food producers can now make plant-based alternatives to cheese slices with the classic smooth, elastic texture and a high protein content of up to eight percent. Thus, stabilizing expert Planteneers addresses the two most important reasons people buy cheese alternatives: enjoyment and health.

Flexible system enables broad product palette

Plant-based alternatives to sliced cheese have until now had low protein contents. The reason is that protein generally negatively influences texture. “The higher the protein component, the more complex the interplay of texture and flavor,” explains Dr. Pia Meinlschmidt, Head of Product Management at Planteneers. “As soon as you add protein the structure becomes sandy and friable. The typical elasticity and flexibility are lost. In addition there is a plant off-taste, that varies with the protein

basis. Quite apart from that, adding protein sources usually shifts the color towards beige or brownish.” With the new functional system, Planteneers has now succeeded in overcoming these central technical barriers. The final products feature good sensory and functional qualities despite their higher protein content. The elastic slices look good and also cut very well.

“Our basic stabilizer based on modified starches already enables the production of plant-based alternatives to sliced cheese without protein,” notes Meinschmidt. “This gives elastic slices that can be made in different flavor varieties like butter cheese, gouda, and stronger cheeses. Combining this with a protein mix lets customers offer flexible protein contents up to eight percent, as desired.”

In the development phase Planteneers started with a combination of fava beans and wheat, giving a particularly elastic texture and very neutral flavor profile. According to Meinschmidt, the combination was very well received by customers in initial projects. However, freedom from allergens was a central issue. “Many customers don’t want to use gluten in their production,” says Meinschmidt. “So we tested other protein mixes and

finally developed a blend of different plant proteins. These complement each other’s functional and sensory characteristics so well that we can make gluten-free slices whose texture and taste are almost identical to the version with wheat.” Flavors from mild to sharp make for a varied product range. Individual inclusions like fenugreek or peppercorns can create further purchase incentives.

Cubes & sticks: Cheddar-style snacks

Alongside appealing flavor and high protein content, clean label is another desirable criterion in the plant-based market. To meet the demand Planteneers has developed a functional system with which manufacturers can market protein-rich, clean-label products as plant-based alternatives to cheese snacks like cubes and sticks. The system is based on native starch and a mix of plant proteins. The final products in cheddar flavor feature a protein content of up to seven percent, addressing one of the 2026 Top Trends identified by Innova Market Insights – tasty, protein-rich snacks. They offer an authentic taste experience, firm bite, and creamy mouthfeel, without declarable E-numbers or other additives like preservatives or flavor enhancers.

MÖ FOODS

Cheese alternative from oats

The Finnish food company Mö Foods has secured financing of €2.4 million, led by Nordic Foodtech VC. Mö aims to redefine cheese alternatives with its oat-based products and, with the investment, will further develop its production technology while also advancing its international expansion.

The company was founded in 2017 and develops new cheese alternatives made from oats. Thanks to its proprietary manufacturing process, Mö’s cheeses, according to the company’s own claims, match traditional dairy products in terms of taste, texture, and cooking properties. The product range includes both melting and slicing cheese varieties, all made from Finnish oats. Currently, the cheese alternatives are already available in the shelves of the largest Nordic supermarket chains—and are expected to launch in the entire European market soon.



Mö Foods develops cheese alternatives from oats (photo: Mö Foods)

Yeast-based LIKE MILK

A new category of milk-alternative beverages

Asahi Group Japan has launched LIKE MILK, the country's first yeast-based beverage with milk-like characteristics. The product is packaged in SIG SmallBloc aseptic cartons and filled using the SIG Small 12 Aseptic filling machine, a high-output, flexible filling solution from SIG. LIKE MILK is currently in test sales in selected Japanese supermarkets and e-commerce channels, with plans to expand distribution by 2026. The launch is marking a first step of the partnership between Asahi Group Japan and SIG.

Filled by co-packer Mori Milk, the debut of LIKE MILK represents Asahi's first commercial product in partner-

ship with SIG. "LIKE MILK is yeast-based and developed using Asahi Group's proprietary yeast technology. The result is a beverage containing levels of protein and calcium comparable to cow milk, yet free from milk components and the 28 specified allergenic ingredients. This makes it ideal for health-conscious consumers and people dealing with dietary restrictions," said Tomohiro Hata, Senior Manager, Future Creation Headquarters Department at Asahi Group Japan.

Central to the launch is the SIG Small 12 Aseptic – a flexible filling machine capable of supporting two carton formats, SIG SmallBloc and SIG SmallFit, and handling up to 16

aseptic carton variants, including various volumes plus closure and straw solutions on a single filling system. With an output of 12,000 packs per hour, the filling line enables beverage manufacturers to accelerate product development, speed up time-to-market, and respond quickly to consumer trends. Its ability to switch between volumes and formats in just a few minutes while maintaining high output enables brands to keep pace with consumer preferences and reduce time-to-market.

"The SIG Small 12 Aseptic offers brands such as Asahi the flexibility to prototype new ideas and commercialize them quickly and at scale," said Angela Lu, President & General Manager, Asia Pacific at SIG.

Asahi Group Japan has launched LIKE MILK, the country's first yeast-based beverage with milk-like characteristics (photo: Asahi)



KYNDA OPENS INDUSTRIAL FERMENTATION SITE

Protein from food sidestreams

Kynda, a biotechnology company specializing in fermentation-based protein production, has opened a new research and production facility in Jelmstorf, Lower Saxony. The 720-square-meter site combines laboratory and production operations, with the aim of converting underutilized food processing sidestreams into fungal mycelium for use as protein. The facility includes 360 square meters of R&D space focused on process optimization and substrate adaptation, alongside a production area with 40,000 liters of fermentation capacity. This scale enables the development of

starter cultures which, according to the company, can support the decentralized production of up to 25,000 tons of fungal mycelium annually at customer facilities. Targeting overlooked materials in the EU food system Kynda's fermentation process is designed to operate within existing industrial infrastructure, targeting sidestreams from plant protein processing, soy and oat beverages, dairy, sugar, and starch production. The company reports that more than 90 million tons of such sidestreams remain unused across the EU each year, despite containing nutrient-rich components.

NEW WHITEPAPER

Ingredients and Biosolutions

As food systems come under increasing pressure to deliver more nutritious food with fewer resources, a new whitepaper by Food Nation explores how Denmark is addressing these challenges through its ecosystem of ingredients and biosolutions.

Titled "Ingredients and Biosolutions – Smart Danish solutions for sustainable food systems and global food security," the paper presents a wide range of Danish products and solutions. These include functional food and feed ingredients as well as biosolutions, such as bio-based technologies that apply biology directly in agriculture and food processing.

According to the report, Danish companies and research institutions are using circular principles to create new value from agricultural by-products and unused biomass. These solutions include fermentation-based technologies, enzymes, microbial cultures, biostimulants,

and biological crop protection. This approach enhances environmental sustainability and economic performance while strengthening supply chain resilience in the face of global challenges.



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