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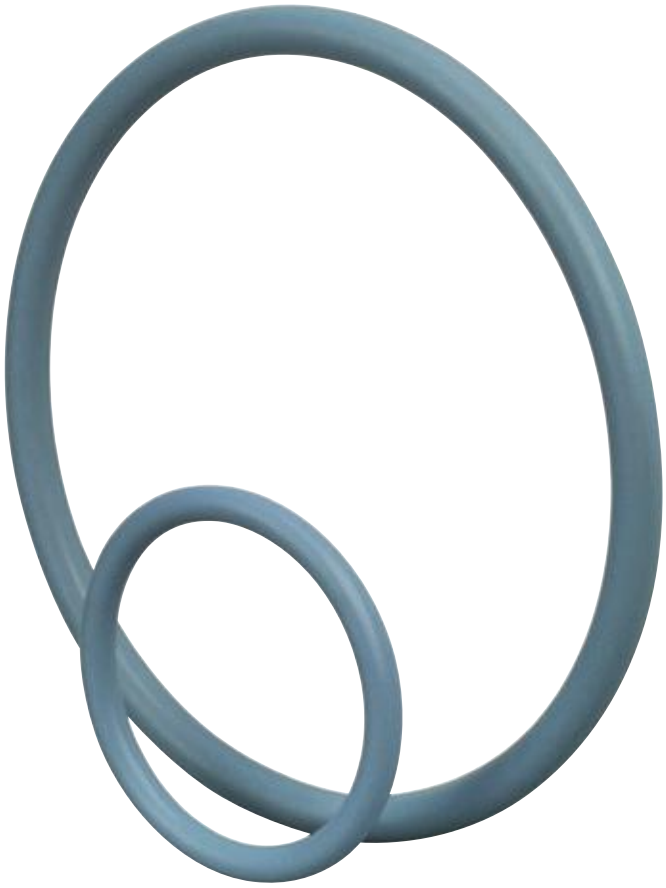

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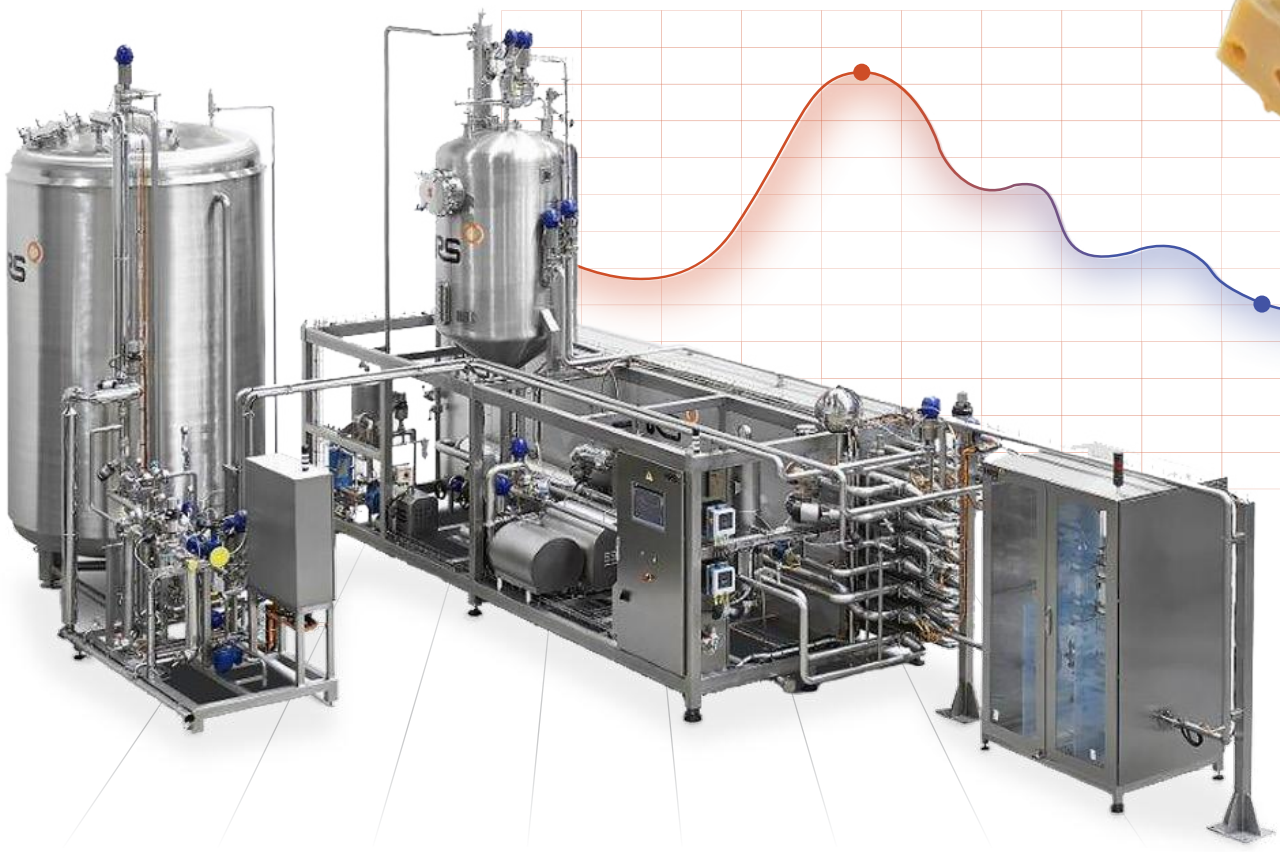

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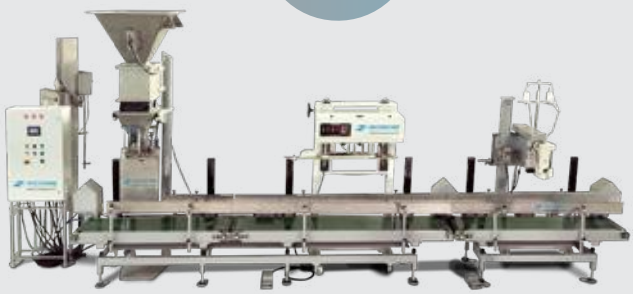

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Dear Readers,

We're excited to bring you the February - 2026 edition of our magazine.

As the global food and beverage industry continues its transition toward smarter, cleaner, and more sustainable production models, the February 2026 edition of Food & Beverages Processing focuses on the innovations reshaping dairy, packaging, and ingredient development. This issue brings together forward-looking perspectives that reflect how technology, sustainability, and nutrition are converging to redefine modern food systems.

Our processing segment opens with ***From Farm to Future: How Sustainable Dairy Production is Reshaping the Global Food System***, exploring how responsible farming practices, energy-efficient processing, and traceability-driven supply chains are helping dairy producers meet environmental goals while strengthening long-term resilience. Complementing this is ***Engineering the Future of Dairy: Modular Facilities Meet Smart Manufacturing***, which examines how flexible plant design, automation, and digital intelligence are enabling processors to adapt quickly to evolving consumer demand, product diversification, and operational efficiency.

In packaging, we spotlight emerging technologies and critical infrastructure shaping the packaged foods sector. ***Carbon Dots and the Future of Intelligent Food Packaging*** highlights how advanced nanomaterials are opening new possibilities for freshness monitoring, safety indicators, and smart labeling. Alongside this, ***Supporting the Growth of Packaged Foods with Reliable Compressed Air Infrastructure*** underscores the often-overlooked role of clean, efficient compressed air systems in ensuring consistent production quality, food safety, and operational uptime across packaging lines.

Our ingredients segment reflects the growing shift toward functional nutrition and plant-forward choices. S***oy Milk: The Plant-Powered Beverage Redefining Modern Nutrition*** explores the rapid rise of soy-based beverages, driven by health awareness, sustainability concerns, and evolving dietary preferences. Rounding out the edition is ***Functional Ingredients Innovation in Dairy and Dairy-Based Functional Foods***, which explores into how probiotics, bioactive compounds, and fortified formulations are transforming traditional dairy into value-added, wellness-oriented products.

Together, these features offer a comprehensive snapshot of an industry in transformation, where sustainability meets smart manufacturing, packaging embraces intelligence, and ingredients evolve to support healthier lifestyles. We hope this edition provides our readers with meaningful insights and practical inspiration as they navigate the opportunities and challenges of a rapidly changing food and beverage landscape.

Further, Please log on to our website (www.foodnbeveragesprocessing.com) for more articles.

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Contents

PROCESSING TECHNOLOGY

PACKAGING TECHNOLOGY

INGREDIENTS & ADDITIVES

WAREHOUSING & LOGISTICS

Contents

CORPORATE HAPPENINGS

SUSTAINABILITY

NEWS & INDUSTRY UPDATES

Beyond Meat® Launches Beyond Immerse™ Protein Drink

Beyond Meat, Inc. announced Beyond Immerse, an innovative combination of plant protein, fiber, antioxidants, and electrolytes designed to replenish the body with every refreshing sip. The line will debut in three crisp and invigorating flavors: Peach Mango, Lemon Lime, and Orange Tangerine. Starting today, Beyond Immerse will be available for a limited time exclusively on Beyond Test Kitchen.

"With Beyond Immerse, we are bringing our pioneering expertise in unlocking the power of plants to a functional beverage line," said Ethan Brown, founder and CEO of Beyond Meat. "Our intent is simple: immerse the consumer in the remarkable nutrition of plants—from protein to fiber, with the addition of antioxidants and electrolytes—all in a single refreshing and satisfying 12 fl oz drink. Beyond Immerse has been specially and carefully designed to provide nutrients that are critical to muscle health, gut health, and immune function, so that whatever the goal is, consumers can Go Beyond."

Beyond Immerse Highlights:

- Features plant-based ingredients like protein from peas and fiber from tapioca
- Available in 3 flavors: Peach Mango, Lemon Lime, and Orange Tangerine
- Each flavor will come in two protein options:
- 10g protein/7g fiber/60 calories
- 20g protein/7g fiber/100 calories
- Good source of protein, critical to support muscle health
- Excellent source of fiber with 7g per serving, vital to support a healthy gut
- Excellent source of antioxidant Vitamin C, essential to support immune function
- Made with electrolytes
- No GMOs or sugar alcohols

Starbucks India Collaborates with Twentyseven Bakehouse

TATA Starbucks has collaborated with Mumbai-based TwentySeven Bakehouse to introduce a curated range of handcrafted food offerings at several stores across Mumbai including the Starbucks Reserve® store and coffee experiential stores. Alongside Starbucks signature food and beverage offerings, customers can now look forward to a selection of TwentySeven Bakehouse's signature bakes, artisanal breads, salads, sandwiches and nourishing bowls to enjoy with their coffee.

The collaboration is designed to delight customers with a wider variety of food options that pair naturally with their signature Starbucks coffee and fit seamlessly into everyday moments. The menu brings together bakery favourites such as croissants, alongside wraps, bowls, desserts, and shareable bites, offering customers greater choice across occasions.

"Our customers come to Starbucks for great coffee and familiar food they enjoy day-to-day," said Adrit Mishra, COO, TATA Starbucks. "This collaboration with TwentySeven Bakehouse introduces a new set of offerings alongside our existing menu, giving customers new flavours and experiences to discover. It reflects the shared focus of both brands on care, quality and attention to detail, while keeping the Starbucks experience consistent and familiar."

Aditya Dugar, Co-Founder & Director, Urban Gourmet India/TwentySeven Bakehouse said, "This was a partnership that made sense right from the start. We're excited to partner up with the biggest coffee company in the world, and serve up our bakes, salads and sandwiches to the discerning Starbucks customer. The brand is already known for its world-class coffee, and I can't think of a better partner to offer bakes and coffees that are baked and brewed bold."

The offerings are now available at the Starbucks Reserve® and coffee experiential stores in Mumbai.

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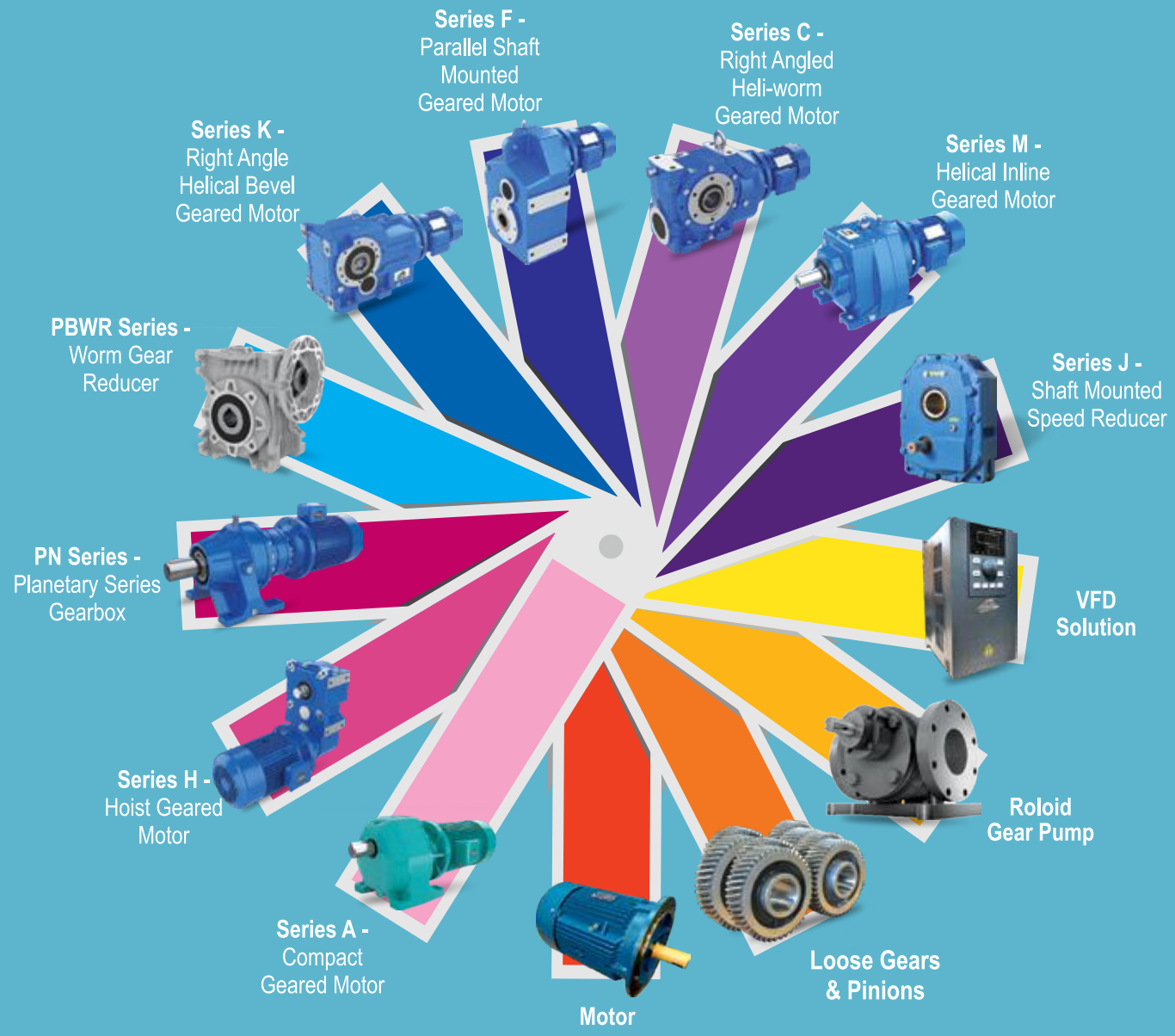

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Ghodawat Consumer Limited Launches Soya Chunks

Under STAR Brand to Tap India's Growing Plant-Based Protein Market

The soya chunks market in India is witnessing robust growth, driven by increasing health consciousness, rising disposable incomes, and the growing popularity of vegetarian, vegan, and flexitarian diets. The meat substitutes category is expanding at a rate of approximately 10% CAGR, presenting significant opportunities for brands with strong distribution networks and high-quality credentials. In line with this, Ghodawat Consumer Limited (GCL), the FMCG arm of Sanjay Ghodawat Group, has announced the launch of soya chunks under its STAR brand, marking a strategic expansion into the fast-growing plant-based protein segment. The launch comes at a time when Indian consumers, from gym-goers to vegetarian families, are actively seeking affordable ways to boost their daily protein intake.

The soya chunks launch diversifies STAR's staples portfolio with a high-protein, affordable, and health-focused product, complementing the company forays into vacuum-fried 100% fruits and veggies and non-alcoholic beverages. This launch aligns with shifting lifestyle trends, supporting sustainability and affordability by offering nutritious alternatives to meat for both rural and urban consumers. It builds a foundation for future expansion into protein-rich and functional foods, reinforcing STAR's leadership in health and wellness.

Salloni Ghodawat, CEO, Ghodawat Consumer Limited, said, "We are seeing a fundamental shift in how Indian families think about nutrition. The demand for protein is no longer niche, it cuts across millennials tracking macronutrients, professionals seeking quick nutrition, value-conscious families, and consumers in tier-2 and tier-3 towns where awareness of plant-based protein is rising rapidly. Soya chunks offer a compelling solution—they are affordable, rich in protein, and extremely versatile. With STAR Soya Chunks, we are addressing a clear consumer need while staying true to our promise of quality and accessibility."

Manufactured in FSSAI-approved, ISO-certified facilities, STAR Soya Chunks are produced using advanced extrusion technology that converts defatted soy flour into textured vegetable protein under high temperature and pressure. Each batch undergoes rigorous quality checks to ensure consistency in texture, rehydration properties, hygiene standards, and protein content. The product is packaged in food-grade, moisture-resistant laminate material designed to preserve freshness and ensure safe storage and last-mile distribution.

A key differentiator of STAR Soya Chunks is their clean-label formulation. The product contains zero preservatives, no additives, and no artificial flavouring, addressing increasing consumer demand for transparency and minimally processed foods. Made from defatted soy flour, a nutrient-dense by-product of soybean oil extraction, the chunks offer high protein content with a complete amino acid profile. Their porous structure allows them to absorb spices and marinades effectively, delivering a fibrous, meat-like texture once rehydrated—appealing to flexitarians and consumers transitioning toward plant-based diets.

To drive rapid market penetration, GCL has rolled out a multi-channel distribution and marketing strategy. STAR Soya Chunks will be available across modern trade partners alongside extensive general trade distribution through kirana stores, with an emphasis on smaller, trial-friendly pack sizes. The product will also be sold via e-commerce and quick-commerce catering to convenience-led consumers. GCL is also targeting the HoReCa segment for bulk and institutional demand.

The company will deploy digital-first marketing campaigns across Instagram, Facebook, and YouTube, highlighting health benefits and recipe versatility. Influencer collaborations with fitness and food bloggers, content marketing through recipe videos and reels, and in-store sampling counters in modern trade outlets will drive trial and repeat purchases.

With STAR's strong rural reach and value positioning, GCL expects the product to build meaningful scale over the next 2–3 years and contribute steadily to its staples portfolio. As India continues to emerge as a key global supplier and consumer of soya-based products, the launch positions Ghodawat Consumer Limited to capitalise on the convergence of affordability, nutrition, and sustainability in the evolving protein landscape.

Eastern celebrates International Chicken Curry Day with the launch of 'The Chicken Song', a musical campaign

Eastern, a leading player in spices, masalas and foods, and part of Orkla India, marked International Chicken Curry Day with the launch of the 'Eastern Chicken song', a high-energy musical tribute that celebrates Kerala's deep-rooted love for chicken curry — a dish that cuts across homes, communities and occasions.

Conceptualized as a fresh cultural expression rather than a conventional brand film, Eastern Chicken song brings to life the everyday emotions, nostalgia, and joy associated with chicken curry, a staple that holds a special place in Kerala's culinary identity. Powered by Eastern Chicken Masala, the anthem underscores how the brand remains an integral part of kitchens — from simple weekday meals to celebratory feasts.

Set to a folk-rock soundscape, the music

video captures Kerala as a lively mosaic of food cultures, communities and shared moments — from everyday family meals to festive gatherings. Powered by Eastern Chicken Masala, the film subtly reinforces the brand's presence in kitchens across generations, without letting branding overshadow the storytelling. The anthem features playback singer Sooraj Santhosh as the voice of the song and actor Manikuttan as the face of the campaign, lending both energy and familiarity to the narrative.

Commenting on the initiative, Mr Girish Nair, CEO, Eastern said, Girish Nair, Chief Executive Officer, Eastern, said: "Chicken curry is not just a dish in Kerala. It's a dish woven into the social fabric in Kerala. With the 'Chicken Song,' we wanted to celebrate the everyday joy that chicken dishes brings into our lives in Kerala. This is our way of thanking generations of consumers who have made Eastern a part of their kitchens and their stories."

Praveen Ramaswamy, Chief Marketing Officer, Eastern noted "We saw this campaign as an opportunity to step back from product centric communication and instead celebrate a cultural truth. Chicken curry is staple in Kerala and Eastern Chicken Masala has been quietly an integral part of the journey for decades. Musica allowed us to tell this story in a way that feels organic, inclusive and emotionally resonant"

"For FCB, this was an opportunity to build a brand idea rooted in lived culture rather than advertising convention. Chicken curry in Kerala is an emotion – deeply democratic, deeply personal. Eastern's belief in the insight allowed the team to execute what feels less like a campaign and more like a cultural expression – authentic and unmistakably Malayalee.", said Sareesh Jameskutty, Vice President, FCB Ulka.

With Eastern Chicken Song, the brand takes a refreshing approach to storytelling, using music and culture to connect with audiences across generations, while reinforcing its position as the masala that elevates every chicken curry.

The campaign comes together to create a spirited, culturally resonant piece that reflects the brand's legacy as deeply rooted in Kerala's food heritage.

Campaign Link: https://www.youtube.com/watch?v=xnmj1HS1y4o

Team Credits for film production

Sooraj Santhosh, the voice behind the anthem

Actor Manikuttan, the face of the anthem

Mridul Nair, the director of the ad

Manikanadan Ayyappa, the music director who set the rhythm

Suhail Koya, the lyricist who penned the anthem

BuyBuyCart Expands Private Label Portfolio with Launch of B2 Premium Snack Range

BuyBuyCart, one of India's fastest-growing retail supermarket chains, has announced the expansion of its private label portfolio with the launch of B2 Premium, a new range of snacks and food products. The launch marks a strategic step in strengthening BuyBuyCart's private label presence across high-demand everyday categories.

B2 Premium is a brand that focuses on quality through its offering, a selection of snacks that are not only of the highest quality but also palatable and nutritious. Their selection consists of dry fruits, flavored makhana, crunchy chips, cookies, cakes, candies, tea & condiments and other staples that are all designed to satisfy the varying tastes and nutritional needs of today's consumers. The products are processed and sourced to retain the natural taste and nutrients, thereby making them perfect for everyday use and even gifting.

Speaking on the announcement, Ashish Pandey, Director & Co-Founder of BuyBuyCart, said, "The addition of our private label to the snack categories is a significant step towards building a stronger product ecosystem. By distributing these items through our network of stores across India, the B2 Premium range is expected to reach 200–300 stores, making them even more accessible and convenient for customers. Our mission is to create reliable, high-quality products that become a part of daily consumption habits without any hassles, while strengthening the value proposition of BuyBuyCart's franchise network nationwide."

The B2 Premium products will be available across BuyBuyCart franchise stores, on Amazon, and via the company's official website, ensuring wide accessibility across offline and online channels. Customers can also purchase select products through BuyBuyCart's quick-commerce platform, "BuyBuyCart – Grocery in Minutes," which is currently being rolled out in regions where the brand's franchise stores are operational.

Cornitos Introduces Korean Chilli Nachos, Expanding Its Flavour Innovation Portfolio

Cornitos, India's leading brand in nachos and healthy snacking, has launched its latest flavour innovation — Korean Chilli Nachos. Inspired by the bold and vibrant flavours of Korean cuisine, this new addition celebrates Cornitos' commitment to bringing global taste experiences to Indian consumers. As Indian consumers increasingly explore global taste experiences, Cornitos continues to lead the snacking evolution with products that bring world flavours to Indian shelves. The new Korean Chilli Nachos combine bold spice, authentic Korean notes, and the signature Cornitos crunch, delivering a fiery, flavourful, and irresistibly crunchy experience in every bite.

At Cornitos, our customers continue to inspire every innovation we create. Over the years — from Nachos to Nuts, Crusties to Tortillas, Tacos to Dips — we've built a diverse snacking portfolio that's loved across India. Taking inspiration from the global K-trend that India has enthusiastically embraced, we're now adding a bold twist to our signature Nacho Crisps with the launch of Korean Chilli Nachos.

Fiery, flavourful, and irresistibly crunchy, it delivers a world-class snacking experience in every bite. This is our spiciest and most exciting creation yet — crafted to delight the adventurous Indian snacker," said Mr. Vikram Agarwal, Managing Director, Greendot Health Foods Pvt. Ltd.

With this launch, Cornitos once again reinforces its commitment to innovation, health, and global flavour leadership in the snacking category. The Korean Chilli Nachos will be available in major retail outlets, modern trade stores, and leading e-commerce platforms across India.

About Cornitos Cornitos, a brand of Greendot Health Foods Pvt Ltd, is a pioneer in the Indian snacking industry, redefining the way consumers experience snacks with bold flavors and innovative offerings. Established in 2009, Cornitos introduced Nacho Crisps to India, setting new benchmarks in taste, quality, and healthy snacking. Over the years, the brand has expanded its portfolio to include a diverse range of premium, gluten-free, and trans-fat-free snacks crafted to meet evolving consumer preferences.

From its signature Nacho Crisps to the newly launched Crusties, a baked-puffed snack available in exciting flavors and continues to push the boundaries of snacking innovation. The brand also offers an extensive selection of Taco Shells, Tortilla Wraps, Roasted Nuts & Seeds, and Mexican Delights such as Chunky Salsa, Cheese Dips and Gherkins, catering to a wide range of tastes and preferences. Cornitos has a strong distribution network across India, with products available in retail, e-retail, modern trade stores, and institutional sales channels like airlines, Horeca, multiplexes, and cafés. Expanding globally, it exports to over 30 countries, including the USA, Australia, China, Russia, UAE, Saudi Arabia, Maldives, Hong Kong, Nepal, Sri Lanka, and Southeast Asia.

Committed to quality, innovation, and sustainability, Cornitos operates a state-of-the-art manufacturing facility in Roorkee, certified with ISO-22000, Halal, and BRC. It also prioritizes sustainability through solar power installations and water recycling initiatives.

Recognized with industry accolades like the Economic Times Best Brands Award, Cornitos enhances the snacking experience by blending taste, health, and convenience while engaging consumers through experiential events and marketing initiatives.

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Vikram Roller Flour Mills expands portfolio with entry into Rice category

The company adds Basmati rice category alongside its existing range of Chakki Atta, Maida, Sooji and Dalia, with the range to be developed gradually.

Vikram Roller Flour Mills Limited (Vikram Mills), a long-established name in India's wheat-based food segment, has entered the rice category. The company is expanding beyond wheat flour and allied staples to include everyday food products such as rice and rice-based items.

Through this expansion, Vikram Mills is looking to increase its presence in essential food categories linked to regular consumption. The basmati rice products will be introduced in stages. Distribution of rice range will cover retail outlets alongwith institutional customers such as hotels, restaurants, food service operators and FMCG companies. The focus will remain on supply continuity while maintaining the product quality. The company supplies its products from its own manufacturing units, including facilities at Lawrence Road Industrial Area (Delhi) and Kiloi, Rohtak. These plants will support the expanded portfolio and ensure controlled, uninterrupted supply across categories.

Vikram Mills has spent the past few years studying customer preferences and demand in basmati rice category. The company has entered the segment after reviewing demand trends and procurement requirements and has ensured supply-chain preparedness before introducing rice. According to the management, customers are increasingly sourcing more than one staple product from manufacturers they already work with.

Basmati rice sourcing will follow a paddy-to-rice model, similar to the company's wheat sourcing approach. Paddy will be procured directly, stored in warehouses for ageing and processed into rice, allowing better control over quality, grading and consistency—on lines comparable to wheat-to-flour operations at Vikram Mills. The rice portfolio has been planned keeping in mind the regional consumption habits and bulk usage requirements. Initial offerings will focus on commonly consumed, high-quality variants, with scope for additions based on market response and feedback from trade partners and buyers.

Speaking on the development, Mr. Shubham Garg, Director, Vikram Roller Flour Mills Limited, said, "Staple foods continue to form the backbone of everyday consumption in India. While wheat-based products remain our core strength, rice is an equally important category across regions. Our entry into basmati rice builds on our manufacturing and sourcing capabilities and allows us to offer customers a wider range of essential products."

The rice category will be supported through sourcing, grading and processing practices similar to those followed for the company's wheat products. The same checks related to hygiene and traceability will apply to the rice range. Over the years, Vikram Mills has built working relationships across procurement, processing and distribution, which are expected to support the steady rollout of the rice business. These existing systems will continue to support the category as it scales in a measured manner.

Its existing product range includes Chakki Atta, Maida, Sooji, Rawa and Dalia, supplied to both household consumers and institutional customers. Basmati rice has now been added to this range. The rice business will be developed in a phased manner, with emphasis on stable operations and market response. Vikram Mills supplies its products across several markets, including tier-II and tier-III locations, through its distribution network. The company works with institutional buyers and trade partners in these markets.

With the addition of basmati rice, Vikram Mills is extending its presence within everyday staple foods while building on its existing manufacturing, sourcing and distribution capabilities. The category will be developed steadily, in line with operational readiness and demand across markets.

CHACHA'S Pickle Enters the Indian Market, Aiming to Serve 10 Million People

At a time when speed has replaced patience and convenience has overtaken craft, CHACHA'S, a heritage-inspired food brand from Mohali, Punjab, has officially entered the Indian market with a mission to revive the disappearing art of traditional chulha-to-jar pickling, aiming to bring its slow-cooked flavors to 10 million people across India. Rooted in ancestral Punjabi recipes, CHACHA'S manages every step entirely in-house at Sohal's residency from hand-selecting ingredients and whole spices to slow cooking, natural ageing, and final packaging. This end-to-end approach ensures uncompromised quality, consistency, and authenticity in every jar.

What sets CHACHA'S apart in an industry often challenged by hygiene and sourcing concerns is its family-led model . With no external labour involved, the founding family oversees every stage from sourcing and cooking to packaging, label design, and even the website. Hygiene is not just a compliance requirement but a personal commitment: the same pickles sold to consumers are enjoyed by the founders' children. This dedication is reflected in strong consumer loyalty, with 60–70% of customers returning for repeat purchases.

Even before its market debut, CHACHA'S successfully defended a trademark challenge from ITC under Class 29 in 2018–19, underscoring the brand's integrity and long-term vision. Founded by the chacha–bhatija duo Manpreet Singh and Ravinder Singh, CHACHA'S revives homestyle pickles made using time-honoured methods once common in Punjabi households. Unlike mass-produced condiments, every jar begins on a slow-burning flame, allowing spices to bloom naturally and flavours to mature patiently.

"Facing a trademark objection early on taught us the importance of building a brand the right way from day one," said Manpreet Singh, Founder, CHACHA'S. "We didn't just want to sell a product; we wanted to preserve a memory. Our goal is to keep the fire of traditional pickling alive."

"We take it straight from the stove to the jar," added Ravinder Singh, Co-Founder, CHACHA'S. "It's not just a pickle, it's a piece of home that time couldn't change. We're bringing the village to the city, one jar at a time."

Beyond tradition, CHACHA'S is redefining pickles as a new-age snacking category rather than just a side dish. The brand aims to build a strong community of consumers who value authenticity and flavour, with the long-term vision to become India's most trusted homestyle pickle brand, known for ethical practices and uncompromising quality from kitchen to consumer.

Product Range & Pricing

- Non-Vegetarian Pickles: Starting at ₹498/-
- Vegetarian Pickles: Starting at ₹356/-

Popular offerings include Chicken Pickle, Punjabi Mutton Pickle, Noor-E-Gudh, Green Chilli Pickle, Green Mango Pickle, Mixed Vegetable Pickle, and Lemon Pickle, celebrating bold regional flavours while ensuring quality, safety, and consistency.
CHACHA'S products are available online at www.chachaspickle.in, with plans to expand through quick commerce channels across India.

POST BUDGET QUOTE

"The Union Budget 2026 recognises dairy as a key driver of farm income stability, nutrition security and rural employment. The announcement of a credit-linked subsidy programme to promote entrepreneurship in animal husbandry, including dairy, is a timely step that will support the growth of organised dairy enterprises and strengthen allied agricultural sectors.

The budget's focus on scaling up the availability of veterinary professionals by more than 20,000, will play a vital role in supporting the dairy industry at grassroots level. It will significantly improve the overall productivity and profitability of the dairy sector in the rural regions where farmers and allied industries lose cattle in avoidable situations. For the FMCG and dairy sector, a stronger focus on dairy-led income diversification and allied value chains reinforces the agricultural backbone that supports essential food categories such as milk and dairy products. By encouraging entrepreneurship and investment in dairy enterprises, the Budget creates a supportive environment for sustainable supply chains while contributing to inclusive rural growth."

Akshali Shah, Executive Director, Parag Milk Foods

"The Union Budget 2026–27 is a forward-looking blueprint that democratises growth across India. As a brand rooted in Raipur, we welcome the focus on Tier-2 and Tier-3 cities as the Bharat's new growth engines. The revival of 2,000 industry clusters and the ₹10,000-crore MSME Growth Fund are masterstrokes for the manufacturing ecosystem. By integrating platforms like GeM and TReDS, the government is effectively solving the liquidity bottlenecks that often hinder small enterprises. Furthermore, the expansion of dedicated freight corridors and national waterways will drastically reduce logistics overheads, which is critical for the food processing industry to remain competitive globally._

The emphasis on SHE Mart and high-value agriculture—particularly the support for coastal crops and rural value chains—demonstrates a deep commitment to empowering women-led enterprises and farmers alike. Coupled with the reduction in the MAT rate to 14%, this budget doesn't just sustain economic momentum; it empowers the next generation of home-grown entrepreneurs to scale sustainably from the heart of India."

Akash Agrawalla, Co-founder, ZOFF Foods

Budget 2026–27 reflects a balanced approach to agriculture, food processing and consumption-led growth. Measures aimed at improving farmer incomes, strengthening agri-value chains and leveraging technology through initiatives such as Bharat-VISTAAR will benefit both producers and FMCG players. Enhanced investment in infrastructure and logistics will help reduce costs and improve market access for food products. The emphasis on rural entrepreneurship and women-led enterprises will support demand creation in semi-urban and rural markets.

Bipin Hadvani, Founder, Gopal Snacks

The Budget strengthens the critical linkage between agriculture and FMCG through a combination of farmer-centric initiatives, infrastructure investments and technology adoption. Measures aimed at improving farm productivity, reducing risk and enhancing market access will benefit plantation crops such as tea. There is a clear focus on rural incomes, women-led enterprises and improved access to MSME financing. Investments in logistics, freight corridors and customs process simplification are expected to improve supply chain efficiency and export competitiveness. The launch of Bharat-VISTAAR, which integrates AgriStack portals and ICAR's agricultural knowledge, can further boost productivity and reduce farm-level risks.

Sanjay Singal, CEO, Wagh Bakri Tea Group

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In today's industrial landscape, efficiency and sustainability are no longer optional; they're essential. Power Build, with its decades of engineering excellence, is at the forefront of this transformation. Through its advanced range of power transmission products, the company is actively helping industries minimize energy consumption, extend machine lifespans, and transition toward greener manufacturing practices.

Power Build's entire gearbox and geared motor portfolio is engineered with energy optimization at its core. Whether it's the Series M Helical Inline Geared Motors, known for their compact design and high efficiency, or the Series K Helical Bevel Geared Motors, offering torque up to 50,000 Nm with minimal energy loss, each product is built to maximize output while reducing unnecessary power draw. These solutions are precision-designed to minimize friction, vibration, and wear three major contributors to energy inefficiency and mechanical failure.

One of the most effective ways Radicon supports sustainability is through its gear systems' high mechanical efficiency, which directly contributes to lower electricity consumption in continuous operations. For example, the Series C Heli-Worm and Series F Parallel Shaft Geared Motors are designed to deliver optimal performance even under varying load conditions, reducing the stress on motors and associated systems. This not only conserves energy but also lowers the carbon footprint of plants over time.

Moreover, Power Build's planetary (Series PL) and worm gear (PBWR) series contribute significantly to space-saving, heat reduction, and maintenance-free operations all of which are key to sustainable plant design. Many of these gearboxes are pre-filled with high-grade lubricants and designed for long maintenance cycles, ensuring reduced downtime and lower waste generation over the life of the equipment.

To complement its mechanical excellence, Radicon also offers the PBL VFD Series (Variable Frequency Drives) a modern, electronic solution that brings intelligent speed and torque control to the table. These drives allow motors to operate at optimal speeds, cutting down on excess energy use during startup, operation, and load variations. The result is a finely tuned drive system that aligns with green manufacturing goals.

Lastly, through extended equipment life cycles, Radicon products inherently reduce the need for frequent replacements and resource consumption. Gear units like the Series J Shaft Mounted Reducers and Roloid Gear Pumps are crafted with durability and long-term efficiency in mind, further reinforcing the company's commitment to sustainable industry practices.

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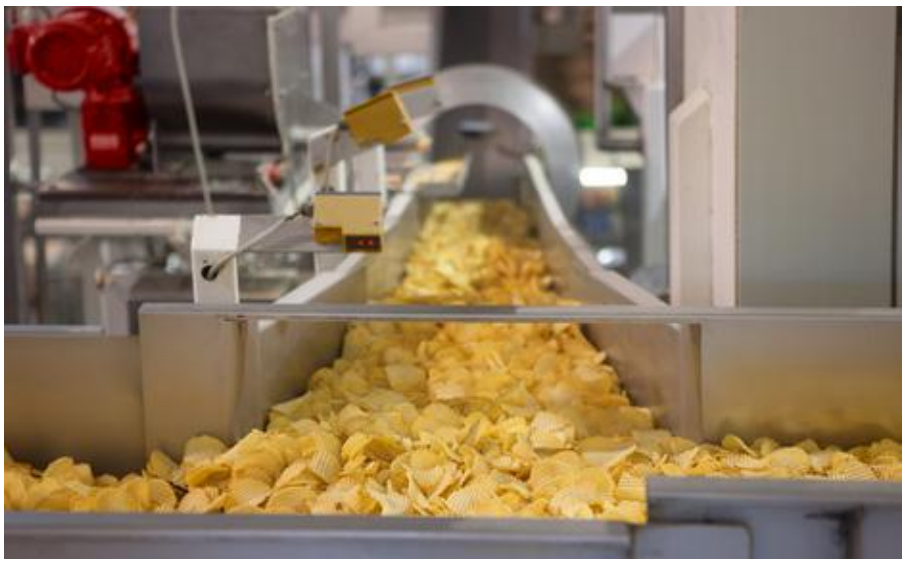
Securing Potato Based Food Production: A Holistic Approach to Contamination Prevention



Kati Hope, Global Account Manager, Mettler-Toledo Product Inspection

Potato-based food – the trend that shows no signs of slowing. As a staple ingredient, potatoes are here to stay. Global potato production exceeded 376 million metric tons in 2021, with China, India, Ukraine and Russia leading the charge[1]. Whether it's French fries, potato waffles or mash, the popularity of potato-based products in ready meals and snacks continues to grow. In 2021 alone, the US processed over 270 million centum weight (cwt) of potatoes for use in products like chips and fries[2]. This high demand means that food manufacturers must continuously raise the bar in terms of the safety and quality checks applied throughout the production process, so that potato-based foods are free from physical contaminants.

The ongoing threat of physical toxins and foreign bodies invading the potato-based food supply is a near-constant risk and a very serious threat, despite technological advances and the close attention paid to food safety procedures. This is especially true for potato-derived products like chips, which are often processed from raw potatoes that come directly from the field.

The US Department of Agriculture's Food Safety and Inspection Service reported in 2019 that over a quarter of product recalls that year were due to the presence of "extraneous material" in food products[3]. These incidents underscore the imperative need for all food manufacturers, including those producing potato-based products, to proactively address, detect and eliminate physical contaminants to maintain the integrity of their products.

The consequences of contamination are not only immediate but can have enduring impacts. Factors such as the severity of a product recall, post-recall efforts and the brand equity of the company influence consumer perceptions. The intricate interplay between remedy and brand equity, particularly during high-severity failures, underscores the importance of a strategic and comprehensive response to contamination incidents.

Understanding Contamination Dynamics

The story of potato-based food begins where soil meets seed - a sprawling expanse of farms, orchards and fields, cultivating the very essence of potato-derived sustenance. It is here where potatoes flourish under the sun's nurturing warmth that a complex narrative of potential contaminants emerges.

Within the vastness of these agricultural landscapes, where the earth is sown, tended and harvested, it is easy to see how metals and rock particles find their way into the potato-based production process.

Contamination complexities unfold from the natural harvest to the production line, with challenges intensifying as these contaminants hide within potatoes. Detecting them becomes tricky due to differences in size and density, especially when a contaminant matches the density of the product or its packaging - a challenge for traditional inspection methods.

Each product and application require a unique detection solution, adding layers of complexity. Potato food manufacturers, bridging nature and technology, must tread this landscape with precision, understanding the subtle nuances of size, density and the stealthy entry of foreign elements into potato-derived products like chips, crisps and potato waffles.

Identifying Weaknesses in the Production Line

Food safety risks from physical contamination can occur anywhere along the production line, from the raw material stage to packaging. The good news is that there are formal frameworks available to aid food businesses in evaluating their manufacturing methods and the most vulnerable points to foreign body contamination.

Hazard Analysis and Critical Control Point (HACCP) and Hazard Analysis Risk-based Preventive Controls (HARPC) audits are intended to assist manufacturers in identifying these vulnerable potential points of contamination. While HARPC aids in planning to mitigate against situations like intentional adulteration, food fraud and terrorist activities, HACCP assists in identifying the danger of infection. Potato food manufacturers face particular challenges, as raw potatoes can sometimes carry soil or foreign matter directly from the field. The earlier a hazard can be discovered throughout the production process, the better.

All manufacturers will be able to set up control points so that checks and systems are properly positioned to help remove

food safety hazards based on the findings of these audits. These are referred to as Preventative Control Points (PCPs) and Critical Control Points (CCPs), respectively. A strategy to reduce the risks of physical contamination can be put in place by understanding how contamination happens and identifying weak spots in the potato production process.

Implementing Multi-layered Defence Strategies

Establishing robust defences against foreign body contamination is pivotal and demands a strategic approach across diverse production stages. The potato-based food manufacturing process necessitates a comprehensive three-tiered defence.

Commencing at the initial stage of raw material inspection, early detection involves scrutinising incoming materials like potatoes for potato-based ready meals, crisps and potato chips. Detecting physical contaminants at this juncture not only helps with the purity of the raw materials but also shields downstream processing equipment from potential harm caused by undetected contaminants, such as stones in a batch of potatoes. This proactive step aims to eradicate foreign bodies before value-adding production processes begin, minimising the risk of contaminants reaching advanced stages of production and escalating costs.

The second line of defence is at an identified CCP during the production process. When inspecting bulk or loose-flow products, it is crucial to virtually eliminate debris that might be generated as a by-product of peeling, cutting and processing at this stage. A meticulous inspection at this phase leads to contaminants being intercepted, e.g. a stone or even golf ball from a field, before becoming integral components of the final product or damaging machinery.

End-of-Line Inspection is essential but should not serve as the sole line of defence. This inspection serves as a last-resort measure, identifying any contaminants introduced during the packaging process, such as metal splinters from broken machinery. However, reliance solely on this stage can prove less cost-effective. Manufacturers of potato-based products should prioritise identifying weak points in the production process early on, before additional valuable ingredients are introduced. This early identification not only minimises operational costs and waste but also leads to a proactive stance against potential contamination risks.

It is wise to maximise the ability to identify contaminants for a particular product or application, and product inspection systems should always be configured for success. But specifications shift. New demands are made on manufacturing facilities as a result of the introduction of new goods, processes and equipment. Therefore, while making decisions on contaminant detection equipment, potato-based food producers should consider future requirements in order to give themselves and their clients the assurance that strong quality assurance will continue to be in existence.

Selecting Appropriate Technology

The selection of inspection technology is crucial in manufacturing potato-based foods, to aid in the identification and removal of physical contaminants. The two main inspection methods, metal detection and x-ray inspection, are closely related to the traits of any potential contaminants, the particular product and its use, including the type of packaging.

Metal detection systems prove highly effective when dealing with metal contaminants in potato-based foods. On the other hand, x-ray systems excel in identifying metal as well as other non-metallic foreign bodies, offering a valuable solution for maintaining the integrity of potato snacks and processed potato products. The selection process is not solely contingent on the type of contaminant; considerations extend to the packaging material. For instance, products encased in aluminium foil can pose challenges for metal detectors but align seamlessly with x-ray inspection systems.

In scenarios where a potato-based snack, such as protein chips, undergoes packaging in a gravity-fed environment with limited insertion space (typical in applications like vertical form, fill, and seal processes), metal detection systems are the preferred choice. However, the versatility of x-ray technology extends beyond mere contaminant detection. It facilitates additional product integrity checks, including counting components, identifying missing or broken items, assessing packaging damage, monitoring fill levels, measuring headspace and detecting any product trapped in the film or seal.

Future-proofing Detection Capabilities

It is wise to maximise the ability to identify contaminants for a particular product or application, and product inspection systems should always be configured for success. But specifications shift. New demands are made on manufacturing facilities as a result of the introduction of new goods, processes and equipment. Therefore, while making decisions on contaminant detection equipment, potato-based food producers should consider future requirements in order to give themselves and their clients the assurance that strong quality assurance will continue to be in existence.

While still meeting regulatory and efficiency criteria, modular systems assist businesses in adapting to these changing needs. Floor space is a big issue in many factories. Combination systems, which combine several inspection methods, can help to solve this issue. One example is the combination of checkweighing with metal detection or x-ray solutions.

Investing in inspection systems with digital data gathering capabilities, which support shifting supply chain and compliance requirements, is another way to prepare for the future. Alternatively, using inspection technologies that make it easier to undertake preventative maintenance to improve inspection performance right away and lower total cost of ownership can be key.

Embracing Digitalisation

Digital technology is changing the supply chain for the entire food production industry, including the rapidly growing potato-based food sector. Real-time monitoring and control of automated inspection devices, as well as the gathering of performance data, are all included in digitalisation. Transparency and traceability are made available to all stakeholders in a supply chain by connecting these technologies and data streams. This transparency and traceability are particularly beneficial in the potato industry, where consistent quality and safety are critical due to the high demand for crisps, chips and other potato products. In the event of a product recall, having immediate access to traceability data is essential for swift action.

The growth of digital systems and networked supply chains to support higher quality requirements in production strengthens the link between digitalisation and food safety even more. In addition to enabling complete documentation for compliance, this may enable producers of potato-based products to rapidly determine

when machinery is not operating effectively and take appropriate action.

Although the digitisation process is not without expenses and difficulties, the majority of potato food manufacturers already gather data from their inspection processes in some way. That is made simpler by digitalisation, which also improves operational effectiveness and efficiency and makes it easier to demonstrate compliance and due diligence. Undoubtedly, one of the major developments in recent times within the food industry is digitalisation. Potato-based food manufacturers who start now will be prepared for the time when a nice-to-have becomes a must-have in the digital supply chain.

Conclusion

With more and more people consuming potato-based foods – from mash to potato cakes – manufacturers must take a proactive and holistic approach to maintaining high standards of product safety. As demand for potato-derived products continues to rise globally, being sure that safety protocols are digitised and efficient is becoming increasingly important.

Understanding potential risks, developing robust plans and embracing technologies like digitalisation are crucial for immediate and future needs. Data-driven decision-making, alongside alternative inspection technologies, contributes to enhancing production line efficiencies and compliance, particularly in the production of potato-based snacks.

So, whether you love potatoes in the form of crispy fries or chunky chips, food manufacturers must take considered steps toward reducing the chance of expensive product recalls and maintaining company reputation. With a strong, decisive and technologically smart approach to foreign body detection in potato-based food manufacturing, the future is looking crisp and golden.

For more insights, click here to download a white paper on metal detection and x-ray inspection or visit www.mt.com/md-xr-eguide-pr

1 https://www.statista.com/topics/2379/potato-industry/#topicOverview

2 https://www.statista.com/topics/2379/potato-industry/#topicOverview

3 https://www.fsis.usda.gov/

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From Farm to Future: How Sustainable Dairy Production is Reshaping the Global Food System

Building resilient milk ecosystems through climate-smart practices, circular models, and technology-led innovation

Kanika Banga

Introduction: Sustainability Moves from Concept to Core Strategy

Sustainability has transitioned from being a supplementary objective to becoming a defining strategy for the global dairy industry. As climate volatility, water stress, soil degradation, and rising production costs intensify, dairy producers and processors are under growing pressure to reimagine how milk is produced and delivered.

Consumers are increasingly seeking transparency around food origins, animal welfare, and environmental impact. Governments are introducing stricter environmental regulations. Investors are prioritising ESG metrics. Together, these forces are reshaping the dairy landscape. For dairy farmers, sustainability is deeply rooted in tradition. Generations have relied on land stewardship, responsible animal care, and resource conservation. However, modern dairy systems must now deliver measurable reductions in emissions, improved biodiversity outcomes, and traceable supply chains, while remaining economically viable.

Sustainable dairy production today represents a complex integration of agriculture, engineering, data science, and community development. It spans everything from feed formulation and manure management to processing efficiency and eco-friendly packaging.

Why Sustainable Dairy Matters Now More Than Ever

The dairy sector supports global nutrition by providing affordable sources of protein, calcium, vitamins, and essential fatty acids. Yet it also accounts for a significant share of agricultural greenhouse gas emissions and freshwater usage.

Sustainability in dairy now rests on five interconnected pillars:

- Environmental responsibility
- Economic resilience
- Animal welfare
- Social inclusion and rural development
- Long-term food security

Balancing these pillars requires coordinated action across the value chain, involving farmers, processors, equipment manufacturers, packaging suppliers, logistics providers, and retailers.

In India, the world's largest milk producer, dairy plays a pivotal socio-economic role. Over 80 million households depend on dairy farming, making sustainability not just an environmental imperative but also a development priority. Improved productivity, reduced input costs, and access to technology can significantly uplift rural incomes while lowering ecological impact.

Reducing Greenhouse Gas Emissions at the Farm Level

Methane, nitrous oxide, and carbon dioxide are the primary greenhouse gases associated with dairy farming. Addressing these emissions requires a combination of biological, technological, and management interventions.

Feed Optimization and Enteric Methane Reduction

Feed quality directly influences milk yield and methane emissions. High-digestibility forages, balanced protein-energy ratios, and targeted feed additives help improve feed conversion efficiency. Emerging solutions such as algae-based supplements, essential oils, and enzyme blends show potential to reduce methane emissions by up to 30 percent per animal. Precision feeding systems allow farmers to tailor rations to individual cows, minimising waste and improving productivity.

Advanced Manure Management and Biogas Production

Manure represents a major opportunity for climate mitigation. Anaerobic digesters convert organic waste into biogas, which can be used for electricity generation, heating, or upgrading into biomethane for vehicle fuel. Digestate produced during this process serves as a high-quality fertiliser, replacing synthetic inputs and improving soil structure. In rural areas, biogas systems provide reliable energy access while reducing dependence on firewood and fossil fuels.

Carbon Sequestration Through Regenerative Practices

Dairy farms can actively remove carbon from the atmosphere by increasing soil organic matter. Practices such as cover cropping, crop rotation, reduced tillage, and managed grazing enhance carbon storage while improving soil health. These regenerative approaches also increase resilience to extreme weather events, helping farms withstand droughts and floods.

Soil Health and Nutrient Management: Strengthening the Production Base

Soil quality determines the productivity

and sustainability of dairy farming systems. Healthy soils support higher forage yields, better water infiltration, and enhanced microbial activity. Precision agriculture tools now enable farmers to apply nutrients based on real-time crop needs. GPS-guided equipment, soil sensors, and drone imagery reduce over-fertilisation and nutrient runoff. Integrating manure with crop residues creates closed nutrient loops, reducing reliance on chemical fertilisers. Improved nutrient efficiency lowers operating costs while protecting surrounding ecosystems.

Protecting Biodiversity Through Responsible Land Use

Dairy feed production has far-reaching impacts on biodiversity. Unsustainable sourcing of soy and maize can drive deforestation and habitat loss. To counter this, leading dairy producers are adopting responsible sourcing policies, promoting native forage species, and restoring marginal lands. Practices such as intercropping, hedgerow planting, and maintaining wildlife corridors enhance on-farm biodiversity. Partnerships with conservation organisations further support landscape restoration and protection of endangered species.

Water Stewardship: Managing a Critical Resource

Water scarcity is becoming a defining challenge for agriculture. Dairy farms consume water for irrigation, animal hydration, cooling systems, and sanitation.

Progressive operations focus on:

- Rainwater harvesting
- Recycling wash water
- Installing water-efficient milking parlours
- Using drip irrigation for fodder crops

Advanced monitoring systems track water usage at every stage, enabling continuous improvement. Reducing water intensity per litre of milk not only conserves resources but also improves profitability.

Animal Welfare and Health: Technology-Enabled Care

Animal welfare is intrinsically linked to productivity, milk quality, and consumer trust. Modern dairy farms are investing in comfortable housing, proper ventilation, cooling systems, and access to pasture. Wearable devices and AI-powered platforms monitor rumination, activity levels, and body temperature, enabling early detection of illness. Reducing stress and disease lowers veterinary costs and antibiotic usage while extending productive lifespans of animals.

Circular Food Production: Closing Resource Loops

A circular dairy economy seeks to maximise value from every input while minimising waste. Cows are increasingly fed agricultural by-products such as brewer's grains, fruit pulp, and oilseed cakes. These materials would otherwise go to landfill, yet they provide valuable nutrients for milk production.

Processing plants are also embracing circularity through heat recovery systems, wastewater treatment and reuse, and by-product valorisation. Whey proteins, lactose, and minerals are extracted from processing streams to create high-value ingredients for food, nutraceuticals, and sports nutrition.

Packaging innovation plays a key role here, with growing adoption of recyclable mono-materials, bio-based plastics, lightweight cartons, and refillable formats.

Sustainable Processing and Packaging: Extending Responsibility Beyond the Farm

Sustainability efforts increasingly extend into dairy processing facilities. Energy-efficient pasteurisers, membrane filtration systems, and automated CIP processes reduce energy and water consumption. Digital twins and smart factories enable processors to simulate production scenarios and optimise resource usage.

Packaging suppliers are collaborating with dairy brands to introduce recyclable multilayer films, paper-based alternatives, and carbon-neutral cartons. Lifecycle assessments help quantify environmental impact across the supply chain. Traceability platforms using blockchain and QR codes allow consumers to track products from farm to shelf, reinforcing transparency and brand trust.

Empowering Rural Communities Through Dairy Value Chains

Sustainable dairy production strengthens rural economies by creating stable income streams and employment opportunities. Training programmes equip farmers with skills in animal nutrition, financial management, and technology adoption. Women-led dairy cooperatives are expanding across many regions, promoting gender inclusion. Cold chain infrastructure, automated milk collection centres, and digital payment systems improve market access while reducing post-harvest losses.

By building resilient dairy ecosystems, communities gain access to nutritious food, reliable income, and cleaner energy solutions.

Research, Innovation, and Global Collaboration

Institutions such as Wageningen University and other research bodies are advancing sustainable dairy practices through data-driven insights. Their work spans methane mitigation, biodiversity measurement frameworks, and animal welfare indicators. Public-private partnerships accelerate the commercialisation of new technologies, from robotic milking systems to climate-smart feed formulations. Global knowledge sharing ensures that best practices reach farmers in both developed and developing markets.

The Road Ahead: A Blueprint for the Dairy Industry

The future of dairy lies in integrated systems that connect healthy soils, productive animals, efficient processing, and responsible packaging.

Key priorities for the coming decade include:

- Scaling regenerative agriculture
- Expanding renewable energy adoption
- Digitising farm operations
- Advancing sustainable packaging
- Strengthening traceability
- Supporting smallholder inclusion

Sustainable dairy is no longer a niche initiative. It is a strategic transformation shaping the next generation of food systems.

Conclusion: Building Dairy Systems That Nourish People and Planet

Sustainable dairy production represents a powerful convergence of tradition and innovation. By embracing circular models, climate-smart technologies, and inclusive value chains, the industry can meet rising food demand while preserving natural resources. The journey from farm to future requires collaboration across agriculture, processing, packaging, and logistics. When these elements work together, dairy becomes more than a source of nutrition. It becomes a catalyst for environmental stewardship, rural prosperity, and resilient global food systems.

Engineering the Future of Dairy: Modular Facilities Meet Smart Manufacturing

Ritesh Verma

Introduction: Redefining Dairy Manufacturing for a Dynamic Market

The global dairy industry is entering a new phase of transformation. Traditional high-capacity processing plants, once designed primarily for volume production, are giving way to smarter, more agile facilities. Today's dairy processors must respond to changing consumer preferences, tighter food safety regulations, sustainability commitments, and increasing pressure to innovate faster. From value-added products such as high-protein beverages and probiotic yogurts to extended shelf-life milk and plant-dairy blends, manufacturers are required to handle greater product diversity while maintaining efficiency and quality. This shift is reshaping dairy plants into modular, digitally connected, and flexible production environments.

The future of dairy manufacturing rests on three interconnected pillars: modular facilities, advanced processing equipment, and flexible manufacturing lines.

Modular Facilities: Building Dairy Plants for Scalability and Speed

From Fixed Infrastructure to Modular Design

Conventional dairy plants are often large, permanent installations built around specific product categories. Any expansion or product change typically requires major civil construction and extended downtime. Modular facilities address these limitations by using prefabricated, standardized production units that can be assembled and expanded as needed.

Each module performs a specific function, allowing processors to scale operations gradually and respond quickly to market demand. Modular dairy plants typically consist of independent yet integrated blocks for milk reception, thermal processing, separation, fermentation, drying, and packaging. These modules are manufactured off-site, fully tested, and then installed at the production location, significantly reducing commissioning time.

Key advantages of modular dairy facilities include:

- Faster plant deployment and reduced construction timelines
- Lower initial capital investment
- Easier expansion and reconfiguration
- Improved operational reliability
- Simplified maintenance and upgrades

Technical Architecture of Modular Plants

Modern modular plants are engineered with standardized mechanical, electrical, and automation interfaces. Plug-and-play connections allow utilities such as power, water, compressed air, and data to integrate seamlessly across modules. All units are designed to comply with international hygienic standards such as EHEDG, 3-A, and ISO 22000. Pre-commissioned automation systems ensure that production can begin shortly after installation. This modular approach enables dairy processors to introduce new product lines without rebuilding entire facilities.

Advanced Equipment: Powering Efficiency and Product Quality

High-Performance Pasteurization and UHT Systems

Pasteurization remains fundamental to dairy safety. Next-generation plants are adopting energy-efficient HTST and UHT systems equipped with advanced heat recovery, automated temperature control, and optimized Clean-in-Place cycles.

Modern pasteurizers feature regenerative heat exchangers capable of recovering up to 90 percent of thermal energy, significantly reducing operating costs. Integrated PLC and SCADA systems ensure precise time-temperature control while maintaining regulatory compliance. Ultra-high temperature processing combined with aseptic filling allows extended shelf-life products, supporting wider distribution and reducing cold chain dependency.

Smart Separation and Homogenization Technologies

Separation and homogenization directly influence product consistency and texture. Today's intelligent centrifugal separators automatically adjust balance and throughput based on incoming milk quality. Advanced homogenizers use real-time pressure feedback to maintain uniform fat globule size, improving stability in flavored milk, cream, and dairy beverages. These machines increasingly incorporate predictive maintenance capabilities. Sensors monitor vibration, temperature, and performance trends to anticipate component wear before failures occur.

Precision Mixing and Fermentation Systems

As demand grows for cultured and functional dairy products, precision in fermentation becomes critical. Automated mixing tanks with variable frequency drives allow controlled agitation and viscosity

management. Fermentation chambers now operate with integrated temperature and pH monitoring, ensuring consistent culture development. Continuous fermentation systems are also being introduced for high-volume yogurt and probiotic beverages, reducing batch variation while increasing productivity.

Packaging Lines Designed for Speed and Sustainability

Packaging is one of the most dynamic areas of dairy processing. Modern facilities rely on high-speed aseptic fillers capable of handling multiple packaging formats including cartons, bottles, cups, and pouches on a single line. Servo-driven changeovers allow fast transitions between SKUs, supporting smaller batch sizes and greater product variety. Vision inspection systems verify seal integrity and label accuracy, while robotic palletizing improves end-of-line efficiency.

Packaging equipment is also evolving to accommodate lightweight materials and higher recycled content, aligning with sustainability targets.

Flexible Manufacturing Lines: Adapting to Rapidly Changing Consumer Demand

The Need for Operational Flexibility

Today's dairy market is shaped by personalization and convenience. Consumers expect a wide range of formats and nutritional profiles, from single-serve protein drinks to low-sugar yogurts and hybrid dairy beverages. Flexible manufacturing lines enable producers to shift between products with minimal downtime. Automated recipe management allows operators to change parameters such as temperature, filling volume, and mixing speed through centralized control systems.

Key enabling technologies include programmable logic controllers, servo-driven equipment, and automated tooling.

Automated Changeovers and Digital Recipes

Traditional product changeovers could take several hours. Advanced lines now achieve this in minutes through:

- Quick-release mechanical components
- Servo-adjusted guides and fillers
- Digital recipe storage within PLC systems

Operators can select a product profile, and the line automatically adjusts to the required configuration.

Pillar	Core Elements	Key Technologies	Business Impact
Modular Facilities	Prefabricated production blocks, plug-and-play utilities, hygienic design	Standardized modules, EHEDG/3-A compliance, pre-commissioned automation	Faster deployment, scalable capacity, reduced capex, quicker product launches
Advanced Processing Equipment	Pasteurization, separation, homogenization, fermentation	HTST/UHT with heat recovery, smart separators, pressure-controlled homogenizers	Higher energy efficiency, consistent quality, extended shelf life
Flexible Manufacturing Lines	Multi-format packaging, rapid SKU changeovers	Servo drives, PLC recipes, quick-release tooling	Shorter changeovers, smaller batches, greater product diversity

Additive Manufacturing for Rapid Tooling

Additive manufacturing, commonly known as 3D printing, is becoming an important tool for improving agility in modern dairy plants. Processors are increasingly using industrial-grade printers to produce custom tooling, low-volume machine components, and replacement parts such as filling nozzles, conveyor guides, sensor mounts, and changeover accessories. This approach significantly shortens lead times, allowing maintenance teams to fabricate critical parts within hours instead of waiting weeks for external suppliers. Advanced food-safe polymers and metal printing technologies now make it possible to manufacture components that meet hygienic design standards, chemical resistance requirements, and thermal stability essential for dairy processing environments.

Beyond maintenance, additive manufacturing supports flexible production and rapid product innovation. Digital part libraries enable facilities to store designs virtually and print components on demand, reducing spare-parts inventory and storage costs. For R&D teams, 3D printing accelerates pilot trials by enabling quick fabrication of experimental tooling for new product formats or packaging sizes. As printing accuracy and material performance continue to improve, additive manufacturing is expected to become a standard capability in future-ready dairy plants, strengthening operational resilience while supporting faster innovation cycles.

Digitalization: The Backbone of Smart Dairy Plants

IoT Sensors and Real-Time Monitoring

Modern dairy plants rely on extensive IoT sensor networks to continuously monitor critical parameters such as temperature, pressure, flow rates, energy usage, and product quality indicators across every stage of production. These smart sensors are integrated with centralized manufacturing execution systems (MES) and SCADA platforms, creating a unified digital environment that provides operators with real-time visibility into plant performance. Immediate access to operational data enables faster decision-making, tighter process control, and early identification of deviations that could affect product quality or equipment efficiency.

Beyond basic monitoring, real-time data collection supports advanced analytics and automated responses. Alerts can be triggered when parameters drift outside acceptable limits, allowing corrective actions before issues escalate into production losses or safety risks. Historical data trends are also used to optimize cleaning cycles, reduce energy consumption, and improve overall equipment effectiveness (OEE). As digital maturity increases, these connected systems form the foundation for predictive maintenance, digital twins, and AI-driven optimization, turning dairy plants into intelligent, self-learning production environments.

Predictive Maintenance and AI Analytics

Predictive maintenance powered by artificial intelligence is transforming how dairy plants manage equipment reliability. Instead of relying on fixed maintenance schedules, AI models continuously analyze machine performance data to identify patterns associated with wear, inefficiency, or impending failure. By processing inputs from sensors embedded in pumps, motors, compressors, separators, and fillers, these systems can forecast maintenance requirements well in advance, allowing teams to intervene proactively. This shift from reactive to predictive maintenance significantly reduces unplanned downtime, improves asset utilization, and lowers overall maintenance costs.

Key condition-monitoring techniques include vibration analysis to detect bearing or shaft misalignment, thermal imaging to identify overheating components, and acoustic sensing to capture abnormal sound signatures from rotating equipment. These technologies work together to provide a comprehensive health profile of critical assets. Over time, machine learning algorithms refine their accuracy by learning from historical failure data, enabling increasingly precise predictions. As adoption grows, AI-driven maintenance strategies are becoming essential for extending equipment life, stabilizing production schedules, and ensuring consistent product quality in modern dairy plants.

Digital Twins and Virtual Commissioning

Digital twins create dynamic virtual replicas of physical dairy plants by integrating real-time operational data with 3D models and process simulations. These digital models allow engineers to test production scenarios, evaluate equipment layouts, and fine-tune process parameters before making physical changes on the shop floor. By simulating throughput, energy usage, and material flow, processors can identify bottlenecks and optimize performance without disrupting ongoing operations. Virtual commissioning further strengthens this approach by enabling automation logic and control systems to be tested in a simulated environment prior to installation, significantly reducing startup risks, shortening commissioning timelines, and ensuring smoother integration of new production lines or modular units.

Quality Management and Traceability

Advanced Quality Management Systems (QMS) now integrate real-time production data with laboratory results, regulatory documentation, and audit trails to create a comprehensive digital record of product quality across the entire dairy operation. These platforms enable automated sampling, deviation tracking, and corrective action management, helping processors maintain consistent standards while meeting food safety regulations. Blockchain-enabled traceability further strengthens this framework by securely recording every step of a product's journey from raw milk collection to final distribution. This immutable data chain improves transparency, enables rapid identification of affected batches during recalls, and builds greater confidence among regulators, retailers, and consumers, making traceability a critical pillar of future-ready dairy plants.

Sustainability: Embedded into Plant Design

Environmental responsibility has become a strategic priority rather than a regulatory obligation. Energy optimization technologies include variable speed drives, heat recovery systems, and solar integration. Water stewardship is addressed through membrane filtration, Zero Liquid Discharge systems, and reuse of treated process water. Organic waste streams are increasingly converted into biogas using anaerobic digesters, supporting circular economy goals. Lifecycle assessment tools help processors quantify carbon footprints and guide decarbonization strategies.

The Workforce of Tomorrow

Automation in dairy plants does not replace the workforce but fundamentally reshapes skill requirements, shifting roles from manual operations toward digital oversight, system optimization, and technical problem-solving. Modern facilities increasingly require professionals proficient in data analysis, automation platforms, robotics, and predictive maintenance systems, alongside traditional process engineering knowledge. Operators are becoming control-room specialists, while maintenance teams are evolving into mechatronics and software-enabled technicians. To support this transition, dairy processors are investing in structured training and upskilling programs focused on cross-functional capabilities, enabling employees to work seamlessly alongside intelligent machines. This human-machine collaboration is becoming central to operational resilience, productivity, and continuous innovation in next-generation dairy plants.

Challenges on the Path Forward

Despite their clear advantages, the transition toward modular and smart dairy plants presents several practical challenges. Integrating advanced automation and digital platforms with existing legacy infrastructure can be complex and time-intensive, while increased connectivity also introduces cybersecurity risks that must be actively managed. Capital investment planning requires careful prioritization, particularly for mid-sized processors balancing modernization with operational continuity. At the same time, workforce upskilling remains critical, as employees must adapt to data-driven environments and advanced equipment. Overcoming these hurdles calls for phased implementation roadmaps, strong change management practices, and close collaboration with technology partners to ensure scalable, secure, and sustainable transformation.

Conclusion: Building Resilient Dairy Operations for the Future

The dairy plant of the future is defined by modular design, digital connectivity, operational flexibility, and sustainability-driven performance. Advanced processing equipment integrated with intelligent automation systems enables producers to deliver consistent quality while responding quickly to shifting consumer demands. Real-time data, predictive analytics, and flexible manufacturing architectures are helping dairy processors improve efficiency, reduce waste, and accelerate innovation, transforming production facilities into responsive, resilient ecosystems.

As product portfolios continue to diversify and environmental expectations rise, dairy manufacturers must adopt this new manufacturing paradigm to remain competitive. Modular facilities, smart machinery, and adaptable production lines are no longer emerging concepts but essential components of modern dairy operations. Those who invest strategically in these capabilities will be better positioned to manage uncertainty, unlock new growth opportunities, and secure long-term success in an increasingly dynamic global dairy market.

Author's Bio

Mr. Verma is an experienced freelance writer with more than 15 years of expertise contributing to a wide range of publications.

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When Your Food Changes Color, It's Trying to Tell You Something

Parkavi Nanthini*, Divya Panneerselvam, R.Surya Priyadharshini, Mansi Thaker & A.G.Saranya Gayathiri

A simple, dual-zone strip made from natural plant pigments could soon help consumers judge the true freshness of meat and cut vegetables—just by watching colors change.

Why the Date on Your Food Can Be Misleading

Every year, a significant quantity of fresh meat and packaged cut vegetables is discarded across households, supermarkets, and food service establishments. In many cases, these foods show no obvious signs of spoilage. They appear fresh, smell normal, and retain acceptable texture—yet they are thrown away because the printed expiry or "use-by" date has passed.

Ironically, incidents of foodborne illness continue to occur even when foods are consumed within the declared shelf life. This paradox highlights a fundamental limitation of current food dating systems. Expiry dates are designed as general guidelines rather than precise indicators of food quality or safety. They reflect predicted shelf life under assumed ideal conditions, not the real condition of food at the moment it is consumed.

This raises an important question: Can a fixed date truly represent the dynamic nature of food spoilage? If freshness depends on storage temperature, handling, and microbial activity, then a static printed label can only offer an approximation—not certainty.

Imagine opening your refrigerator and finding a sealed pack of cut vegetables. There is no unpleasant odor, no visible slime, and no discoloration. However, the expiry date suggests the product is no longer safe. Most consumers would choose to discard it to avoid risk. Now imagine the same package containing a small color-changing strip that has shifted from purple to green, clearly indicating chemical changes associated with spoilage. The decision is no longer based on doubt, but on visible evidence.

The Hidden Chemistry of Food Spoilage

Food spoilage is a gradual biochemical process driven primarily by microbial activity. Expiry dates are calculated using standardized models that assume consistent refrigeration, minimal temperature abuse, and controlled storage conditions from production to consumption. In reality, food experiences multiple temperature fluctuations during transportation, retail display, and domestic storage.

Microorganisms present in fresh foods metabolize proteins, carbohydrates, and lipids as they grow. In protein-rich foods such as meat, microbial degradation leads to the formation of volatile nitrogenous compounds, including amines, ammonia, and other alkaline by-products. These compounds gradually increase the pH of the food environment.

Importantly, these chemical changes begin long before spoilage becomes sensorially obvious. Unpleasant odors, slime formation, and discoloration appear only at advanced stages. Because expiry dates cannot respond to these real-time biochemical changes, they fail to capture the actual freshness status of highly perishable foods.

When Packaging Starts Communicating

Smart packaging offers a powerful alternative to traditional date labeling. Rather than acting as a passive barrier, smart packaging systems are designed to sense changes occurring inside the package and communicate them directly to users.

Among the various smart packaging approaches, color-changing freshness indicators are particularly attractive. They require no electronics, no batteries, and no user training. Instead, they translate complex chemical reactions into simple visual cues. Consumers do not need to interpret numbers or codes; they only need to observe a color shift.

Why a Single Color Isn't Enough

Many existing freshness indicators rely on a single sensing material that responds to one spoilage parameter, such as pH. While these indicators can provide useful information, they often struggle to capture the complexity of spoilage in real foods. In protein-rich products like meat, multiple spoilage reactions occur simultaneously, producing a variety of chemical signals.

A single color response may be weak, delayed, or ambiguous under such conditions. This can lead to misinterpretation, reducing consumer trust and limiting practical usefulness. Two Zones, Two Signals, Clearer Decisions To overcome these limitations, a dual-zone color-changing freshness indicator has been developed using natural pigments extracted from red cabbage and hibiscus flowers. These pigments contain anthocyanins—naturally occurring compounds known for their strong and reversible color responses to changes in chemical environment.

The indicator strip consists of two spatially separated sensing zones. One zone is primarily sensitive to pH variations associated with early spoilage, while the second zone responds strongly to volatile amines released during protein degradation.

By monitoring two complementary spoilage markers, the strip provides a more complete and reliable assessment of freshness.

This dual-response system reduces uncertainty and improves interpretation. Instead of relying on a single visual cue, consumers receive layered information that better reflects real spoilage progression.

Nature-Based Sensors for Safer Food

The use of plant-derived pigments offers several important advantages. Anthocyanins are non-toxic, food-safe, biodegradable, and environmentally sustainable. When combined with biopolymer matrices such as chitosan and paper-based substrates, the resulting indicator strips remain lightweight, low-cost, and easy to integrate into existing packaging systems. Crucially, this approach avoids synthetic dyes, heavy metals, and electronic components, making it compatible with sustainability goals and food safety regulations.

Benefits Beyond the Kitchen

The application of color-changing freshness indicators extends well beyond household use. Retailers, distributors, and food processors could use such indicators to monitor product quality throughout storage and transportation. Instead of discarding entire batches based on conservative expiry dates, decisions could be made using real-time freshness information. This condition-based assessment could significantly reduce food waste, lower economic losses, and improve supply-chain efficiency—without compromising consumer safety.

A Future Where Food Tells the Truth

A simple color-changing strip inside packages of fresh meat and cut vegetables has the potential to redefine how freshness is evaluated. By shifting from time-based labeling to real-time chemical sensing, such technology empowers consumers, improves safety, and supports sustainability. Food packaging is evolving from passive protection to active communication. Dual-zone freshness indicators represent a meaningful step toward a future where food no longer hides its condition behind a printed date—but speaks for itself, clearly, naturally, and honestly.

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FPS Food Process Solutions and GEM Equipment of Oregon

Launches VersaFry as Latest Collaborative Innovation to Target Growing Snack and Appetizer Market

FPS Food Process Solutions ("FPS"), a global leader in turn-key food processing solutions, and subsidiary GEM Equipment of Oregon ("GEM"), launches VersaFry as the latest collaborative innovation, specifically targeted to the growing snack and appetizer market. Known as GEM VersaFry, it is the latest innovation in fryer design – engineered for maintenance, safety and durability. With the ability to handle a variety of product shapes, consistencies and textures, the GEM VersaFry is excellent at handling specialty potato products, poultry, seafood, assorted vegetables, baked goods and other high value products requiring precision frying before further processing.

The GEM VersaFry offers Operation and Sanitation Modes, highlighting attention to detail such as oil quality, fire prevention safety measures and cleanability. Some of the key defining features include:

- PEEK/Teflon Adjustable Infeed Conveyor for smooth transfer and batter setting under high oil temperatures
- Long-Life Main Conveyor designed for easy splicing and reduced contamination risk
- Hood Raise Screw Jack System for full kettle access during sanitation and maintenance
- Oil Recirculation Pump to maintain oil level and temperature consistency
- Dual Crumb Removal with surface skimmer and bottom return belt for extended oil life

Every fryer is built with robustness and longevity as top priorities, to provide customers with the lowest cost of ownership. Combined with FPS's foothold in key industry food sectors and established service and support network, the GEM VersaFry is already breaking ground in major food processing plants.

"GEM Equipment continues to astound – with their deep engineering expertise and robust workmanship, we are truly collaborative in every sense of the word. This is what it means to offer customers a "one-stop shop" for their food processing needs," says Jeffrey Chang, President, FPS Food Process Solutions Corp.

About FPS Food Process Solutions

FPS Food Process Solutions is a global leader in turn-key food processing solutions, serving customers across six continents. Founded in 2010, FPS employs over 1,000 professionals worldwide and operates more than 1,280,000 ft^2 (119,000 m^2) of space across 23 locations, including its Canadian headquarters, manufacturing facilities, and international sales offices. Through our subsidiaries and strategic partnerships, FPS delivers comprehensive, end-to-end processing solutions—providing a true "one-stop shop" for food processors around the world.

For more information, go to

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For more information about GEM, got to

https://www.gemequipment.com/

Carbon Dots and the Future of Intelligent Food Packaging

Dr. Vithu Prabha

Food travels a long and fragile path after harvest, through aggregation, storage, transport, retail, and finally to the consumer. Globally, nearly 30–33% of food produced is lost or wasted, contributing to 8–10% of total anthropogenic greenhouse gas emissions. In India alone, post-harvest losses of fruits and vegetables are estimated at Rs 90,000–Rs 1,00,000 crore annually, even when packaging is used. Every discarded kilogram represents not only wasted food, but also wasted water, energy, refrigeration, transport, and embedded carbon emissions.

Conventional packaging remains largely passive; it protects food but provides no information on freshness, early spoilage, or microbial activity. Decisions across the supply chain are therefore driven by fixed expiry dates or visual judgement, often leading to premature disposal of still-edible food. This limitation has led to growing interest in intelligent food packaging—systems designed to sense changes in food quality and communicate them in real time. Among the materials enabling this shift, carbon dots have emerged as a promising option. These carbon-based fluorescent nanoparticles respond to pH changes, spoilage gases, and microbial metabolites, and can be produced from low-cost agricultural and food-processing waste at moderate temperatures. When incorporated into packaging films or indicator labels at low levels (0.1–0.5 wt%), carbon dots provide visible freshness signals while also offering UV protection and antimicrobial effects, transforming packaging from a passive barrier into an information-rich, low-carbon tool for reducing food waste and emissions across the supply chain.

Why Packaging Needs to Become Intelligent

Packaging efficiency plays a direct but often underestimated role in climate mitigation within food systems. When 1 kg of fresh fruit is wasted, it carries an embedded carbon footprint of approximately 1.5–4.0 kg CO_2-equivalent, arising from cultivation, packaging, transport, and refrigeration. Such losses are common across post-harvest handling chains, not necessarily because food is unsafe, but because conventional packaging provides no real-time information on food quality.

Intelligent packaging addresses this information gap by reducing unnecessary rejection and premature disposal. Even a modest 10% reduction in post-harvest waste can yield substantial climate benefits at scale. For a 10-ton-per-day fruit handling unit, this translates to 1 ton of food saved per day, avoiding 1.5–4 tons of CO_2-equivalent emissions daily, or roughly 500–1,400 tons of CO_2-equivalent per year. Importantly, these savings are achieved without changing farming practices, infrastructure, or logistics, but simply by improving packaging intelligence and decision-making accuracy. The pathway through which intelligent packaging converts food savings into carbon reduction is illustrated in Figure 1.

Carbon Dots: Small Particles with Useful Signals

Carbon dots are ultra-small particles made entirely of carbon, typically 2–10 nanometres in size, so small that thousands could fit across the width of a human hair. When excited by light in the 300–420 nm range, carbon dots emit light most commonly in the blue to green region (450–550 nm). This phenomenon, known as fluorescence, is more than a visual effect; it forms the basis of their use as freshness indicators and chemical sensors. Depending on the synthesis route, carbon dots can convert 10–60% of absorbed light into emitted light, with biomass-derived carbon dots typically showing efficiencies of 15–35%—sufficient for clear, naked-eye detection in food packaging applications.

The synthesis of carbon dots from agricultural waste is conceptualised in Figure 2. In simple terms, biomass is treated with water under moderate hydrothermal conditions (160–220 °C), during which organic components break down and reorganise into nano-sized carbon structures. The resulting mixture is then subjected to simple filtration to remove larger residues, followed by repeated washing or electrodialysis to eliminate excess salts and small soluble impurities. This process yields a stable, water-dispersible, and food-contact–compatible carbon dot solution, suitable for incorporation into smart packaging systems.

How Carbon Dots Function in Intelligent Packaging

Carbon dots enable intelligent packaging by converting invisible chemical changes that occur during food spoilage into simple visual signals that can be easily understood by farmers, handlers, retailers, and consumers. Unlike many existing intelligent packaging systems, such as time–temperature indicators or preset colour labels, carbon dot–based systems respond directly to the actual chemical and microbial conditions of the food, providing condition-based freshness information rather than estimates based on storage history.

1. Freshness and Spoilage Sensing

As food quality deteriorates, several measurable changes occur well before spoilage becomes visible, making early detection difficult with conventional packaging. Key changes include:

- Fish and meat release spoilage gases known as volatile amines (such as ammonia), typically in the range of 10–100 ppm
- Fruits and vegetables release organic acids, causing the pH to drop from around 6.5 to below 5.5
- Microbial populations increase rapidly, from about 10^3 CFU/g in fresh food to more than 10^7 CFU/g during spoilage

Carbon dots are inherently sensitive to these chemical signals and translate them into visible optical responses:

- Their natural light emission weakens by 20–80% (fluorescence quenching) when exposed to spoilage gases or pH changes
- This change appears as a clear shift in colour or brightness, typically within 2–6 hours of spoilage onset
- Carbon dots can detect spoilage gases at very low concentrations, down to 1–5 ppm of ammonia or related amines

By converting early, invisible chemical and microbial changes into timely and easy-to-interpret visual cues, carbon dot–based freshness sensing enables condition-based decision-making. This helps reduce premature food rejection, improves safety assurance, and directly lowers avoidable post-harvest losses and their associated carbon footprint.

2. Shelf-Life Extension

When carbon dots are incorporated into packaging films at low concentrations (0.1–0.5 wt%), they do more than indicate freshness—they actively slow down key spoilage processes, thereby extending the usable life of food.

Typical shelf-life improvements reported include:

- Fresh-cut fruits: extension by 2–4 days
- Fish fillets (chilled): extension by 1–3 days
- Meat products: shelf-life improvement of 20–30%
- Bakery items: extension by 3–5 days

Figure 1. Reduction of food waste and carbon emissions by intelligent packaging

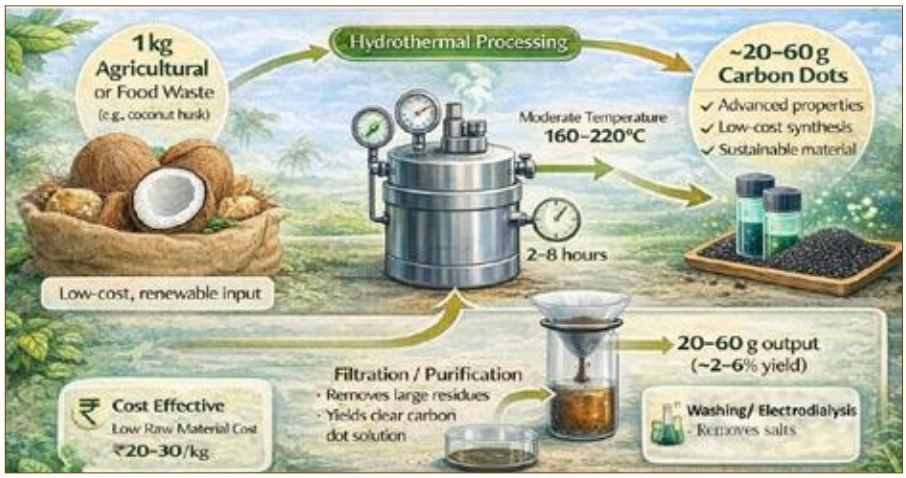


Figure 2. Synthesis of carbon dots from agri-waste

Importantly, these gains are not achieved through chemical preservatives, but through protective functions introduced by carbon dots within the packaging material. Carbon dot–enabled films can reduce microbial growth by 1–2 log cycles, limit light-induced oxidation by 30–50%, and improve barrier performance, leading to a 15–25% reduction in oxygen permeability. Together, these effects create a more protective micro-environment around the food, slowing microbial and oxidative deterioration. In practical terms, this results in longer marketability, lower rejection during distribution, and reduced losses at retail and household levels, all without compromising food composition or safety.

3. Working with Biodegradable Packaging Materials

One of the key practical advantages of carbon dots is that very small amounts are sufficient to deliver both functional and mechanical benefits in biodegradable packaging films. In typical film-forming formulations, carbon dots are added at 0.1–0.5 wt% of the total polymer solids, meaning that only 1–5 grams of carbon dots are required per kilogram of biopolymer. At these low levels, carbon dots disperse uniformly within the film matrix and do not increase film thickness or processing complexity, making them easy to integrate into existing manufacturing practices.

In practice, biodegradable packaging films are commonly produced within thickness ranges suitable for food applications:

- Starch-based films: 50–120 µm
- Cellulose or chitosan films: 40–100 µm
- Protein-based films (gelatin, whey): 60–150 µm

These films are typically prepared using standard casting or coating methods, with 3–6% polymer solids in water, into which carbon dots are incorporated as a minor additive. Rather than weakening the material, carbon dots often reinforce the polymer network, resulting in measurable performance gains. Reported improvements include a 10–30% increase in tensile

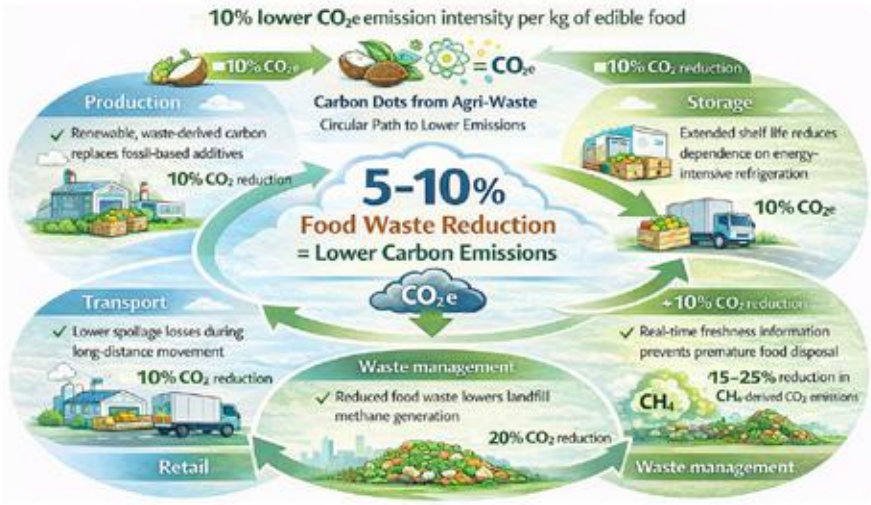
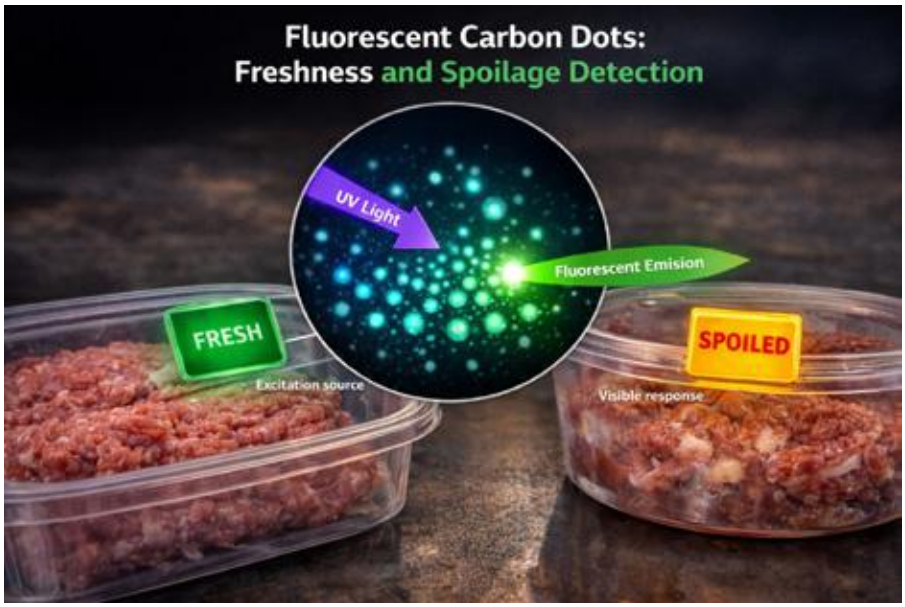


Figure 3. Carbon reduction across the food supply chain



strength, maintained or slightly improved elongation at break, and a 15–35% reduction in water vapour permeability, enhancing moisture protection. From a manufacturing and sustainability perspective, this means that a few grams of carbon dots can upgrade kilograms of biodegradable polymer into strong, functional, and smart packaging films.

4. Turning Agricultural Waste into Smart Materials

Carbon dot–based packaging links agricultural waste utilisation with carbon reduction through a simple circular pathway. Because carbon dots are required only in very small quantities, even decentralised, small-scale systems can generate meaningful climate and economic benefits.

Agricultural residues such as fruit peels, coconut shells, and starch waste can be converted into carbon dots, transforming low-value biomass into a functional packaging additive. At a practical scale, a unit processing around 100 kg of agri-waste per day can produce 2–5 kg of carbon dots, sufficient to functionalise 1–5 tonnes of biodegradable packaging film at low incorporation levels (0.1–0.5 wt%). The energy demand for this conversion is modest—typically 3–6 kWh per kg—making it suitable for decentralised deployment near farming or food-processing clusters.

Once integrated into packaging systems, carbon dots help reduce food losses during storage, transport, and retail, lower refrigeration demand, and decrease organic waste entering landfills. Together, these effects reduce greenhouse gas emissions across the food supply chain, as illustrated in Figure 3. Notably, even a 5–10% reduction in food waste achieved through packaging intelligence can deliver climate benefits comparable to many high-cost mitigation strategies, positioning carbon dots as a material-level solution for low-carbon food systems.

Conclusions

Carbon dot–based smart packaging presents practical entry points for entrepreneurs and farmer-linked enterprises without demanding major changes to existing food or packaging systems. Low-cost freshness indicator labels (Rs 1–3 per unit) can reduce rejection and improve price realisation, while small agri-waste processing units converting biomass into carbon dots can operate with modest capital investment (Rs 10–20 lakh) and realistic payback periods of 2–3 years. For export-oriented food sectors, where spoilage losses are costly, intelligent packaging offers a direct route to lower rejection rates (15–30%), and for MSME packaging manufacturers, carbon dots function as an add-on technology, compatible with existing film-forming and coating lines.

Some practical challenges remain, including food-contact regulatory approval, long-term stability of indicator performance, and the need for user awareness. However, these are implementation challenges rather than fundamental limitations. Overall, this work highlights that carbon reduction can begin at the material and information level. By embedding nanometre-scale intelligence into packaging, it becomes possible to reduce avoidable food losses, create value from agricultural waste, and support decentralised, farmer-linked circular economies. In the broader context of climate action, carbon dot–based packaging demonstrates how small material innovations can translate into meaningful system-level environmental benefits.

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Supporting the Growth of Packaged Foods with Reliable Compressed Air Infrastructure

Deepesh Upadhyay, Vice President, Delair India Pvt. Ltd.

Modern packaging invariably depends on compressed air for facilitating high speed filling lines, making fill seal machines and powering pneumatic equipment and conveying systems. As production volumes rise, compressed air demand becomes both continuous and load-intensive. Under these conditions, unmanaged moisture in compressed air systems can disrupt line efficiency, cause frequent disruption, and undermine productivity targets. Presence of moisture in compressed air is capable of inducing corrosion in pipelines, blockages in valves, erratic performance of systems, altogether increasing the chances of pneumatic components wear & tear. For manufacturers running multi-shift operations, these seemingly small issues translate into unplanned downtime, higher maintenance costs, and lost output which directly affects margins.

India's packaged food sector is on the path of accelerated growth and transformation that is no longer influenced solely by demand for registering growth. It is now being driven by scale, speed and consistency as well, pushing the manufacturers to focus on capacity expansion in addition to diversifying product portfolios. There is an underlying need to meet both domestic and export demands, placing operational reliability on par with product innovation. Against the backdrop of changing landscape, establishing a resilient compressed air infrastructure, including compressed air dryers acts as an enabler, giving impetus to the sector's growth.

It might seem that compressed air dryer is a basic utility, but it comes with the potential to impact the throughput, equipment efficiency and continuity of production across the processing and packaging of food. With plants being focused on scaling the production and speeding up the operations, poor air quality severely leads to larger operational bottlenecks.

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Presence of moisture in compressed air is capable of inducing corrosion in pipelines, blockages in valves, erratic performance of systems, altogether increasing the chances of pneumatic components wear & tear. For manufacturers running multi-shift operations, these seemingly small issues translate into unplanned downtime, higher maintenance costs, and lost output which directly affects margins. Compressed air dryers play a critical role in stabilising plant operations by ensuring consistent moisture control regardless of ambient conditions or load variations. They are even more important in India's extreme climatic conditions, particularly during monsoon when humidity levels keep fluctuating significantly. Owing to this, drying of compressed air is a prerequisite to reduce the instances of production uncertainties.

Compressed air dryers maintain a controlled pressure dew point for supplying quality air throughout the year. This translates to reliable performance of the pneumatic systems, prolonged equipment lifespan, helping in uninterrupted alignment of production schedules even when there is capacity expansion. Failing to install the dryers can sabotage multiple processes, underscoring the need to deploy robust drying solutions that transcend generic utility setups.

Given to the evolving lifestyle consumers

nowadays heavily rely on convenience, ready-to-eat meals that come with longer shelf life. This puts a lot of pressure on precision packaging that gives brands a competitive edge over others in the market. The role of clean and dry compressed air is realized to the fullest for maintaining seal integrity, ensuring accurate portioning and preserving the product quality during the high-speed packaging.

In case the compressed air is laden with moisture, it triggers inconsistent sealing, condensation in packaging equipment and creates problems in material handling, particularly in PET packaging applications. Over time, these inefficiencies increase rejection rates and compromise brand consistency in the market. Compressed air dryers support stable packaging operations by eliminating moisture-related disruptions, allowing manufacturers to run faster lines with confidence while maintaining uniform product presentation.

In addition to this, energy efficiency and driving cost-effective production remains to be an area of concern for the manufacturers. As energy costs continue to rise, manufacturers are under pressure to optimise utility consumption without compromising performance. Inefficient drying systems can significantly increase compressed air energy losses, making air one of the most expensive utilities on the shop floor.

Modern compressed air dryers are engineered to balance performance with efficiency. Advanced High Pressure Delpet refrigeration Air dryers equipped with intelligent controls and optimised heat exchange mechanisms, reduce energy wastage while delivering consistent drying performance. When correctly sized and integrated, dryers help manufacturers lower lifecycle operating costs and improve overall plant efficiency.

Perceiving the crucial role of compressed air dryers it is an essential equipment for packaged food manufacturers and must be included in the core infrastructure. They must be seamlessly integrated into the plant design to fortify long-term scalability. The dryers play a decisive role in complying with the quality standards of domestic and global markets alike. The next phase of growth for packaged food sector will be anchored in operational resilience alongside projected market demand. Here, compressed air drying infrastructure will be critical for driving safety, efficiency and profitability of the industry.

India's Rapidly Growing Food Packaging Market

India's food packaging market is witnessing steady momentum as changing consumer lifestyles, retail expansion, and supply chain modernisation reshape how food is produced and delivered. Valued at USD 13.4 billion in 2024, the market is projected to reach USD 24.8 billion by 2033, growing at a CAGR of 6.37 percent during 2025–2033. This growth highlights packaging's evolving role from basic protection to a strategic enabler of quality, branding, and distribution efficiency.

Rapid urbanisation and the rise of nuclear households are driving demand for processed, ready-to-eat, and convenience foods. These categories require advanced packaging that ensures hygiene, extends shelf life, and supports easy handling. At the same time, organised retail and online grocery platforms are expanding distribution footprints, increasing the need for durable, transit-ready packaging that performs across longer delivery cycles while maintaining shelf appeal for digital commerce.

Investments in automation and smart manufacturing are helping packaging converters improve productivity and quality consistency. Collaboration with material science firms is enabling improved barrier technologies that preserve freshness while reducing dependence on preservatives. Export growth in packaged foods is also encouraging Indian brands to adopt global packaging standards, increasing demand for tamper-evident, traceable, and high-performance formats. For startups and smaller brands, digital printing and contract manufacturing are enabling faster market entry, driving greater SKU diversity and demand for flexible packaging runs.

Sustainability has become central to packaging innovation. Regulatory frameworks and extended producer responsibility policies are accelerating the shift toward recyclable mono-materials, lightweight flexible films, and circular packaging designs. Manufacturers are reducing material usage, improving laminates, and redesigning packs for recyclability to lower both environmental impact and logistics costs. Consumers, meanwhile, are showing growing preference for transparent labeling and environmentally responsible packaging.

Technological advances are further reshaping the market. Enhanced printing, barrier coatings, and heat-sealing techniques are improving shelf life without compromising food safety. Intelligent packaging solutions such as freshness indicators and moisture-control layers are emerging as tools to reduce food waste and improve quality assurance. Localised pack sizes tailored to regional consumption habits are creating new opportunities for flexible converters and regional suppliers.

Looking ahead, India's food packaging sector is evolving into a smarter, more integrated ecosystem. The convergence of automation, sustainability priorities, and changing consumer behaviour is expanding demand for high-performance packaging solutions. As supply chains modernise and retail channels diversify, packaging will continue to play a critical role in supporting food safety, brand differentiation, and the next phase of growth in India's food and beverage industry.

Information are based on a report from Imarcgroup

Amcor and Alter Eco collaborate

on lighter-weight, paper-based chocolate packaging

Amcor, a global leader in developing and producing responsible packaging solutions, has partnered with French organic snack producer, Alter Eco, to introduce a recyclable*, paper-based and reduced-weight packaging solution for their 200-gram chocolate range.

Alter Eco produces chocolate using carefully selected organic cacao, sourced through fair and transparent supply chains. Grown by small-scale farms organised in cooperatives, the cacao reflects Alter Eco's commitment to responsible sourcing and product integrity. As part of its broader sustainability strategy, Alter Eco identified packaging as an area for improvement. The company set out to redesign the packaging across its three 200-gram chocolate bar variants, available on the French market. One of the brand's main objectives was to reduce packaging weight by replacing the existing cardboard sleeve and inner aluminium foil wrap, while preserving the premium look and feel consumers associate with Alter Eco products.

Working closely with Alter Eco and HALBA, a Swiss chocolate specialist and experienced co-packer, Amcor supported the transition to AmFiber™ Performance Paper, a paper-based and recyclable* packaging solution. The Alter Eco design combines a natural kraft look with a matte finish, reinforcing the product's authentic shelf presence. At the same time, the new packaging delivers high-barrier performance, providing effective protection against water vapour and grease.

One SKU containing almonds added complexity, as the new packaging needed to maintain a smooth, high-quality appearance despite the product's textured surface. This was successfully achieved with the AmFiber™ solution. Alter Eco's redesigned packaging using AmFiber™ Performance Paper achieves up to 61% weight reduction** compared with the previous packaging and can be recycled in the paper stream in France. The fiber used is FSC®-certified, ensuring it is sourced from responsibly managed forests, and the packaging aligns with CEPI and 4evergreen recyclability guidelines.

"This project illustrates our commitment to innovation, combining reduced environmental impact with uncompromising quality. Designing a thinner packaging that still protects the chocolate and preserves its organoleptic qualities is a true technical challenge and a major step forward for Alter Eco," said Anne Descarsin, R&D pack manager for Alter Eco. Janice Narainsamy, senior product development engineer at Amcor, said, "Paper-based packaging combines strong shelf appeal with a well-established perception of sustainability. With the right barrier performance, it can also deliver the protection needed for demanding applications like chocolate. Alter Eco's transition to AmFiber™ Performance Paper demonstrates this in a real market context, delivering a significant reduction in packaging weight."

***Recyclable in practice where paper recycling streams exist.*

**For the three redesigned packs, the resulting weight reduction was 37% for the dark dessert chocolate and 61% for both the dark chocolate with whole hazelnuts and the dark chocolate with whole almonds.*

Forest Stewardship Council® certification C176182

Benefitt launches Thailand's first

high-protein UHT milk in SIG's on-the-go carton packs

Benefitt, a new brand developed by Lactasoy Co. Ltd., has introduced Thailand's first high-protein UHT-milk. The new Benefitt High Protein UHT Milk is filled in SIG SmallBloc 350 ml carton packs and is now available nationwide at 7-Eleven stores. With 31 grams of protein per pack, the product brings a new level of convenience to Thailand's growing demand for high-protein beverages.

Until now, high-protein milk in Thailand has mainly been available in pasteurized formats that require cold-chain distribution and have shorter shelf life. Benefitt High Protein UHT Milk overcomes these limitations through aseptic processing and packaging, allowing consumers to enjoy high protein nutrition in an ambient, ready-to-drink format that fits easily into daily routines. Made of high-quality ingredients, the product provides 31 grams of protein per 350 ml serving and is formulated to offer a smooth, low-viscosity texture that is easy to drink. It contains no added sugar and is suitable for a wide range of consumers including those seeking convenient meal replacements, office workers looking for nutritious options, and health-conscious individuals focused on protein intake.

The product is filled on an SIG Small 24 Aseptic filling machine, which supports 16 packaging options in terms of formats, volumes and openings combined with unmatched quick volume and format changeovers. This flexibility enables beverage producers to introduce new formats without additional investment in new filling equipment. For Lactasoy, the solution offered the agility to expand into a new category with an ambient, ready-to-drink high-protein beverage.

"Our goal with Benefitt is to make high-protein milk accessible, convenient and enjoyable for consumers across Thailand. The UHT format allows us to deliver high nutritional value without the need for refrigeration, and the SIG packaging gives us a solution that is easy to carry, easy to drink and suitable for nationwide distribution", said Phanwana Mahasup, Advertising Manager and Marketing Coordinator for Benefitt at Lactasoy.

"This launch shows how flexible aseptic filling technology can open new opportunities and help customers innovate and expand into new categories efficiently. By working closely with Lactasoy, we've supported the successful introduction of a high-protein UHT milk that reflects both evolving consumer needs and market growth potential," said Vatcharapong Ungsrisawasdi, Regional Director for Thailand, Laos, Myanmar, and Cambodia at SIG. The introduction of Benefitt High Protein UHT Milk represents a new step forward for Thailand's beverage market. By combining nutritional innovation with ambient UHT technology, Lactasoy and SIG are helping create new opportunities in the growing high-protein segment.

Tastepoint by Iff Predicts Ten Flavor Trends for 2026

From cherry to chai spice, Tastepoint's trend experts reveal ten flavors poised to stand out this year.

Tastepoint by IFF, a leader in innovative flavor creations and taste solutions, has identified ten flavors expected to shape the North American food and beverage landscape in 2026. These predictions spotlight flavors anticipated to trend in retail, food service and beyond throughout the coming year.

"To continue delivering product development solutions that meet consumers' unique and changing needs, we stay attuned to industry and market trends, keeping a pulse on what's relevant now and in the future," said Nicole Potash, Tastepoint general manager. "Our annual flavor trend predictions reflect a vibrant mix of influences, from nostalgia-driven classics to global favorites gaining momentum in the US, as well as bold new combinations. We hope this year's list provides brands with valuable insights and fresh inspiration to create products that excite the senses and spark imagination."

At the intersection of science and creativity, Tastepoint draws on decades of experience to guide brands in developing trend-driven food and beverage products that ignite inspiration and delight consumer palates.

Each year, Tastepoint forecasts ten flavor trends based on data-driven market analysis, food service menu tracking, social listening and changes in consumer behavior. The 2026 list offers insights across categories including confectionery, beverages, dairy, culinary, snacks and bakery. It reflects key trend movements such as nostalgia and better-for-you and identifies global flavors expected to gain traction in North America.

The top 10 flavors to watch in 2026 are:

1. Mandarin: Already popular in juices and sparkling beverages, this citrus favorite is poised to expand into cocktails, coffee, frozen novelties, salad dressings and sauces.
2. Cherry: The sweet and tart flavor of cherry delivers a powerful sense of nostalgia and is expected to lead the way in new beverage launches and appear in snack bars and mixes, confectionery, and dairy applications.
3. Sweet Corn: Historically a staple dish worldwide, sweet corn is seeing renewed interest. Driven by the popularity of Mexican street corn, or Elote, and other global favorites, its versatility continues to expand.
4. French Onion Soup: A timeless comfort food, its deep, savory profile is projected to move into new menu applications.
5. Cola: With its iconic flavor profile currently experiencing a resurgence, cola is expected to move beyond beverages and into unexpected categories such as ice cream and bakery.
6. Limoncello: As consumers seek authentic, premium experiences, this quintessential Italian liqueur is expected to influence new categories, from baked goods to ready-to-drink teas and coffees.
7. Sweet Heat: Often known as "swicy", the crave-worthy combination of sweet and spicy flavors is gaining traction, expanding beyond culinary and snacks, into ice cream, cocktails and beyond.
8. Pancake: This comforting, sweet flavor is predicted to break free from breakfast and appear in a wide range of new formats fit for scoop shops or late-night snacks.
9. Tiramisu: Offering a decadent, layered flavor experience, tiramisu-inspired products are well positioned to appear in categories beyond the bakery space.
10. Chai Spice: With chai's rise as a global favorite, its sweet-and-spicy profile is gaining popularity in food and beverage applications. Its aromatic depth offers a comforting yet elevated alternative to traditional warming spices.

Soy Milk: The Plant-Powered Beverage Redefining Modern Nutrition

Tracking soy milk's rapid adoption across retail, foodservice, and health-driven consumer segments worldwide

Kiran Kumar

Introduction: A New Era of Dairy Alternatives

The global beverage landscape is undergoing a quiet but powerful transformation. As consumers become increasingly conscious of health, sustainability, and dietary choices, plant-based alternatives are rapidly moving from niche shelves to mainstream markets. Among these, soy milk stands tall as one of the earliest and most established dairy substitutes.

Derived from soaked and ground soybeans, soy milk offers a creamy texture and impressive nutritional profile that has helped it gain acceptance across cultures and age groups. What was once a traditional Asian staple has now evolved into a global wellness beverage, embraced by vegans, lactose-intolerant consumers, fitness enthusiasts, and environmentally conscious buyers alike. Today, soy milk represents not just a drink, but a shift in consumer mindset—towards cleaner labels, plant-powered nutrition, and sustainable food systems.

The Origins of Soy Milk: Rooted in Tradition

Soy milk traces its roots back over 2,000 years to ancient China, where soybeans were first cultivated as a vital source of protein. Early forms of soy beverages were prepared as part of Buddhist dietary practices, especially among communities that avoided animal products. Over centuries, soy milk became deeply embedded in East Asian food culture, commonly consumed at breakfast or used in cooking. Its transition from traditional kitchens to commercial production began in the early 20th century, when improved processing technologies made large-scale manufacturing possible. The real breakthrough came in the late 1900s, as Western markets began exploring plant-based alternatives to dairy. With growing awareness around lactose intolerance, cholesterol, and ethical food choices, soy milk emerged as a natural solution—paving the way for today's booming alternative milk category.

Market Introduction and Global Expansion

Soy milk was among the first plant-based beverages to achieve commercial success outside Asia. Initially introduced in health food stores and specialty outlets, it gradually found shelf space in supermarkets and cafés worldwide. The early adopters were primarily vegetarians and individuals with lactose intolerance. However, as product quality improved with better flavor profiles, fortification, and packaging oy milk gained broader consumer acceptance. In recent years, the plant-based beverage market has witnessed exponential growth, driven by lifestyle changes, urbanization, and rising health consciousness. Soy milk continues to hold a strong position within this segment, competing alongside almond, oat, coconut, and rice milk.

Key factors accelerating soy milk adoption include:

- Increasing prevalence of lactose intolerance globally
- Rising vegan and flexitarian populations
- Growing demand for cholesterol-free beverages
- Expanding café culture and use of plant milks in coffee
- Greater availability of flavored and fortified variants
- Improvements in processing technology enhancing taste and shelf life

Emerging economies, particularly in Asia-Pacific regions, are seeing renewed interest in soy milk, while mature markets in North America and Europe continue to innovate through organic, non-GMO, and barista-grade offerings.

Adoption of Soy Milk in Foodservice Channels

The foodservice industry's adoption of soy milk is driving market growth, as institutional buyers select plant-based alternatives to meet dietary requirements and manage costs. Foodservice operators choose soy milk for its high protein content and operational efficiency in large-scale food preparation. Among plant-based alternatives, soy milk's protein composition is most similar to dairy milk, making it suitable for institutional nutrition programs. The demand for specialized barista formulations is increasing, particularly from coffee chains and restaurants that require products that maintain foam stability and prevent curdling in hot beverages.

The removal of additional charges for non-dairy milk options by Starbucks in October 2024 demonstrates the growing institutional acceptance and demand for plant-based alternatives, including soy milk. The foodservice sector values soy milk's consistent supply and standardized nutritional content over alternatives like almond or oat milk, which face greater raw material price and availability fluctuations. This widespread adoption in foodservice establishments supports sustained market

growth beyond retail consumer trends, establishing soy milk as an essential component of the food industry.

Increasing Adoption of Vegan and Vegetarian Diets

The global soy milk market is experiencing substantial growth due to the increasing adoption of vegan and vegetarian diets, primarily driven by health consciousness, environmental sustainability concerns, ethical considerations, and economic factors. Consumer preferences are shifting towards plant-based alternatives due to rising awareness of lactose intolerance, concerns about cholesterol levels, and the environmental impact of traditional dairy farming. The market growth is further propelled by technological advancements in processing methods, enhanced product formulations, and significant investments in research and development.

According to World Population Review, India and Mexico's vegan population reached 9% in 2025, particularly supported by the rapid expansion of modern retail formats, increasing urbanization, rising disposable incomes, and growing awareness of plant-based nutrition benefits. This shift is further accelerated by the expansion of retail distribution networks, product innovations in taste and nutritional content, and increasing investments in plant-based protein technologies across the food and beverage industry.

Product Innovations and Diverse Flavors Expand Market Reach

Product innovation and flavor diversification are driving the expansion of the global soy milk market through strategic responses to consumer demands for health benefits and taste preferences. The market growth is primarily influenced by increasing health consciousness, rising lactose intolerance cases, and the growing adoption of plant-based diets. Manufacturers are responding to these trends by developing enhanced soy milk products beyond traditional plain varieties, utilizing advanced processing technologies and ingredient formulations. Companies have systematically expanded their product portfolios to include vanilla, chocolate, and functional variants fortified with calcium, vitamin D, and omega-3s, addressing specific nutritional requirements. This trend is exemplified by Lactasoy's March 2023 launch of a chocolate-flavored soy milk with 26% reduced sugar content, directly addressing the growing consumer demand for healthier alternatives in the flavored beverage segment. The product contains nine amino acids and omega-3, 6, and 9, strategically targeting the expanding demographic of consumers seeking chocolate flavor with additional protein benefits. These systematic innovations particularly resonate with younger consumers and flexitarians who demonstrate a consistent preference for products that balance taste and nutritional value in their beverage choices.

> *The soymilk market size in 2026 is estimated at USD 12.28 billion, growing from 2025 value of USD 11.50 billion with 2031 projections showing USD 17.07 billion, growing at 6.8% CAGR over 2026-2031. Several factors contribute to this growth, including increased health awareness and growing concerns about sustainability among consumers. The rising cases of lactose intolerance and milk allergies worldwide have driven consumers toward soymilk, a naturally lactose-free and hypoallergenic alternative. The adoption of vegan and flexitarian diets, particularly among younger and urban populations, has accelerated the transition from traditional dairy products. Soymilk's nutritional composition, which includes high-quality protein, essential amino acids, vitamins, and minerals, appeals to health-conscious consumers seeking nutritious beverages.*

The Indian Market: A Growing Opportunity

In India, soy milk is steadily gaining traction as awareness of plant-based nutrition rises. Traditionally dominated by dairy, the Indian beverage sector is now opening up to alternatives, especially among urban consumers, millennials, and health-focused households. Several domestic and international brands have entered the Indian market, offering soy milk in plain, vanilla, chocolate, and unsweetened formats. The growth of e-commerce and modern retail has further boosted accessibility, while cafés and quick-service restaurants increasingly offer soy milk as a dairy substitute. India's large lactose-intolerant population, combined with rising disposable incomes and interest in wellness products, positions soy milk as a promising segment within the broader functional beverage market.

Nutritional Profile: A Powerhouse in a Glass

One of soy milk's strongest advantages lies in its impressive nutritional composition. Unlike many other plant-based beverages, soy milk closely matches cow's milk in protein content, making it especially appealing to consumers seeking balanced nutrition.

A typical serving of soy milk provides:

- High-quality plant protein containing all essential amino acids
- Naturally low saturated fat
- Zero cholesterol
- Calcium (often fortified)
- Vitamins D, B12, and riboflavin (in fortified versions)
- Iron, magnesium, and potassium

This makes soy milk a complete and versatile beverage suitable for children, adults, athletes, and seniors alike.

Health & Family Welfare Department, Government of Odisha

Health Benefits of Soy Milk

Supports Heart Health

Soy milk is naturally cholesterol-free and low in saturated fat. Regular consumption may help reduce LDL (bad cholesterol) levels, thereby lowering the risk of cardiovascular disease. Soy protein has also been linked to improved arterial function and overall heart health.

Aids in Weight Management

With its high protein content and moderate calorie profile, soy milk promotes satiety, helping consumers feel fuller for longer. This makes it a valuable addition to weight management diets and active lifestyles. Protein-rich beverages like soy milk can help reduce unhealthy snacking and support portion control by stabilizing blood sugar levels. Additionally, its low saturated fat content makes it a heart-friendly option for calorie-conscious consumers seeking sustainable weight-loss solutions without compromising nutrition.

Promotes Bone Strength

Most commercial soy milk products are fortified with calcium and vitamin D, essential nutrients for maintaining strong bones and preventing osteoporosis, particularly in aging populations. Soy milk also contains magnesium and phosphorus, which work synergistically to improve bone mineral density. Regular consumption may help reduce the risk of fractures, especially among postmenopausal women and older adults. For individuals avoiding dairy, fortified soy milk serves as an effective alternative to meet daily calcium requirements.

Supports Digestive Comfort

For individuals who are lactose intolerant or sensitive to dairy, soy milk offers a gentle alternative that is easier to digest, helping prevent bloating, cramps, and discomfort associated with traditional milk. It contains natural fibers that support gut health and promote smoother digestion. Unlike dairy milk, soy milk does not trigger lactose-related gastrointestinal distress, making it suitable for populations with digestive sensitivities. Its smooth texture and light consistency further enhance tolerance across age groups.

May Help Balance Hormones

Soy contains isoflavones—plant compounds that mimic estrogen in the body. These have been associated with easing menopausal symptoms such as hot flashes and supporting hormonal balance in women. Isoflavones may also contribute to improved bone health and cardiovascular function during menopause. Emerging studies suggest that regular soy consumption can help moderate hormonal fluctuations while offering protective benefits against certain age-related conditions, positioning soy milk as a functional beverage for women's wellness.

Encourages Muscle Growth and Repair

Thanks to its complete protein profile, soy milk is widely used in sports nutrition and post-workout recovery, supporting muscle building and repair. It provides all nine essential amino acids required for muscle regeneration and strength development. Athletes and fitness enthusiasts increasingly incorporate soy milk into smoothies and recovery drinks due to its fast absorption and anti-inflammatory properties. Its plant-based protein content also appeals to vegan consumers seeking performance nutrition without animal-derived ingredients.

The Road Ahead: A Staple of Future Nutrition

As global food systems shift toward plant-forward models, soy milk is well positioned to remain a cornerstone of alternative dairy. Its nutritional completeness, affordability, and adaptability make it a strong contender in both developed and emerging markets. With growing investments in product development, distribution networks, and consumer education, soy milk is transitioning from an alternative option to an everyday essential—supporting healthier lifestyles and more sustainable food choices.

Conclusion: More Than Just a Milk Substitute

Soy milk has journeyed far from its ancient origins to become a modern symbol of wellness and sustainability. Backed by science, embraced by consumers, and supported by innovation, it represents a powerful intersection of nutrition, technology, and conscious living. As demand for clean, plant-based beverages continues to rise, soy milk stands as a proven pioneer—offering a nutritious, versatile, and eco-friendly solution for today's evolving food and beverage landscape.

Author's Bio - Supporting Editor

https://www.mordorintelligence.com/industry-reports/soy-milk-market

Source: World Population Review, "Veganism by Country 2025", worldpopulationreview.com

Antifreeze Proteins Market Set for Rapid Expansion Through 2034

The global antifreeze proteins (AFP) market is poised for exceptional growth, with its size expected to reach USD 262.17 million by 2034, expanding at a striking CAGR of 35.14 percent during the forecast period of 2025–2034, according to a recent study by Polaris Market Research. This rapid rise reflects growing demand for advanced cold-protection solutions across multiple industries, particularly food processing, pharmaceuticals, medical research, and agriculture. As industries increasingly focus on quality preservation, extended shelf life, and improved performance under extreme temperatures, antifreeze proteins are emerging as a high-value bio-based solution.

Understanding Antifreeze Proteins and Their Functional Role

Antifreeze proteins are naturally occurring biomolecules that enable organisms such as fish, insects, plants, fungi, and microorganisms to survive in sub-zero environments. These proteins work by binding to ice crystals and inhibiting their growth, thereby preventing cellular damage caused by freezing. This unique functionality has driven strong interest in AFPs across industrial applications where temperature control and freeze resistance are critical. Their natural origin and high efficiency further strengthen their appeal amid the global shift toward bio-based and sustainable solutions.

Expanding Applications Across Food, Agriculture, and Healthcare

In the food and beverage industry, antifreeze proteins are increasingly used to improve the texture, stability, and quality of frozen products such as ice cream, yogurt, and frozen desserts. By controlling ice crystal formation, AFPs help maintain smooth textures and consistent sensory quality. In agriculture, these proteins are gaining traction for enhancing frost resistance in crops, helping farmers mitigate losses caused by unexpected freezing conditions. The pharmaceutical and medical sectors represent the largest end-use segment, where AFPs play a critical role in cryopreservation of cells, tissues, and organs, as well as in extending the viable preservation time for donor organs used in transplantation.

Market Segmentation and Regional Growth Trends

From a segmentation perspective, the solid form dominated the market in 2024, accounting for 74.80 percent of revenue share, primarily due to its superior stability and longer shelf life in food, cosmetic, and medical applications. By source, fish-derived antifreeze proteins led the market with a 57.44 percent revenue share, supported by ease of extraction and proven effectiveness. Regionally, North America accounted for 42.79 percent of global revenue in 2024, driven by strong pharmaceutical research capabilities and advanced cryopreservation technologies, with the U.S. alone contributing over 90 percent of the regional share. Meanwhile, Asia Pacific is expected to emerge as a major growth engine by 2034 due to expanding food processing industries and rising healthcare expenditure, while Europe is projected to grow steadily under stringent food safety and quality regulations.

Competitive Landscape and Future Outlook

The antifreeze proteins market features a mix of biotechnology innovators and global industrial players, including A/F Protein Inc., BASF SE, Cargill, Kaneka Corporation, MyBioSource, ProtoKinetix, Sirona Biochem, and Unilever. Looking ahead, continued advancements in biotechnology, rising investments in medical research, and growing demand for high-performance frozen and cold-stable products are expected to sustain strong momentum. As industries place greater emphasis on preservation efficiency, safety, and natural functionality, antifreeze proteins are likely to play an increasingly strategic role in next-generation food, agricultural, and medical solutions. Groceries

www.polarismarketresearch.com

Functional Ingredients Innovation in Dairy and Dairy-Based Functional Foods

Payoshni S. Joshi and Dr. Manmath Sontakke

1. Introduction

The dairy sector has provided several essential elements, such as high-quality protein, calcium, vitamins, and biological activity, to satisfy human nutritional needs for generations. Dairy has evolved into much more than just a healthy basis for growth and bone development. Consumer decisions to buy dairy products have been influenced by changes in our lifestyle, rising health consciousness, and an increasing focus on preventative health care. Today's consumers demand dairy products that offer them health benefits in addition to satisfying their taste and hunger.

The creation of functional dairy products, which are dairy foods that have been specially designed to provide extra physiological benefits beyond basic nutrition (i.e., to support optimal digestive/gut health or immunity), has drawn more attention as a result of this shifting perception. Probiotics, prebiotics, bioactive peptides, fortified minerals, and other plant-based ingredients are examples of functional ingredients that have been added to functional dairy products with the goal of improving immunity, metabolic health, digestive/gut health, and general well-being.

2. Functional Ingredients in Dairy: Concept and Classification

2.1. Definition of Functional Ingredients
Beyond only providing nutrients, dairy has biologically active ingredients that improve health. Instead of supplying calories or vital nutrients, functional substances improve bodily processes like immune system support or digestion. The functional element in dairy products may be added on purpose to improve the physiological response when dairy products are regularly ingested, or it may be created naturally during processing. Because of its high nutrient density, dairy and functional foods can offer a means to use this functional ingredient as a source of nutrition while also obtaining other health benefits by producing an optimal substrate for introduction into the body.

2.2. Difference Between Conventional Dairy Ingredients and Functional Ingredients

The natural ingredients used to make conventional dairy products include lactose, casein, whey, fat, vitamins, and minerals. These ingredients provide fundamental nourishment.
Additional ingredients and physiological advantages are present in functional dairy products. Probiotics, which promote a healthy gut microbial balance, and dietary fibers, which enhance digestion, are two examples of how they aid in the improvement of bodily systems. These can be found in nature or added to the final dairy product to improve its health value.

2.3. Role of Functional Ingredients Beyond Basic Nutrition

Functional ingredients included in dairy products are used not only to nourish your body but also to assist maintain a healthy gut microbiota and enhance your immune response by modifying gut bacteria. Dairy's functional components also affect how different nutrients are metabolized, which improves biochemical processes including antioxidant activity. When consumed as part of a healthy lifestyle, these functional ingredients not only help dairy products meet customers' daily nutritional needs but also offer possible long-term health advantages and could lower the chance of acquiring chronic diseases.

3. Key Functional Ingredients Driving Innovation in Dairy Products

Dairy advancements in recent years have focused on functional ingredients, transforming products like yogurt, milk, and fermented drinks into tailored health solutions for today's health-conscious consumers. Furthermore, this change shows a deeper comprehension of how particular bioactive ingredients interact with the human body and offer advantages beyond mere nourishment, rather than being only a marketing ploy.

3.1. Probiotics in Dairy Products

Many dairy products, such as yogurt, fermented milk products, and probiotic beverages, contain live helpful bacteria called probiotics. The two most popular probiotic bacteria for preserving gut microbiota and supporting digestive health are Lactobacillus and Bifidobacterium. Additionally, probiotics aid in immune system modulation and metabolic regulation. Because of these characteristics, probiotic consumption improves wellbeing and lowers the risk of gastrointestinal problems. Probiotic organisms can be destroyed or degraded by air exposure, storage conditions, and processing conditions (such as heating and pH changes).

3.2. Prebiotics and Dietary Fibers

Prebiotics are non-digestible food ingredients that have the ability to specifically promote the growth and activity of specific beneficial microorganisms found in the human digestive system. Common prebiotic ingredients like resistant starch,

FOS, and inulin stay undigested in the upper part of the human digestive tract and are fermented by bacterial microflora in the colon, creating byproducts that improve host immunity and maintain the integrity of the intestinal mucosal barrier.

In dairy applications, inulin and FOS improve the mouthfeel and texture of some dairy products (such as fermented or low-fat yogurt) in addition to intestinal health. These products may promote feelings of fullness (satiety) and decrease glycemic reactions, increasing consumer appeal for a greater variety of dairy products with an emphasis on health and activity.

3.3. Fortifying Ingredients: Vitamins and Minerals

Dairy products are frequently great carriers for food fortification because of their inherently high nutritional density. To enhance the health benefits of dairy, calcium, vitamin D, iron, and zinc are commonly added to milk, yogurt, and other dairy products. These products can treat nutrient deficiencies that many people have. For instance, the combination of calcium and vitamin D improves bone health and increases the absorption of minerals.

3.4. Bioactive Peptides and Natural Antioxidants

Bioactive peptides are produced from milk proteins either by fermentation or by using an enzyme to break down milk proteins. These bioactive peptides have a wide range of effects on the body, such as antibacterial properties, blood pressure reduction, and defense against free radicals. Additionally, bioactive peptides may improve metabolic and cardiovascular health. Furthermore, natural antioxidants, like those in plant phenolics or fruit extracts, can be added to enhance the final product's oxidative stability and provide many of the same functional characteristics as the bioactive peptides.

4. Technological Innovations Supporting Functional Dairy Ingredients

The dairy business has the chance to apply innovative technology to improve the functional qualities, stability, and sensory appeal of dairy products due to the growing customer desire for transparency and healthier food. Microencapsulation is one of these technologies that shields delicate components by encasing them in a protective matrix while they are being processed, stored, and digested.

Enhancement based on fermentation is a large-scale invention. In addition to giving dairy products a wide variety of aromas and textures, regulated fermentation produces natural bio-actives and facilitates digestion. New methods for producing particular functional ingredients, such as customized proteins, with reliable performance and quality include precision and biomass fermentation.

Proteases, lactases, and other enzymes can change the proteins and carbohydrates in dairy products to improve their nutritional value and sensory appeal, giving dairy products even more possibilities. Dairy producers may accelerate maturation, boost sweetness, and lower lactose levels without using artificial additives thanks to enzymatic treatments.

Clean labels and minimal processing are gaining popularity among consumers. As a result, customers want clean label (and less processed) foods with fewer artificial additives. Food makers may produce safe, long-lasting products without compromising nutrition or sensory quality thanks to non-thermal processing technologies (high-pressure processing and pulsed electric field).

5. Applications of Functional Ingredients in Value-Added Dairy Products

Functional ingredients are revolutionizing the production, distribution, and consumption of milk and all dairy products, transforming what has historically been a basic milk into an outstanding nutritional product with added health advantages.

5.1. Functional Milk and Dairy Beverages

One of the most well-known dairy products with additional value is "Fortified Milk." By adding extra vitamins and minerals (including calcium and vitamin D) to the regular milk formula, fortified milk helps address common micronutrient shortages while preserving milk's delicious flavor, aroma, and texture. Fortified milk is a product that appeals to consumers who are health-conscious because it contains additional calcium and vitamin D, which are beneficial elements for growing bones and immune systems.

Another quickly expanding area of the dairy industry is probiotic dairy drinks. The milk component of fermented dairy beverages is blended with live probiotic cultures to create probiotic dairy drinks, which help maintain gut health and general well-being.

5.2. Fermented Dairy Products

Among the most well-liked functional dairy meals are fermented dairy products like yogurt, curd, kefir, etc. Probiotics like Lactobacillus and Bifidobacterium, along with starter cultures, ferment the milk and create beneficial compounds. These substances support the growth of a robust immune system and a healthy digestive system. Because they include live cultures that improve digestion and reduce inflammation, kefir and probiotic-enhanced products are becoming more and more popular.

5.3. Dairy-Based Functional Foods

Advancements in dairy cheese and dessert foods are progressively adding beneficial formulations to their range of products. For instance, cheese products may be made with more protein, probiotics, and/or micronutrients to appeal to consumers who are more concerned about their health. Similar to this, high-quality dairy protein is combined with other useful ingredients (fibers, antioxidants, and plant extracts) in dessert and meal replacement dairy-based products to create nutritionally dense goods that support people's needs for satiety, metabolic health, and other health objectives.

6. Regulatory and Quality Considerations

The Food Safety and Standards Authority of India (FSSAI) framework, which categorized foods with added probiotics, prebiotics, vitamins, and other functional ingredients under the Food Safety and Standards (Food or Health Supplements, Nutraceuticals, Foods for Special Dietary Uses, Foods for Special Medical Purpose, Functional Foods and Novel Food) Regulations, 2016, governs functional dairy products in India. Before being utilized in food formulations, these laws guarantee that any functional component used in dairy products satisfies safety and scientific substantiation requirements.

Health claims and permissible ingredients must be supported by reliable data. Vague, overstated, or therapeutic statements (such as "cures disease") on product labels or advertising materials are prohibited by FSSAI. Only scientific data from clinical trials, research, or accepted nutritional standards may support health claims like "supports immunity" or "helps bone health." The Food Safety and Standards (Packaging and Labelling) Regulations, 2011 regulate labeling requirements and consumer transparency. The ingredient list, nutritional

data, FSSAI license number, net quantity, production and expiration dates, and allergen declarations must all be prominently shown on labels. Regulatory action may follow misleading or deceptive labeling.

7. Challenges in Functional Ingredients Innovation in Dairy

Key obstacles to innovation in functional dairy include shelf life and ingredient stability because bio-actives like probiotics are sensitive to processing and storage, necessitating expensive methods like microencapsulation. When functional ingredients change a product's taste, texture, or scent, it might cause sensory problems that impact consumer approval. Affordability is restricted by high costs and scalability issues brought on by pricey ingredients and sophisticated processes, particularly in price-sensitive markets. Furthermore, the requirement for transparent, unambiguous communication supported by science is highlighted by consumer mistrust and a lack of knowledge regarding functional claims.

8. Future Trends and Opportunities in Functional Dairy Products

Personalized nutrition, with products designed for particular health needs including bone, intestinal, and metabolic health, is what will drive the future of functional dairy. Dairy products are being combined with indigenous and underutilized nutrients like millets, ginger, and turmeric to provide both practical and culturally recognizable benefits. Innovation is also being shaped by ethical and sustainable sourcing, as customer choices are increasingly influenced by both nutrition and ecologically friendly production.

9.Conclusion

Dairy products are becoming healthier due to functional additives that boost immunity, gastrointestinal health, nutrient metabolism, and general well-being. Technological developments that improve stability, bioavailability, and sensory quality include microencapsulation, fermentation, and enzymatic modification. Functional dairy has the potential to significantly improve public health due to the growing demand for customized, nutrient-rich products. Through consumer education, sustainable sourcing, and research, it is expected to play a significant role in healthy diets across the globe.

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References to the article are available upon request from readers.

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Modular and Decentralised Cold Storage: The Future of Dairy Distribution in Emerging Markets

Ritesh Verma


Image: Cryo Systems

Introduction: Rethinking the Dairy Cold Chain

The dairy industry is entering a decisive phase of transformation. Rapid population growth, expanding urban centres and rising disposable incomes across emerging economies are driving unprecedented demand for milk and dairy products. At the same time, producers and processors are under pressure to deliver fresher products, reduce losses and operate more sustainably. This convergence of challenges and opportunities is reshaping how dairy supply chains are built, particularly in regions where infrastructure gaps remain significant. At the heart of this evolution lies modular and decentralised cold storage, a model increasingly viewed as essential for the future of dairy distribution in emerging markets.

The Limitations of Traditional Cold Storage Infrastructure

Cold storage has always been a critical link in the dairy value chain. Milk and dairy products are highly perishable and require strict temperature control from farm to consumer. However, traditional cold storage systems in many developing regions have been heavily centralised, capital intensive and dependent on unreliable grid power. Large cold warehouses are often located near processing plants or urban markets, far from rural milk-producing areas. This distance increases transportation time, raises costs and exposes products to temperature fluctuations. As a result, spoilage rates remain high, farmer incomes suffer and processors struggle to maintain consistent quality.

Understanding Modular and Decentralised Cold Storage

To address these structural limitations, the industry is increasingly turning to modular and decentralised cold storage systems. Modular cold storage refers to prefabricated, scalable units that can be rapidly deployed and customised according to local needs. Decentralised cold storage distributes capacity across multiple smaller locations rather than concentrating it in a few large facilities. By placing cold storage closer to farms, collection centres and local markets, this model reduces transit time, lowers spoilage and creates a more resilient supply chain.

Market Forces Driving Adoption in Emerging Economies

Several powerful forces are accelerating the adoption of modular and decentralised cold storage. Rising dairy consumption across Asia, Africa and Latin America is placing enormous pressure on existing infrastructure. At the same time, advances in IoT-based monitoring, energy-efficient cooling systems and cloud platforms are making small-scale cold storage smarter and more reliable. The integration of renewable energy, particularly solar power, has opened new possibilities for rural regions where grid connectivity remains inconsistent.

Strengthening the Dairy Value Chain from Farm to Consumer

Decentralised cold storage creates value at every stage of the dairy ecosystem, starting at the farm gate and extending all the way to retail shelves. For smallholder farmers, who form the backbone of dairy production in most emerging markets, access to nearby cold storage dramatically reduces milk spoilage and quality degradation. Instead of rushing to sell raw milk immediately after milking, farmers can store it safely at controlled temperatures, giving them greater flexibility in choosing when and where to sell. This reduces dependency on middlemen, improves price realization, and strengthens farmers' negotiating power.

For dairy cooperatives and collection centres, decentralised cold storage enables efficient aggregation of chilled milk from multiple villages. This improves logistics planning, reduces transport frequency, and allows larger volumes to be delivered to processors in fewer trips. The ability to consolidate quality-controlled milk also enhances traceability and supports compliance with food safety standards.

Processors benefit from a more consistent and reliable supply of high-quality raw material. When milk is chilled immediately after collection, bacterial growth is minimized, resulting in better yields during processing and reduced rejection rates. This consistency allows processors to diversify into higher-value products such as cheese, yogurt and flavoured dairy beverages, expanding market opportunities beyond liquid milk.

Retailers gain access to fresher products with longer shelf life, enabling them to serve smaller towns and semi-urban markets that were previously difficult to reach due to cold chain limitations. Ultimately, consumers benefit from safer, higher-quality dairy products, even in regions far from major processing hubs. This end-to-end improvement strengthens trust in dairy brands while supporting broader goals of nutrition and food security.

Real-World Applications and Emerging Market Case Studies

Across emerging economies, decentralised cold storage is already delivering measurable impact. In India, village-level solar-powered micro cold rooms installed at milk collection centres allow farmers to chill milk within minutes of delivery. These systems have helped reduce spoilage, increase average milk prices received by farmers, and extend collection windows, especially during peak summer months. Many cooperatives now use these cold rooms to stabilise supply during seasonal fluctuations.

In East Africa, modular cold storage units powered by hybrid solar-grid systems are enabling cooperatives to operate longer collection hours and serve remote communities. By reducing losses and improving milk quality, these facilities are helping small farmers integrate into formal dairy value chains for the first time. In Kenya and Uganda, such deployments have also supported women-led dairy enterprises by lowering entry barriers and improving income stability.

Southeast Asia is seeing rapid adoption of IoT-enabled cold rooms, particularly in Vietnam and Indonesia. These smart systems allow operators to remotely monitor temperature, humidity and energy consumption, ensuring consistent quality while lowering operating costs. Real-time alerts help prevent product loss, and data analytics support predictive maintenance, reducing downtime. In parts of Latin America, decentralised cold storage is strengthening informal dairy markets by introducing basic temperature control and hygiene standards. This has enabled local vendors to handle milk and dairy products more safely, expanding access to fresh dairy in peri-urban areas while improving livelihoods for small-scale producers and traders.

These examples illustrate how modular cold storage adapts to diverse regional needs while delivering a common outcome: stronger, more inclusive dairy supply chains.

Technology Innovations Reshaping Cold Storage Design

Modern modular cold storage systems are increasingly driven by intelligent design and digital integration. Advanced insulation materials and energy-efficient cooling technologies significantly reduce power consumption, making small-scale cold rooms economically viable even in energy-constrained environments. Variable-speed compressors adjust cooling output based on load, while phase-change materials help maintain stable temperatures during power interruptions.

IoT sensors embedded within cold storage units provide continuous visibility into temperature, humidity and equipment performance. This real-time data enables operators to identify risks early, prevent spoilage and optimise energy use. Cloud-based platforms aggregate information across multiple locations, giving processors and logistics teams a holistic view of their cold chain. Digital tools also support inventory management and logistics coordination. Operators can track milk volumes, monitor storage duration and plan transportation routes more efficiently. Predictive maintenance algorithms use equipment data to forecast failures before they occur, reducing repair costs and extending asset life. Together, these innovations are transforming cold storage from a passive infrastructure asset into an active, data-driven component of the dairy value chain.

Financing Models Enabling Wider Access

Scaling decentralised cold storage requires innovative financial frameworks. Leasing models and equipment-as-a-service reduce capital barriers for small processors and cooperatives. Public-private partnerships and blended finance structures help extend cold infrastructure into underserved regions. Pay-per-use systems further democratise access, allowing farmers to store produce without heavy upfront investment.

Addressing Challenges in Deployment and Operations

Despite strong momentum, modular cold storage faces several operational challenges. Power reliability remains a concern in many rural regions, requiring hybrid energy systems that combine solar, grid and battery backup. Technical skill gaps can affect maintenance and uptime, highlighting the need for local training programs and service networks. Logistics coordination across decentralised sites adds complexity, particularly when integrating collection centres, processors and transport providers. Digital platforms are increasingly used to streamline communication and scheduling, improving efficiency across the network. Regulatory compliance is another critical factor, as cold storage facilities must adhere to food safety standards related to hygiene, temperature control and traceability.

To address these issues, stakeholders are adopting standard operating procedures, implementing quality audits and investing in workforce development. Building trust among farmers, operators and buyers is essential for long-term success, making transparency and consistent performance key priorities.

A Strategic Roadmap for Scaling Decentralised Cold Storage

The future growth of decentralised cold storage will depend on coordinated action across the public and private sectors. Governments can support deployment by mapping dairy production clusters, offering incentives for rural infrastructure and encouraging local manufacturing of modular units. Technology providers and investors must collaborate to deliver affordable, standardised solutions that can be easily replicated across regions.

Workforce development will be equally important. Training technicians, operators and logistics managers ensures that cold storage systems remain functional and efficient over time. Standardised digital platforms can improve interoperability and data sharing across the dairy value chain, supporting better planning and quality control.

Above all, solutions must remain farmer-centric. Cold storage models should be designed around local realities, keeping costs low, operations simple and benefits clearly visible to producers. When aligned with renewable energy, smart technology and inclusive financing, decentralised cold storage has the potential to redefine dairy distribution in emerging markets, creating resilient supply chains that support economic growth, food security and sustainable development.

Conclusion: Building Resilient Dairy Distribution Networks for the Future

Modular and decentralised cold storage represents a fundamental shift in how dairy supply chains operate in emerging markets. By bringing refrigeration closer to production points, reducing losses and improving quality, this model supports more resilient, inclusive and sustainable dairy ecosystems. As renewable energy, digital innovation and flexible financing continue to converge, decentralised cold storage is poised to become a cornerstone of future dairy distribution, enabling emerging economies to meet growing demand while strengthening rural livelihoods and food security.

Author's Bio: Mr. Verma is an experienced freelance writer with more than 15 years of expertise contributing to a wide range of publications.

Carlsberg India Inaugurates New Can Line at Mysuru Brewery, Reinforcing Commitment to Karnataka

Carlsberg India, a subsidiary of the globally renowned Danish brewer with a 178-year legacy, announced the inauguration of a new can line at its Mysuru brewery. This milestone reinforces the company's long-term commitment to Karnataka, following its ₹350 crore expansion pledge made at Invest Karnataka 2025 to further expand the Mysuru facility.

The new can line has been established with an investment of ₹100 crore and offers a production capacity of 22,000 cans per hour (CPH). The addition significantly enhances the brewery's ability to meet growing consumer demand and forms an integral part of Carlsberg India's broader expansion strategy across the country.

Speaking at the inauguration, Shri Yathindra Siddaramaiah, Member of the Legislative Council (MLC), Government of Karnataka, said, "We appreciate Carlsberg India's continued investments of ₹350 crore in Karnataka, particularly in Mysuru, and their impactful work that contributes positively to society. These efforts reflect the company's strong confidence in the state's industrial ecosystem. We encourage more companies to step forward with increased local investments and job creation, especially in Mysuru, to support inclusive and sustainable regional development."

Commenting on the development, Mr. Nilesh Patel, Managing Director, Carlsberg India, said, "Our continued investment in Karnataka underscores our long-term commitment to the state. Through this expansion, we aim to sustainably produce international-quality beers for consumers, contribute to state excise revenues, and generate additional direct and indirect employment opportunities for the local community."

Located in Nanjangud taluk, the Mysuru brewery is spread across 28 acres and manufactures Carlsberg and Tuborg brands. The facility reflects Carlsberg India's strong focus on responsible and sustainable brewing practices. It operates biomass boilers using husk and biogas as fuel. Additionally, 85% of the brewery's power requirements are met through solar energy.

Carlsberg India is also actively engaged in water sustainability initiatives in Karnataka, working in partnership with WaterAid and local communities to promote responsible water stewardship.

In the Image- Mr. Nilesh Patel, Managing Director, Carlsberg India; Shri Yathindra Siddaramaiah, Member of the Legislative Council (MLC), Government of Karnataka; Mr. Sanjeev Gupta, Vice President – Integrated Supply Chain, Carlsberg India; H. E. Peter Winther-Schmidt, Consul General of Denmark in Bengaluru Ms. Vandana Kapur, Vice President – People & Culture, Carlsberg India; Mr. Rishi Chawla, Vice President – Corporate Affairs, Carlsberg India.

Avro India Leads Waste-to-Wealth Shift with India's Largest Flexible Plastic Recycling Unit

Avro India Limited, a leading manufacturer of plastic-moulded furniture, is set to address one of India's most complex environmental challenges—recycling difficult-to-process plastic waste—with the launch of its state-of-the-art greenfield recycling facility in Ghaziabad. Operating under AVRO Recycling Limited, a 100% owned subsidiary of Avro India Limited, the facility houses India's largest flexible plastic recycling plant, with a current processing capacity of 500 metric tonnes per month (MTPM). The capacity is scheduled to scale up to 1,000 MTPM by Q4 of FY 2025–26.

The capital expenditure invested in the recycling plant stands at Rs 25 crore as of date, with plans to invest an additional Rs 30 crore by FY 2027. As part of its long-term sustainability vision, the company also plans to expand pan-India through future greenfield recycling projects. Founded in 2002, Avro India Limited has consistently delivered durable, high-quality, and affordable plastic-moulded furniture to households, businesses, and institutions across India. Today, the company enjoys nationwide prominence and is listed on both the NSE and BSE.

Avro has built one of India's most extensive distribution networks, comprising over 30,000 retailers, supported by more than 300 distributors across 24 states. Historically, difficult-to-process plastic waste—such as cement bags, salt bags, sugar bags, putty bags, and calcite packaging—was considered largely non-recyclable and was either downcycled or handled by the unorganised sector. After more than three years of intensive research, trials, and technological innovation, Avro has developed a proprietary system capable of upcycling such complex plastic waste at scale, enabling the responsible processing of nearly 1 million metric tonnes per annum (MTPA) of such waste generated in India.

The recycled granules produced at the facility are fully utilised in the manufacture of high-value end products, including plastic furniture, air coolers, washing machines, automotive components, and

other industrial and consumer applications. These granules are available at up to 40% lower cost than virgin plastic, while meeting stringent technical and durability standards—helping manufacturers remain cost-efficient, compliant, and environmentally responsible. With the implementation of Extended Producer Responsibility (EPR) norms by the Government of India—mandating the use of at least 30% recycled plastic content in rigid plastics—brand owners are facing a significant supply gap of high-quality recycled raw materials. Addressing this challenge, Avro India has emerged as the largest and most reliable organised player in the flexible plastic recycling space, offering consistent volumes at industrial scale.

Commenting on the development, Mr. Sushil Kumar Aggarwal, Chairman and Whole-Time Director, Avro India Limited, said"India's plastic challenge cannot be solved through fragmented efforts. It requires scale, technology, and intent. At Avro, we have invested years of research to build a system that converts complex plastic waste into valuable raw material. Our vision goes beyond recycling—we are building a nationwide ecosystem that transforms waste into opportunity while protecting our planet."

Looking ahead, Avro India is developing a pan-India network of 'mother and baby' recycling plants, aimed at decentralizing waste processing and accelerating India's transition to a circular economy. Through innovation, scale, and collaboration, the company aims to play a defining role in positioning India as a global leader in sustainable plastic management.

Avro India Limited is one of India's leading manufacturers of plastic furniture and recycled polymer solutions. With advanced manufacturing infrastructure, a strong national presence, and a firm commitment to sustainability, Avro is actively contributing to India's circular economy by transforming plastic waste into high-value, durable products. The company manufactures a diverse product range backed by a three-year guarantee, ensuring durability and weather resistance for both indoor and outdoor applications. Its key competitive advantage lies in a highly cost-effective pricing strategy, with products priced approximately 40% lower than national and established brands, driven by low overheads and operational efficiency. High-volume production at its Ghaziabad facility has positioned Avro as the largest player in North India and among the top five plastic-moulded furniture companies nationwide.

Riddhi Siddhi Gluco Biols Ltd. signs asset purchase agreement to acquire

Cargill India's corn wet milling division in Davangere, Karnataka

Riddhi Siddhi Gluco Biols Ltd. (RSGBL), a publicly listed company on the Bombay Stock Exchange (BSE), has signed an Asset Purchase Agreement (APA) to acquire the assets of Cargill India Pvt. Ltd.'s (CIPL) Starch & Sweeteners business in Davangere, Karnataka. The deal includes the acquisition of land, manufacturing facilities, warehouses, and corn silos that provide integrated storage infrastructure supporting the corn wet milling operations, subject to the terms and conditions of the APA and obtaining of customary approvals.

Operational since 2016, the 52-acre facility boasts 300,000 MT annual processing capacity, and manufactures maltodextrin, liquid glucose, and co-products like corn germ, corn gluten, and corn fiber.

Commenting on the APA, Mr. Siddharth Chowdhary, Executive Director, RSGBL, said: "We are pleased to have signed the APA to acquire Cargill India's Davangere corn wet milling assets, including land, warehouses, and corn silos. This acquisition aligns perfectly with RSGBL's long-term growth vision, expanding our footprint in food and pharmaceutical segments to better meet unmet customer demand. The facility's strategic Karnataka location bolsters our competitive service to domestic and export markets. Additionally, our intent to operate the facility using renewable energy sources reflects our long-term commitment to clean energy and sustainable manufacturing."

With over three decades in starch and starch derivatives, this move cements RSGBL's leadership in India's starch industry through enhanced footprint and innovation. Speaking on the transaction, Dheeraj Talreja – Vice President & Managing Director, Food South Asia, Cargill India Pvt Ltd said, "We wish RSGBL success and are confident that this asset will support their growth as they expand their presence in the starch industry".

In India, Cargill has been operating since 1987 and currently has pan-India presence with businesses spanning refined oils, food ingredients, industrial specialties, grain and oilseeds, cotton, animal nutrition, and trade & capital markets.

www.riddhisiddhi.co.in

FPS Food Process Solutions Targets Global Food Manufacturing and Technology Market with Major Expansions Around the World

FPS Food Process Solutions ("FPS"), a global leader in turn-key food processing solutions, targets global food manufacturing and technology market with major expansion plans around the world. Key milestones include:

- FPS MEA opens its 2nd location in central Morocco, to facilitate its logistics center to oversee equipment, parts and inventory for the Middle East and Africa region. The new location is now fully operational.
- GEM Equipment of Oregon, currently undergoing renovations to expand its Mt Angel, Oregon location, is expected to finish completion in Spring 2026. The 110,000 ft^2 (10,200 m^2) space will accommodate manufacturing, spare parts, inventory and office space.
- FPS Brazil, based in a major industrial technology site in São Paulo, will be able to offer manufacturing, spare parts and office space in its new 29,000 ft^2 (2,700 m^2) location by Summer 2026.
- FPS China recently held its ground-breaking ceremony in Zhongshan, Guangdong, China. Scheduled for completion in Autumn 2026, the 119,000 ft^2 (11,100 m^2), nine-floor facility will incorporate an integrated food production platform, equipment R&D, global training center, and technological command center for real-time remote equipment monitoring.
- FPS Europe is expected to complete expansion of its Goes, Netherlands facility to increase manufacturing capacity and inventory space totalling 61,000 ft^2 (5,700 m^2) by end 2026.

"2026 will be a major year in implementing this new chapter of development for FPS — one where innovation, technology, manufacturing and full-scale production are fully coming together in key locations around the world. What was once an idea is turning into reality where industry professionals can make a difference, all to advance the future of food manufacturing," says Jeffrey Chang, President, FPS Food Process Solutions Corp.

About FPS Food Process Solutions

FPS Food Process Solutions is a global leader in turn-key food processing solutions, serving customers across six continents. Founded in 2010, FPS employs over 1,000 professionals worldwide and operates more than 1,280,000 ft^2 (119,000 m^2) of space across 23 locations, including its Canadian headquarters, manufacturing facilities, and international sales offices. Through our subsidiaries and strategic partnerships, FPS delivers comprehensive, end-to-end processing solutions—providing a true "one-stop shop" for food processors around the world.

For more information, go tohttps://www.fpscorp.ca/

PT United Chemicals Inter Aneka to distribute GNT's plant-based EXBERRY® colors in Indonesia

GNT has signed a distribution agreement with PT United Chemicals Inter Aneka to accelerate the growth of its plant-based EXBERRY® colors in Indonesia. EXBERRY® colors are made from non-GMO fruit, vegetables, and plants using sustainable production methods. They are natural, halal-certified, and can deliver a complete spectrum of vibrant shades in food and drink.

PT United Chemicals Inter Aneka is a key supplier for food and drink manufacturers across Indonesia and offers a broad range of natural, sustainable ingredients. Part of the Omya Group, the company provides strong market access, distribution expertise, and scalable logistics. It also offers high-level technical support and has recently opened a new application laboratory that combines global R&D capabilities with local expertise. This provides Indonesian customers with access to cutting-edge formulation guidance, processing support, and concept innovation.

The partnership got underway on January 1, 2026, and PT United Chemicals Inter Aneka is now working to help EXBERRY® expand across categories including beverages, confectionery, and dairy. GNT's Andreas Thiede, General Manager at GNT Singapore, said: "PT United Chemicals Inter Aneka's strong footprint in Indonesia, combined with a history of consistent growth, gives us great confidence in their ability to deliver results. We believe EXBERRY® colors are the perfect addition to their range and are excited to help them enhance customer value with our innovative plant-based colors."

PT United Chemicals Inter Aneka's Adelia Sia, Sales Director – Life Science, added: "Consumer demand and evolving global regulations are driving manufacturers to switch to natural colors. We're delighted to help food and drink companies make the move to EXBERRY®, which provides a futureproof solution with vibrant shades, natural ingredient declarations, and sustainable production methods."

www.exberry.com

ADVERTISER'S INDEX

Alfa Laval introduces ThinkCircularity: Closing the loop on plastic waste

Alfa Laval is turning circularity into action with the launch of ThinkCircularity, a take-back programme that recycles materials from its ThinkTop valve control units. The pilot project has been well received by customers and partners, and the company has already received its first returned products for recycling.

Circular thinking is not just a buzzword for us – it is a responsibility, says Inger Bygum, Head of Sustainability at Alfa Laval Hygienic Fluid Handling and Heat Transfer Technologies. "With ThinkCircularity, we ensure that materials from old ThinkTops can be reused, recycled or disposed of in the most responsible and value-creating manner."

ThinkCircularity initially focuses on plastic recycling. Each ThinkTop contains 500 grams of plastic, and the pilot project has demonstrated that this material can be recycled to produce new units without compromising quality. Tests confirm that the mix of reused and virgin plastic in future units meets all performance standards – from tensile strength to durability.

Furthermore, other materials and components from the ThinkTops – such as valuable metals and electronics – are responsibly recycled.

First ThinkTops returned

In food, dairy and pharma industries, there is an ongoing focus on process optimization and resource savings. For instance, by upgrading their existing ThinkTop control units, which can save 90% on water and energy used for cleaning-in-place. This is also the case in Norway, where Skala, the Alfa Laval Master Distributor, specializes in servicing hygienic industries. They recently introduced the ThinkCircularity take-back scheme to their customers and have already sent back several hundred units.

Our customers care about water and energy efficiency – and sustainability," says Owe Barsten, Responsible Manager at Skala Components. "Upgrades mean that older units are scrapped, but now we can offer a truly circular solution where old ThinkTops give life to the next generation."

First step in a broader circularity strategy

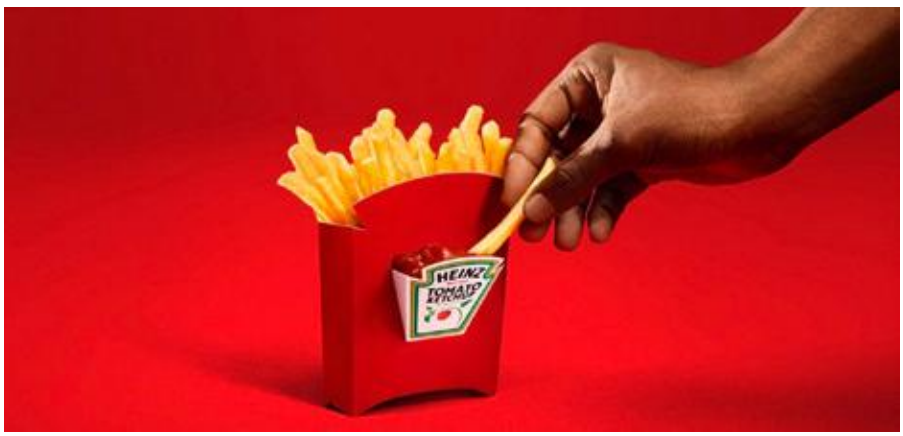
Key elements in Alfa Laval's circularity strategy include designing products for durability, high efficiency and long lifetime. With ThinkCircularity, the company now closes the loop by offering an end-of-life solution that ensures that old products are scrapped responsibly and new products in the future can be made from recycled plastic. Inger Bygum emphasizes that this pilot project is only the start:

Recycling plastic from old ThinkTops is just a small drop in a vast ocean of circular opportunities. Still, this pilot project is important to us and has taught us valuable lessons that will help us develop new business models, partnerships and methods to scale reuse and recycling."

So far, the ThinkCircularity initiative has been launched in selected European countries.

www.alfalaval.com

HEINZ Unveils the First Fry Box with a Built-In Condiment Compartment in Eleven Countries Across the Globe



Nearly all fry lovers can agree that ketchup and french fries are the perfect pair.[1] Though, fans have long struggled to enjoy their favorite duo while on-the-go – until now. Today, HEINZ – the global leader in condiments – announces an innovative solution: the HEINZ Dipper, a first-of-its-kind fry box with a built-in ketchup compartment engineered for dipping on-the-go. Born from a universal truth shared by fry and ketchup lovers, the patent-pending HEINZ Dipper marks a bold step in creative innovation. Starting today, the HEINZ Dipper will debut at participating restaurants and sports stadiums in eleven

countries around the globe.

Whether balancing sauce packets on car dashboards or squeezing ketchup directly onto individual fries, fans have long struggled to enjoy their favorite pairing away from the table. In fact, 70 percent of ketchup and fry lovers have spilled ketchup when dipping on-the-go and 80 percent say they have considered skipping condiments altogether due to a lack of dip-friendly packaging options.[2] The HEINZ Dipper directly tackles these pain points with a simple, intuitive and mess-free design that makes dipping effortless anywhere, anytime.

"After spotlighting the uncanny resemblance between fry boxes and our iconic HEINZ Keystone globally, we wanted to take the next bold step: redesigning the age-old fry box to work even harder for our HEINZ lovers everywhere," says Nina Patel, Vice President, Global Heinz Brand at the Kraft Heinz Company. "As more eating occasions happen away from home in drive-thrus and on-the-go moments, the HEINZ Dipper is a fun and relevant way to innovate to meet fans where they are and strengthen our role in their everyday lives."

Marking the most widespread global activation from the brand to date, the HEINZ Dipper will debut globally across eleven different countries including six cities within the U.S., and ten other countries including Canada, Mexico, Brazil, Germany, Italy, Portugal, Philippines, Thailand, China and Kuwait. Fans can visit participating locations to receive fries served in the new HEINZ Dipper container, while supplies last.

The HEINZ Dipper serves as a test for expanded distribution and long-term growth in the brand's "Away from Home" channel. With a footprint across eleven markets around the world, the launch marks a milestone in the brand's growing global footprint – as HEINZ seeks to expand its reach while reinforcing fans' irrational love for its unmistakably rich sauce.

For more information on the HEINZ Dipper and where fry lovers around the world can experience it, visit www.heinz.com/heinzdipper.

1 NPD Group's Consumption Tracking Service, 2025

2 Talker Research surveyed 1,000 Americans + 1,000 Canadian respondents; the survey was commissioned by HEINZ and administered and conducted online by Talker Research between Dec4-8, 2025.

Stora Enso introduces Performa Lumi, a lightweight GC1 folding boxboard with premium visual performance

Stora Enso introduces Performa Lumi, a new GC1 folding boxboard (FBB) designed for brands seeking both premium visual impact and efficient material use. Produced on Stora Enso's new BM6 packaging line in Oulu, Finland, Performa Lumi expands the Performa range alongside Performa Nova, offering a complementary option for everyday beauty, personal care, and healthcare packaging.

Performa Lumi is a CTMP board coated on both sides with a light-coated reverse, delivering high whiteness, excellent printability, and a smooth surface that supports strong brand expression. It is an ideal choice for applications where shelf appeal and consistent performance are equally important.

Like Performa Nova, Performa Lumi is produced using FiberLight TecTM, Stora Enso's proven proprietary technology that enables the creation of strong yet lightweight board structures. This allows brand owners to achieve the desired functionality while optimising material efficiency.

"Performa Lumi is designed for brands that want premium appearance without unnecessary complexity," says Kati Ekman, Head of Product Line FBB. "For brand owners, that means one board solution that can cover multiple end-uses, from beauty to personal care and beyond with reliable results."

Performa Lumi has been designed to withstand external stresses in printing and conversion, making it well-suited for demanding end-uses. The board is suitable for direct food contact and adheres to industry odour and taste standards. Performa Lumi is available in grammages from 205 to 310 gsm and offers high stiffness and efficient yield across the range, supporting a variety of packaging formats.

Performa Lumi joins Stora Enso's expansive portfolio of carton board products. With its launch, Stora Enso continues to drive innovation in renewable materials, offering customers flexible supply and helping to shift toward circular packaging solutions.

The forest is at the heart of Stora Enso, and we believe that everything made from fossil-based materials today can be made from a tree tomorrow. We are the leading provider of renewable products in packaging, biomaterials, and wooden construction, and one of the largest private forest owners in the world. In 2024, Stora Enso had approximately 19,000 employees, and the Group sales were EUR 9 billion.

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