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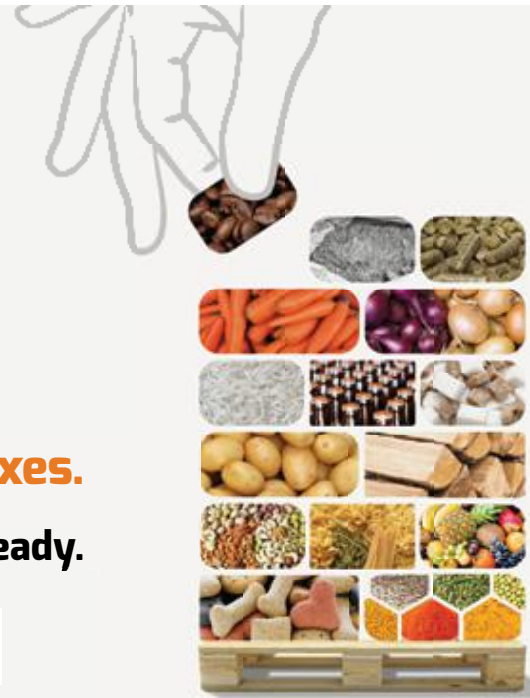
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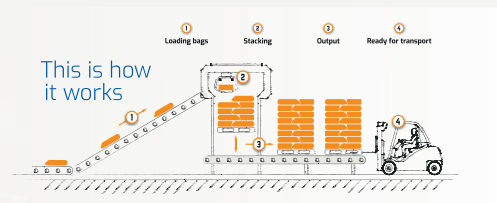


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Dear Readers,

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

This July marks a proud milestone for Food & Beverage Processing Magazine as we celebrate 13 years of excellence in publication and advertising services. What began as a vision to serve the food and beverage processing industry has grown into a trusted platform connecting manufacturers, technology providers, packaging experts, ingredient suppliers, and industry leaders across India and beyond.

We extend our heartfelt gratitude to our readers, advertisers, subscribers, industry partners, contributors & authors, interviewees, printing and production partners, and our dedicated editorial, design, marketing, and support teams for their unwavering support. Most importantly, we thank the entire food and beverage industry for making us a part of its remarkable growth journey.

In this special anniversary edition, our Processing Technology section explores two important topics shaping the future of food manufacturing. We present an overview of Hydrocooling of Fruits and Vegetables, highlighting its role in preserving freshness, extending shelf life, and reducing post-harvest losses. We also examine Sustainable Meat Processing Technologies, showcasing how innovations in equipment, automation, and resource management are helping processors reduce energy consumption, conserve water, and minimize waste while maintaining high standards of food safety and product quality.

Our Packaging Technology segment focuses on the latest developments transforming modern packaging. We take a closer look at The Beverage Packaging Equipment Industry, exploring how automation, smart machinery, and flexible production systems are enhancing

efficiency and meeting the demands of today's beverage manufacturers. Another feature discusses Essential Oil-Based Edible Coatings for Shelf Life Extension of Fresh-Cut Fruits and Vegetables, demonstrating how natural coatings can improve food preservation while reducing dependence on conventional packaging materials. We also explore emerging Sustainable Packaging Solutions that are helping brands balance environmental responsibility with product protection and consumer convenience.

In the Ingredients & Additives section, we highlight the growing importance of value-added agricultural resources and healthier product formulations. Our feature on Cashew Apple: A Nutritious Resource with High Value Addition Potential for Farmers explores the untapped commercial and nutritional opportunities of this often-overlooked fruit. We also present Naturally Sweet: Fruit-Sweetened Chocolate Redefines the Future of Healthy Indulgence, examining how natural fruit-based sweeteners are enabling manufacturers to create better-for-you confectionery without compromising on taste.

Alongside these features, this edition also includes updates from our corporate happenings and sustainability segments, offering insights into industry developments, business strategies, and environmental initiatives across the food ecosystem.

We also invite you to explore more insightful articles by visiting our website at www.foodnbeveragesprocessing.com

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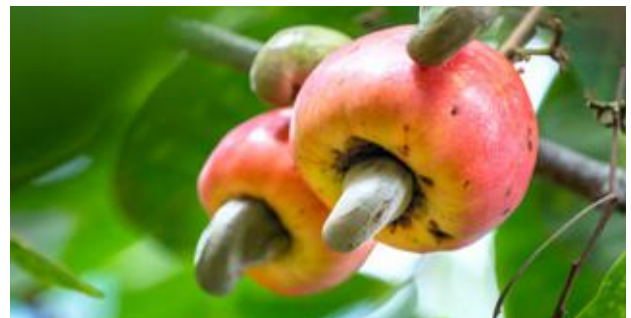
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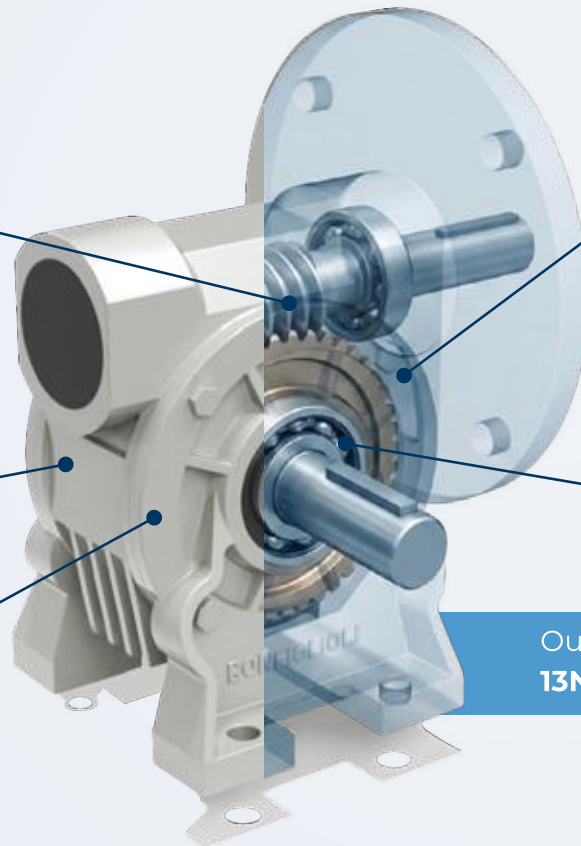
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Liquid I.V. Expands its Hydration Portfolio in India with the Launch of Sugar-Free Range



Hindustan Unilever Limited (HUL) has expanded its hydration portfolio in India with the launch of Liquid I.V. Sugar-Free, following the successful debut of the brand in the country last year. The launch marks the next phase of the brand's strategy to

deliver science-backed, functional hydration solutions for India's growing wellness-focused consumer base. With rising demand for sugar-free beverages driven by increasing health awareness, fitness trends, and mindful consumption, the new product strengthens Liquid I.V.'s presence in the country's rapidly evolving functional beverage market.

Designed for affluent Gen Z and millennial consumers, Liquid I.V. Sugar-Free offers cleaner hydration without compromising on performance or taste. The formulation features a proprietary amino acid blend of L-Glutamine and L-Alanine to support fluid absorption without glucose, along with sodium, potassium, calcium, magnesium,

chloride, nine essential vitamins and minerals, and plant-based stevia. Free from artificial sweeteners and artificial colours, the product is available in three flavours—Mango Pineapple, Raspberry Melon, and Juicy Peach—and is formulated to maintain optimal osmolality for effective hydration and replenishment.

Commenting on the launch, Guntas Randhawa, Head of Liquid I.V., India, said the wellness and hydration category in India is evolving rapidly as consumers increasingly seek functional benefits and cleaner formulations. He noted that the introduction of Liquid I.V. Sugar-Free reflects the company's commitment to expanding access to science-backed hydration solutions while strengthening its portfolio and driving long-term growth in the wellness segment. The product is now available through Liquid I.V. India's official website, leading e-commerce and quick-commerce platforms, and select retail stores across the country.

Pluckk Owned Upnourish Grows 5X In 18 Months As Functional Nutrition Demand Surges



Pluckk, India's fresh food digital brand, has reported strong growth for Upnourish, the functional nutrition and wellness brand it acquired in 2024. Within just 18 months of the acquisition, Upnourish has achieved an overall 5X growth, with its functional plant protein range emerging as the key growth driver, recording an impressive 10X increase. The milestone reflects the

rising demand for clean-label, science-backed nutrition as Indian consumers increasingly adopt sustainable daily wellness habits over short-term diet trends.

A major contributor to this growth is Upnourish's clean-label Plant Protein Bar, made from a pea-and-rice protein blend that delivers 15 grams of protein without refined sugar or preservatives. Developed by nutritionists for everyday consumption, the product caters to growing consumer demand for transparent, gut-friendly, and functional nutrition. Available in three flavours across more than 50 Indian cities through retail chains, e-commerce platforms, and direct-to-consumer channels, the brand is also preparing to launch a fourth flavour following its entry into the UK, marking its first international expansion.

Beyond protein bars, Upnourish's personalised nutrition services, meal-replacement shakes, and soups have each recorded 3X growth,

driven by working professionals and fitness-conscious consumers seeking convenient, balanced nutrition. Women have emerged as the primary users of its personalised nutrition programmes, particularly for fat loss, PCOS, thyroid, diabetes, and metabolic health. While 70% of customers are from India's top metro cities, the remaining 30% now come from Tier II cities, highlighting the growing adoption of preventive wellness across emerging markets.

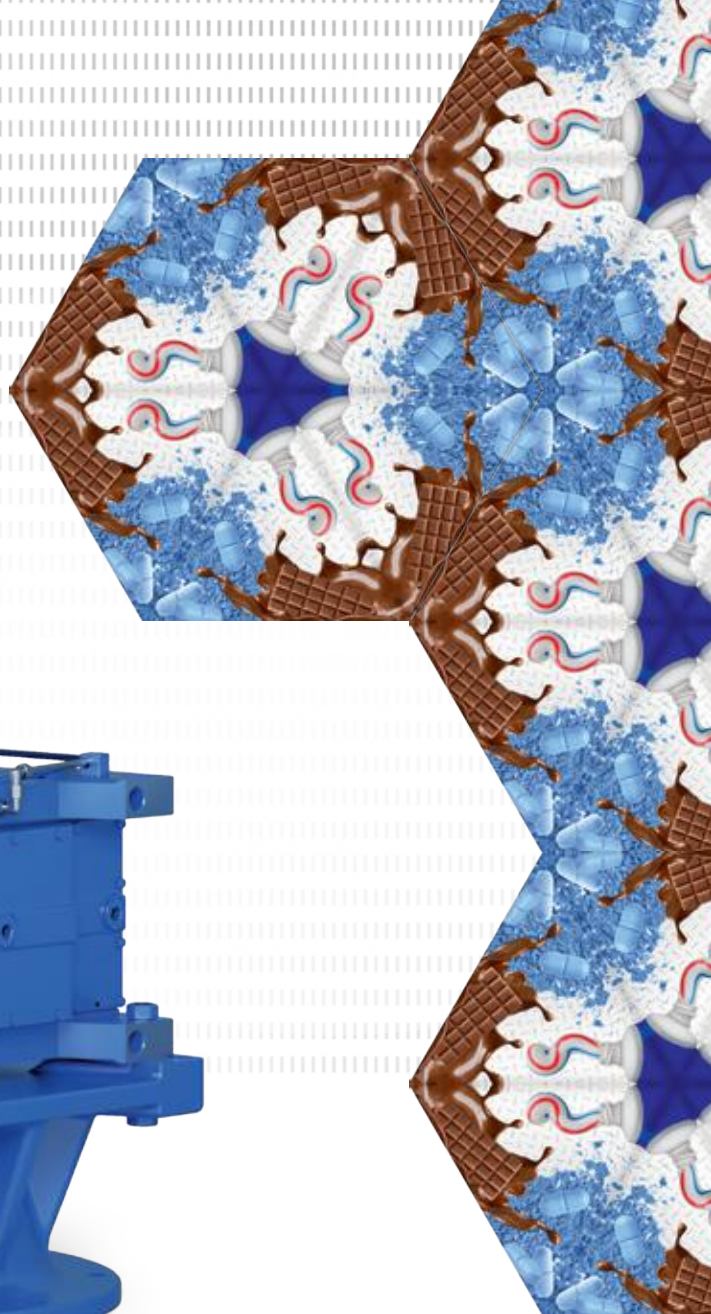
Pratik Gupta, CEO and Co-founder of Pluckk, said the company is focused on building a trusted wellness ecosystem by combining fresh foods with functional nutrition that is free from preservatives, refined sugar, and palm oil. Operating at an annualised revenue run rate of ₹100 crore in FY25, Pluckk plans to further strengthen its portfolio spanning fresh produce, cold-pressed juices, clean-label FMCG products, and functional nutrition while expanding its science-backed wellness solutions across India and international markets.



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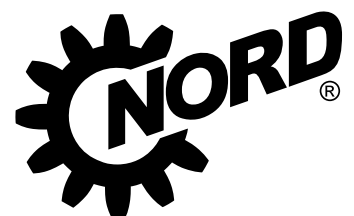
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HUL Expands Horlicks Portfolio with Ready-to-Drink Milkshake for Gen Z Consumers



Hindustan Unilever Limited (HUL) has expanded the Horlicks brand portfolio with the introduction of Horlicks Milkshake, marking its entry into the fast-growing Ready-to-Drink (RTD) nutrition beverage segment. The new product is aimed at Gen Z consumers seeking convenient, flavourful and nutritionally balanced beverage options that fit modern, on-the-go lifestyles.

Horlicks Milkshake is available in three variants—Classic Malt, Chocolate and Kesar Badam—and combines the familiar taste of Horlicks with a chilled, ready-to-consume format. The beverage is enriched with 10 essential nutrients, including zinc and vitamins, and contains 40% less total sugars, offering a more mindful indulgence option. Priced at Rs. 20, the product is positioned as an affordable nutrition-led beverage

for everyday consumption. The launch comes at a time when demand for healthier and more convenient beverage formats continues to rise. Consumers, particularly younger demographics, are increasingly seeking products that deliver both taste and nutritional benefits without compromising convenience. Horlicks Milkshake has been developed to address this evolving demand by bringing together flavour, nutrition and portability in a single offering.

To drive awareness and consumer engagement, HUL has introduced an integrated marketing campaign under the theme “No Guilty, Only Pleasure.” The campaign highlights changing consumption habits among Gen Z consumers, who are making more balanced lifestyle choices while still seeking enjoyable food and beverage

experiences. Through relatable storytelling, the campaign positions Horlicks Milkshake as a companion for everyday occasions, including commuting, work breaks, college gatherings and evening snacking moments.

The marketing initiative will be supported by a comprehensive 360-degree media strategy encompassing television, digital and social media platforms, influencer partnerships, outdoor advertising, consumer activations and large-scale product sampling. Metro branding and high-visibility out-of-home campaigns will also be rolled out in selected cities to encourage product trials and increase brand visibility.

Commenting on the launch, Rajneet Kohli, Executive Director, Foods and Refreshment, HUL, said that the RTD category is witnessing strong growth as consumers increasingly look for convenient and mindful nutrition solutions. He noted that the launch of Horlicks Milkshake builds on the company's recent expansion of the Boost RTD range and reflects HUL's commitment to developing future-ready nutrition categories that align with changing consumer preferences.

With the introduction of Horlicks Milkshake, HUL further strengthens its footprint in the RTD beverage segment while expanding its portfolio of nutrition-focused products designed for evolving consumption occasions and lifestyles.

ITC Fabelle unveils 64% Ghana-Origin Dark Chocolates



As Indian consumers increasingly seek deeper cocoa flavours, cleaner ingredient stories, and more mindful indulgence, Fabelle Chocolates, ITC's homegrown luxury chocolate brand, unveils its new 64% Dark Chocolate range. Crafted with premium Ghana Origin Cocoa, known for its superior aroma and depth, the range reflects Fabelle's mastery in chocolate making through precise cocoa sourcing, ultra-fine particle size technology, and extended conching that enhances flavour, texture, and mouthfeel of chocolates.

Dark chocolate is no longer a niche preference; it is fast becoming the language of sophistication for the discerning palate. Responding to this evolving shift, Fabelle

presents a range of dark chocolate bars and pralines that celebrate cocoa in its most expressive form, while offering distinct flavour journeys that elevate everyday indulgence.

While 64% Ghana Cocoa remains at the core of these creations, Fabelle explores how thoughtfully paired inclusions can enhance the dark chocolate experience. From Cranberry Noir, which combines cocoa with mild tartness of cranberry, to Orange Eclipse where dark chocolate comes with gentle citrus notes, to No Added Sugar Dark Chocolate Bar, designed for those who seek the pure, unadulterated character of cocoa. Elevating the range further is Dark Symphony, which is a box of 10 handcrafted pralines curated with no added sugar and a refined medley of almond, macadamia, pecan, hazelnut and pistachio. The range brings together a nuanced spectrum of dark chocolate expressions, each crafted to showcase the richness of fine cocoa.

Mr. Subash Balar, Business Head – Confectionery, Chocolates & Coffee, ITC Ltd., said, “The modern Indian consumer is rethinking indulgence, seeking greater transparency, balance, and choice without giving up on experience. This is evident in the rapid growth of dark chocolate in India, which industry re-

ports indicate has more than doubled over the past five years, outpacing traditional milk chocolate. Alongside this, demand for no added sugar options continues to rise. Through Fabelle, we are shaping a more refined chocolate culture that reflects how consumers

want to indulge today.” The new Fabelle 64% Dark Chocolate range reflects the brand’s vision of elevating everyday indulgence through thoughtfully crafted experiences. The range will be available across Fabelle boutiques in select cities, and on Fabelle.in.

Mingle Mocktails Launches Feel-Good Summer Variety Pack with Two New Functional Flavors

Mingle Mocktails has expanded its functional beverage portfolio with the launch of the Mingle Mood four-flavor variety pack, offering Berry Lemon Bliss, Serene Citrus Spritz, Juicy Watermelon Spritz, and Subtly Spicy Margarita. The new pack builds on the strong consumer response to the Mingle Mood range, which debuted in September 2025, and is designed to provide a refreshing, alcohol-free option for summer occasions. Each sparkling mocktail is infused with functional ingredients including ashwagandha, lion's mane, and L-theanine to help promote calm, focus, and overall balance, while delivering vibrant flavors suited for poolside gatherings, beach outings, rooftop parties,



and other social occasions. The variety pack is available through Mingle Mocktails' official website and Amazon at a retail price of \$64.95 for a 16-pack.



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The launch expands Organic Valley's butter lineup with a format made for how people cook, snack and eat today. As more shop-

pers look for premium butter options that offer both taste and ease, Organic Valley® Butter with Olive Oil gives them an organic choice that fits naturally into everyday routines.

"We made Organic Valley® Butter with Olive Oil for people who want the rich taste of organic butter and the convenience of a product that they can spread straight from the fridge," said Laurie Drake, vice president of marketing, Organic Valley. "It is smooth, creamy and delicious, and it brings together the flavor people love with the ease they want for everyday meals and snacks."

Organic Valley® Butter with Olive Oil is made with all organic ingredients and reflects the cooperative's long-standing commitment to high-quality organic food. The butter is made from milk from cows raised without antibiotics, synthetic hormones, toxic pesticides or GMOs. Organic Valley® Butter with Olive Oil will be sold in an 8-ounce tub with a suggested retail price of \$5.49.

Organic Valley is innovating once again by introducing Organic Valley® Butter with Olive Oil, a new organic butter made for a common frustration in the kitchen: cold butter that will not spread. Available at retailers nationwide beginning this month, the new product combines delicious

India's Desi Bhindi Gets a Gen Z Glow-Up: TBH Okra Chips Spark Viral 'Snack Revolution' Across Social Media



As India's healthy snacking market continues to evolve, Ghodawat Consumer Limited's 'To Be Honest' (TBH) Foods is strengthening its position in the real vegetable snacks category through a decade of innovation, consumer-centric product development, and a commitment to mindful consumption. The brand's journey, rooted in Indian entrepreneurial spirit since 2017, has now ignited a nationwide snack revolution as Desi Bhindi gets a dazzling Gen Z makeover and explodes across social media feeds. TBH Okra Chips, already a favourite among

health-conscious snackers, have catapulted into a full-blown digital sensation, powered not by traditional media spends, but by the unstoppable force of user-generated content and authentic, shareable moments.

Over the past month, TBH Okra Chips have gained significant momentum among young Indian consumers, with social media abuzz with reels and snack-inspired content. These, videos have collectively garnered more than 50 to 60 million organic views. From college dorm rooms and workplace breaks to midnight snacking, India's Gen Z and millennial consumers are enthusiastically showing off their love for the crispy, clean-label snack, transforming okra into the season's most coveted foodie flex.

Salloni Ghodawat, CEO, Ghodawat Consumer Limited, said, "The response to TBH Okra Chips demonstrates that consumers are increasingly open to healthier snack formats that do not compromise on taste. What is particularly encouraging is that much of this momentum has been driven organically by consumers themselves. This is a story of how Indian flavours, combined with innovation and authenticity, can truly capture the imagination of the new generation. Our

consumers, especially Gen Z, want to connect with brands that are real, responsible, and relatable. Social media hasn't just spread our message; it's shaped it, making TBH Okra Chips the face of mindful, modern snacking."

Retailers and e-commerce partners have reported record-breaking demand for TBH Foods' Okra Chips, with products flying off shelves and quick-commerce platforms witnessing unprecedented search volumes and repeat purchases, driven by a wave of consumer-generated reels, reviews, and snack hacks that have turned the brand into a cultural phenomenon. A pioneer in the 100% real vegetable and fruit chips category, TBH offers a diverse range of vacuum-cooked snacks, including okra, sweet potato, arbi (taro root), beetroot, golden banana, purple sweet potato, and mixed vegetable chips. The unique vacuum-cooking process preserves natural colours, fibre, and nutrients while using 50% less oil than conventional chips, resulting in vegan, gluten-free snacks with authentic flavour.

Since becoming part of Ghodawat Consumer Limited in 2023, the brand has expanded to over 30 Indian cities and more than 13 international markets through leading retail and quick-commerce channels. By transforming traditional Indian vegetables and fruits into trendy, Instagram-worthy snacks, TBH has successfully blended nostalgia with innovation, setting a new benchmark for digital-first FMCG branding and reinforcing its leadership in the rapidly growing healthy snacking segment.

Meevaa Foods by Zappfresh Expands Pan-India Reach Through Amazon India Launch



Meevaa Foods by Zappfresh, an export-grade frozen food brand specialising in ready-to-cook and convenience foods, has launched its product range on Amazon India as part of its e-commerce expansion strategy, making its portfolio accessible to consumers across the country. The range includes frozen momos, spring rolls, samosas, kebabs, and other ready-to-cook snacks designed for quick, convenient meals, with several products ready to serve in as little as three minutes. The brand has expanded its presence across nearly 350 Amazon

fulfilment and distribution points, enhancing product availability and enabling faster deliveries nationwide.

Director Prreya Agarwaal said the launch strengthens Meevaa Foods' digital presence amid rising demand for convenient, hygienic, and high-quality frozen foods, while reinforcing its commitment to export-grade manufacturing standards, clean-label ingredients, and consistent consumer experience. The company has also accelerated its growth through product innovation, expanded processing capabilities, and the recent acquisition of a majority stake in Avyom Foods, which enhances frozen food processing, product development, and supply chain integration. Looking ahead, Meevaa Foods plans to expand to additional e-commerce and quick-commerce platforms while investing further in frozen-food infrastructure, nationwide distribution, and digital commerce capabilities to capitalise on the growing demand for organised frozen and ready-to-cook food products in India.

ITC Launches Ultra Mintz, Redefining Everyday Freshness with a Premium Sugar-Free Mint Experience



ITC Ltd. has announced the launch of Ultra Mintz, a premium, sugar-free mint offering that strengthens its presence in the confectionery category. Developed to cater to evolving consumer preferences for sophisticated, on-the-go refreshment, Ultra Mintz delivers a refined and lasting mint experience through a combination of elevated taste and contemporary design.

Speaking about the launch, Subash Balar, Vice

President and Business Head – Chocolates, Coffee and Confectionery & NCD, Foods Division, ITC Ltd, said, "We are witnessing growing demand for premium adult confectionery that combine convenience, quality, and great product experience. Ultra Mintz has been developed to address this opportunity, bringing together world-class quality mints in a pocketable format to deliver a refined and elevated experience. The launch reflects our commitment to expanding into high-growth segments and creating innovative products that resonate with evolving consumer lifestyles."

Available in two variants: Strong Peppermint and Sensational Strawberry, Ultra Mintz combines bold, refreshing flavours and a tin that feels subtle, suave and sophisticated. Whether it is a moment between meetings, after a meal, or while on the move, the product offers a convenient way to stay refreshed and confident throughout the day.

Priced at Rs. 150, Ultra Mintz is currently available across leading quick-commerce platforms and select retail stores.



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Bulk Food Safety: Why Inspection Technology is a Game-Changer



Mike Pipe, Head of Product Inspection UK, Mettler-Toledo Product Inspection

Food safety is more than just a regulatory requirement - it is a critical factor in maintaining consumer trust and brand reputation. In a world where product recalls can make headlines overnight, food manufacturers must take proactive steps to detect physical contamination before it becomes a costly crisis. For bulk food processors, the challenge is even greater: how do you inspect large quantities of loose product efficiently, without slowing down production? The answer lies in cutting-edge product inspection technology, which is reshaping the industry and setting new standards for quality control.

The Hidden Risks in Bulk Food Processing

From nuts and dried fruit to cereals and frozen seafood, bulk food products pass through multiple stages of processing before they reach the consumer. At every stage, there is a risk of contamination - whether from raw materials, processing equipment or even human error. The consequences of missing contaminants can be severe, leading to product recalls, damaged reputations and even health risks for consumers.

What makes bulk food inspection unique is the sheer scale of the operation. Unlike packaged products, bulk food items move rapidly through production lines in loose form,

making traditional inspection methods less effective. This is where advanced product inspection technologies step in, offering rapid, reliable detection of foreign bodies before they reach the final product stage.

The Power of Early Detection

Implementing product inspection systems at Critical Control Points (CCPs) is one of the most effective ways to prevent physical contamination. By identifying issues early in the process, manufacturers can avoid costly waste, protect expensive machinery and maintain the integrity of their supply chain. But where should inspections take place? Many producers choose to inspect raw materials as they enter the facility, catching physical contaminants before they mix with other ingredients. Others opt for in-line inspection during processing or at the final stage before packaging. Each approach has its benefits, but one thing is clear: catching foreign body contaminants early is always the best strategy.

Metal Detection vs. X-ray Inspection

Selecting the right inspection technology depends on the type of contamination risks present in a particular production environment. The two leading technologies - metal detection and x-ray inspection - each have unique advantages.

Metal Detection: Metal detectors are a staple in the food industry, effectively identifying ferrous, non-ferrous and stainless steel contaminants. They are especially useful for bulk-flow products like powders, cereals and meat blocks before grinding. Metal detection systems offer high sensitivity and are a cost-effective choice when metal is the primary concern.

X-ray Inspection: X-ray systems identify an

even wider range of physical contaminants including glass, mineral stone, calcified bone and high-density plastics. They also provide additional quality control benefits, such as checking for missing items, verifying product mass and facilitating consistency in bulk materials. For manufacturers facing multiple contamination risks, x-ray inspection is a powerful tool.

Strategic Placement of Inspection Systems

Where an inspection system is placed can significantly impact its effectiveness. For example, as discussed, bulk product inspection at the start of production is ideal for catching contaminants early, but inspection at later stages may also be necessary to be sure of final product quality. Some manufacturers even implement multiple inspection points to provide an extra layer of protection.

In addition to strategic placement, inspection systems are becoming smarter. Advanced automatic reject mechanisms quickly remove contaminants from production lines, reducing waste and keeping operations running smoothly. Integrated data monitoring further enhances efficiency, allowing manufacturers to track trends and improve quality control measures.

The Future of Food Safety

The food industry is always moving, much like bulk food down a production line - and so is inspection technology. The latest systems are designed to work at high speeds without compromising accuracy, enabling manufacturers to maintain efficiency while meeting stringent safety standards. Innovations such as real-time monitoring, predictive analytics and AI-powered detection are making it easier than ever to identify and remove contaminants before they become a problem.

With food safety regulations becoming increasingly rigorous, there's no room for compromise. Investing in the right inspection technology not only protects consumers but also strengthens brand credibility in an industry where trust is everything.

Conclusion

Food safety is no longer just about compliance—it's about staying ahead of potential risks and being sure of product integrity at every stage of production. Whether you're considering metal detection, x-ray inspection or a combination of both, taking a proactive approach is key.

For a deeper insight into bulk food inspection and expert guidance on selecting the right technology for your operation, download our full whitepaper today by clicking here or visit www.mt.com/pi-bulk-wp-pr

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From Fresh Proteins to Integrated Food Solutions: Zappfresh's Vision for the Future of Convenience Foods

As consumer demand shifts towards convenient, safe, and high-quality food products, Zappfresh has evolved from a fresh meat and seafood brand into an integrated food solutions company with capabilities spanning sourcing, processing, manufacturing, cold-chain logistics, aquaculture, and value-added foods. Backed by the expansion of Meevaa Foods and its growing presence in the frozen and ready-to-cook segments, the company is well positioned to capitalize on India's rapidly evolving food market. In an exclusive interaction with *Food & Beverages Processing Magazine*, Prreya Aggarwal, Director, *DSM Fresh Foods Ltd*, shares insights into Zappfresh's growth journey, its vertically integrated business model, commitment to food safety and innovation, and the company's vision for building a future-ready, diversified food platform.

Prreya Aggarwal, Director, DSM Fresh Foods Ltd.

Zappfresh has evolved from a fresh meat and seafood brand into an integrated food solutions company. Could you briefly introduce the company and the key product categories driving growth today?

Over the past decade, Zappfresh has evolved from a direct-to-consumer fresh meat brand into a fully integrated food platform with capabilities spanning sourcing, processing, manufacturing, cold-chain logistics, aquaculture, and value-added foods. Today, we operate across multiple food categories through our brands Zappfresh and Meevaa Foods, serving consumers, retail partners, and institutional customers across India.

FY26 was a milestone year for us, with revenue crossing ₹220 crore and growing nearly 69% year-on-year, while EBITDA and PAT grew 91% and 59% respectively, reflecting the scalability and operational strength of our integrated business model.

Our growth today is driven by a diversified portfolio comprising fresh chicken, mutton, fish and seafood, alongside an expanding range of frozen, ready-to-cook, and ready-to-eat products. Seafood has emerged as one of our fastest-growing categories, supported by our aquaculture initiatives and farmer partnerships. At the same time, the launch of Meevaa Foods has enabled us to participate in the rapidly growing frozen and convenience foods segment, significantly expanding our addressable market.

In addition to our consumer business, our growing HoReCa and institutional partnerships provide a strong and diversified revenue base. Looking ahead, our vision is to build India's most trusted integrated

food platform, combining sourcing, manufacturing, technology, distribution, and food innovation to serve both domestic and global markets.

Fresh meat and seafood require stringent quality controls. How does Zappfresh's vertically integrated supply chain help ensure hygiene, traceability, freshness, and consistency across its operations?

At Zappfresh, quality is driven by our vertically integrated farm-to-fork model. We source directly from farmers, process products in-house, maintain strict temperature-controlled operations, and deliver through a cold-chain network- ensuring traceability, consistency, and food safety at every stage.

Our strength lies in controlling the entire value chain, from sourcing and processing to packaging and delivery - supported by standardized processes, technology-led forecasting, and rigorous hygiene protocols. This not only ensures superior product quality but also builds long-term consumer trust.

With the addition of Meevaa Foods, we have further expanded our capabilities into export-grade frozen foods, manufactured in certified facilities and blast-frozen at -18°C to preserve taste, texture, and safety.

The organised fresh foods market is becoming increasingly competitive. What are the key differentiators that enable Zappfresh to stand out among established players in the fresh and frozen food segments?

The organised fresh and frozen foods market is expanding rapidly, but we believe long-

term leadership will be defined by supply-chain control, operational discipline, and consumer trust.

At Zappfresh, our biggest differentiator is our vertically integrated model. Unlike traditional food businesses that rely heavily on intermediaries, we have built capabilities across sourcing, processing, cold-chain logistics, aquaculture, manufacturing, and distribution. This gives us greater control over quality, traceability, consistency, and margins.

A second differentiator is our diversified growth engine. We operate across fresh meat, seafood, frozen foods, ready-to-cook and ready-to-eat categories, while serving both consumers and HoReCa partners. This allows us to participate in multiple high-growth food segments through a single integrated platform.

We are also investing ahead of the curve through initiatives such as aquaculture partnerships, seafood backward integration, and the expansion of Meevaa Foods, which strengthens our presence in the fast-growing convenience foods segment. Ultimately, our focus is not just on selling food products but on building a scalable, technology-enabled food platform that delivers quality, trust, and profitable growth across categories.

The acquisition of Ambrozia Frozen Foods marks an important milestone in your growth journey. How does this acquisition strengthen your capabilities in frozen, ready-to-cook, and value-added food categories?

The acquisition of Ambrozia Frozen Foods is a significant step in Zappfresh's evolution from a fresh protein company to an integrated

food platform. It provides us with an export-ready manufacturing ecosystem, strengthens our processing capabilities, and significantly expands our presence in the frozen, ready-to-cook, and ready-to-eat categories.

Through this acquisition, we have been able to accelerate the launch of Meevaa Foods, giving us access to a broader portfolio of value-added products and enabling us to cater to the growing consumer demand for convenient, high-quality food solutions. The facility's multi-category manufacturing capabilities also allow us to innovate faster, scale efficiently, and serve both domestic and international markets.

Importantly, it diversifies our revenue streams beyond fresh meat and seafood, strengthens our margins through higher-value products, and creates a strong foundation for future growth in the rapidly expanding convenience foods segment. Ultimately, the acquisition aligns with our long-term vision of building a diversified, technology-enabled food platform spanning fresh, frozen, ready-to-cook, and value-added food categories.

Consumer demand is shifting towards convenience-led food solutions. What trends are you observing in purchasing behaviour, and how are these influencing your product innovation and portfolio expansion strategies?

Consumer food preferences are evolving rapidly, with convenience emerging as a major growth driver. Today's consumers want products that are quick to prepare without compromising on taste, quality, hygiene, or nutrition. This trend is being driven by urban lifestyles, nuclear families, rising disposable incomes, and increasing demand for restaurant-quality experiences at home.

At the same time, consumers are becoming more conscious about food safety, sourcing transparency, and product consistency, particularly in categories such as meat, seafood, and processed foods. Trust has become as important as convenience. These evolving preferences are shaping our innovation strategy. We are continuously expanding our portfolio across ready-to-cook, ready-to-eat, frozen, and value-added food categories through Meevaa Foods, while leveraging our integrated supply chain and manufacturing capabilities to maintain quality and consistency at scale.

The strong consumer response to Meevaa Foods reinforces our belief that convenience-led food categories will be a key growth driver in the years ahead. Our focus is on building a diversified food portfolio that aligns

with changing consumption habits while continuing to deliver the trust and quality that consumers expect from Zappfresh.

Food safety and cold chain management are critical in highly perishable categories. Could you elaborate on the technologies, infrastructure, and quality standards that support your processing and distribution operations?

Food safety and cold-chain management are at the core of Zappfresh's operating model. Given the highly perishable nature of meat, seafood, and frozen foods, maintaining quality across the entire value chain is non-negotiable.

Our vertically integrated infrastructure enables us to control critical stages including sourcing, processing, secondary processing, packaging, cold storage, and last-mile distribution. Products are processed in temperature-controlled environments, supported by standardized quality protocols and multiple quality checks before dispatch.

We also leverage technology across demand forecasting, inventory planning, cold-chain monitoring, and logistics management to improve traceability, reduce wastage, and ensure product freshness. This data-driven approach allows us to maintain consistency while scaling efficiently.

With the addition of Meevaa Foods, we have further strengthened our capabilities through export-grade manufacturing and blast-freezing technology, ensuring food safety, product integrity, and shelf-life without compromising on taste or quality.

Looking ahead, what are Zappfresh's key priorities for domestic expansion, exports, and building a diversified food platform beyond the protein category?

Our growth strategy is centred around building a diversified, integrated food



platform with strong capabilities across sourcing, processing, manufacturing, distribution, and consumer brands.

A key priority is strengthening our leadership in fresh proteins and seafood through deeper sourcing integration and aquaculture partnerships. We see significant long-term potential in seafood and are investing in initiatives that enhance traceability, supply security, and farmer participation across the value chain. At the same time, we are scaling our value-added foods business through Meevaa Foods. The ready-to-cook, ready-to-eat, and frozen food segments are benefiting from strong consumer demand, and our expanded manufacturing capabilities position us well to capture this opportunity.

On the domestic front, we will continue expanding our omnichannel presence, strengthening HoReCa and institutional partnerships, and increasing penetration across existing and new markets. Internationally, our export-ready manufacturing platform provides a strong foundation to expand across key markets in North America, the Middle East, and Europe.

Ultimately, our vision is to move beyond being a fresh meat and seafood company and build a future-ready food platform that serves evolving consumer needs across fresh, frozen, ready-to-cook, and convenience food categories. We believe the next phase of growth in the food industry will be driven by integrated, trusted, and scalable food ecosystems, and that is exactly what we are building at Zappfresh.





Hydrocooling of Fruits and Vegetables - An Overview

Aastha kumari¹, Janani Krishna K², Dawn CP Ambrose³ and S K Aleksha Kudos⁴

Fresh fruits and vegetables begin losing quality the moment they are harvested. Heat from the field accelerates respiration, moisture loss, and microbial growth, reducing shelf life and market value. To address this challenge, the agricultural industry increasingly relies on hydro cooling—a fast and efficient method for removing field heat and preserving freshness.

Hydrocooling

Hydrocooling is a form of precooling in which the product is sprayed with or immersed in chilled water. It is a cooling method that uses ice or cold water and it stands out for being simple, practical, and efficient for reducing the temperature of the vegetable before it is transported and stored. This method removes heat from freshly harvested products in the field and is designed to slow metabolism and reduce product deterioration.

Importance of Hydrocooling

Field heat can cause rapid deterioration of some horticultural crops and therefore it is desirable to remove this heat as quickly as possible after harvesting. In contrast, when it comes to produce quality, every minute counts and that precooling is among the most cost-effective and efficient quality preservation method available to commercial crop.

Hydrocooling is performed to rapidly remove this field heat and bring the produce temperature down to a level that slows physiological and biochemical activities.

Hydrocooling is well suited to beans, asparagus, broccoli, cabbage, carrots, cucumbers, radishes, sweet corn, etc. Hydrocoolers cause no moisture loss in cooling – in fact, produce often gains slightly in weight. However, water quality is critical: pathogens can be easily carried and spread by the cooling water, so chlorination and regular water management are essential. Packaging must also tolerate water contact – plastic or waxed corrugated containers work well, while untreated cardboard does not.

By reducing respiration and water loss, hydrocooling helps maintain freshness, crispness, colour, flavour, and nutritional value. The process also delays senescence, minimizes postharvest losses, and extends the storage and market life of fruits and vegetables.

Another important reason for hydrocooling is its speed and efficiency. Water removes heat much faster than air, making hydrocooling one of the most effective precooling methods for many horticultural crops. This rapid cooling is particularly beneficial for highly perishable commodities.

Benefits of Hydrocooling

Extends Shelf Life

One of the primary benefits of hydrocooling is its ability to prolong the storage life of fruits and vegetables. Lower temperatures reduce respiration rates, slowing the consumption of

sugars and organic acids that keep produce fresh. As a result, fruits and vegetables remain marketable for a longer period, allowing growers and retailers more flexibility in storage and transportation.

Preserves Freshness and Quality

Hydrocooling helps maintain the crispness, firmness, colour, flavour, and nutritional value of fresh produce. Rapid cooling slows enzymatic and biochemical reactions responsible for aging and quality degradation. This is particularly important for highly perishable commodities such as sweet corn, broccoli, carrots, cherries, and leafy vegetables.

Reduces Water Loss and Wilting

Fresh produce continuously loses moisture after harvest through transpiration. Excessive moisture loss causes shrivelling, wilting, and loss of market value. Because hydrocooling rapidly lowers product temperature and often exposes produce to a high-moisture environment, it helps reduce water loss and maintain turgidity, resulting in fresher-looking produce.

Minimizes Postharvest Losses

Postharvest losses account for a significant proportion of fruit and vegetable production worldwide. By slowing spoilage and delaying deterioration, hydrocooling reduces losses during storage, transportation, and marketing. This contributes to improved food availability and reduced food waste throughout the supply chain.

Improves Market Value

Consumers prefer fruits and vegetables that appear fresh, firm, and attractive. Hydrocooling helps preserve these desirable characteristics, increasing consumer acceptance and market competitiveness. Better quality produce often commands higher prices and provides greater economic returns for farmers and distributors.

Methods of Hydrocooling

Spray-Type Hydrocooling

Spray hydrocooling works much like a refreshing shower on a hot day. Freshly harvested fruits and vegetables pass through a cooling tunnel where chilled water is sprayed continuously over their surfaces. As the cold-water flows over the produce, it rapidly absorbs and removes the heat accumulated in the field. This method is particularly popular in commercial packing houses because it provides quick and uniform cooling while reducing excessive handling of produce. Crops such as sweet corn, broccoli, celery, and leafy vegetables are commonly cooled using this technique.

Spray hydrocooling is especially effective for commodities that require rapid cooling but may be damaged by prolonged water immersion.

Immersion-Type Hydrocooling

In immersion hydrocooling, fruits and vegetables are placed directly into tanks or flumes containing chilled water. Since the produce is surrounded by cold water on all sides, heat is removed very quickly and efficiently. This method is often considered one of the fastest forms of hydrocooling because water has excellent heat-transfer properties. Commodities such as cherries, peaches, carrots, radishes, and some leafy vegetables are commonly cooled through immersion. The technique is particularly useful when rapid temperature reduction is needed immediately after harvest. To ensure food safety, the cooling water is usually filtered and sanitized to prevent the spread of microorganisms.

Features of Hydrocooling:

Hydrocooling is well suited to beans, asparagus, broccoli, cabbage, carrots, cucumbers, radishes, sweet corn, etc. Hydrocoolers cause no moisture loss in cooling – in fact, produce often gains slightly in weight. However, water quality is critical: pathogens can be easily carried and spread by the cooling water, so chlorination and regular water management are essential. Packaging must also tolerate water contact – plastic or waxed corrugated containers work well, while untreated cardboard does not.

Conclusion:

As the demand for high-quality fresh produce continues to grow, hydrocooling offers a practical solution for reducing post-harvest losses and enhancing overall supply chain efficiency. Immersion hydrocooling is best suited for sturdy commodities such as melons, carrots, cucumbers, and citrus fruits, where uniform cooling is required. Shower or spray hydrocooling is more appropriate for moderately sensitive produce because it provides rapid cooling while limiting prolonged water contact. Compared with other precooling methods, hydrocooling offers faster heat transfer and lower moisture loss, contributing to better product quality. Therefore, selecting the appropriate hydrocooling method according to commodity characteristics is essential for maximizing postharvest benefits.

Author's Bio

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Next-generation rotating retractors clean hard-to-reach areas in processing lines

In spray-drying applications, including powder production, within hygienic processing industries, incomplete cleaning of hard-to-reach surfaces can lead to contamination risks, product loss, and costly downtime. To address these challenges, Alfa Laval today announces the launch of the Controlled Rotating Retractors, designed to effectively remove residues and contaminants from ducts, pipes, tanks, and enclosed areas.

The introduction of the high-performance CIP cleaning devices underscores Alfa Laval's commitment to providing manufacturers across the dairy, food, beverage, pharmaceutical, and biotech industries with solutions that optimize cleaning performance in hygienic processing lines.

These innovative devices expand Alfa Laval's tank cleaning portfolio of retractable cleaning devices. They deliver up to twice the cleaning efficiency of traditional static spray ball systems, effectively reaching shadow zones while reducing water and cleaning media consumption. By achieving full coverage with fewer devices, they enable safer, faster, and more resource-efficient operations.

"These controlled rotating retractors make it possible to access challenging areas with fewer devices," says Kim Kjellberg, Global Tank Cleaning Portfolio Manager at Alfa Laval. "They deliver what today's manufacturers demand – faster, more precise cleaning with minimal manual intervention. Moreover, they also improve operational performance, support sustainability goals, and cut installation and cleaning costs."

Reduced resource consumption and lower costs

The Controlled Rotating Retractors reduce water and cleaning media usage by up to 55% compared to static spray balls. Their extended jet reach allows each unit to cover a larger surface area, minimizing the number of devices required. As a result, manufacturers can lower both capital expenditures and operating costs while maintaining high cleaning performance.

Validated performance and process control

Integrated with the Alfa Laval ThinkTop® V70 sensing and control unit, these retractable cleaning devices provide real-time



monitoring and performance validation. This ensures full process control, minimizes downtime, and enhances workplace safety by reducing the need for manual intervention.

Smart, hygienic design

During production, the rotating cleaning retractors remain sealed and flush with the vessel wall, preventing contact with the product area. During cleaning, the cleaner head extends to provide full coverage of product-contact surfaces. Once the cleaning cycle is complete, the cleaner head retracts, leaving the duct, pipe, tank, or enclosed area ready for immediate production.

Maintenance made easy

Simplify maintenance with a one-handed tool that allows easy wear-part removal without detaching the supply tube, keeping the retractor securely connected for safe, easy servicing — even in hard-to-reach areas.

Documentation and compliance

The devices support good manufacturing and hygienic practices and comply with FDA, EU and China regulations. For high-purity pharmaceutical and biotechnology applications, the Controlled Rotating Retractor UltraPure includes Alfa Laval Q-doc documentation, providing full traceability of all product contact parts. Q-doc covers conformity declarations, material certificates, relevant test certificates, and documentation to support a smooth qualification and validation process.

www.alfalaval.com

JBT Marel launches new Fresh'n Squeeze® 3300 Citrus Juicer

Reimagined design and smarter controls combine with legacy whole fruit extraction technology for high-volume juice programs.

JBT Marel, a leading food and beverage equipment provider responsible for juicing over 75% of the world's citrus, launched Fresh'n Squeeze® 3300. This new model within its legacy juicing portfolio is built to optimize daily operations and deliver excellent-tasting juice at high throughput in retail environments such as grocery stores, wholesale clubs and central kitchens.

Since the mid-1980s, JBT Marel's Fresh'n Squeeze® innovations have enabled premium flavor and higher juice output. The Fresh'n Squeeze® 3300 model is the next step in this evolution, incorporating the same industrial whole fruit extraction technology the brand is known for – which produces 50% more juice per fruit than traditional cut-and-press methods. It also contains new features designed specifically for the realities of modern foodservice operations.

Since the mid-1980s, JBT Marel's Fresh'n Squeeze® innovations have enabled

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The standout enhancement of the 3300 is its large touchscreen interface, which provides operators with real-time workflow notifications, automatic jam-clearing capabilities, and easy access to service and maintenance features.

"Our goal for the Fresh'n Squeeze® 3300 was to keep what worked, which is the industrial extraction technology, durability, and incredible taste, while also stepping into the future," said Megan Dyer, Director of Key Accounts and Beverage at JBT Marel. "Our juicers set the gold standard in the industry, and we're



confident that this new model will keep customers' operations on trend and running smoothly."

The launch follows the momentum of the compact, countertop Fresh'n Squeeze® 1800 model, which was recently honored with a prestigious 2026 Kitchen Innovations (KI) Award by the National Restaurant Association. The new floor-standing 3300 builds on this award-winning technology.

For more information on the Fresh'n Squeeze® 3300, a part of the JBT Marel family, or to learn more about the entire line of citrus juicers in the Fresh'n Squeeze® portfolio, visit <https://jbtmarel.com/en/fresh-n-squeeze/>.

Launching CoLOS® Version 7:

A leap ahead to a future-proof, secure and comprehensive software suite for industrial coding operations



Markem-Imaje, part of Dover Corporation and a global provider of end-to-end supply chain solutions and industrial marking and coding systems, announced today the launch of CoLOS® Software Version 7, a release that expands the software suite with new features designed for organizations with multiple production facilities. This version builds on the strengths of CoLOS® Version 6 with enhanced automation, industry compli-

ance, reinforced security layers, and intuitive operations to increase production efficiency and reduce inconsistency errors.

CoLOS® Version 7 offers industry certified advanced security features, centralized management for organizations with multi-site packaging operations, high availability to minimize downtime and a next generation responsive web user interface.

The key highlight of this version is the CoLOS® multi-site feature that allows centralized design, control and automate approval workflows of messages/labels in production, and resource management across multiple factories globally. It ensures consistency, compliance and a single source of truth for all messages and label designs across multiple sites. In addition, it allows a comprehensive visibility into production efficiency and scale up possibilities as the scope expands.

Product quality and security are the topmost priorities at Markem-Imaje. That is why CoLOS® Version 7 is certified for the IEC 62443-4-2 standard for Cyber security requirements for Product components. This enables organizations to move local software systems used for production to central IT infrastructure without worrying about cyber security.

CoLOS® Software Version 7 is available for use with the complete range of Markem-Imaje printers and is now also available both as on-premises and cloud-based subscription model. CoLOS® follows global standards for marking and coding including 1D/2D barcodes and compliant with newest GS1 Digital Link.

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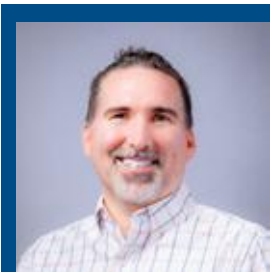
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Business Integration vs. Systems Integration: Why the Difference is Worth Millions



Bryan Stone, Principal
of Client Delivery,
JBF Consulting

A food and beverage processing facility can invest heavily in the latest ERP platforms, production scheduling software, and traceability systems. But if no one understands the production workflows, regulatory compliance requirements, SKU complexity, or how plant operations connect to procurement and distribution, the business still underperforms.

The technology may function perfectly. The business does not.

That distinction increasingly defines what is happening across food and beverage technology implementations today.

Processors continue investing aggressively in supply chain management systems, warehouse and inventory technologies, AI-driven demand planning tools, quality management platforms, and traceability automation. Yet despite those investments, most implementations still fail to deliver the operational or financial outcomes leadership expected when the initiative was approved. Recent industry findings¹ reveal that only 12.1% of supply chain technology programs ultimately delivered on time, on budget, and

achieved their expected business outcomes. More than 91% experienced budget overruns, while nearly 89% realized less than 76% of projected ROI.

The reason is straightforward: most companies are executing systems integration when what they actually need is business integration.

Technology Isn't the Problem. Operational Readiness Is.

The food and beverage processing industry has spent years assuming implementation struggles are primarily technology problems. Increasingly, the data suggests otherwise. Systems integration focuses on getting the platform technically operational: configuring the software, migrating production and inventory data, testing workflows, and connecting systems. Business integration focuses on whether the organization itself is operationally prepared to absorb the technology through governance structures, workflow redesign, compliance readiness, change management, adoption planning, and decision authority.

One installs the system. The other enables the business to function through it. Too many processors complete the first while assuming the second will happen organically. One of the clearest examples appears in how food and beverage organizations approach data integration. Recent industry polling identified data quality and system integration as the single largest operational challenge, impacting 32% of respondents². For food processors, that manifests as inconsistencies across production records, lot traceability,

supplier data, and regulatory documentation — problems that no software can resolve without first resolving the underlying business process and ownership questions.

Organizations often attempt to layer sophisticated planning tools, optimization engines, or AI capabilities onto operational environments where workflows, data ownership structures, business rules, and reporting standards remain inconsistent across production, quality, procurement, and distribution. The software becomes the visible failure point, but the underlying issue existed long before implementation began.

Technology amplifies organizational discipline. It does not replace it.

Why Most Implementations Fail Before Go-Live

When supply chain leaders were asked what would have reduced the need for mid-project correction, 61.4% identified one issue above all others: a structured transition from vendor contracting into implementation. Yet fewer than 10% reported actually having that discipline in place¹.

Food and beverage processors spend enormous time evaluating software capabilities but comparatively little time designing the operational framework required to support the implementation itself. Readiness assessments are incomplete, governance structures are introduced too late, timelines are driven by vendor availability rather than plant operational readiness, and authority structures across production, quality, IT, and executive leadership remain ambiguous.

Industry findings show that 82.6% of organizations required more than six months to reach full operational adoption, while 11.6% took more than a year¹. For food processors operating on thin margins with strict compliance obligations and seasonal demand volatility, delayed adoption creates compounding financial and regulatory exposure.

The same pattern is now emerging with AI adoption. Industry polling shows that 37% of organizations are still exploring where AI could provide operational value, while another 29% remain stuck in pilots². For food and beverage, AI holds significant



promise across demand forecasting, yield optimization, and quality control automation. But those capabilities depend on clean workflows, integrated operational data, and standardized business logic — not software features alone.

Adoption Is the Real ROI Metric

Yet many organizations still approach training primarily as a software orientation exercise. Only 8.2% of organizations reported providing role-specific, workflow-based training tailored to how employees actually perform their jobs¹. In food processing, that means production supervisors, quality technicians, procurement managers, and distribution coordinators each need training specific to how their role interacts with the system — not a one-size-fits-all approach. The issue is not whether employees understand the software. It is whether they understand how the business now operates through the software.

That distinction defines business integration.

Food and beverage processing organizations that consistently outperform their peers do not treat implementation as an IT event. They treat it as an enterprise operational transformation initiative involving governance, workflows, accountability, compliance process enablement, and organizational readiness. As processing operations become more automated, interconnected, and AI-enabled, the organizations that separate themselves will not simply be the ones buying more advanced technology. They will be the ones integrating their businesses more effectively around that technology. The companies that win will not just install the systems. They will know how to run the operation.

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1: <https://jbf-consulting.com/the-implementation-integrity-gap/>

2: <https://ortec.com/en-us/news/ortec-2026-optimus-showcases-ai-decision-intelligence>

GEA launches new KOB high pressure homogenizer series for small and medium-scale production

GEA is presenting the complete range of its KOB series, a new cost-efficient line of homogenizers reaching up to 400 bar. The series is designed to give small and medium production plants access to industrial-grade performance at an attractive investment level. With KOB models 11, 22, 45 and 90 available, the homogenizers offer a compact, hygienic and flexible solution for a broad range of food, beverage, chemical and personal care applications, including homogenizing and feeding spray dryers. Optimized and compact mechanical construction, lower noise levels, simplified maintenance access and efficient power use create a strong value proposition for existing plants and new lines alike.

Built for performance: up to 400 bar and flexible valve options

At the core of the GEA KOB homogenizers is a robust high-pressure design up to 400 bar, ensuring stable and efficient homogenization for demanding, moderately viscous and abrasive applications. To meet the requirements of diverse applications, higher-efficiency homogenizing valve technology and more wear-resistant materials are available as options. The base configuration uses competitively priced wear-resistant parts, providing an economical choice for standard, non-abrasive products, while optional high-wear-resistant materials extend service life in more demanding, abrasive formulations.

Compact machines engineered for efficiency, low noise and reduced operating costs

The KOB homogenizer series is designed for processors who need adequate and fit-for-purpose homogenization performance within a limited footprint. Its compact architecture is enabled by an optimized crankcase and gear-reducer design that delivers high mechanical efficiency while generating minimal heat, noise and vibration. As the drive compartment requires neither oil cooling nor forced-air ventilation, the machines rely on fewer auxiliary components and deliver lower installation, maintenance, energy and utility demands.

A newly engineered frame and cladding,



developed using advanced structural analysis, further contributes to low vibration levels and long-term durability. The use of poppet-type pumping valves enhances flow characteristics and feeding stability, significantly reducing noise and cavitation while improving volumetric efficiency and extending component life.

Together, these mechanical considerations result in a homogenizer family that reduces energy consumption, simplifies daily operation and maintenance, and minimizes downtime. With their compact footprint and minimal maintenance-space requirements, KOB machines are well suited for both new installations and the replacement of legacy homogenizers without major layout modifications.

Hygienic, CIP/SIP-capable design

Designed to meet demanding sanitary requirements, every KOB model is available with CIP and SIP capabilities and can be configured to meet 3-A sanitary standards. Steamable full-stroke barrier chambers provide aseptic product handling. The machines can be equipped with a second-stage pressure gauge and pressure transmitters on both homogenization stages as well as the outlet, for process automation and control. This makes the KOB homogenizers ideal for a broad range of products and processes such as milk, dairy ingredients, beverages, plant-based formulations and selected chemical, personal care and cosmetic products in manual, semi-auto and fully automated production lines.

Modular automation for easy integration

The KOB series supports a wide range of automation levels, from simple motor-starter solutions to full PLC/HMI control. Connectivity options enable seamless integration into SCADA and plant-wide automation systems, allowing processors to choose the right level of digitalization for their operation. This modularity helps ensure fast installation and smooth retrofitting into existing production lines.

Brewing Innovation: Cherise's Vision for India's Smart Beverage Future

In an exclusive conversation with Food & Beverages Processing magazine, Parimal Shah, Founder of Cherise, shares how the company is redefining India's beverage industry through its innovative Farm-to-Cup ecosystem and IoT-enabled smart vending solutions. He discusses Cherise's expanding portfolio of premium beverages, advanced in-house vending technology, stringent quality standards, growing market presence, and the company's vision to transform on-demand beverage consumption across India.

Mr. Parimal Shah, Founder, Cherise, India



Cherise has created a unique Farm-to-Cup beverage ecosystem. Could you briefly share the company's journey, vision, and current product portfolio?

At Cherise, we believe that chai is more than just a beverage—it is an experience. Through our Farm-to-Cup ecosystem, we bring authentic, farm-fresh beverages to consumers with quality, consistency, and convenience at the core.

Our flagship Cherise Tapri IoT-enabled smart vending machines dispense a wide variety of hot and cold beverages, including tea, coffee, soups, milk beverages, iced tea, and coconut water, in just a click. The machines support cashless payments, offer customizable branding, and are ideal for offices, factories, hotels, hospitals, colleges, and other public spaces. Our vision is to redefine on-demand beverage consumption by combining technology with authentic Indian flavours.

With offerings spanning teas, coffees, soups, milk beverages, and smart vending solutions, which product categories are currently driving the strongest growth for the company?

Our growth is being driven by a combination of smart vending solutions and our diversified beverage portfolio.

Cherise Tapri continues to see strong demand for authentic Indian beverages through our Farm-to-Cup ecosystem. Our premium tea brand Specialiteas is gaining traction for its handcrafted gourmet blends made with 100% natural ingredients. Brewdays caters to consumers seeking convenient wellness-focused beverages, while Sunfields and Beanlovers continue to strengthen our tea and coffee offerings. We are also witnessing growing demand for our ready-to-serve cold

beverages, including iced teas, cold coffee, tender coconut water, Aam Panna, and Jeera Soda.

Cherise's IoT-enabled vending machines are a key differentiator. What are the unique features and advantages that set your vending ecosystem apart from competitors in the market?

Cherise smart vending machines are designed and manufactured in-house using advanced mechatronics and our proprietary IoT platform, enabling real-time monitoring and machine management.

Key features include contactless dispensing, app-based operation, GPS tracking, cloud connectivity, touchscreen interface, multiple cashless payment options, auto self-cleaning, live inventory monitoring, high-speed dispensing capacity, and plug-and-play installation. The machines are available in multiple configurations for organised and traditional sectors, offering businesses a smart, scalable, and efficient beverage solution.

Quality, safety, and hygiene are critical in the beverage industry. What manufacturing practices, quality standards, and technological measures does Cherise follow to ensure consistent product excellence?

Quality and safety are fundamental to everything we do. Cherise is audited and certified by Bureau Veritas, while our beverage formulations are tested at Eurofins Laboratories. Our manufacturing facilities comply with globally recognised standards, including ISO 22000:2018, ISO 9001:2015, ISO 14001:2015, GMP, HACCP, and USFDA guidelines. These stringent quality processes ensure consistent taste, hygiene, and product

excellence across our entire portfolio.

The company has expanded its presence across multiple Indian cities in a short span. What has been the market response so far, and which regions offer the greatest growth opportunities?

The market response has been extremely encouraging, driven by increasing demand for hygienic, convenient, and technology-enabled beverage solutions.

Our long-term vision is to make India run on Cherise by deploying millions of smart vending machines across offices, factories, educational institutions, hospitals, transport hubs, hospitality establishments, residential societies, and neighbourhood retail outlets. This scalable business model offers significant growth opportunities across urban and emerging markets while creating widespread brand visibility and accessibility.

How do changing consumer preferences, particularly the demand for convenience, premium beverages, and contactless solutions, influence your product development and business strategy?

Consumer preferences have played a key role in shaping our innovation strategy. Today's customers seek convenience, hygiene, premium quality, and transparency. Our smart vending ecosystem addresses these needs by offering authentic Indian-centric beverages, contactless dispensing, real-time inventory tracking, cloud-based monitoring, and hygienic in-house manufactured machines. Unlike conventional vending systems, our formulations do not use liquid milk, reducing health risks, while our proprietary technology ensures only Cherise beverages are dispensed, maintaining consistent quality and accountability.

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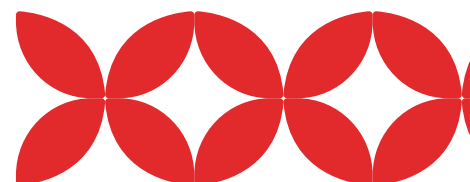
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Sustainable Meat Processing Technologies: Reducing Energy, Water & Waste through Innovation

Kanika Banga



As the global demand for meat continues to rise, the meat processing industry is facing increasing pressure to produce more with fewer resources. Consumers are becoming more conscious of how their food is produced, while governments and retailers are tightening environmental standards. Sustainability is no longer viewed as an optional initiative or a corporate responsibility exercise. It has become a business necessity that influences operational efficiency, regulatory compliance, and long term profitability.

Meat processing is one of the most resource intensive sectors within the food industry. Large amounts of electricity are required for refrigeration, processing equipment, lighting, and cold storage, while significant volumes of water are consumed for slaughtering, cleaning, sanitation, and product handling. In addition, processors generate considerable quantities of organic waste, wastewater, and greenhouse gas emissions. Today, however, technological innovation is helping the industry address these challenges through smarter operations, improved resource management, and circular economy practices.

Smarter Energy Management

Energy represents one of the highest operating costs for meat processing facilities, with refrigeration systems accounting for a major share of electricity consumption. To reduce energy use without compromising food safety, processors are increasingly adopting intelligent energy management systems.

Modern facilities use sensors and digital monitoring platforms to track electricity consumption across production lines. These systems identify inefficient equipment, detect

energy losses, and help operators optimize machine performance in real time. Variable Frequency Drives installed on motors, pumps, compressors, and conveyor systems automatically adjust motor speeds according to production demand instead of running continuously at full capacity. This simple upgrade can significantly reduce electricity consumption while extending equipment life.

Artificial intelligence is also improving energy efficiency by predicting production schedules and adjusting refrigeration loads accordingly. Rather than operating at maximum capacity throughout the day, cooling systems respond dynamically to actual processing requirements. Many processors are also recovering waste heat from refrigeration compressors and boilers to heat water used for cleaning and sanitation, reducing fuel consumption and improving overall plant efficiency.

Renewable Energy Gains Momentum

To reduce dependence on fossil fuels and lower carbon emissions, many meat processors are investing in renewable energy solutions. Rooftop solar panels are becoming a common feature in processing facilities, supplying electricity for production equipment, warehouses, and office buildings. Some companies are also exploring wind power where local conditions permit.

A particularly promising innovation is the use of biogas generated from organic processing waste. Through anaerobic digestion, materials such as blood, fat, offal, and wastewater sludge are converted into methane rich biogas. This renewable fuel can be used to generate electricity or power boilers, allowing processors to transform waste into a valuable energy source while reducing disposal costs.

Water Conservation Through Technology

Water is essential throughout meat processing, from livestock washing and equipment cleaning to cooling and sanitation. However, increasing water scarcity and rising treatment costs are encouraging processors to rethink water management. Modern facilities are replacing conventional cleaning methods with automated Clean in Place systems that carefully control water flow, detergent concentration, temperature, and cleaning duration. These systems maintain hygiene standards while using significantly less water.

Real time monitoring systems also allow managers to identify leaks and excessive water use before they become costly problems. Many processors now reuse relatively clean water from one stage of production for less critical operations such as floor cleaning, equipment pre rinsing, and cooling systems. These water reuse practices reduce freshwater consumption while lowering operating costs.

Wastewater Recycling

Meat processing generates wastewater containing fats, proteins, suspended solids, and organic matter that require proper treatment before discharge. Instead of viewing wastewater as a disposal challenge, many processors now see it as a recoverable resource.

Modern wastewater treatment combines physical separation, biological treatment, and membrane filtration to produce water suitable for reuse in non food applications. Treated water can be used for cooling towers, equipment cleaning, or irrigation, reducing demand for freshwater supplies. Advanced treatment technologies also recover valuable fats and oils that can be further processed into industrial products or renewable energy, supporting both environmental and economic objectives.

Turning Waste into Valuable Resources

One of the biggest changes in sustainable meat processing is the shift from waste disposal to waste valorization. Materials that were once discarded are now being converted into high value products. Animal fats are processed into biodiesel, industrial lubricants, and specialty chemicals. Blood is converted into protein rich animal nutrition products and fertilizers. Bones are used to

produce gelatin and mineral supplements, while hides provide collagen for food, cosmetic, and pharmaceutical applications.

Some of the most valuable products recovered from meat processing by products include:

- Biodiesel
- Collagen peptides
- Gelatin
- Organic fertilizers
- Animal feed ingredients
- Pharmaceutical materials

This circular economy approach reduces landfill waste while creating additional revenue streams for processors.

Automation Improves Efficiency and Reduces Waste

Automation has become one of the most effective tools for improving both sustainability and productivity. Vision guided robotic cutting systems use cameras and artificial intelligence to identify the best cutting path for each carcass, reducing trimming losses and maximizing meat yield. Automated weighing and grading systems ensure precise portion sizes, minimizing product giveaway while maintaining consistency. Collaborative robots are also being used for repetitive tasks such as packaging, palletizing, and material handling, improving worker safety and operational efficiency.

Digital twin technology is helping processors simulate production processes before implementing changes. By testing equipment layouts and production schedules virtually, companies can reduce energy consumption and improve resource utilization without disrupting operations.

Sustainable Refrigeration Solutions

Maintaining strict temperature control is essential for meat quality and food safety, but refrigeration is also one of the industry's largest energy consumers. Improving refrigeration efficiency has therefore become a major sustainability priority. Many processors are replacing conventional refrigerants with natural alternatives such as ammonia and carbon dioxide, which have significantly lower environmental impact. Smart refrigeration systems equipped with sensors continuously monitor storage conditions and automatically adjust compressor performance according to demand. Predictive maintenance software further improves efficiency by identifying equipment issues before they lead to energy losses or unexpected downtime.

Digital Technologies Drive Smarter Operations

Industry 4.0 technologies are transforming

sustainability management across meat processing plants. Sensors installed throughout facilities collect data on electricity use, water consumption, refrigeration performance, steam generation, and waste production.

Cloud based software converts this information into real time dashboards that help managers identify inefficiencies and make informed decisions. Artificial intelligence analyzes historical data to optimize production schedules, improve maintenance planning, and reduce resource consumption. Digital traceability systems also provide greater transparency throughout the supply chain, enabling processors to monitor sustainability performance alongside food safety and product quality.

Sustainable Packaging and Carbon Reduction Sustainability efforts increasingly extend beyond processing operations to include packaging and transportation. Many meat processors are adopting recyclable mono material packaging, lightweight trays, and bio based materials where product compatibility allows.

Modified Atmosphere Packaging extends product shelf life by maintaining optimal conditions inside the package, helping reduce food waste during transportation and retail storage. Companies are also reducing carbon emissions through electric forklifts, automated guided vehicles, and intelligent logistics systems that optimize delivery routes and minimize fuel consumption. Collaboration with livestock producers on regenerative farming and methane reduction initiatives is further lowering emissions across the entire supply chain.

Artificial Intelligence Accelerates Sustainability

Artificial intelligence is rapidly becoming one of the industry's most valuable tools for resource optimization. AI systems can forecast production demand more accurately, reducing overproduction and unnecessary waste. Machine learning algorithms optimize refrigeration loads, monitor water usage, schedule preventive maintenance, and automate quality inspection.

Key applications of AI in sustainable meat processing include:

- Predictive equipment maintenance
- Energy optimization
- Water management
- Production planning
- Automated quality inspection
- Demand forecasting
- Waste reduction

As these technologies continue to evolve, AI



will play an even greater role in improving operational efficiency while reducing environmental impact.

Looking Ahead

The future of meat processing will be shaped by continued investment in sustainability driven technologies. Carbon neutral processing facilities, advanced water recycling systems, hydrogen based heating, autonomous production lines, and fully circular manufacturing models are expected to become increasingly common. Growing regulatory requirements, consumer expectations, and retailer sustainability commitments will continue encouraging processors to adopt cleaner technologies that reduce energy use, conserve water, and maximize resource recovery.

Conclusion

Sustainability has become one of the defining priorities for the modern meat processing industry. By combining automation, artificial intelligence, renewable energy, water conservation, wastewater recycling, and waste valorization, processors are significantly reducing their environmental footprint while improving operational performance.

Perhaps the industry's greatest transformation lies in its shift toward a circular economy, where waste is viewed as a valuable resource rather than a disposal challenge. Companies that invest in sustainable technologies today are not only reducing energy consumption, water use, and waste generation, but are also building more resilient, efficient, and future ready businesses. As innovation continues to reshape meat processing, sustainability will remain at the heart of producing high quality protein in a way that supports both economic growth and environmental responsibility.

The Beverage Packaging Equipment Industry: Innovations Shaping a USD 17.93 Billion Future



Every bottle of water on a supermarket shelf, every energy drink sealed with precision at 50,000 units per hour, every aseptically filled carton of flavored milk — all exist because of an industry most consumers never see. Beverage packaging equipment is the invisible engine of the global drinks supply chain, and according to the latest research, it is entering a decade of substantial technological and commercial transformation.

A comprehensive market intelligence report published by Polaris Market Research reveals that the Beverage Packaging Equipment Market was valued at USD 10.42 billion in 2024 and is projected to reach USD 17.93 billion by 2034, expanding at a steady CAGR of 5.6% over the forecast period from 2025 to 2034. For manufacturers, engineers, investors, and material scientists operating at the intersection of advanced materials and smart manufacturing, the data paints a compelling picture of opportunity.

What Is Beverage Packaging Equipment and Why Does It Matter Now?

Beverage packaging equipment encompasses the full spectrum of machinery used to prepare, fill, seal, label, sterilize, and palletize liquid products — from bottled water and carbonated soft drinks to dairy beverages, juices, and alcoholic drinks. The category spans filling and capping machines, labeling and coding systems, cleaning and sterilizing units, conveying and handling infrastructure, wrapping and bundling equipment, and cartoning machines.

What makes this market especially significant from an advanced materials and chemicals perspective is the increasingly sophisticated materials science embedded in modern packaging lines. New-generation machinery must now be engineered to handle an evolving portfolio of packaging substrates — including recyclable polymers, biodegradable films, lightweight aluminum, bio-based plastics, and multi-layer barrier materials — without sacrificing throughput speed or hygiene compliance. The machinery itself must be built from corrosion-resistant alloys, food-grade stainless steel, and precision-engineered composites to meet global safety standards.

The Forces Shaping Market Growth

1. Surging Demand for Ready-to-Drink Beverages

Modern consumers — particularly younger demographics — have embraced an on-the-go lifestyle that places a premium on convenience. Ready-to-drink (RTD) beverages, spanning bottled water, energy drinks, plant-based milks, cold brew coffees, and functional wellness drinks, have become staples rather than indulgences. This behavioral shift is translating directly into capital investment in high-speed, high-volume packaging lines capable of handling enormous production diversity.

The World Health Organization's Global Status Report on Alcohol and Health 2024 highlighted a notable global trend toward declining alcohol consumption

and a corresponding rise in non-alcoholic alternatives — a trend that is reshaping which categories of beverages require the most sophisticated packaging infrastructure. Dairy beverage packaging, in particular, is projected to register the fastest application growth over the forecast period, driven by surging demand for flavored milks, protein shakes, yogurt drinks, and plant-based dairy alternatives that require aseptic filling and precision sterilization technologies.

2. Automation and AI Integration Redefining Factory Economics

The case for automation in beverage packaging has never been stronger. Rising labor costs, tightening hygiene regulations, and the relentless pressure to reduce cost-per-unit are driving manufacturers to invest in fully automatic systems. The fully automatic segment held the largest revenue share in 2024, a position reinforced by its capacity to handle large continuous production volumes with minimal human intervention while integrating seamlessly with smart factory systems.

Critically, artificial intelligence is no longer a distant concept in this space — it is an active operational tool. AI-powered robots are being deployed for filling, sealing, labeling, and palletizing. Predictive maintenance algorithms analyze real-time equipment data to identify wear patterns and schedule interventions before costly breakdowns occur. AI-driven material optimization is reducing excess packaging waste, simultaneously lowering costs and carbon footprints. A 2024 overview published by the U.S. Bureau of Labor Statistics noted that automation in manufacturing is fundamentally reshaping workforce composition and productivity benchmarks — a trend fully reflected in this market's trajectory.

3. Sustainability as a Design Imperative — Not an Option

Environmental regulation and consumer expectations are converging to make sustainable packaging a non-negotiable design criterion. Manufacturers across North America, Europe, and increasingly Asia Pacific are investing in packaging equipment capable of processing recyclable, biodegradable, and lightweight materials. This is where the advanced materials dimension becomes especially strategic: equipment must be re-engineered at the materials level to handle substrates that differ significantly in tensile

strength, thermal properties, and sealing behavior from conventional PET or glass.

This green transition is also driving demand for more energy-efficient machinery. Modern filling lines increasingly incorporate variable-speed drives, heat recovery systems, and closed-loop water treatment units — all embedded within advanced material frameworks designed to minimize lifecycle environmental impact.

Segmental Intelligence: Where Growth Is Concentrated

By Type: Filling and capping machines dominate revenue share as the foundational, indispensable component of every beverage production line globally. However, labeling and coding machines are the fastest-growing type segment, powered by regulatory traceability requirements, e-commerce logistics needs, and the rising role of smart packaging in brand storytelling and QR-code-enabled consumer engagement.

By Automation: Semi-automatic equipment is the fastest-growing automation segment, fueled by the explosive growth of craft beverage brands, regional specialty drink producers, and SME manufacturers that require flexibility and lower capital entry points rather than full-line automation.

By Application: Bottled water remains the single largest application driver globally, given the sheer scale of worldwide packaged water consumption. The dairy beverage segment is the growth leader, reflecting the structural shift toward functional, protein-enriched, and plant-based beverages.

Regional Dynamics: Asia Pacific Leads, Europe Innovates

Asia Pacific commands the largest regional revenue share, anchored by China's massive consumer base, government-backed industrial modernization initiatives, and rapidly expanding middle-class demand for packaged beverages. Rising urbanization — the UN-Habitat estimates Asia accounts for 54% of the global urban population — is directly correlated with increased beverage consumption and the need for scaled, automated packaging infrastructure.

North America is characterized by a strong automation orientation and a highly diversified beverage portfolio. High labor costs and the complexity of US consumer preferences — spanning sparkling water, RTD cocktails, functional beverages, and health drinks — drive investment in flexible, multi-format packaging lines.

Europe leads in regulatory stringency and

sustainability innovation. Germany, in particular, serves as a global hub for high-precision, high-performance packaging technology, with German engineering firms setting international benchmarks for bottling line sophistication and energy efficiency.

Competitive Landscape: Giants and Innovators

The competitive landscape of the beverage packaging equipment industry is led by multinational powerhouses offering integrated, full-line solutions: Krones AG, KHS GmbH, Sidel (Tetra Laval), GEA Group, Syntegon Technology, Tetra Pak, ProMach, Aetna Group, Fuji Machinery, Nichrome Packaging Solutions, and Mitsubishi Heavy Industries.

Recent strategic activity underscores the pace of innovation. In May 2025, IMA Food North America launched the Hamba Flexline — a high-speed cup fill-seal system with

integrated sterilization capable of producing over 57,000 cups per hour. In July 2024, Coesia acquired a minority stake in PWR (Packaging with Robots), a move designed to deliver fully automated, robotics-and-vision-system-enabled packaging lines to the broader market. These developments signal an industry in active, competitive evolution.

Conclusion: A Market at the Intersection of Materials Science and Intelligent Manufacturing

The beverage packaging equipment market is far more than an assembly of machines — it is a critical node where advanced materials engineering, digital automation, sustainability science, and consumer behavior converge. For stakeholders across the chemicals and advanced materials value chain, the USD 17.93 billion opportunity by 2034 represents both a commercial prize and a call to innovate.

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The Economics of Flexible Packaging: Why Laminated Pouches are Replacing Rigid Formats

Shailesh Sheth, Chairman & Managing Director, Kris Flexipacks

The business case for flexible packaging spent a long time resting almost entirely on cost. Compared to glass, rigid plastic, or metal, laminated pouches and flexible formats were cheaper to produce, lighter to ship, and more efficient to store. That was enough for most procurement conversations, and it drove significant adoption across FMCG, food processing, and personal care over the past two decades.

The cost argument remains valid. But anchoring the case for flexible packaging to cost alone has started to obscure everything else the format has become capable of doing.

The Material and Logistics Foundation

The efficiency advantages of flexible packaging are real and worth stating clearly, because they compound in ways that are not always obvious at the unit level.

According to data published by the Flexographic Technical Association, plastic packaging enables weight savings of more than 78 percent compared to alternative packaging materials, with one truckload of flat pouches equivalent to 15 to 25 truckloads of empty rigid containers. That reduction flows through the entire supply chain: lower raw material consumption, reduced shipment weight, more units per pallet, lower warehousing requirements.

In India specifically, flexible packs captured 54.32 percent of the country's packaging market in 2024, with converters reporting freight cost reductions of up to 70 percent compared to rigid formats. These are not theoretical benefits. They show up in actual freight invoices and warehouse utilisation figures, which is why flexible packaging has maintained its growth trajectory even during periods of raw material price pressure.

Barrier Performance and Product Integrity

What the cost conversation often overlooks

According to data published by the Flexographic Technical Association, plastic packaging enables weight savings of more than 78 percent compared to alternative packaging materials, with one truckload of flat pouches equivalent to 15 to 25 truckloads of empty rigid containers. That reduction flows through the entire supply chain: lower raw material consumption, reduced shipment weight, more units per pallet, lower warehousing requirements.

is the technical performance of modern laminated structures. Multi-layer flexible packaging can be engineered to provide precise barrier properties against moisture, oxygen, light, and contaminants, calibrated to the specific requirements of the product inside.

This matters operationally. Extended shelf life reduces spoilage across the supply chain, which is a cost benefit in itself but also a product quality benefit that affects consumer experience at the point of use. A product that reaches the consumer in better condition than a competitor's product, simply because the packaging was better engineered, is a competitive advantage that rarely gets attributed correctly. The barrier engineering in modern flexible packaging has become sophisticated enough that it now outperforms many rigid formats in specific protection requirements, not just matches them.

Consumer Interaction Has Changed

There is a consumer dimension to flexible packaging that the industry has not always articulated well. The user experience of a well-designed flexible pack, with a resealable zipper, a clean tear notch, a stable stand-up base, is meaningfully better than most rigid alternatives for everyday use.

Consumers notice this, even if they do not articulate it as a packaging preference. Ease

of opening, re-closability, portion control, storage convenience after opening: these are practical interactions that happen every time someone uses the product. Over repeat purchases, they build brand preference in ways that are difficult to measure in isolation but not difficult to observe at a category level.

Packaging that makes the product easier to use is doing something that advertising cannot. It is reinforcing brand preference at the moment of use, not just the moment of purchase. As category expectations have risen, flexible formats with thoughtful functional design have moved from a differentiator to something closer to a baseline requirement in several categories.

Print Quality Closed the Visual Gap

For a long time, flexible packaging carried a visual disadvantage relative to premium rigid formats. Glass and rigid plastic had a physical presence and a print quality that pouches and flexible packs could not reliably match. Advances in flexographic and gravure printing have changed that. Current flexible packaging supports the kind of graphic quality, colour accuracy, and finish variety that brand and design teams previously associated only with rigid formats. The visual gap has effectively closed for most practical applications, which means brands no longer need to choose between the functional efficiency of flexible formats and the visual presentation standards their categories demand.

The Recyclability Question

Flexible packaging's sustainability profile is genuinely complicated, and the industry does not serve itself by being evasive about it. Multi-layer laminate structures that deliver strong barriers and functional performance are difficult to recycle through conventional streams. That is a real challenge, and consumer and regulatory pressure around it is increasing.



Image - krisflexipacks

Progress is being made through mono-material flexible structures, chemical recycling pathways, and design-for-recycling approaches. In India, the transition toward mono-material PE and PP laminates is already gaining traction as manufacturers work to comply with plastic waste management regulations. But brands making packaging decisions today are operating ahead of when those solutions will be widely available at scale.

The honest position is that flexible packaging's environmental footprint involves trade-offs: lower material use and transport emissions on one side, recyclability limitations on the other. Brands should be making those trade-offs consciously, with clear visibility of where material technology is heading. Kris Flexipacks builds that conversation into its development process because decisions made now will need to hold up against requirements that will look considerably different in five years.

Beyond the Cost Conversation

The brands that are getting the most from flexible packaging are not the ones that chose it primarily because it was cheaper. They are the ones that understood what the format could do across barrier performance, consumer experience, visual presentation, and logistics efficiency, and built their packaging strategy around that fuller picture. Cost will always be part of the evaluation. But treating it as the primary frame means consistently underinvesting in what flexible packaging is actually capable of delivering. The format has earned a more complete conversation than it typically gets.

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The Power of Packaging

Why flexibility, sustainability and automation are so important to the future of the food and beverage industries



BottleClip Carrier (Source: Frank Reinhold)



KHS Premium LITE and KHS SUPREME



Ernst van Wickeren (Source: Frank Reinhold)



KHS Innopack Kisters TSP Advanced

Political crises, economic instability, lack of specialist workers and an increasing number of regulatory requirements: the beverage and packaging industries are facing massive upheaval. KHS supports its customers worldwide with a holistic line strategy that gives them maximum flexibility, reliability, cost-effectiveness and sustainability.

It's a familiar scenario: trawling around the supermarket, you're presented with row after row of products of all shapes and colors, all of them full of promise. Your eye roves along the jam-packed shelves and suddenly comes to an abrupt halt. It's already made a decision – while your brain's still thinking about which item is best. In many cases, it's the packaging that triggers your decision to buy. So that it convinces consumers and companies alike, the entire package has to be just right, providing a pleasing design combined with uncompromising product protection and sustainable materials at an attractive price.

KHS meets these high demands with its holistic line strategy. This starts with the packaging design and culminates in the development of perfectly orchestrated line systems and solutions that are ideally tailored to market requirements and the individual needs of the customer. In doing so, the turnkey supplier from Dortmund, Germany, offers its clients processes that boast a maximum of flexibility, reliability and cost-effectiveness.

Reliability, flexibility and cost-effectiveness the key to success

Thanks to this strategic alignment, KHS is able to give its customers key support in overcoming the challenges of our day and age. On the one hand, these include the world's turbulent political situation with its growing number of conflicts and the negative consequences these are having on the economy, such as rising energy costs, higher prices for raw materials and persistent problems with the supply chain.

The USA's unpredictable tariffs policy is causing additional instability, creating great uncertainty and compounding the financial burden on companies in general.

On the other hand, lots of producers in the beverage and food sector are battling with an acute lack of specialist workers. The availability of qualified operating personnel has dropped worldwide over the past few years. In return, the demand for fully or partly automatic systems has risen steeply. The manifold legal provisions businesses in the beverage and packaging industries are confronted with on a global scale are also proving to be a considerable challenge. The most recent example of this is the European Union's new Packaging and Packaging Waste Regulation (PPWR) that will mean profound change – not all of it foreseeable at present – for the entire sector. Resource-conserving packaging and increased use of recycled materials in particular are therefore very much in demand. The worldwide requirement for low-plastic or plastic-free systems has significantly increased in the last few years, especially with regard to secondary packaging. Here, there's a definite shift towards cardboard, paper and plastic film that contains a high percentage of recycle.

KHS provides diverse packaging and machinery portfolio

As a turnkey supplier with a comprehensive packaging and machinery portfolio, KHS can always expertly provide systems and

solutions to cater for changing market conditions. One example of this is the further-developed KHS Innopack Kisters TSP Advanced. The fully automatic machine gives operators a high level of flexibility, packing PET and glass bottles and cans on trays, in film as well as on trays or pads and film. At interpack, KHS will be presenting this well-established system with its new patented, optional BottleClip Carrier application for the very first time. The cardboard carrying handle joins PET containers together to form stable packs. It's a resource-conserving alternative to plastic ring systems which are no longer allowed in some countries. The new BottleClip Carrier option is available for all standard KHS Kisters machines in the Advanced series that have been specially developed for the high-performance sector. The KHS Innopack Kisters TSP Advanced, for example, processes up to 7,200 packs per hour. What's more, KHS packaging machines are convincing with their low operating costs, high line availability and fully automatic processes that significantly reduce operating requirements.

Besides the BottleClip Carrier, secondary packaging made of paper and the Carton Nature Pack (CNP) from KHS are also currently proving very popular. The CNP bundles cans to form stable packs with the help of a cardboard topper clipped onto the upper rim of the can. No plastic whatsoever is used.

KHS' globally market-proven Nature MultiPack (NMP) does away with both cardboard and plastic film, turning cans or PET bottles into stable packs using nothing more than a few small dots of adhesive. This sustainable KHS system cuts down on valuable resources and gives consumers maximum pack stability coupled with perfect carrying convenience. Each container can be easily detached from the rest of the pack as and when required.

Resource-conserving packaging on the rise

With its Nature MultiPack, KHS has taken on a pioneering role in establishing plastic-free packaging on an international scale. In many regions of the world, particularly in Asia, Africa and South America, secondary packaging made of film and PET bottles continue to dominate the market. KHS helps companies worldwide to develop and establish sustainable packaging, whether for secondary film, cardboard, paper and adhesive dot applications or for primary can, carton, glass and PET containers. In doing so, together with its customers KHS strives to meet corporate sustainability targets and fully comply with legal requirements. In its plastic systems and solutions, the Dortmund



Nature MultiPack (Source: Frank Reinhold)

packaging and line specialist strongly centers on increased use of recyclate and lightweighting.

Two groundbreaking bottle innovations serve as examples of this strategic alignment. KHS Premium LITE, for instance, combines minimal material consumption with a high-quality look. Clocking up just 6.2 grams on the scales, the 0.25-liter PET container is extremely light. Despite its minimal weight, this bottle designed in cooperation with Husky Technologies is ideal for processing at maximum filling speeds.

With KHS SUPREME, the systems supplier has taken the protection of oxygen-sensitive beverages up to the next level. The premium PET bottle combines the protective properties of glass with the weight benefits of plastic. It applies tried-and-tested Plasmax barrier technology from KHS, a wafer-thin layer of silicon oxide on the inside of the PET bottle that reliably protects highly sensitive products such as juice, CSDs, beer, tea, wine and liquid food from oxidation and the loss of carbon dioxide. This preserves taste, color and quality for long periods of time and considerably lengthens the product's shelf life. Plasmax coating can be used on lightweight containers and on bottles made of virgin PET or up to 100% recyclate. It completely dissolves during the standard recycling process. Unlike conventional barrier material systems such as scavengers and multilayers that make recycling more difficult, here, the purity of the separated PET is maintained. This means that Plasmax-coated bottles are fully recyclable and perfect for use in closed-loop PET systems.

Competent service for maximum system availability and future-proof packaging systems

The development of resource-conserving, future-proof packaging is a complex affair. KHS thus offers its clients a holistic consultancy service for container systems. Bottles & Shapes strikes a balance between consumer- and environmentally-friendly design, reliable line behavior and the efficient use of resources – for PET/[r]PET as well as



Packaging diversity (Source: Frank Reinhold)

glass bottles and cans. Here, KHS experts support customers from their initial design to the launch of a product that's perfectly tailored to the specific requirements of the respective company.

KHS' broad service portfolio is intended to provide long-term line availability at a low TCO. Its success is founded in the intensive support KHS specialists provide their customers with – working in cooperative partnership with them on an equal footing. The company's individual needs and challenges are always in focus, whether this be the design of a turnkey line or the overhaul of an existing machine. This is how KHS gives its clientele constantly high quality, reliable performance and maximum efficiency and flexibility.

KHS' extensive range of services also includes its established InnoLine Basic Line Monitoring software, 3D line design, remote diagnostics and maintenance system ReDiS and its Augmented Reality Service. Using KHS InnoPET iflex automated line changeovers, KHS facilitates customer format changeovers within 30 minutes, with product changeovers performed in just ten minutes. When applying the iflex option on PET lines, up to 80% of all manual line conversion tasks are rendered superfluous. Regarding automation, operators also profit from AI-assisted inspection technology for tethered caps.

Holistic packaging and line expertise from a single source

Outstanding packaging and line expertise paired with a multifaceted service portfolio ensures long-term success for both KHS and its customers – as well as giving them stability in politically and economically challenging times. Thanks to its strategic concentration on processes that provide maximum flexibility, reliability, cost-effectiveness and sustainability, KHS stands firm as one of the world's leading developers of packaging and plant technology for the beverage and liquid food industries.

www.khs.com

Sustainable Packaging Solutions: From Global Imperative to India Growth Story



In mature and emerging markets alike, the commercial winners are likely to be companies that align packaging with a broader circularity model. That means designing packs that are easier to collect, simpler to sort, lighter to transport, and more credible in consumer communication. It also means moving away from vague environmental claims and toward measurable outcomes: recycled content, recovery rates, refill participation, material simplification and lower lifecycle impact. In practical terms, sustainable packaging is becoming a business model question rather than a marketing slogan.

The India Opportunity: From Compliance Pressure to Competitive Advantage

India deserves special attention because it combines scale, regulatory intensity and industrial adaptability. The policy backdrop has become significantly more structured. The Government of India has linked the phase-out of certain single-use plastics with a stronger Extended Producer Responsibility framework for plastic packaging. According to the Press Information Bureau, the EPR guidelines notified in February 2022 introduced mandatory targets for collection, recycling, reuse of rigid plastic packaging and recycled content, while the CPCB-led centralised portal created a formal compliance infrastructure. The same PIB update notes that registered Producers, Importers and Brand Owners increased from around 310 before the guidelines to around 5,400, and that 2.26 million tonnes of plastic packaging were covered under EPR in 2022-23.



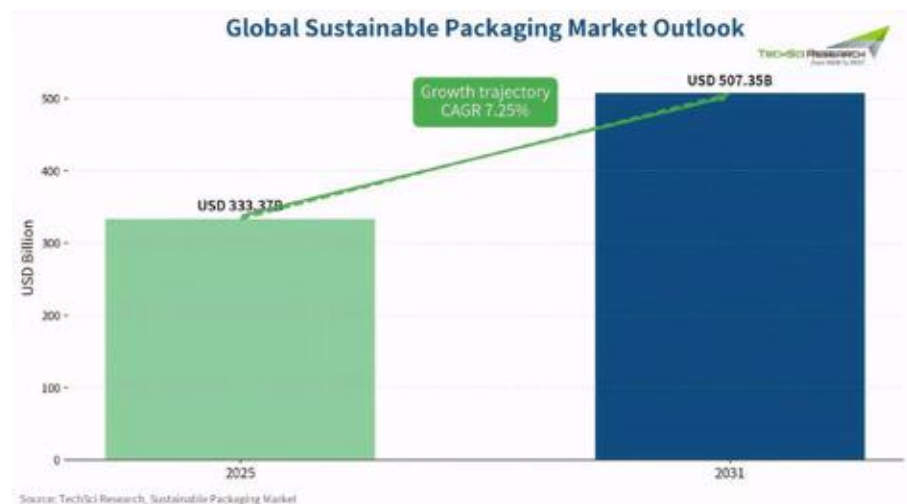
Sustainable packaging is no longer a peripheral sustainability initiative; it is becoming a core business discipline. Across consumer goods, food and beverage, beauty, healthcare and e-commerce, packaging decisions are now being shaped by a combination of regulation, investor scrutiny, customer expectations and operational economics. The companies that once treated packaging as a downstream procurement issue are increasingly treating it as a strategic lever for brand equity, risk management and growth. That shift is global in character, but it is becoming particularly significant in India, where regulation, recycling capability and consumer market scale are converging to create a distinctive opportunity.

The Global Scenario: Why Packaging Strategy Has Entered the Boardroom

At the global level, the direction of travel is clear. UNEP has argued that the plastics economy must move beyond incremental fixes and toward systemic change built on three shifts: reuse, reorientation toward sustainable alternatives, and stronger recycling economics. The same report notes that only 9% of plastics produced are mechanically recycled today, underscoring

the scale of the redesign challenge and the commercial space for innovation. For business leaders, that means sustainable packaging can no longer be understood only as a materials question. It is now about portfolio architecture, supply-chain design, logistics efficiency, recyclability, refill models, labelling clarity and data-backed compliance.

According to TechSci Research, the global sustainable packaging market is projected to grow from USD 333.37 billion in 2025 to USD 507.35 billion by 2031, at a CAGR of 7.25%. In parallel, TechSci Research report on the global flexible packaging market states the market was valued at USD 270.51 billion in 2024 and is expected to reach USD 347.64 billion by 2030. The implication is important: sustainability is not displacing packaging growth; rather, it is redefining which formats, materials and designs will capture value over the next decade.



That matters because regulation in India is not merely restrictive; it is beginning to formalise the economics of sustainable packaging. The CPCB guidance manual shows that compliance now depends on digital registration, transaction recording, certificate workflows, annual filings, audits and environmental compensation for non-compliance. In other words, packaging sustainability in India is increasingly measurable, auditable and linked to operational discipline. For organised businesses, this creates an opening: those that build traceability and packaging intelligence early can turn compliance into a source of resilience and preferred-customer credibility.

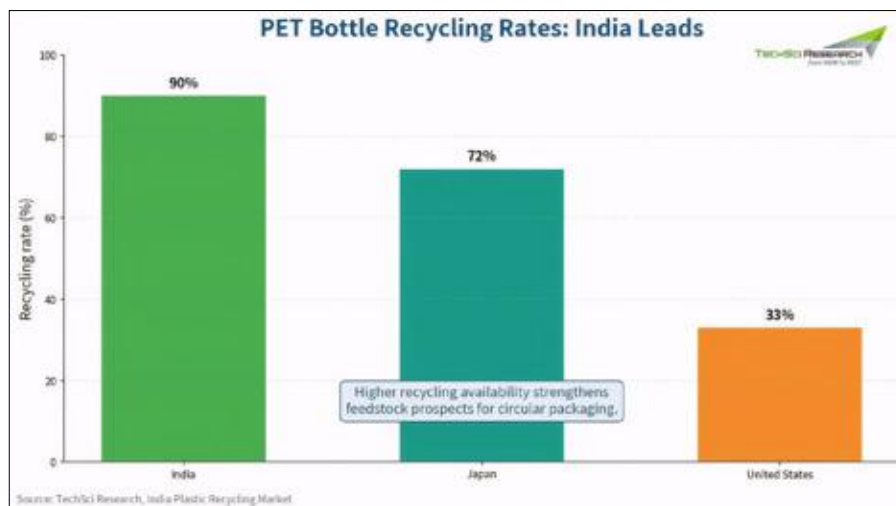
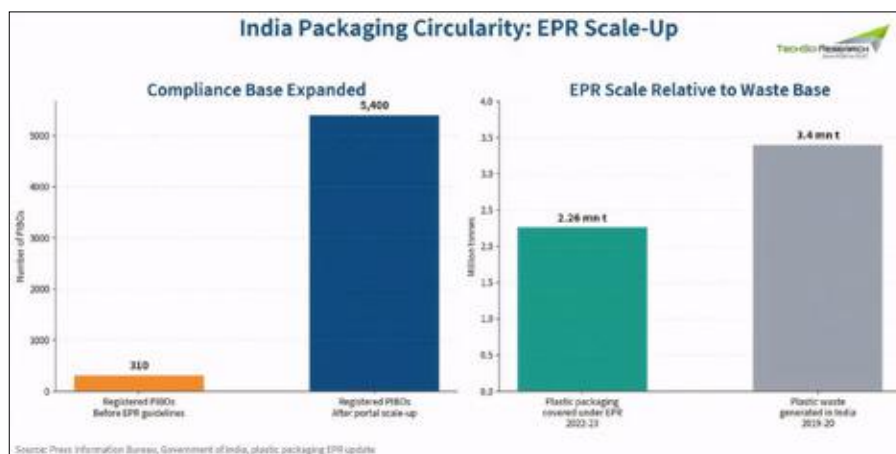
Why India's Recycling Base Changes the Conversation

The strongest reason India can become a serious sustainable-packaging growth story is that circularity is not beginning from zero. TechSci Research estimates that the India Plastic Recycling Market stood at USD 2,188.65 million in 2024 and is projected to reach USD 3,648.60 million by 2030, growing at 10.76% CAGR. More importantly for packaging strategists, the report highlights the packaging industry as a major driver of demand for recycled plastics and notes India's PET bottle recycling rate of 90%, compared with 72% in Japan and 33% in the United States. That single comparison is commercially powerful: it signals that India already has meaningful feedstock potential for circular packaging, especially where material streams are better organised.

This does not mean the transition is complete. Collection quality, food-grade approvals, design inconsistency, multi-layer complexity and economics across informal and formal chains still remain major issues. However, the Indian market is now in a much stronger position than many business narratives assume. Brands that can design for recyclability, contract reliably for recycled resin, and align packaging specifications with recovery realities will not only improve compliance readiness; they will also improve supply security as circular-material demand rises. Sustainable packaging in India should therefore be seen not as a cost burden alone, but as an input strategy.

Innovation Beyond Recycling: Functional, Premium and Waste-Reducing Formats

India's packaging transition will not be driven by recycling alone. It will also be shaped by format innovation that reduces waste, extends shelf life and improves product evacuation. TechSci Research report on the India Airless Packaging Market estimates a market size of USD 352.69 million in 2024, rising to USD



India Sustainable Packaging Action Matrix

Priority area	Why it matters	Business action	Suggested KPI
Design for recyclability	Reduces material complexity and improves post-consumer recovery.	Shift to mono-material formats where feasible; simplify inks, labels and adhesives.	Share of SKUs redesigned for recyclability
Recycled content sourcing	Builds circularity credentials and supports EPR alignment.	Secure long-term rPET/rHDPE supply partnerships and validate quality protocols.	Average recycled content by pack type
Reuse and refill pilots	Cuts virgin material use in high-frequency categories and dense urban markets.	Pilot returnable, refillable or bulk-dispense models in premium and institutional channels.	Refill participation and repeat-use rate
Compliance digitisation	India's EPR regime rewards traceability, filings and certificate discipline.	Integrate procurement, sales, waste recovery and portal reporting workflows.	On-time filings and EPR target fulfillment
Consumer communication	Clear messaging increases adoption and prevents greenwashing risk.	Use disposal guidance, QR-linked material information and outcome-based claims.	Pack-level disposal comprehension score

467.02 million by 2030 at a 4.75% CAGR. The significance of this report goes beyond category size. It points to a broader trend: packaging formats that reduce spoilage, preserve formulation integrity and minimise residual product waste are becoming more commercially relevant in India, especially in beauty, personal care, pharmaceuticals and healthcare-adjacent products.

That shift is strategically important for Indian manufacturers and brand owners. Sustainable packaging is often misunderstood as a narrow substitution exercise paper instead of plastic, compostable instead of conventional, recycled instead of virgin. In reality, the higher-value opportunity is to redesign packaging around performance outcomes. If a format improves product usage, extends

shelf life, lowers leakage, protects against contamination and reduces returns, it can strengthen both sustainability and profitability. This is why the next phase of India's sustainable-packaging journey will likely reward companies that combine material responsibility with packaging engineering.

What Business Leaders in India Should Prioritise Now

For Indian businesses, the first priority is design discipline. Packaging portfolios need to be reviewed SKU by SKU for recyclability, material complexity, label and adhesive impact, and compatibility with actual end-of-life pathways. The second priority is recycled-content strategy. As regulation and brand commitments intensify, access to quality recycled resin will become a differentiator, not a commodity purchase. The third is digital compliance capability. With the EPR architecture becoming more data-driven, companies need systems that can connect procurement, packaging specifications, sales, waste recovery and regulatory reporting.

The fourth priority is consumer communication. Sustainable packaging only creates reputational value when claims are credible and instructions are clear. Disposal behaviour, refill participation and brand trust are influenced by communication on-pack and across digital touchpoints. The fifth is channel-specific innovation. India is not one packaging market; it is a portfolio of use cases spanning modern retail, kirana ecosystems, institutional demand, e-commerce fulfilment and premium urban consumption. The packaging solution that works in one channel may fail in another. Therefore, businesses should think in terms of packaging architecture, not isolated packaging projects.

From Cost Centre to Value Platform

The most forward-looking companies are beginning to recognise that sustainable packaging can create value in at least five ways. First, it reduces regulatory exposure. Second, it protects brand trust in a market where environmental scrutiny is rising. Third, it can lower total system cost when lightweighting, refillability or material simplification are properly designed. Fourth, it improves resilience by diversifying material inputs and building access to circular feedstocks. Fifth, it supports innovation-led premiumisation, particularly in segments where hygiene, shelf life and consumer experience matter.

The broader lesson is that sustainable packaging is no longer about choosing between growth and responsibility. The market evidence suggests that growth itself is being reorganised around responsibility. Globally, packaging markets are evolving

toward sustainability-linked formats, and in India the enabling conditions for that transition are strengthening quickly. Companies that wait for perfect certainty may find themselves trapped between tighter regulation and more demanding customers. Those that move now can help shape the standards, supply chains and consumer habits of the next packaging era.

Conclusion

Sustainable packaging solutions have moved from the margins of CSR into the centre of business strategy. The global market is expanding, policy frameworks

are tightening, and packaging design is becoming inseparable from circular-economy performance. India, meanwhile, stands out as a market where regulation, recycling momentum and innovation potential are interacting in real time. For magazine readers in business and industry, that is the key takeaway: the future of packaging will not be decided by materials alone, but by how intelligently companies connect design, compliance, recovery, consumer behaviour and commercial ambition. In that future, India is not simply following the global conversation. It is increasingly positioned to influence it.

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Essential Oil-Based Edible Coatings for Shelf Life Extension of Fresh-Cut Fruits and Vegetables

Pooja Nikhanj



Fresh-cut fruits and vegetables have become increasingly popular because of their convenience, freshness, and nutritional value. Consumers today prefer ready-to-eat produce such as sliced apples, peeled carrots, fresh-cut melons, shredded cabbage, and salad mixes. However, minimal processing operations including peeling, slicing, chopping, and cutting accelerate physiological deterioration and microbial spoilage. These operations damage plant tissues, increase respiration rate, enzymatic browning, moisture loss, and microbial contamination, ultimately reducing shelf life and market quality. To overcome these challenges, researchers and food industries are focusing on natural preservation techniques. Among the emerging technologies, edible coatings enriched with essential oils have gained significant attention due to their eco-friendly, biodegradable, antimicrobial, and antioxidant properties. Essential oil-based edible coatings are now considered a promising alternative to synthetic preservative for maintaining the quality and safety of fresh-cut produce.

What Are Edible Coatings?

Edible coatings are thin layers of edible materials applied to the surface of food products. These coatings act as semi-

Several studies have demonstrated the effectiveness of essential oil-based coatings on different fresh-cut commodities. Chitosan coatings containing cinnamon or clove oil have been reported to reduce browning, microbial growth, and texture softening in apple slices during refrigerated storage. Tulsi essential oil incorporated into chitosan coatings effectively inhibited microbial growth and maintained firmness and color of fresh-cut carrots. Coatings enriched with thyme or oregano oil reduced fungal decay and extended shelf life by several days under cold storage conditions.

permeable barriers against moisture, oxygen, carbon dioxide, and microbial invasion. They help in reducing respiration rate, delaying oxidation, maintaining firmness, and preserving sensory quality.

Edible coatings are generally prepared from natural biopolymers such as:

- Polysaccharides (chitosan, starch, alginate, pectin, cellulose)
- Proteins (gelatin, whey protein, soy protein)
- Lipids (waxes, fatty acids)

Importance of Essential Oils in Food Preservation

Essential oils are volatile aromatic compounds extracted from plants, herbs, spices, flowers, and seeds. They contain bioactive compounds such as phenols, terpenes, aldehydes, and alcohols that possess strong antimicrobial and antioxidant activities. The antimicrobial activity of essential oils is mainly attributed to compounds such as eugenol, thymol, carvacrol, citral, and menthol. These compounds damage microbial cell membranes, disrupt enzyme systems, and inhibit the growth of spoilage microorganisms and food borne pathogens. Some commonly used essential oils in edible coatings include:

- Cinnamon oil
- Clove oil
- Thyme oil
- Oregano oil
- Lemongrass oil
- Peppermint oil
- Basil oil
- Tulsi oil
- Rosemary oil

Mechanism of Action of Essential Oil-Based Coatings

Essential oil-incorporated edible coatings extend the shelf life of fresh-cut fruits and vegetables through multiple mechanisms:

1. Reduction of Microbial Growth

Essential oils inhibit bacteria, yeasts, and molds responsible for spoilage. They are effective against pathogens such as *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella*.

2. Control of Moisture Loss

Edible coatings reduce water evaporation and maintain texture, firmness, and freshness.

3. Delay in Oxidation and Browning

Antioxidant compounds present in essential oils reduce enzymatic browning and lipid oxidation, thereby preserving color and nutritional quality.





4. Regulation of Gas Exchange

The semi-permeable nature of coatings modifies internal gas composition and slows down respiration and ripening processes.

5. Maintenance of Sensory Quality

Appropriate concentrations of essential oils can preserve aroma, flavor, and overall acceptability of fresh-cut produce.

Applications in Fresh-Cut Fruits and Vegetables

Several studies have demonstrated the effectiveness of essential oil-based coatings on different fresh-cut commodities. Chitosan coatings containing cinnamon or clove oil have been reported to reduce browning, microbial growth, and texture softening in apple slices during refrigerated storage. Tulsi essential oil incorporated into chitosan coatings effectively inhibited microbial growth and maintained firmness and color of fresh-cut carrots. Coatings enriched with thyme or oregano oil reduced fungal decay and extended shelf life by several days under cold storage conditions. Essential oil coatings helped reduce weight loss, maintain firmness, and delay spoilage. Edible coatings containing lemongrass and peppermint oils showed strong antimicrobial activity and preserved sensory quality.

Role of Nanoemulsion Technology

One major limitation of essential oils is their volatility, poor water solubility, and strong aroma. To overcome these problems, researchers are developing nanoemulsion-based edible coatings.

Nanoemulsions are fine oil-in-water dispersions with extremely small droplet sizes that improve:

Essential oils are volatile aromatic compounds extracted from plants, herbs, spices, flowers, and seeds. They contain bioactive compounds such as phenols, terpenes, aldehydes, and alcohols that possess strong antimicrobial and antioxidant activities. The antimicrobial activity of essential oils is mainly attributed to compounds such as eugenol, thymol, carvacrol, citral, and menthol. These compounds damage microbial cell membranes, disrupt enzyme systems, and inhibit the growth of spoilage microorganisms and food borne pathogens.

- Stability of essential oils
- Controlled release of bioactive compounds
- Antimicrobial efficiency
- Uniform distribution in coatings

Recent studies indicate that essential oil nanoemulsion coatings exhibit superior mechanical and barrier properties compared to conventional emulsions. They also provide prolonged antimicrobial action during storage.

Advantages of Essential Oil-Based Edible Coatings

- Natural and biodegradable preservation system
- Reduced dependence on synthetic chemicals
- Improved microbial safety
- Enhanced antioxidant protection
- Maintenance of nutritional and sensory quality
- Environmentally friendly packaging alternative

- Extended shelf life and reduced food waste

Challenges and Limitations

Despite their advantages, several challenges limit the commercial application of essential oil-based edible coatings:

- Strong flavor and aroma may affect consumer acceptability
- High concentrations can cause phytotoxicity or undesirable taste
- Essential oils are volatile and sensitive to environmental conditions
- Stability during storage remains a challenge
- Regulatory approval and safety assessment are required
- Large-scale industrial application is still limited

Future Perspectives

The future of essential oil-based edible coatings appears highly promising. Advances in nanotechnology, biodegradable polymers, and active packaging systems are expected to improve the effectiveness and commercial feasibility of these coatings. Integration with non-thermal preservation technologies such as ultraviolet treatment, cold plasma, and modified atmosphere packaging may further enhance shelf life and food safety. In addition, growing awareness regarding sustainability and food waste reduction is likely to increase the adoption of natural edible coatings in the food industry. Researchers are also focusing on developing smart coatings capable of responding to environmental changes and microbial contamination.

Conclusion

Essential oil-based edible coatings represent an innovative and sustainable approach for extending the shelf life of fresh-cut fruits and vegetables. Their antimicrobial and antioxidant properties effectively reduce spoilage, preserve quality, and improve food safety. The incorporation of essential oils into biodegradable edible coatings offers a natural alternative to synthetic preservatives while meeting consumer demand for safer and eco-friendly food products. Although challenges related to stability, sensory impact, and commercialization still exist, recent developments in nanoemulsion technology and active packaging systems have significantly improved the potential of these coatings. Continued research and industrial collaboration will help establish essential oil-based edible coatings as an important preservation strategy for the future food industry.

Author's Bio: Pooja Nikhanj is from Department of Microbiology, Punjab Agricultural University, Ludhiana

Naturally Sweet: Fruit-Sweetened Chocolate Redefines the Future of Healthy Indulgence



Introduction

The global chocolate industry is undergoing a significant transformation as consumers increasingly seek indulgent treats that align with healthier lifestyles. Growing concerns over excessive sugar consumption, coupled with the rising popularity of clean-label and plant-based foods, are driving manufacturers to rethink traditional confectionery formulations. Among the emerging trends, fruit-sweetened chocolate has gained considerable traction by replacing refined sugar with naturally sweet ingredients such as dates, raisins, figs, apples, and bananas. Offering a combination of rich chocolate flavour and added nutritional benefits, this innovative category is rapidly carving out its place in the premium confectionery market.

Market Poised for Strong Growth

According to the latest report by Growth Market Reports, the global fruit-sweetened chocolate market was valued at USD 1.34 billion in 2024 and is expected to grow at a CAGR of 8.1% between 2025 and 2033, reaching USD 2.65 billion by 2033. The market's expansion is being fuelled by growing consumer demand for natural sweeteners, healthier confectionery, and products with clean-label credentials.

Health and Clean Labels Drive Consumer Demand

Rising awareness of the health risks associated with excessive sugar intake is encouraging consumers to choose chocolates that offer both indulgence and nutritional value. Fruit-sweetened chocolates naturally contain fibre,

Driven by rising demand for healthier indulgence and clean-label products, the fruit-sweetened chocolate market is gaining momentum worldwide. By replacing refined sugar with naturally sweet ingredients such as dates, raisins, figs, apples, and bananas, manufacturers are creating chocolates that combine rich flavour with added nutritional benefits. Supported by continuous product innovation and growing consumer preference for natural ingredients, this emerging segment is poised to redefine the future of the global confectionery industry.

vitamins, minerals, and antioxidants, making them an attractive alternative to conventional sugar-based products. At the same time, clean-label trends continue to influence purchasing decisions, with consumers increasingly preferring products made with simple, recognisable ingredients and free from artificial additives.

The category also appeals to a wider audience by supporting vegan, gluten-free, and allergen-friendly formulations, enabling manufacturers to cater to diverse dietary preferences.

Innovation Expands Product Appeal

Product innovation remains a key growth driver for the market. Chocolate manufacturers are introducing new flavour profiles by combining premium cocoa with fruits such as figs, apples, bananas, and

raisins to create distinctive taste experiences. These innovations not only enhance flavour but also improve the nutritional profile of the products, allowing brands to differentiate themselves in an increasingly competitive confectionery landscape.

Challenges Remain

Despite its promising outlook, the fruit-sweetened chocolate segment faces several challenges. Fruit-based ingredients often increase production costs and may reduce shelf life compared to conventional chocolate formulations. Achieving the right balance between natural fruit sweetness and the characteristic cocoa flavour also requires careful product development. In addition, premium pricing may restrict wider adoption, particularly in price-sensitive markets.

Emerging Markets Present New Opportunities

The market offers significant opportunities as demand for healthier and functional confectionery continues to grow. Consumers seeking low-glycaemic and diabetic-friendly alternatives are creating new avenues for brands to position fruit-based sweeteners as natural substitutes for refined sugar. Emerging economies across Asia-Pacific, Latin America, and the Middle East are also expected to contribute to future growth, supported by rising disposable incomes, urbanisation, and increasing interest in premium food products.

Leading Industry Players

The competitive landscape features a mix of multinational confectionery companies and specialised premium brands, including:

- The Hershey Company
- Nestlé S.A.
- Mars, Incorporated
- Mondelez International
- Lindt & Sprüngli AG
- Barry Callebaut AG
- Chocolive
- Endangered Species Chocolate
- Alter Eco
- Hu Kitchen

Outlook

The future of the fruit-sweetened chocolate market appears highly promising as manufacturers continue to invest in natural sweeteners, sustainable sourcing, and functional ingredients. With consumers increasingly prioritising healthier indulgence without compromising on taste, fruit-sweetened chocolate is expected to move beyond a niche offering and become an important segment within the global confectionery industry.

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Cultivating the Future with Regenerative Agriculture...

With growing awareness around sustainable agriculture, clean-label foods, and ingredient transparency, Two Brothers Organic Farms has established itself as a leading force in India's regenerative food movement. From reviving heirloom grains and wood-pressed oils to building a global network of regenerative farmers, the company is redefining how food is grown, processed, and consumed. In an exclusive interaction with Food & Beverages Processing Magazine, Satyajit Hange, Co-founder & Farmer, Two Brothers Organic Farms, shares the brand's inspiring journey, its commitment to soil-first farming, product authenticity, transparency, sustainability, and the vision of building a regenerative food ecosystem for the future.

Two Brothers Organic Farms has built a strong reputation in the regenerative and clean food space. Could you take us through the company's journey, key milestones, and the vision behind the brand?

Two Brothers Organic Farms began when my brother Ajinkya and I left our corporate careers and returned to our ancestral farm - Bhodani in Maharashtra. What started as a personal effort to restore soil health soon evolved into a larger mission, to rebuild trust in the food system and demonstrate that farming can be both regenerative and economically viable.

Satyajit Hange, Co-founder & Farmer of Two Brothers Organic Farms

Over the years, we have grown from a single farm to a network of thousands of farmers, serving consumers in over 65 countries. Along the way, we have helped bring traditional Indian staples such as heirloom grains like A2 Cultured Ghee, Khapli atta, wood-pressed oils, and naturally processed jaggery back into mainstream conversations around nutrition and wellness.

A key milestone for us has been proving that consumers are willing to support products that prioritize transparency, traceability, and responsible farming. Our vision is to create a food ecosystem where healthy soil, farmer prosperity, and consumer well-being are interconnected. We believe the future of food lies not in producing more, but in producing better.

From ghee, oils, atta, spices, jaggery, and grains to wellness products, your portfolio is highly diversified. How do you maintain consistency, quality, and authenticity across such a broad range of products?

As the food industry scales, consistency often becomes a challenge. We address this by standardizing processes at the source rather than at the end of the supply chain. Every product category follows the same principles, regenerative cultivation, traditional processing methods, and end-to-end traceability.

Whether it's stone-ground atta or wood-pressed oils, our focus is on preserving the ingredient's natural nutritional profile. We further strengthen consumer trust through rigorous testing and certifications, including our recent Glyphosate Residue Free certification from The Detox Project which is a US based global certification body, it reflects our commitment to producing clean, responsibly grown food. This farm-to-

fork approach allows us to maintain quality, authenticity, and transparency across a diverse portfolio.

Regenerative agriculture is central to your philosophy. How does this farming approach create value for farmers, consumers, and the environment while ensuring long-term sustainability?

At its core, regenerative agriculture is about giving back more to the land than we take from it. For decades, agriculture has focused on extracting from the soil to maximize production. We chose a different path, one that treats soil as a living ecosystem. When the soil thrives, everything else follows: healthier crops, healthier animals, healthier people, and healthier communities.

For farmers, regenerative agriculture reduces dependence on expensive external inputs and helps build more resilient farms. For consumers, it provides access to food grown in living, biologically active soils rather than depleted land. For the environment, it improves biodiversity, enhances water retention, and helps restore natural ecosystems. We believe regenerative agriculture is not just a farming method; it is a long-term commitment to leaving the land healthier for the next generation than we found it.

Traceability and transparency have become important factors in consumer purchasing decisions. How does Two Brothers Organic Farms build trust and educate consumers about the origin and quality of its products?

We are seeing consumers move beyond simply looking for a 'clean' label. They increasingly want to know where their food comes from, who grew it, and how it was processed.

Our approach is to make the food journey visible. Today, nearly 20% of our portfolio is fully traceable to its source, allowing consumers to connect directly with the farms and farmers behind their food, and our goal is to eventually make 100% of our portfolio traceable. To support this, we have a dedicated team of 25 Farmer Relationship Managers who work closely with our farming partners, helping maintain quality standards, ensure adherence to regenerative practices, and strengthen transparency across the supply chain.

Through farmer stories, educational content, and traceability initiatives, we help consumers understand the connection between soil health, farming practices, and food quality. We believe the future of food lies not just in clean ingredients, but in creating a transparent ecosystem where consumers can confidently know the origin and journey of what they consume.

The company now works with thousands of farmers and serves customers across more than 60 countries. What have been the key drivers behind your domestic and international growth?

Our growth has been driven by three key factors: increasing awareness around food quality, rising demand for traceable and minimally processed products, and a growing global interest in traditional Indian foods.

Products such as heirloom grains like A2 Cultured Ghee, Khapli atta, wood-pressed oils, and naturally processed jaggery are finding relevance well beyond India as consumers increasingly seek foods that are traditionally made and minimally processed. There is a growing appreciation, both in India and overseas, for time-tested Indian food traditions and processing methods that prioritize quality over industrial efficiency. This shift has helped create demand for products rooted in authenticity and traditional wisdom. At the same time, our direct relationship with consumers has enabled us to scale while staying closely connected to evolving preferences and building trust over time.

Sustainability is increasingly shaping the future of the food industry. What initiatives has Two Brothers Organic Farms implemented to promote responsible farming, resource conservation, and environmentally conscious operations?

Sustainability is embedded in our operating model rather than treated as a separate initiative. At the farm level, we practice regenerative agriculture that improves soil fertility, supports biodiversity, and enhances

water retention. We do not use chemical fertilizers or synthetic pesticides, instead we use traditional, farm-made inputs such as Panchgavya and Dashparni, which help nourish crops while protecting soil and water ecosystems.

A key principle on our farms is that nothing should go to waste. Crop residue, cattle-based inputs, and other farm by-products are reused within the ecosystem, creating a circular model that minimizes waste and reduces dependence on external inputs. Equally important is farmer sustainability. A food system cannot be truly sustainable unless farming remains economically viable. Our efforts therefore focus on creating long-term value for both the environment and the farming communities that produce our food.

As consumer demand shifts toward clean-label, nutrient-dense, and minimally processed foods, what emerging trends are you observing, and how are they influencing your product development strategy?

One of the biggest shifts we are seeing is that consumers are becoming more interested in food provenance than ever before. They are asking not only what is in their food, but also how it was grown and processed. There is also renewed interest in traditional ingredients, healthy fats, heirloom grains, and minimally processed staples. Our product strategy is shaped by these trends, we focus on reviving nutrient-rich foods rooted in India's agricultural heritage while making them relevant for today's consumer.

Following your recent funding and expansion efforts, what are your key priorities for the future, and how do you see the regenerative food movement evolving in the coming years?

Our immediate priorities are expanding our manufacturing capabilities, onboarding more farmers into the regenerative agriculture ecosystem, and strengthening our presence in international markets. The recent funding will help us scale these efforts while staying committed to our soil-first philosophy and maintaining the quality and transparency that consumers expect from us.

Looking ahead, I believe regenerative food will move from a niche category to a mainstream expectation. Consumers are increasingly connecting food quality with soil health, environmental impact, and farmer livelihoods. As this awareness grows, the industry will place greater emphasis on transparency, traceability, and measurable impact, reshaping the future of food.

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Premium Milling Meets Consumer Demand: The Expanding 00 Flour Market



Fueled by viral pizza-dough tutorials, gluten-conscious eating, and a booming artisanal bakery scene, the global 00 flour market is on track to grow from USD 1.4 billion in 2025 to USD 1.7 billion by 2034, expanding at a 4.11% CAGR. Once a niche ingredient reserved for Italian pizzerias and professional pasta makers, 00 flour has become one of the fastest-growing specialty categories on grocery shelves. According to Polaris Market Research, the 00 Flour Market Size, Demand & Growth, Global Report, 2025–2034 maps out exactly how culinary trends, health-driven food choices, and shifting retail habits are converging to reshape this corner of the food ingredients industry.

Why 00 Flour Is Having a Moment

Milled from soft wheat to an ultra-fine, silky texture, 00 flour has long been prized by chefs for its ability to create the stretchy, blistered crust associated with authentic Neapolitan pizza. Today, that same appeal is drawing in home cooks, retailers, and ingredient manufacturers alike, for a few clear reasons.

Home baking has gone mainstream — and social. Consumers are increasingly recreating restaurant-style dishes in their own kitchens, driven in large part by food content on platforms like Instagram and TikTok. Gen Z, which accounts for roughly one-fifth of the U.S. population and forms the backbone of food-focused social media, engages with this content at a remarkably high rate, turning pizza-dough stretches and pasta-rolling videos into genuine purchase drivers for premium flour brands.

Pizza demand keeps climbing. The scale of pizza consumption in the U.S. alone is staggering — more than 3 billion pizzas sold annually, equal to about 350 slices every second — and pizzerias now make up close to 17% of all American restaurants, a segment that grew roughly 2.3% year-over-year to surpass 78,000 locations. Every one of those

kitchens needs a reliable, high-performance flour supply, and 00 flour remains the benchmark for texture and consistency.

Dietary and wellness trends are reinforcing demand. 00 flour's comparatively lower gluten content and smooth consistency appeal to gluten-sensitive consumers, while the broader revival of ancient grains — spelt, einkorn, and emmer — has inspired a new generation of 00-style blends marketed on tradition and nutrition. This aligns closely with rising interest in the Mediterranean diet, which favors whole, minimally processed grains. Awareness and shelf life remain hurdles. The report notes that many consumers still don't understand what sets 00 flour apart from standard all-purpose flour, and its shorter shelf life compared to heavily processed alternatives can discourage first-time buyers. Closing that education gap is likely to be a key differentiator for brands competing in this space.

Breaking Down the Market by Segment

The Polaris analysis segments the market across ingredient type, application, distribution channel, and geography, revealing where the sharpest growth is concentrated.

- **Ingredient type:** Soft wheat 00 flour holds the largest share today thanks to its strong gluten development and elasticity, essential for classic Italian doughs. Whole wheat 00 flour, however, is the fastest-growing sub-segment as shoppers gravitate toward whole-grain nutrition claims.
- **Application:** Pizza dough dominates end-use demand, a direct reflection of the global surge in Neapolitan-style pizza-making, both in commercial kitchens and home ovens.
- **Sales channel:** B2B currently leads, powered by the expanding foodservice and pizzeria sector, while B2C is

projected to be the fastest-growing channel as e-commerce and specialty grocery expansion put premium milled flour within easy reach of everyday consumers.

- **Region:** North America leads the global market on the strength of its pizza culture and artisanal baking community, while Asia Pacific is set to post the fastest regional growth as Western-style cuisine, urbanization, and rising incomes drive new consumption patterns.

Who's Competing and How

The competitive field blends legacy Italian milling houses with major global food manufacturers, including Antimo Caputo, Bob's Red Mill, Casillo, Central Milling, King Arthur Flour, La Molisana, Mulino Marino, Pivetti, and Shipton Mill. Many of these companies are actively pursuing partnerships, acquisitions, and geographic expansion to capture a larger share of the growing category.

Large packaged-food players are entering the space too. The J.M. Smucker Company recently extended its Robin Hood brand with a 00-style pizza flour built for artisan bread, focaccia, and ciabatta baking, while ADM broadened its HarvestEdge line with a premium pizza-flour offering designed to help foodservice operators build customized blends. These launches suggest that 00 flour has graduated from artisanal curiosity to a genuine strategic priority for major ingredient suppliers.

Strategic Takeaways for the Industry

For millers, ingredient suppliers, and foodservice brands, the message from this data is clear: differentiation and education will matter more than raw production scale. Consumers are willing to pay a premium for authenticity and performance, but only once they understand what that premium buys them — meaning packaging, marketing, and in-store education are just as critical as sourcing high-quality wheat.

On the supply side, foodservice remains the anchor of demand, so consistent quality and dependable logistics for pizzerias, bakeries, and restaurants will continue to underpin most volume, even as retail and e-commerce channels open new growth avenues. With a steady, sustainable CAGR rather than a speculative spike, 00 flour looks positioned as a durable, long-term category rather than a passing trend — a strong argument for stakeholders to invest now in regional distribution, product innovation, and consumer-facing storytelling.

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CAVIAR - A Novel Food in Nutrition: A Superfood for the Future

¹Dr. G. Pandidurai and ²Mrs. S.Kokila Vani



Introduction

In today's rapidly evolving food landscape, consumers are no longer satisfied with foods that merely fill the stomach—they seek foods that nourish, protect, and enhance overall health. This shift has led to the growing popularity of functional and novel foods, which provide benefits beyond basic nutrition. Among such emerging foods, caviar stands out as a unique and highly valuable dietary component.

Traditionally regarded as a symbol of luxury and exclusivity, caviar is now being rediscovered through a scientific lens for its remarkable nutritional density and bioactive properties. As global concerns about malnutrition, lifestyle diseases, and sustainable food systems intensify, caviar is increasingly being recognized not just as a delicacy, but as a future-ready superfood with immense health potential.

What is Caviar?

Caviar refers to the processed and salted roe (eggs) of fish, primarily obtained from sturgeon species. These eggs are carefully

harvested and minimally processed to preserve their delicate texture, flavor and nutritional integrity. The uniqueness of caviar lies in its combination of sensory appeal and exceptional nutrient concentration.

Over time, the concept of caviar has expanded beyond traditional sturgeon sources. Today, a wide variety of caviar substitutes, including those derived from salmon, trout, and even plant-based ingredients, are available in the market. This diversification has not only increased accessibility but also opened new avenues for innovation in food science and nutrition.

The availability of substitutes has made caviar

more accessible, opening doors for small-scale enterprises and rural processing units.

Nutritional Composition of Caviar

One of the most striking features of caviar is its extraordinary nutritional profile, making it one of the most nutrient-dense foods available. Unlike many conventional foods, caviar delivers a high concentration of essential nutrients in a very small quantity, making it highly efficient as a dietary supplement.

It is particularly rich in high-quality proteins, which contain all essential amino acids required for body growth and repair. In addition, caviar is an excellent source of omega-3 fatty acids (EPA and DHA), which play a vital role in maintaining heart and brain health. The presence of vitamins such as A, D, E, and B12, along with minerals like iron, calcium, and selenium, further enhances its nutritional significance. This combination positions caviar as a complete and balanced nutritional package.

Caviar is a compact source of essential nutrients, delivering high nutritional value even in small servings. This clearly shows that caviar provides superior nutritional benefits in smaller quantities, making it ideal for specialized diets.

Health Benefits of Caviar

The health benefits of caviar extend far beyond its basic nutritional value, largely

MAJOR TYPES OF CAVIAR AND THEIR CHARACTERISTICS					
Type	BELUGA	OSETRA	SEVRUGA	SALMON ROE	TROUT ROE
Source	Sturgeon	Sturgeon	Sturgeon	Salmon	Trout
Color	Grey	Brown	Black	Orange	Orange-red
Market Value	Very High	High	Medium	Moderate	Moderate
Key Feature	Soft texture	Nutty flavor	Strong taste	Rich in omega-3	Mild taste

Table: Major Types of Caviar and Their Characteristics

due to its bioactive compounds and essential fatty acids. Regular consumption, even in small amounts, can contribute significantly to overall well-being.

Caviar plays an important role in cardiovascular health, as its omega-3 fatty acids help reduce harmful cholesterol levels, improve blood circulation, and minimize the risk of heart diseases. At the same time, it supports brain function and cognitive development, making it particularly beneficial for growing children and aging populations.

Furthermore, the vitamins and antioxidants present in caviar help strengthen the immune system, enabling the body to resist infections more effectively. Its role in skin health and anti-aging is also noteworthy, as it promotes hydration, elasticity, and cellular regeneration. Altogether, these benefits establish caviar as a functional food with therapeutic potential.

Caviar as a Functional and Novel Food

In modern nutritional science, caviar is increasingly classified as a functional food, meaning it offers health benefits beyond basic nourishment. Its unique composition of bioactive compounds contributes to disease prevention, metabolic regulation, and improved physiological functions.

As a novel food, caviar represents innovation in dietary practices, combining traditional knowledge with modern scientific understanding. Its high nutrient bioavailability ensures that the body can efficiently absorb and utilize its components. This makes caviar particularly suitable for inclusion in specialized diets, nutraceutical formulations, and advanced food systems aimed at improving human health.

Production and Processing of Caviar

The production of caviar involves a series of carefully controlled processes to ensure quality, safety, and preservation of nutrients. From harvesting the roe to cleaning, grading, salting, and packaging, each step is carried out with precision to maintain its premium characteristics.

Minimal processing techniques are typically used to retain the natural flavor, texture, and nutritional value of the eggs. The salting process not only enhances taste but also acts as a natural preservative. Advances in processing technologies are further improving the efficiency and hygiene standards of caviar production, making it safer and more widely available.

Caviar Substitutes and Alternatives

Due to the high cost and limited availability of traditional caviar, various substitutes and

Component	Quantity	Health Role
Protein	25 g	Tissue repair, growth
Fat	17 g	Energy source
Omega-3	4 g	Heart & brain health
Vitamin B12	20 µg	Nerve function
Iron	11 mg	Hemoglobin formation
Calcium	275 mg	Bone strength

Table: Nutritional Profile of Caviar (per 100 g)

Food	Protein (g)	Omega-3 (g)	Special Feature
Caviar	25	4	High nutrient density
Egg	13	0.1	Easily available
Milk	3.4	0.05	Calcium-rich
Chicken	27	0.2	Lean protein

Table: Comparison with Other Protein Foods

Health Benefit	Key Nutrient	Impact
Heart health	Omega-3	Reduces cholesterol
Brain function	DHA	Improves memory
Immunity	Vitamins A & E	Disease resistance
Skin health	Antioxidants	Anti-aging
Bone strength	Calcium	Prevents osteoporosis

Table: Health Benefits and Nutrients Responsible

“Caviar is particularly rich in high-quality proteins, which contain all essential amino acids required for body growth and repair. In addition, caviar is an excellent source of omega-3 fatty acids (EPA and DHA), which play a vital role in maintaining heart and brain health. The presence of vitamins such as A, D, E, and B12, along with minerals like iron, calcium, and selenium, further enhances its nutritional significance. This combination positions caviar as a complete and balanced nutritional package.

alternatives have been developed. These include fish roe from species such as salmon, trout, and lumpfish, as well as innovative plant-based caviar made from seaweed and algae.

These alternatives offer several advantages, including affordability, sustainability, and wider accessibility. While they may differ slightly in taste and texture, many substitutes retain similar nutritional benefits, particularly in terms of omega-3 content. As a result, they play a crucial role in democratizing access to this otherwise exclusive food.

Sustainability and Environmental Concerns

One of the major challenges associated with traditional caviar production is the overexploitation of sturgeon species, many of which are now endangered. This has raised serious environmental and ethical concerns, prompting the need for more sustainable practices.

To address these issues, the industry is increasingly adopting aquaculture systems, which allow controlled and responsible fish farming. Additionally, the development of substitutes and strict regulatory measures are helping reduce pressure on natural fish populations. Sustainable production practices are essential to ensure that caviar remains a viable food resource for future generations.

Role of Caviar in Future Nutrition

As the global population continues to grow, the demand for nutrient-rich and sustainable food sources is becoming more critical. In this context, caviar holds significant promise due to its high nutrient density, compact form, and versatility.

It has potential applications in clinical nutrition, nutraceuticals, space food systems, and high-performance diets. Its ability to deliver essential nutrients in small quantities makes it particularly useful in situations where space, weight, or intake capacity is



limited. Thus, caviar is not only relevant today but is also poised to become an integral part of future food systems.

Economic and Market Potential

The global market for caviar is expanding steadily, driven by increasing awareness of its health benefits and nutritional value. Advances in aquaculture and food processing technologies are making production more efficient and cost-effective. This growth presents significant opportunities for entrepreneurs, food industries, and export markets. As demand continues to rise, caviar is expected to transition from a niche luxury product to a more widely consumed functional food commodity.

Conclusion

Caviar represents a remarkable blend of tradition, nutrition, and innovation. Once considered a luxury reserved for a select few, it is now gaining recognition as a powerful superfood with far-reaching health benefits. Its rich composition of proteins, omega-3 fatty acids, vitamins, and minerals makes it an ideal candidate for addressing modern nutritional challenges. With continued advancements in sustainable production and increased accessibility, caviar and its alternatives are set to play a vital role in shaping the future of global nutrition and food security.

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Cashew Apple: A Nutritious Resource with High Value Addition Potential for Farmers

Dr. M. J. Anitha Sri¹, Dr. M. Prabhu² and Dr. K. P. Saravanan³



Turning an underutilized farm by-product into health, income and enterprise opportunity

India is one of the world's leading producers of Cashew. While the cashew nut receives high market value and attention, the cashew apple, which develops along with the nut, often remains neglected in many production areas. In most orchards, large quantities of cashew apples fall to the ground and go unused despite their rich nutritional value and excellent processing potential.

Cashew apple is highly juicy, aromatic and rich in vitamins. It can be processed into several value-added products, especially juice, creating additional income opportunities for farmers, women self-help groups and village entrepreneurs. Proper utilization of cashew apple can convert what is often considered waste into a profitable product.

Scenario of Cashew Apple production

India is among the major cashew-growing countries of the world. Important cashew-growing states include Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra, Andhra Pradesh and Odisha.

According to the Government of India (2025), India's cashew production increased from 840 thousand tonnes in 2023 – 24 to 910 thousand tonnes in 2024 – 25, marking a 9% annual growth and it is estimated to be around 925,000 to 980,000 tons in 2026. India produces over 6 million tonnes of cashew apples annually, but less than (10%) is commercially utilized. While the fruit is

highly nutritious rich in vitamin C over (90%) goes to waste due to its extreme perishability and historical focus strictly on the cashew nut. This represents a major opportunity for farm-level value addition.

There is an ever-increasing demand for cashew kernels both in the international market and in the domestic market. The industry faces challenges such as reliance on imported raw cashew nuts to meet demand. Government initiatives under MIDH and RKVY aim to boost production through expanded cultivation and high-yield variety adoption across traditional and non-traditional states.

Health Benefits of Cashew Apple Juice

- Rich Source of Vitamin C
- Builds Natural Immunity
- Improves Digestion
- Good for Hydration
- Rich in Antioxidants
- Helps Reduce Food Waste

Value Addition Opportunities from Cashew Apple

Cashew apple offers wide scope for diversification beyond fresh juice.

Value Added Products

Beverages

- fresh juice
- squash
- syrup
- RTS (ready-to-serve drink)
- nectar
- blended fruit beverages

Nutritional Importance of Cashew Apple Juice

The nutritional composition of fresh cashew apple can vary slightly depending on the ripeness, variety (yellow, orange, or red), and soil. Typical values include:

Nutrient	Approximate amount
Energy / Calories	40 – 52 Kcal
Moisture	85 – 88 g
Carbohydrates	8.0 - 10.5 g
Dietary Fiber	1.0 - 2.0 g
Protein	0.5 – 1.0 g
Fat	0.1 – 0.3 g
Vitamin C (Ascorbic Acid)	150 – 260 mg
Calcium	15 – 25 mg
Phosphorus	10 – 20 mg
Iron	0.2 – 0.6 mg
Potassium	120 – 150 mg

Cashew apple juice is highly nutritious and refreshing. It is particularly known for having very high Vitamin C, often several times higher than many common fruits like citrus family.

Traditional Products

- jam
- jelly
- chutney
- pickle

Processed Products

- candy
- dehydrated slices
- fruit leather

Fermented Products

- vinegar
- wine
- fermented beverages

By-products

- animal feed from residue
- compost from processing waste

Consumption Pattern in India

Consumption of cashew apple juice in India is increasing due to growing awareness about natural beverages and healthy foods.

It is consumed as:

- fresh juice
- chilled beverage
- health drink
- blended fruit juice
- fermented beverage
- syrup-based drink



Cashew apple juice has strong acceptance among consumers when processed properly with reduced astringency and improved flavour.

Demand is growing in:

- local markets
- health food outlets
- tourism centers
- agro fairs
- exhibitions
- farm producer retail outlets
- supermarkets

Income Opportunity for Farmers and Rural Enterprises

Cashew apple processing creates excellent opportunities for

- individual farmers
- rural youth
- women self-help groups
- farmer producer organizations
- village-level food processing units

Instead of allowing apples to spoil in the orchard, they can be converted into marketable products with higher returns.

Benefits to Farmers

- additional income from orchard produces
- better use of available farm resources
- reduced wastage during harvest
- employment generation in rural areas
- women-led enterprise development
- local nutrition improvement

Scope for Tamil Nadu Farmers

In Tamil Nadu, cashew-growing belts have strong potential for small-scale cashew apple processing. Village-based units can process fresh fruits into juice and other products during harvest season and market them through:

- local weekly markets
- KVK exhibitions

- farmer producer organizations
- cooperative outlets
- schools and nutrition programmes
- local food festivals

With proper training in hygienic processing, packaging and branding, cashew apple products can become a profitable micro-enterprise.

Conclusion

Cashew apple is a valuable yet underutilized gift from the cashew orchard. Though often discarded after nut harvest, it has enormous nutritional and economic potential. By promoting cashew apple juice production and value addition, farmers can generate additional income, reduce wastage, improve rural nutrition and create village-based enterprises.

"Use the Nut for Market Value...
Use the Apple for Nutrition and Added Income."

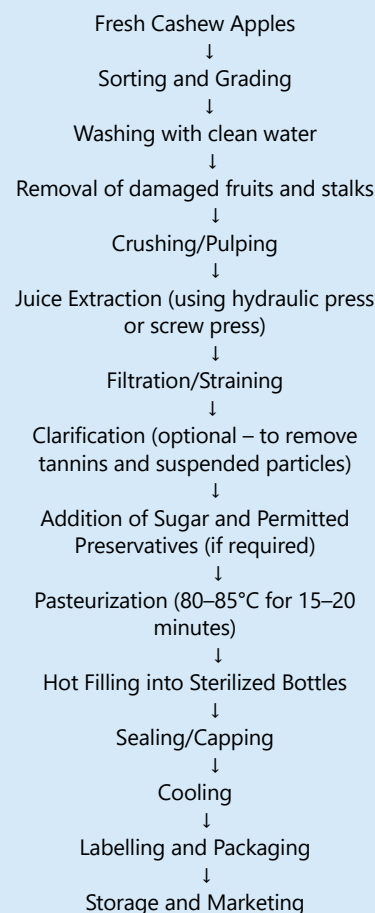
Author's Bio

1,2Subject Matter Specialist and 3Associate Professor

Cashew Apple Juice Production

Cashew apple juice preparation can be done at household level, SHG level or small-scale processing unit level.

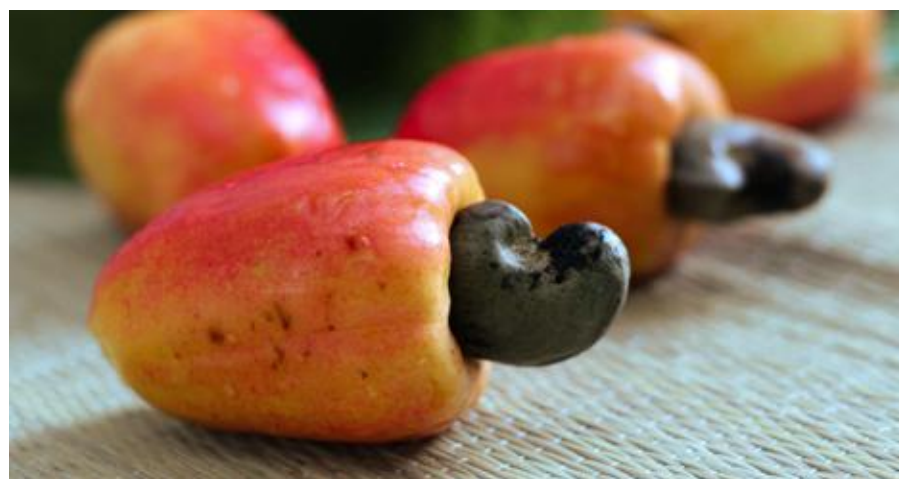
Cashew Apple Juice Processing Flow Chart



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Next-Generation Probiotics (NGPs)

Dr. Loveleen Sarao, Sydney, Australia

Next-generation probiotics (NGPs) represent a fundamental shift in microbiome science—moving away from general digestive support toward precision medicine. Unlike traditional probiotics (e.g., *Lactobacillus*), which are often sourced from fermented foods, NGPs are typically human commensal bacteria naturally resident in a healthy gut. These "keystone" species are being developed as Live Biotherapeutic Products (LBPs) to target specific chronic conditions, including obesity, inflammatory bowel disease (IBD), and even neurological disorders.

Traditional vs. Next-Generation Probiotics

The distinction lies in their origin, function, and regulatory status.

- **Source:** Traditional probiotics are largely lactic acid bacteria (LAB) from dairy or plants. NGPs are "indigenous" to the human gut, often identified through advanced metagenomic sequencing.
- **Targeting:** Conventional strains offer broad benefits like "supporting digestive balance". NGPs are tailored for specific metabolic or immune pathways, such as modulating the gut-brain axis or enhancing the gut barrier.
- **Regulation:** While many traditional strains are "Generally Recognized as Safe" (GRAS) for food, NGPs often follow a pharmaceutical track, requiring rigorous clinical trials to be classified as drugs.

Major Next-Generation Candidates

Current research focuses on a few high-impact "super-bugs" that naturally populate a healthy human microbiome.

The global probiotics market is projected to surpass \$105 billion by 2029. While traditional brands like Life-Space and Spectrumceuticals continue to dominate the broad-spectrum market, the "Next Gen" sector is moving toward personalized probiotics. Future consumers may use home microbiome testing kits to identify which specific NGP strains they lack and receive a customized formulation.

***Akkermansia muciniphila*: The Weight & Barrier Specialist**

Often called a "keystone strain," *Akkermansia* makes up 1–5% of the healthy adult gut.

- **Mechanism:** It lives in and consumes the gut's mucus layer. This process signals the body to produce more mucus, effectively thickening the gut lining and preventing "leaky gut".
- **Metabolic Impact:** High levels are associated with a leaner body mass and better insulin sensitivity. It may also stimulate GLP-1 production, the same hormone targeted by modern weight-loss drugs.
- **Commercial Status:** Companies like Pendulum Therapeutics have commercialized *Akkermansia* after solving the challenge of growing it in oxygen-free environments.

***Faecalibacterium prausnitzii*: The Anti-Inflammatory Powerhouse**

One of the most abundant bacteria in the healthy colon, its depletion is a hallmark of Crohn's disease and ulcerative colitis.

- **Mechanism:** It is a prolific producer of butyrate, a short-chain fatty acid that serves as the primary energy source for

colon cells and exerts powerful anti-inflammatory effects.

- **Therapeutic Potential:** Research indicates it can block pro-inflammatory messengers (like IL-8) and induce anti-inflammatory responses (like IL-10).

***Christensenella minuta*: The "Lean" Microbe**

- **Discovery:** Identified as one of the most heritable microbes in the human gut.
- **Potential:** It is strongly linked to lower body mass index (BMI) and healthy metabolic profiles. Supplementation in animal models has been shown to protect against weight gain.

Emerging Therapeutic Frontiers

Research is expanding beyond the gut to address systemic health.

- **Gut-Brain Axis:** Strains like *Bacteroides fragilis* and *Akkermansia* are being studied for their ability to produce neuroactive substances that may impact Alzheimer's, Parkinson's, and depression.
- **Immuno-Oncology:** Some NGPs, including *F. prausnitzii*, may enhance the efficacy of certain cancer treatments, such as immune checkpoint inhibitors, by priming the immune system.

Technical and Regulatory Challenges

Despite their potential, NGPs face significant hurdles before widespread use.

- **Survival:** Most NGPs are obligate anaerobes, meaning they die instantly if exposed to even trace amounts of oxygen. Manufacturing shelf-stable versions requires specialized anaerobic fermentation and advanced microencapsulation.
- **Safety & Standardization:** Because many of these strains have no history of use in the food supply, regulators (like the FDA or EFSA) require extensive safety data, including whole-genome sequencing to ensure they don't carry antibiotic-resistance genes.

Market Outlook for 2026 and Beyond

The global probiotics market is projected to surpass \$105 billion by 2029. While traditional brands like Life-Space and Spectrumceuticals continue to dominate the broad-spectrum market, the "Next Gen" sector is moving toward personalized probiotics. Future consumers may use home microbiome testing kits to identify which specific NGP strains they lack and receive a customized formulation.

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Smart Food Preservation: How Digital Technologies are Transforming Spoilage Prevention

Ritesh Verma



Introduction

Food spoilage remains one of the biggest challenges confronting the global food and beverage industry. Despite remarkable advances in food production and processing, nearly one-third of all food produced worldwide is still lost or wasted every year. Much of this loss occurs because of inadequate storage, temperature fluctuations, inefficient logistics, poor inventory management, and limited visibility across increasingly complex supply chains. Beyond the enormous economic cost, food spoilage also contributes to greenhouse gas emissions, excessive water consumption, and the unnecessary depletion of natural resources.

Today, preserving food is no longer limited to refrigeration, freezing, or conventional packaging. It has evolved into a technology-driven process where food quality can be monitored continuously throughout its journey from the processing plant to warehouses, distribution centres, retail shelves, and finally to consumers. The growing adoption of digital technologies is enabling food companies to detect potential risks much earlier, extend product shelf life, improve operational efficiency, and significantly reduce food waste.

Technologies such as the Internet of Things

(IoT), artificial intelligence (AI), blockchain, smart packaging, predictive analytics, and robotics are changing the way food quality is managed. Rather than reacting after spoilage has occurred, businesses can now predict quality deterioration and intervene before products are compromised. As supply chains become longer and consumer expectations for freshness and transparency continue to increase, these technologies are rapidly becoming essential investments for the modern food industry.

The Rising Cost of Food Spoilage

Food spoilage affects every stage of the supply chain, beginning with harvesting and processing and continuing through packaging, transportation, warehousing, retail, and even household consumption. Highly perishable products such as dairy, meat, poultry, seafood, fresh fruits, vegetables, bakery products, and ready-to-eat meals are particularly susceptible to spoilage because of their sensitivity to environmental conditions.

The consequences extend far beyond discarded food. Every spoiled product represents wasted raw materials, labour, packaging, transportation, energy, and storage costs. It also affects customer satisfaction, brand reputation, regulatory compliance, and overall business profitability. As food products increasingly travel across countries and continents before reaching consumers, maintaining consistent quality throughout the supply chain has become more challenging than ever.

To address these issues, companies are investing in technologies that provide real-time visibility into storage conditions, transportation environments, and inventory movement, enabling them to identify risks before spoilage occurs.

IoT Enables Continuous Monitoring

Among the many technologies reshaping food preservation, the Internet of Things has emerged as one of the most impactful. IoT connects sensors, refrigeration systems, transport vehicles, warehouses, and cloud platforms to create an intelligent monitoring network capable of tracking food quality around the clock.

Temperature and humidity sensors continuously monitor environmental

conditions during storage and transportation. If temperatures exceed acceptable limits or humidity levels fluctuate unexpectedly, automated alerts allow operators to take immediate corrective action before product quality deteriorates. This technology is especially valuable for cold chain-dependent industries such as dairy, frozen foods, seafood, pharmaceuticals, and fresh produce. Refrigerated vehicles equipped with IoT systems can transmit live information on cargo conditions throughout transit, while smart warehouses use connected sensors to regulate temperature, humidity, airflow, and energy consumption more efficiently.

Cloud-based monitoring platforms further improve supply chain visibility by allowing manufacturers, logistics providers, and retailers to access real-time information from any location. This enables faster decision-making and reduces uncertainty across the entire distribution network.

Artificial Intelligence Brings Predictive Capabilities

While IoT provides continuous monitoring, artificial intelligence helps businesses anticipate future risks. AI systems analyse vast amounts of historical and real-time data to identify patterns associated with food spoilage and recommend preventive actions. Predictive analytics allows companies to estimate remaining shelf life by evaluating multiple variables, including storage conditions, transportation delays, packaging integrity, microbial growth patterns, and environmental fluctuations. This enables manufacturers and distributors to prioritise shipments, optimise inventory movement, and reduce unnecessary waste.

Retailers are increasingly relying on AI-powered inventory management systems to improve demand forecasting and stock rotation. Better forecasting reduces overproduction, minimises excess inventory, and decreases the likelihood of products expiring before they are sold.

Another growing application is computer vision. AI-enabled cameras installed in food processing plants can automatically detect defects such as bruising, mould formation, discoloration, texture changes, or damaged packaging with greater consistency than manual inspections. Similarly, machine learning algorithms can predict refrigeration

equipment failures before they occur, allowing preventive maintenance that helps avoid spoilage caused by cooling system breakdowns.

Smart Packaging Is Becoming More Intelligent

Packaging has evolved far beyond its traditional protective role. Today's smart packaging solutions actively monitor product quality while providing valuable information to manufacturers, retailers, and consumers.

Several intelligent packaging technologies are gaining widespread adoption, including:

- Time-temperature indicators that change colour when products are exposed to unsafe temperatures.
- Gas sensors capable of detecting spoilage-related gases such as carbon dioxide, ammonia, and hydrogen sulphide.
- Antimicrobial packaging materials that inhibit bacterial and fungal growth, helping extend product shelf life.
- QR-code-enabled labels that provide consumers with information about product origin, freshness, storage conditions, and sustainability credentials.

These innovations not only improve food safety but also strengthen consumer confidence by increasing transparency throughout the supply chain.

Blockchain Improves Traceability

As food supply chains become increasingly global, traceability has become a critical component of food preservation and safety. Blockchain technology offers a secure and tamper-resistant digital record of every transaction and movement throughout the supply chain. Each stage of production, processing, transportation, and distribution is permanently recorded, allowing stakeholders to verify product history quickly and accurately. When integrated with IoT sensors, blockchain can also document storage temperatures, humidity levels, and handling conditions throughout transportation.

In the event of contamination or spoilage, blockchain enables companies to identify affected batches within minutes rather than days. Faster traceability reduces the scale of product recalls, minimises waste, and enhances consumer safety. Consumers also benefit from greater transparency by being able to verify product origins and sourcing practices through mobile applications.

Cold Chain Technologies Continue to Advance

Maintaining uninterrupted cold chain integrity remains one of the most effective

methods for preserving food quality. Recent innovations are making refrigerated storage and transportation more reliable and energy efficient.

Modern cold chain systems now incorporate GPS-enabled fleet tracking, AI-powered route optimisation, automated temperature control, and predictive maintenance capabilities. These technologies help maintain stable storage conditions while reducing transportation delays and equipment failures.

Advanced insulation materials and phase-change technologies are also improving temperature stability, particularly during last-mile delivery and e-commerce distribution. Automated cold storage facilities equipped with robotics further reduce manual handling while maintaining consistent environmental conditions that extend product shelf life.

Automation Reduces Human Error

Automation is becoming increasingly important in food processing and warehousing, where speed, precision, and hygiene directly influence product quality. Robotic systems are now widely used for sorting, grading, packaging, palletising, and warehouse operations. By reducing manual handling, automation lowers contamination risks while improving consistency and productivity. Autonomous mobile robots help move products efficiently through warehouses while preserving cold chain conditions. Automated cleaning and sanitation systems further enhance food safety by maintaining hygienic processing environments and ensuring compliance with regulatory standards.

Driving Sustainability Through Smart Preservation

Reducing food spoilage has become a sustainability priority as well as a business necessity. Every kilogram of food saved translates into lower greenhouse gas emissions, reduced water consumption, and more efficient use of agricultural resources.

Smart preservation technologies contribute to sustainability in several ways:

- Reducing food waste through continuous quality monitoring.
- Improving inventory management and demand forecasting.
- Lowering energy consumption with intelligent refrigeration systems.
- Minimising overproduction by aligning production with actual market demand.
- Supporting circular economy initiatives by extending product shelf life.

Together, these technologies help companies achieve both operational efficiency and

environmental responsibility.

Challenges and the Road Ahead

Despite the significant benefits, widespread adoption of smart preservation technologies still faces several obstacles. High implementation costs, infrastructure limitations, cybersecurity concerns, and the lack of digital expertise continue to challenge many food businesses, particularly small and medium-sized enterprises. Another key challenge is integrating data across multiple stakeholders within the supply chain. Sensors, software platforms, logistics providers, manufacturers, and retailers must be able to communicate seamlessly for these technologies to deliver their full value.

However, rapid technological advancement and declining hardware costs are making digital solutions increasingly accessible. Governments and industry organisations are also encouraging digital transformation through food safety and sustainability initiatives.

Looking ahead, emerging innovations such as digital twins, nanotechnology-based biosensors, autonomous delivery systems, and next-generation AI are expected to further transform food preservation by enabling even more precise monitoring and predictive capabilities.

Conclusion

The future of food preservation is becoming increasingly intelligent, connected, and data driven. Digital technologies are enabling food companies to move beyond traditional quality inspections towards continuous monitoring, predictive decision-making, and real-time supply chain visibility.

IoT, artificial intelligence, blockchain, smart packaging, automation, and advanced cold chain solutions are helping businesses reduce spoilage, improve food safety, enhance operational efficiency, and minimise environmental impact. As consumer expectations continue to evolve and global supply chains become more complex, these technologies will play an increasingly important role in ensuring that food reaches consumers fresher, safer, and with less waste. For the food and beverage industry, investing in smart preservation technologies is no longer simply about reducing losses. It is about building a more resilient, transparent, and sustainable food system capable of meeting the demands of the future.

Mr. Verma is a freelance writer with over 10 years of experience in delivering high-quality content to the industry

Corbion launches LUMI™ Set to help bakers reformulate away from titanium dioxide without sacrificing visual appeal



Regulatory and customer pressure around titanium dioxide (TiO₂) is accelerating across the United States. Multiple states have passed or are advancing legislation that could restrict the ingredient in certain food applications or channels, and restrictions on its use in products sold in retail, CPG, and school food channels are growing. For commercial bakers who rely on titanium dioxide to support the finished appearance of baked-good icings, this is creating real urgency. Many are already looking for viable reformulation options.

Corbion has developed a direct answer to that challenge: LUMI Set, a new boil-up type icing stabilizer for water-based icings that contains no titanium dioxide. LUMI Set is a versatile solution for thick icings and string icings. It supports excellent visual appeal across a range of sweet baked-good applic-

ations without relying on titanium dioxide. Bakers can maintain the finished appearance their customers expect, while meeting the requirements of a changing regulatory environment. LUMI Set was developed by Corbion's formulation scientists to support the texture, stability, and application performance bakers depend on in water-based icings.

The launch of LUMI Set reflects Corbion's broader commitment to helping bakers solve real formulation challenges without having to choose between compliance and quality. As ingredient regulations continue to shift, bakers need partners that can move with them, providing practical solutions that work in real production environments.

"Titanium dioxide restrictions are creating real urgency for bakers, and we designed LUMI Set to give them a clear path forward," said Abby Ceule, Vice President, Functional Systems at Corbion. "This isn't just about compliance; it's about making sure bakers can maintain the visual quality their customers expect while keeping pace with a regulatory landscape that's changing fast."

LUMI Set is now available through Corbion's bakery solutions portfolio. For more information or to request a sample, contact your Corbion representative or visit www.corbion.com.

tified vegan products, make informed purchasing decisions, and place greater trust in manufacturers' vegan claims. The move is also expected to bring greater consistency to product labeling while reducing confusion arising from varying packaging practices adopted by different brands.

To ensure uniform implementation across the industry, FSSAI has laid down detailed specifications covering the logo's design, dimensions, colour, and placement on food packaging. Manufacturers will be required to follow these specifications once their products receive approval under the Vegan Foods Regulations. The standardized labeling framework is expected to benefit consumers, food businesses, retailers, and regulatory authorities alike by creating a common visual identity for vegan products throughout the country.

The amendment follows an extensive consultation process that began in December 2022, when FSSAI issued a draft notification inviting comments, objections, and suggestions from industry stakeholders and the public over a 60-day period. After reviewing the feedback received, the authority finalized the amendments to the Vegan Foods Regulations, 2022, resulting in the current notification. The regulation has been signed by Rajit Punhani, Chief Executive Officer of FSSAI, and reflects the regulator's ongoing efforts to strengthen transparency and standardize food labeling practices in line with the evolving needs of the market.

Alongside the vegan labeling amendment, FSSAI has also issued an important advisory regarding the use of Ashwagandha (*Withania somnifera*) in food products. Referring to the Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations, 2016, the authority reiterated that only Ashwagandha roots and their extracts are approved for use in health supplements, nutraceuticals, and specialized dietary products, subject to the prescribed limits.

FSSAI Introduces Mandatory Vegan Logo Norms for Food Products, Effective July 2027



The Food Safety and Standards Authority of India (FSSAI) has taken another significant step toward strengthening India's food regulatory framework by introducing mandatory vegan logo requirements for all approved vegan food products while also issuing a clarification on the permitted use of Ashwagandha in food formulations. The two regulatory updates reinforce the authority's focus on improving labeling standards, ensuring in-

gredient compliance, and enhancing consumer confidence across the country's rapidly growing food and nutraceutical sectors.

Under the Food Safety and Standards (Vegan Foods) Amendment Regulations, 2026, every approved vegan food product sold in India will be required to prominently display a standardized green "VEGAN" logo featuring a leaf motif on its packaging. The amendment, published in the Gazette of India on May 25, 2026, will come into effect from July 1, 2027. The mandatory logo is intended to establish a uniform identification system for vegan products available in the Indian market. With consumer demand for plant-based foods growing steadily, the standardized symbol will help shoppers easily identify cer-

The advisory follows reports that some manufacturers have been using Ashwagandha leaves and leaf extracts in their formulations. FSSAI has clarified that only Ashwagandha roots and their extracts are permitted under the current regulations, while the use of leaves in any form is not allowed. Together with the new mandatory vegan logo requirement, these regulatory updates reinforce FSSAI's commitment to strengthening food safety, improving labeling transparency, ensuring regulatory compliance, and supporting responsible growth of India's expanding vegan food and nutraceutical sectors.

BENEO launches collection of inspirational sugar-free confectionery concepts to boost category innovation

BENEO has unveiled a new range of sugar-free hard-boiled candy concepts featuring its functional sugar replacer, Isomalt, to inspire confectionery manufacturers with innovative product ideas. Showcased in its new 'Sweets Box', the collection was developed by experts at the BENEOTechnology Center and demonstrates how traditional confectionery can be reimagined to meet evolving consumer demand for healthier, flavourful, and visually appealing products.

The range includes three drink-inspired concepts: Yuzu & Matcha Liquid Filled Candy, combining citrusy yuzu with a matcha liquid centre for a multi-sensory

gourmet experience; Caramel Coffee Candy, offering a sugar-free caffeine boost for on-the-go consumers; and Energy Drink Candy, which translates the popular energy drink flavour into a convenient hard candy format aimed at young adults.

All concepts feature Isomalt, a sugar beet-derived sugar replacer that delivers a mild, sugar-like taste without a cooling effect. It enables reduced-calorie, tooth-friendly confectionery while offering excellent colour stability, swirl effects, longer shelf life through low hygroscopicity, and precise multi-layer and filled candy designs. Its slow dissolution also extends the consumption experience.



With the functional confectionery market projected to grow at a CAGR of 8% between 2025 and 2033, BENEEO says the new concepts address rising demand for confectionery that combines indulgence with added functionality. The company believes Isomalt enables manufacturers to create sugar-free products that meet modern expectations for taste, functionality, and visual appeal while unlocking new opportunities for innovation in the hard-boiled candy category.

Ingredion Acquires Benicaros® Prebiotic Fiber to Expand Functional Ingredient Portfolio

Ingredion Incorporated a leading global provider of ingredient solutions for the food, beverage and industrial markets, announced the acquisition of Benicaros®, a patented, prebiotic fiber made from upcycled carrot pomace clinically shown to support immune health.

"As we expand our functional ingredients offering, Benicaros' versatility and health benefits makes it a perfect fit for our portfolio," said Nate Yates, Ingredion's vice president & general manager of sugar reduction and fiber fortification. "This highly differentiated pre-

biotic carrot fiber addresses the limitations of traditional prebiotic fibers that require high daily intake, have tolerance issues and formulation challenges."

Benicaros stimulates beneficial gut bacteria, resulting in immune health benefits at extremely low dosage. It is water-soluble with minimal effect on taste, texture or odor. This makes it versatile for use in functional foods, beverages, and dietary supplements. Additionally, Benicaros addresses multiple consumer demands by being plant-based, clean-label, kosher, halal, gluten-free, up-

cycled and sustainable.

"The benefits list of Benicaros is quite long, and the fact that it comes from upcycling carrot juice production, supporting sustainability and a circular-economy, is all the more exciting," Yates added. The acquisition is an asset deal that includes full ownership of all intellectual property, trademarks, human clinical trials, and know-how related to manufacturing the product.



Cargill Invests €56 Million to Expand Food Manufacturing and Innovation Capabilities in Belgium

Cargill has invested approximately €56 million to expand its production and R&D capabilities across three facilities in Belgium, reinforcing the country's role as a strategic hub for its European operations. The investment includes €21 million to modernize and nearly double the capacity of its Izegem edible oils bottling facility—Europe's largest—through automation and the addition of two dedicated foodservice production lines; €30 million to add 10,500 sq. m. of production space at its Mouscron gourmet chocolate plant, almost doubling

production capacity for its premium Veliche couverture chocolate range while improving customization and lead times; and €5.4 million for a new extrusion pilot plant at the Vilvoorde Innovation Center to support rapid prototyping, ingredient testing, and customer collaboration across food, feed, and pet food applications. The investments strengthen Cargill's production, innovation, and sustainable manufacturing capabilities in Belgium, where it has operated since 1953 and employs more than 1,500 people across nine locations.



Tetra Pak Unveils Industry-First Carton Packaging for Shelf-Stable Tuna



Tetra Pak, in collaboration with Spanish seafood producer Jealsa, has introduced the food industry's first carton packaging solution for shelf-stable tuna using its Tetra Recart® technology. The innovative packaging was launched in Sweden with retailer Axfood in a 200 ml Mini format and will now be made available to food manufacturers and brands globally.

Developed by combining Tetra Pak's expertise in sustainable food packaging with Jealsa's

decades of seafood processing experience, the paper-based Tetra Recart® offers a modern alternative to conventional metal cans. The launch comes at a time when the global shelf-stable tuna market is projected to grow by 12% to reach 12.4 billion units by 2030, driven by increasing demand for affordable, convenient, and protein-rich food products.

The new packaging supports a wide range of tuna products, including spreads, flakes, shredded tuna, and chunks, with plans to expand into additional product formats. It provides food producers with a cost-competitive and scalable solution while enabling brands to differentiate themselves in a traditionally uniform category. Beyond product innovation, Tetra Recart® delivers significant sustainability benefits. The package has an estimated carbon footprint up to 85% lower than steel cans and 83% lower than

glass jars, while containing up to 71% FSC™-certified paper sourced from responsibly managed forests. Its rectangular shape also improves transportation efficiency, warehouse storage, shelf utilization, and e-commerce handling.

Consumer research has shown strong market acceptance, with more than 80% of consumers willing to purchase tuna packaged in Tetra Recart®, while 58% prefer it over existing packaging formats. The carton's flat surfaces also provide greater branding opportunities and enhanced shelf visibility compared to traditional round cans.

Following the successful Swedish launch, Jealsa plans to introduce Tetra Recart® across multiple product categories under its own brands—Rianxeira, Mare Aperto, and Robinson Crusoe—as well as for third-party brands. The collaboration marks a significant step towards modernizing the shelf-stable seafood category by offering a more convenient, efficient, and sustainable packaging solution for the growing global market.



Cosmo Films Launches CSP DigiLux-MW for High-end Digital Printing Applications

Latest offering under Cosmo Synthetic Paper vertical with enhanced whiteness, providing luxurious look to the printed materials

Cosmo Films, a global leader in specialty films for packaging, lamination, and labelling applications announced the launch of a new product under its Cosmo Synthetic Paper vertical, the CSP DigiLux-MW.

With a strong emphasis on durability, sustainability and quality, Cosmo First's CSP DigiLux-MW has been designed to elevate the printing experience for high-end digital applications. Ideal for high-end applications where the visual appeal of the print is crucial, this latest offering with enhanced whiteness, providing a luxurious look to the printed materials.

The newly launched CSP DigiLux-MW is suitable for Powder toner technology like Xerox, Konica Minolta, Kodak, and Canon to name a few. In addition, the new product offers printability with a host of technologies like Conventional & Offset, Water & UV based Flexo, Screen, Thermal transfer with

Wax Ribbons, Wax Resins and Resin Ribbons, Letter Press, UV Inkjet and HP-Latex.

Speaking on the occasion Mr. Kulbhushan Malik, Global Business Head, Cosmo Films, said, "At Cosmo Films, we are unflinchingly committed to designing and offering sustainable solutions that are not only durable but also adhere to the highest standard of quality. The launch of CSP DigiLux-MW under our Cosmo Synthetic Paper vertical is testament to our endeavour to seamlessly cater to the diverse needs of synthetic paper in the evolving commercial printing industry. Through innovation, we hope to continue set industry benchmarks by consistently adding premium products to our bouquet of offerings."

According to reports, the Indian synthetic paper market was valued at \$53.42 million in 2023 and is projected to grow at a CAGR of 6.74% through 2029. With rapid growth

in e-commerce, FMCG and consumer goods, the packaging industry is fuelling demand for durable and weather resistant solutions. Additionally, various demands from the chemical, industrial and printing industries are providing the necessary tailwinds for labels, tags and print solutions requiring robust synthetic papers which can withstand exposure to moisture, chemicals and rough handling.

Cosmo Synthetic Paper is a co-extruded, white opaque, polypropylene-based film that resembles paper in appearance. It is a replacement of paper in applications where longevity and durability are desired. The vertical meets compliance standards such as EU 10/2011, USFDA, REACH, and RoHS, ensuring adherence to regulatory requirements.



Siegwerk and Enplater develop fully recyclable mono-PP pouch with integrated barrier and sealing performance



Siegwerk, one of the leading global providers of printing inks and coatings for packaging applications and labels, and Enplater Group, a specialist in the printing and production of rigid and flexible packaging, announced today the joint development of an innovative mono-material packaging solution made of polypropylene (PP) that offers high technical performance full recyclability.

The joint development combines Siegwerk's

expertise in high-performance, regulatory-compliant ink and coating systems with Enplater's extensive know-how as an experienced specialist for rigid and flexible packaging. Through close collaboration between the technical and R&D teams of both companies, the partners conducted comprehensive trials under realistic production conditions, generating application-oriented insights that supported the optimization of the new high-barrier mono-PP pouch structure for food packaging.

"As the packaging industry continues its transition toward circular solutions, collaboration across the value chain is essential to keep driving innovation forward," said Javier Garcia, Head of Sales & Technology Iberia. "By combining our advanced ink and coating technologies with Enplater's specialized converting expertise, we have been able to develop a mono-material PP pouch that performs on-par with existing multi-material barrier solutions, while driving the material

efficiency necessary to meet the strict Design for Recycling mandates of the upcoming PPWR."

As part of the project, several key technologies from Siegwerk's were used. CIRKIT OXYBAR WHITE, a combined oxygen-barrier and white ink technology applied in-line in a single step. This enables the transition away from PVdC, metallized mixed materials (such as met-PET and met-OPP) and EVOH-based structures by simply replacing the standard backing white, introducing a new level of inventory flexibility with zero additional capital expenditure. In addition, Siegwerk's latest polyurethane (PU)-based ink systems were used, which offer high print quality and excellent adhesion and are suitable for demanding flexible packaging applications.

Enplater emphasized that its collaboration with Siegwerk has accelerated the development of recyclable mono-material packaging by combining the expertise and technologies of both companies. The partnership has resulted in a high-performance packaging solution that meets production requirements and growing demand for recyclable structures, while reinforcing both companies' commitment to sustainable innovations that address manufacturing, regulatory, and food protection challenges.

Elopak launches low-carbon aluminium for liquid packaging cartons

Elopak has started sourcing low-carbon aluminium made with renewable electricity in its European carton production, an important step to reduce the climate impact of its packaging materials. The low-carbon aluminium is now used in the company's standard ambient cartons manufactured at plants in the Netherlands, Denmark and Ukraine. The transition to low-carbon aluminium results in an immediate 8% reduction in the carbon footprint of Elopak's standard aluminium ambient cartons. As a result of this change, the carbon footprint of a standard aseptic Pure-Pak® carton has been reduced from 53 to 49 g CO₂e per carton, based on cradle-to-gate calculations.

Commenting on the launch, Emilie Olderskog, Global Head of Sustainability at Elopak, said: "By sourcing aluminium produced with renewable electricity, we are taking another concrete step in reducing the climate impact of our packaging materials. The introduction of low-carbon aluminium delivers an immediate and measurable reduction in the footprint of our standard ambient cartons, while allow-

ing us to retain the functional properties that are critical for food protection and shelf life."

Aluminium plays an important role in ambient cartons by providing an effective barrier against light and oxygen and by enabling aseptic sealing. These properties help extend product shelf life and reduce food waste, without the need for preservatives. Multiple life-cycle assessments have shown that, in many applications, our liquid packaging cartons can have a lower carbon footprint than plastic packaging formats," Olderskog continued. "At Elopak, we continue to improve the environmental performance of our cartons and work with our customers as they seek to reduce the climate impact of their packaged products."

Prior to the introduction of low-carbon aluminium, a standard ambient Pure-Pak® carton had a carbon footprint of 53 g CO₂e per carton. Following the transition, this can be reduced to 49 g CO₂e per carton. Elopak also offers Pure-Pak® eSense, its aluminium-free aseptic carton designed for ambient distribu-



tion, which supports further emissions reductions and optimized recycling performance.

Elopak is strengthening its commitment to sustainable packaging by sourcing aluminium exclusively from Aluminium Stewardship Initiative (ASI) members, operating on 100% renewable electricity across its manufacturing sites and offices, and advancing recyclable, low-carbon carton solutions. The company's latest innovation, cartons made with recycled polymers introduced in 2025, supports compliance with upcoming EU Packaging and Packaging Waste Regulation (PPWR) requirements. Going forward, Elopak will continue to enhance the environmental performance of its packaging portfolio through solutions that reduce emissions, improve resource efficiency, and increase recyclability while helping customers achieve their sustainability goals.



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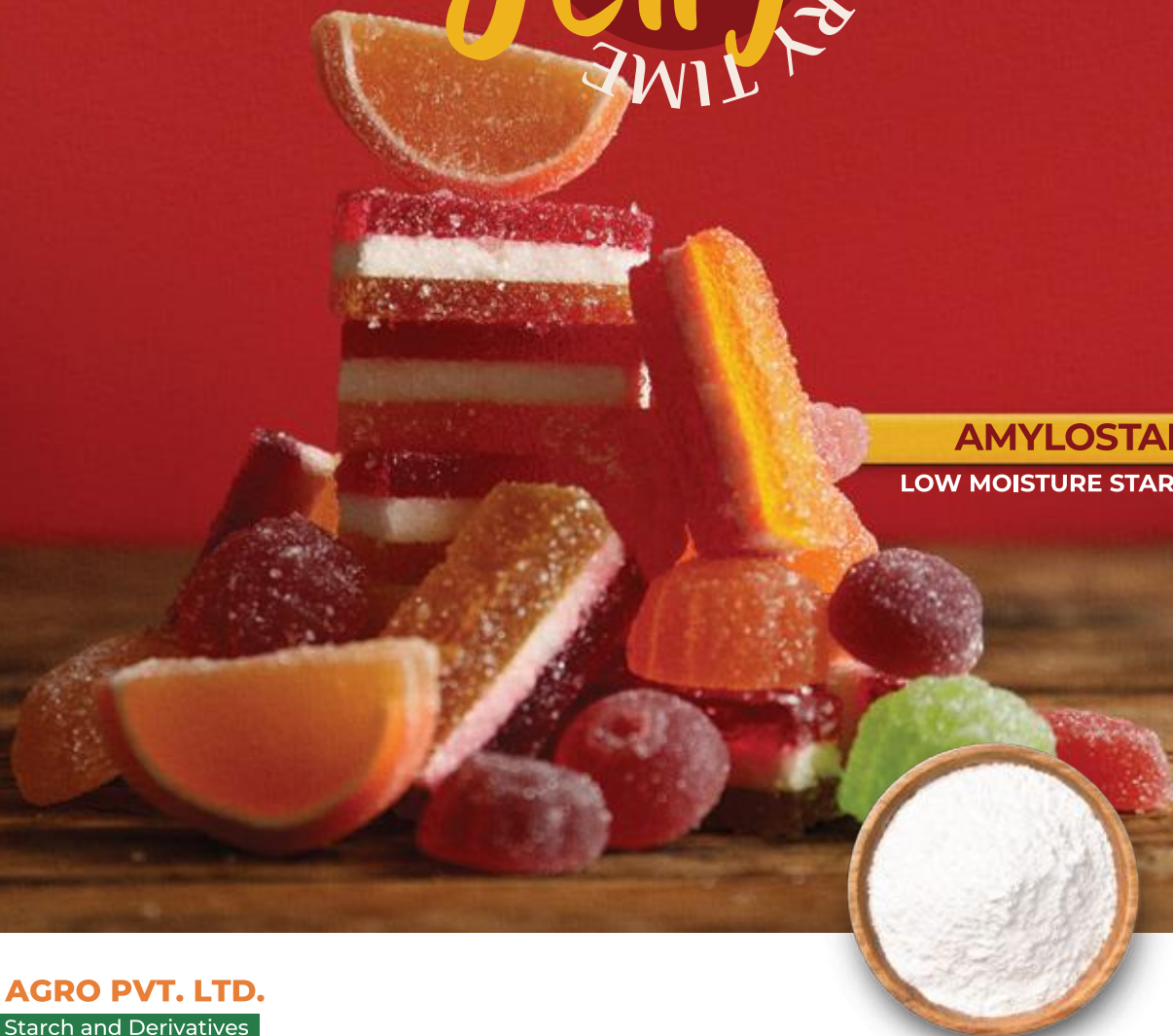
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