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& Beverages Processing

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in Modern Food Storage: Protecting Quality, Safety, and Shelf Life

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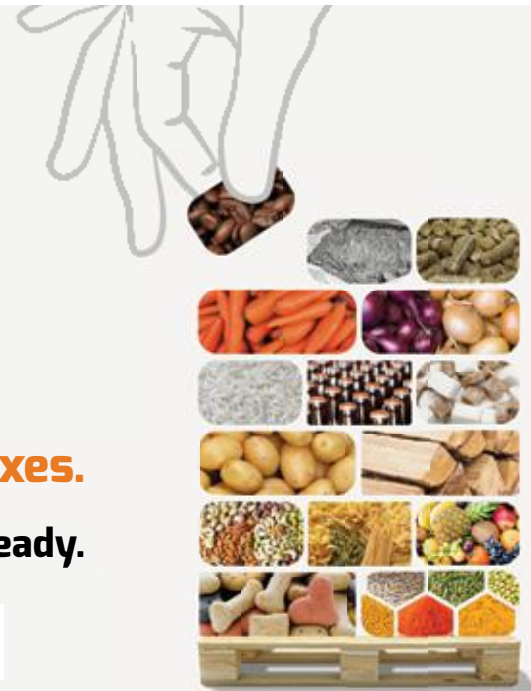
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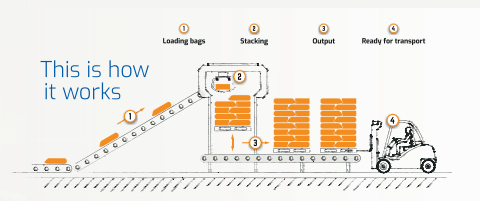


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Food
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Ingredients • Processing • Packaging • Technology

Dear Readers,

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

In this edition, we bring together a diverse collection of insights that highlight the latest developments across the food value chain. Our focus this month is on technologies, ingredients, and operational strategies that are helping manufacturers meet growing consumer expectations while maintaining quality, safety, and sustainability.

In our Processing Technology segment, we explore the emerging role of edible leaves as natural food preservation solutions, showcasing how traditional knowledge is inspiring modern food preservation techniques. We also examine the growing influence of Artificial Intelligence and Digital Transformation in the Food Industry, highlighting how data-driven technologies are improving productivity, traceability, and decision-making across manufacturing operations. Additionally, our feature on Quality Assurance Beyond Visual Inspection in Food & Beverage Manufacturing discusses the advanced inspection systems and monitoring technologies that are redefining quality control standards.

The Packaging Technology section focuses on two important trends shaping the future of food packaging. Our article on the Edible Packaging Revolution explores how consumable films are integrating food safety, sustainability, and waste reduction into packaging design. We also investigate why many FMCG companies are increasingly adopting 360-Degree Shrink Sleeve Packaging, a solution that offers enhanced branding opportunities, product differentiation, and greater shelf appeal.

Within our Ingredients & Additives segment, we delve into the critical role of

ingredients in product development and consumer health. Our feature "Sugar Is Not a Commodity — It's Food" examines sugar's multifaceted role beyond sweetness and its importance in food formulation. We also spotlight Fermented Functional Beverages, with a closer look at kefir as a next-generation probiotic drink responding to the rising demand for digestive wellness and functional nutrition. Complementing this discussion is our comparative analysis of Millets and Millet Microgreens, evaluating their nutritional profiles and potential applications in modern food products.

Finally, in our Warehousing & Logistics section, we address a crucial yet often overlooked aspect of food storage. Our article on Humidity Control in Modern Food Storage: Protecting Quality, Safety, and Shelf Life examines how environmental management strategies help preserve product integrity, reduce losses, and support regulatory compliance throughout the supply chain.

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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Thank you
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Parag Milk Foods Launches a Milk-Based Protein Drink in Collaboration with Tetra Pak



Parag Milk Foods Ltd, through its sports nutrition brand Avvatar, has expanded into India's rapidly growing ready-to-drink (RTD) protein beverage segment with the

launch of Avvatar Protein Cold Coffee. Developed in partnership with Tetra Pak, the product is being introduced in India's first Tetra Prisma® Aseptic 250E pack, offering consumers a convenient blend of nutrition, taste, and portability.

Priced at ₹120, the new beverage marks Avvatar's move beyond traditional sports nutrition products into the broader functional and lifestyle nutrition category. The launch comes at a time when demand for whey protein-based products is rising in India, while studies indicate that nearly 73% of Indians remain protein deficient, creating significant opportunities for convenient protein-enriched food and beverage formats.

Available in Classic and Vanilla variants, Avvatar Protein Cold Coffee delivers 15g of protein per 250 ml pack and is formulated with milk protein, containing no added sugar and no artificial sweeteners. By combining protein with one of India's most popular beverages, the company aims to make daily protein consumption more accessible and appealing

to mainstream consumers. A notable feature of the launch is its distinctive octagonal-shaped packaging, which offers improved ergonomics, a premium shelf presence, and enhanced portability. The lightweight, paper-based, and recyclable pack also aligns with growing industry emphasis on sustainable packaging solutions.

The launch follows strong business performance for Parag Milk Foods, with its new-age business segment, including Avvatar, recording an impressive 91% year-on-year growth in FY26, reflecting increasing consumer interest in health and wellness products.

Industry stakeholders view the launch as an example of how innovation in both product formulation and packaging can help accelerate adoption of functional beverages in India. The collaboration between Parag Milk Foods and Tetra Pak highlights the growing role of advanced packaging formats in supporting the expansion of nutrition-focused beverage categories.



Too Yumm! Enters High Protein RTC Breakfast Segment With Launch of Super Oats

Too Yumm!, one of India's most disruptive snacking brands under the RP-Sanjiv Goenka Group, has announced its entry into the ready-to-cook (RTC) breakfast segment with the launch of High Protein Super Oats, marking a strategic expansion into a category largely dominated by sweet offerings. With this move, the brand aims to disrupt the conventional protein oats space by introducing a savoury, masaledaar alternative that aligns more closely with Indian taste preferences while staying rooted in its signature taste-first philosophy.

Super Oats reimagine the way protein oats are consumed by shifting the focus from purely functional nutrition to a more enjoyable, flavour-forward experience. Built on the idea of "tasty protein," the product is designed to deliver on taste without positioning itself as a compromise between health and indulgence. By combining bold, chatpata flavours with a familiar format, Too Yumm! is transforming an otherwise routine

category into something more craveable and relevant for everyday consumption.

Commenting on the launch, Yogesh Tewari, Chief Marketing Officer, Too Yumm!, added, "Super Oats is a strategic step towards redefining what protein-led foods can mean for today's consumer. While awareness around protein and better eating is on the rise, the category remains limited in how it fits into Indian consumption habits – especially with most offerings skewing sweet. In a market like India, where breakfast is inherently savoury, we saw a clear opportunity to bridge this gap with a flavour-forward, masaledaar approach that feels far more intuitive to adopt. At Too Yumm!, we believe nutrition should never come at the cost of taste. With Super Oats, our focus is to make the shift towards better eating simple, consistent, and far less intimidating – so consumers don't feel like they're compromising on indulgence but rather upgrading their everyday choices."

The range is available in two variants – Protein Masala with 22g protein and Masala Magic with 11g protein – catering to consumers looking for accessible and consistent ways to incorporate better food choices into their daily routines. Super Oats are designed for urban, conscious consumers who prefer savoury breakfast options over sweet and are seeking quick, convenient solutions that fit into fast-paced lifestyles.

Around the world, breakfast tends to be sweet, and oats have largely been confined to that category. In India, however, mornings start savoury. Built around the bold flavours, Too Yumm! Super Oats enters the category as a natural fit from day one. With this launch, the brand continues to build on its approach of making "better-for-you" foods more exciting and accessible, while strengthening its position as a brand that prioritizes taste, relevance, and everyday usability in an evolving food landscape.



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Britannia Treat Croissant Launches Dubai Kunafa Croissant Pista Crème, Bringing a Global Flavour in a Croissant Format

Taking indulgence up a notch, Britannia Treat Croissant has announced the launch of its newest offering, Dubai Kunafa Croissant – Pista Crème. Drawing inspiration from the globally loved flavour, the croissant combines the softness of a sourdough croissant with a decadent filling made using real pistachios, bringing together familiarity and a globally inspired flavour experience, for the first time, in a convenient, ready-to-eat format.

Blending familiar textures with globally inspired flavours, the Dubai Kunafa Croissant – Pista Crème has been crafted for consumers seeking more elevated, indulgent snacking experiences. With its soft, layered texture and creamy filling, the croissant brings to-

gether indulgence and convenience in every bite. The launch reflects the growing consumer interest in globally inspired flavours and evolving snacking preferences. With Britannia Treat Croissant, the brand continues to introduce differentiated flavour experiences for Indian consumers through formats that feel both accessible and premium, while steadily strengthening the croissant category in India.

Commenting on the launch, Puneet Das, Chief Marketing Officer, Britannia, said, "Globally inspired flavours are seeing strong consumer excitement today, especially indulgent flavour experiences. With the Dubai Kunafa Croissant – Pista Crème, we wanted to take a flavour profile that consumers are already excited about, are trending, and re-

interpret it in a croissant format. The idea was to bring together a global flavour inspiration and the comfort of an everyday format in a way that feels fresh and exciting for consumers. The richness of pistachio crème paired with soft croissant creates a more indulgent and elevated snacking experience while still feeling familiar and easy to enjoy."

Building on its growing portfolio, Britannia Treat Croissant continues to offer a range of flavours, including Cocoa, Vanilla, Triple Choco and Mixed Fruit, catering to diverse taste preferences while strengthening its presence in the evolving croissant segment in India. Britannia Treat Dubai Kunafa Croissant – Pista Crème is currently available across select cities at leading retail outlets and Q-commerce platforms.

Pepsi launches nostalgic ice cream-inspired trio



Vanilla, Raspberry Ripple and Salted Caramel Ice Cream Flavours for the ultimate summer treat. The unique new offering is set to give retailers a fresh opportunity to attract a generation of younger shoppers, who have mastered the art of intentional treating, and boost sales within the cola category.

With its strong track record in flavour innovation, Pepsi continues to lead the way and deliver growth to the cola category. Pepsi's Strawberries 'N' Cream and Cream Soda range, launched in 2025, proved the most successful cola NPDP in the latest 5 years, responsible for 30.4% incremental growth to the cola category and 44.3% to total Pepsi Cola. The brand is therefore well-positioned to disrupt shoppers this summer, with an innovative offering that keeps consumers engaged in the soft drinks category.

The trio aims to meet consumer appetite for bold flavours, as the flavoured cola category continues to grow ahead of unflavoured cola. Cold, bold and surreal, with a classic Pepsi base, the new flavours add a creamy, sweet kick to the iconic

cola recipe, re-imagining and remixing the classic nostalgic combination of cola and ice cream and will step up as the ultimate sweet treat for shoppers to enjoy across a range of occasions. From celebrating the little wins, making it through a long Monday, to cooling down in the summer heat, Pepsi's new offering redefines the treat moment.

Natalia Filippociants, SVP and General Manager Europe International Beverages, PepsiCo, said: "Pepsi continues to innovate and bring unique flavours, as well as zero sugar offerings to retailers' shelves and this new launch only builds on that momentum. These new Ice Cream-inspired Flavours have been crafted with a younger generation in mind, designed to be a fun, zero-sugar summer treat that's a little unexpected – but in the best way. With its bold look and feel designed to stand-out on-shelf and in chillers, the new offerings are set to create excitement, and drive sales in an increasingly competitive category."

Munnawar Chishty, Chief Marketing Officer, Carlsberg Britvic, adds: "The addition of these new Ice Cream Flavours is an exciting

Carlsberg Britvic is expanding its Pepsi range with an indulgent trio of Ice-Cream-inspired Flavours made to be the ultimate refreshment, with a smooth taste and zero-sugar sweetness. The new, zero sugar colas will be available in Cherry &

moment for the Pepsi brand. Shoppers are actively seeking soft drinks that offer great flavour and following in the success of Strawberries 'N' Cream and Cream Soda flavours, we're confident that the trio will continue to deliver. With its vibrant packaging, and nostalgic-inspired flavour line-up, the Ice Cream Flavours will offer retailers an eye-catching proposition that stands out in-store and will aim to reach consumers across a range of missions—from on-the-go impulse buys, to a treat to cool down in the summer heat."

The new Ice Cream Flavours will join the existing Strawberries 'N' Cream and Cream Soda flavours launched last year. The new additions is available in Tesco from 18 May, before a wider, nationwide roll out of the Cherry & Vanilla and Raspberry Ripple Ice Cream Flavours from 14 July. Each flavour will be available in a range of formats, including an 8 can multipack, plus 500ml plain and price-marked packs. The Cherry & Vanilla and Raspberry Ripple Ice Cream Flavours will also be available in individual 330ml cans. The launch will be supported by a bold OOH campaign and sampling activity, championing its 'deliciously confusingly, not real ice cream' positioning.

Royal Grove Brings Authentic Coconut Richness to Contemporary Kitchens

Rich and creamy, the all-new plant-based Coconut Milk by Royal Grove brings the naturally sweet taste and aroma of fresh coconuts to every recipe.

Made using a specialised process that retains the smooth texture and authentic coconut flavour, Royal Grove Coconut Milk blends effortlessly into a wide variety of dishes and beverages. From slurp-worthy bowls of Thai Green Curry and Tom Kha soup to silky coconut puddings, smoothies, baked treats, coconut coffees, refreshing piña colodas, cocktails, and mocktails, it adds a rich, velvety finish with every spoonful and sip.

Designed for the evolving preferences of modern kitchens, the range is available in two variants: 12–14% coconut extract for lighter recipes and 17–19% coconut extract for a richer, creamier texture, making it ideal for both everyday cooking and professional culinary creations. Naturally lactose-friendly, cholesterol-free, and free from added colours, artificial flavourings, and preservatives,



Royal Grove Coconut Milk offers a versatile dairy alternative for everything from comforting curries to indulgent desserts and beverages.

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Bisleri Launches Limited-Edition Karuppu Packs Featuring Suriya



Timed with the film's growing buzz, the association taps into the deep cultural influence of Tamil cinema and transforms everyday consumer touchpoints into moments of fandom. By bringing Karuppu to retail shelves, Bisleri continues to strengthen its regional connect through hyperlocal, culturally relevant campaigns that resonate strongly with consumers.

Commenting on the association, Tushar Malhotra, Director of Sales and Marketing at Bisleri International, said, "At Bisleri, we are always looking for meaningful ways to connect with consumers through moments and passions that matter to them. In Tamil Nadu, cinema is more than entertainment, it is an integral part of popular culture. Our association with Karuppu allows us to participate in that cultural excitement while building stronger consumer engagement at scale."

The limited-edition Karuppu packs will be available across retail outlets in Tamil Nadu, spanning general and modern trade channels. The campaign will also be amplified through branded retail visibility, on-ground activations, digital engagement, ensuring fans can experience the collaboration across multiple touchpoints.

Bisleri International, India's leading packaged drinking water brand, has announced its limited-edition bottles inspired by the much-anticipated Tamil film Karuppu. Featuring south superstar Suriya, who leads the film alongside Trisha Krishnan, the collectible bottles are now available across Tamil Nadu in 250 ml, 500 ml, 1 Litre and Bisleri Soda packs.

Quaker has launched its biggest brand refresh in India, aimed at making balanced nutrition easier for consumers to understand and adopt. Responding to evolving breakfast preferences and increasing consumer focus on protein and fibre, the brand is highlighting its nutritional credentials more prominently across packaging, communication, content, and consumer engagement platforms.

The refresh comes at a time when Indian consumers are becoming more health-conscious and informed about their food choices. According to market insights cited by the company, high-protein and high-fibre content have emerged as key factors influencing food and beverage purchasing decisions, particularly among younger consumers. Quaker® is therefore bringing greater attention to the nutritional benefits of oats, emphasizing 12g of natural protein and 33% fibre as part of its proposition.

According to Saakshi Verma Menon, the initiative reflects PepsiCo India's focus on delivering nutrition-led products that align with changing consumer lifestyles while maintaining taste and trust. She noted that the refresh is designed to make balanced nutrition more accessible and easier to adopt in everyday breakfast routines.

The campaign is supported by a new television commercial that addresses the growing confusion among consumers regarding whether protein or fibre should take priority in their diets. Set in a contemporary household, the film portrays a consumer overwhelmed by conflicting nutritional advice before arriving at a simple solution—a bowl of Quaker® Oats, which offers both protein and fibre. The campaign reinforces the brand's message of delivering balanced nutrition without compromise.

Pepsico Strengthens Nutrition Credentials With Landmark Quaker® Restage Spotlighting Protein and Fibre



Commenting on the initiative, Sriram Iyer said the refresh builds on Quaker's 145-year legacy of trusted nutrition while helping consumers navigate an increasingly cluttered food information landscape. The objective, he added, is to transform breakfast from a routine habit into a more informed and purposeful nutritional choice.

The creative campaign was developed by Vikram Pandey, who noted that the film captures the challenge of navigating contradictory health advice in today's digital world and positions Quaker® as a clear and credible solution for consumers seeking both protein and fibre in their breakfast. With this comprehensive refresh, Quaker® aims to strengthen its position in India's breakfast category and reinforce its role as a trusted nutrition brand for modern, health-conscious consumers.

DS Group Expands Catch Sprinkler Range with New Seasoning Variants



Catch Salt and Spices, a brand from DS Group, has expanded its Catch Sprinkler portfolio with the launch of several new-age and regional seasoning variants. The move aims to strengthen the brand's presence in the growing packaged seasoning and convenience food segment across India.

The newly introduced range includes pizza pasta seasoning, chilli flakes, oregano, magic masala, mixed herbs, Jeeravan (Poha Masala), and Podi Masala. Designed for modern and experimental consumers, the expanded portfolio caters to the rising demand for convenient, flavourful, and easy-to-use cooking solutions in metro as well as Tier 2 and Tier 3 markets.

According to Sandeep Ghosh, Business Head, Catch Salt & Spices, DS Group, the expansion reflects the company's focus on evolving consumer preferences, flavour innovation, and premium yet accessible offerings. The products are available across general trade, modern retail, e-commerce, and quick commerce platforms nationwide. Launched in 1987 with its table-top salt sprinkler, the Catch brand has grown into a major player in the Indian spices and seasoning market, offering over 140 variants and 330 SKUs across nine categories. The company continues to strengthen its market reach through digital marketing, modern trade expansion, and consumer-focused product innovation.

United Breweries Limited launches Amstel Grande Packaged Drinking Water

NEW AMSTEL GRANDE



United Breweries Limited (UBL), part of the HEINEKEN Company, today announced the launch of Amstel Grande Packaged Drinking Water, adding to its packaged drinking water portfolio. Amstel Grande Packaged Drinking Water will be available in 200 ml and 500ml formats, with an initial rollout in Uttar Pradesh, followed by other states. The product will be distributed through UBL's wide network.

Vikram Bahl, Chief Marketing Officer, United Breweries Limited, said, "Amstel Grande Packaged Drinking Water is an important addition to our portfolio. Leveraging UBL's well-established distribution network and deep channel partnerships, we are well positioned to grow this brand." Amstel Grande Packaged Drinking Water is produced to high standards of quality and safety, consistent with UBL's quality standards.



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

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

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

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

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antioxidants. It prevents oxidation of fats and oils in food and helps maintain freshness and nutritional quality. Curry leaves help in reducing excess moisture when used in storage. It prevents fungal growth and mold formation. Curry leaves can be dried, powdered and mixed with food products to extend shelf life.

4) Betel leaves – Betel leaves are used to wrap certain food items. It protects food from dust, air, and microbes. It is commonly used for sweets and herbal preparation. The strong aroma of betel leaves acts as a mild insect repellent. Betel leaves impart a distinctive flavor and aroma. Improves taste while contributing to preservation.

5) Turmeric leaves – Wrapping food in turmeric leaves reduces exposure to air, dust, and microorganisms. It keeps food hygienic during storage and transport. Turmeric leaves are biodegradable and environmentally safe. It provides a sustainable alternative to plastic packaging. Turmeric leaves contain bioactive compounds related to curcuminoids and essential oils. These inhibit the growth of bacteria and fungi thereby help in preventing spoilage of food.

6) Onion leaves – Adding chopped onion leaves to dishes (like rice or curries) can slightly extend shelf life because of their mild preservative effect. The strong smell of onion leaves can help repel insects, which indirectly helps in preserving food, especially in open environments. They contain flavonoids and antioxidants that reduce oxidation in food. This helps in delaying spoilage, especially in cooked foods.

7) Rosemary leaves – Rosemary contains compounds like Carnosic acid and Rosmarinic acid, which prevent oxidation of fats and oils. This helps in preserving foods like meat, oils, and fried items by delaying rancidity. Rosemary leaves are often added to marinades or rubbed on meat. This not only enhances flavor but also extends shelf life by reducing microbial spoilage. Rosemary extract is used as a natural preservative in processed foods as an alternative to synthetic chemicals.

8) Mint and coriander leaves – Both leaves act as antimicrobial compounds. It inhibits the growth of bacteria and fungi helping slow down food spoilage. Keep foods fresh for long time.

Methods of Preservation Using Edible Leaves

Wrapping and Packaging:

Wrapping food in large, non-toxic, leafy

Uses of Edible Leaves for Food Preservation

Abinaya.B, Uma Maheswari.T, Geethanjali.S

Introduction

Food preservation has been an essential practice since ancient times, aimed at extending shelf life and maintaining the quality of food. Use of edible leaves is one of the traditional and eco-friendly methods. These leaves are widely used across different cultures due to their natural preservative properties, availability, and safety for consumption. Edible leaves such as Banana leaves, Neem leaves, Curry leaves, contain bioactive compounds like antioxidants, antimicrobial agents, and essential oils. These compounds help inhibit the growth of spoilage microorganisms and delay oxidation, thereby preserving food naturally. In addition to preservation, edible leaves also enhance the flavor, aroma, and nutritional value of food. Their use reduces dependence on synthetic preservatives, making them an important component of sustainable and traditional food systems. Thus, edible leaves play a significant role in both preserving food and promoting healthier consumption practices.

Types of Edible Leaves Used

Various edible leaves are commonly used in food preservation, depending on the region and availability. Some important examples include:

- Banana leaves
- Neem leaves
- Curry leaves
- Betel leaves
- Turmeric leaves
- Onion leaves

- Rosemary leaves
- Mint and coriander leaves

Each of these leaves contains natural compounds that help in preserving food and enhancing its flavor.

1) Banana leaves – Banana leaves are commonly used to wrap food items such as rice, idli, fish. They act as a protective covering against dust, dirt, and microorganisms. It reduces direct exposure to air and the waxy surface of banana leaves helps retain moisture in food. It keeps food fresh, soft, and prevents drying. Banana leaves can withstand heat and are used in steaming and roasting. Heat kills microbes, aiding preservation.

2) Neem leaves – It is traditionally used in food preservation due to their strong antimicrobial and insect-repellent properties. They are widely used in rural and household practices to protect food and grains from spoilage. Neem leaves contain bioactive compounds such as Azadirachtin, Nimbin, and Nimbidin. These compounds inhibit the growth of bacteria and fungi. Helps in preventing food spoilage and contamination. Neem leaves act as a natural insect repellent which protect stored grains and pulses from pests like weevils and beetles. Leaves are commonly placed in storage containers.

3) Curry leaves – Curry leaves are rich in



compared to modern methods.

- Limited effectiveness – they provide mild antimicrobial action, not complete protection
- Hygiene concerns – if not properly cleaned, leaves may introduce microbes.
- Seasonal availability – some leaves are not available throughout the year.
- Not suitable for all foods – cannot be used effectively for every type of food.
- Bulk storage limitations – not practical for large-scale or industrial preservation.

Conclusion:

Edible leaves play an important role in food preservation by offering a natural, safe, and eco-friendly alternative to synthetic methods. Leaves such as Banana, Neem, and Mint help protect food through their antimicrobial, antioxidant, and moisture-retaining properties. They also enhance flavor, reduce spoilage, and are cost-effective and biodegradable. However, their use is mainly suitable for short-term and small-scale preservation. Overall, edible leaves remain a valuable traditional practice that supports sustainable and healthy food preservation.

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foliage (e.g., banana leaves) acts as a natural, breathable wrapper that protects from dirt and insects, while some leaves contain natural antimicrobial substances. Edible leaves are widely used to wrap food items such as rice, sweets, fish, and meat. This method protects food from dust, insects, and microbial contamination.

Antimicrobial Action: Certain leaves like Neem and Turmeric contain natural antimicrobial compounds that inhibit the growth of bacteria and fungi. This helps in slowing down food spoilage.

Moisture Retention: Leaves help maintain the moisture content of food, preventing it from drying out. At the same time, they allow slight air circulation, which reduces the chances of fungal growth.

Aroma and Flavor Enhancement: Leaves such as curry and turmeric not only preserve food but also impart a pleasant aroma and taste, making the food more appealing.

Storage of Perishables: In rural areas, edible leaves are used to cover and store perishable items like fruits, vegetables, and dairy products. This acts as a natural barrier against environmental factors.

Temperature Regulation: Edible leaves can act as natural insulators. They help keep food warm or cool for a longer time. For example, banana leaves are often used in steaming because they retain heat and distribute it evenly.

Eco-Friendly and Biodegradable: Unlike plastic, edible leaves are biodegradable and environmentally friendly. They reduce pollution and are sustainable for long-term use.

Steaming using leaves: Food is wrapped in banana leaves or turmeric leaves and then steamed. And it is mainly used for dumplings, fish, rice cakes. The steaming method kills microorganisms and leaves act as a protective barrier.

Traditional and Cultural Importance: Some leaves particularly Banana leaves are commonly used in festivals and daily meals in South India. They serve both as serving plates and preservation material.

Advantages:

- Edible leaves are natural and free from harmful chemicals.
- Leaves have antimicrobial properties that prevent spoilage and contain antioxidants that delay oxidation.
- They are eco-friendly, biodegradable, easily available and cost-effective.
- Help retain moisture and freshness of food.
- Enhance flavor and aroma naturally and act as natural insect repellents.
- Add nutritional value to food.

Limitations:

- Short-term preservation only – leaves cannot preserve food for long durations

Supporting India's Industrial Expansion:

The importance of oil-free air in food, pharma and breweries



like ISO 8573-1 Class 0 which defines the highest level of air purity. From a business standpoint, this directly translates into fewer product rejections, stronger brand trust, and smoother access to export markets.

Ensuring uncompromised purity in pharmaceutical manufacturing

The pharmaceutical industry operates under some of the strictest quality controls, where purity is non-negotiable. In India's pharma sector, which ranks third globally, regulators like CDSCO mandate such standards for sterile processes. Compressed air is used extensively in drug manufacturing, packaging, and material handling and even the smallest presence of oil can compromise drug safety and efficacy.

Oil-free compressors help ensure that the environments are sterile and free from contamination, which supports compliance and reduces the risk of batch failures. As scrutiny increases this is no longer just a technology upgrade it is a basic requirement.

Consistency at the core of breweries

In breweries consistency is key. Compressed air is used in bottling, fermentation, cleaning and process control. Even a small trace of oil can affect the taste, aroma and overall quality of the product. Oil-free systems remove this uncertainty helping breweries maintain uniformity across batches and protecting their brand reputation.

What is often overlooked is the advantage of oil-free systems. They reduce the need for filters eliminate oil handling and disposal and lower maintenance requirements. This translates into lower total cost of ownership and improved energy efficiency. It also aligns with the growing push toward sustainable and responsible manufacturing.

As India strengthens its position as a global manufacturing hub, the adoption of oil-free compressed air is no longer optional but strategic. Customers and regulators want reliability, traceability and adherence to standards.

Oil-free air is no longer a niche requirement reserved for a few critical applications. It's becoming a foundational element of modern manufacturing in India. Businesses that recognise this early are better placed to scale, meet global benchmarks, and protect what ultimately matters most, their product.



Mr. Prashant Sanghotra,
Business Line Head – Oil
Free Compressors – Chicago
Pneumatic Compressors

Why is oil-free air becoming non-negotiable?

Compressed air is often referred to as the "fourth utility" in industrial operations, but its quality is frequently underestimated. In industries where air comes into direct or indirect contact with products, even microscopic traces of oil can lead to contamination, product spoilage, and costly recalls. In food production, this could mean altered taste or unsafe products. In pharmaceuticals, it could impact drug purity and in breweries, it could affect flavour consistency across batches.

Oil-free air compressors address this risk at the source. By eliminating oil from the compression process, they ensure that the air remains free from contaminants, helping manufacturers meet highest purity standards (ISO 8573-1 Class 0) without relying entirely on downstream filtration. This level of purity is not a technical goal it is also a requirement for industries that want to compete globally.

Protecting quality across every stage of food processing

In the food industry compressed air is used in stages from conveying ingredients to packaging and fermentation. Any oil contamination can change the taste, compromise hygiene and pose health risks.

Using oil-free air ensures that food products are not contaminated. It also helps companies follow recognized standards

India's industrial landscape is growing rapidly, driven by government initiatives such as Make in India, PLI schemes and increasing global demand for high-quality products. While much of the conversation around industrial growth centres on capacity, infrastructure, and investment, what truly defines it is consistency, compliance, and trust, especially in sectors such as food processing, breweries and pharmaceuticals, where product quality cannot be compromised. In many ways, this reliability comes down to the smallest details, including something as invisible, yet critical as compressed air.

Across food processing, pharmaceuticals, and breweries, compressed air is deeply embedded in everyday operations. It powers automation, supports processing and often comes in direct or indirect contact with the end product. The challenge, however, lies in ensuring that this air is absolutely clean.



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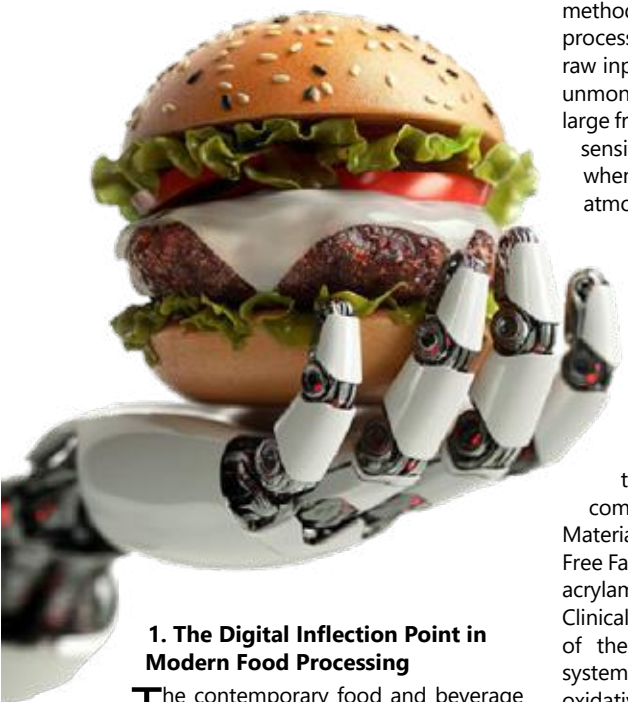


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AI & Digital Transformation in the Food Industry

¹Pallavi Ghorpade and ²Payoshni Joshi



1. The Digital Inflection Point in Modern Food Processing

The contemporary food and beverage processing landscape is undergoing an unprecedented paradigm shift. For decades, production lines were managed via highly localized mechanical machinery, legacy operational frameworks, and reliance on retrospective laboratory compliance verification. Today, escalating commodity pricing volatility, changing crop yield profiles due to shifting global environments, and strict international food safety governance mandate a structural transformation of manufacturing plants.

The integration of Artificial Intelligence (AI), the Industrial Internet of Things (IIoT), and machine learning analytics has evolved from an experimental IT luxury into a necessary foundation for operational resilience and profitability. This document provides a deep systems-engineering perspective on this transition by examining the digitization of high-volume industrial frying, snack manufacturing, commercial catering, and ready-to-eat (RTE) sectors. We analyze how legacy open-loop processes can be re-engineered into highly precise, automated, and secure cyber-physical networks.

2. Chemical Threat Matrices and Legacy Vulnerabilities

To understand the value of digital architectures, we must first examine the deep vulnerabilities inherent in legacy operational

methodologies. Within high-output processing facilities, edible process fluids and raw inputs are frequently subjected to harsh, unmonitored physical cycles. For example, in large frying systems, edible oil acts as a highly sensitive organic medium that degrades when exposed to extreme thermal peaks, atmospheric oxygen, and moisture fractions released by processed food batches.

This continuous exposure sparks an aggressive cascade of biochemical degradation paths: rapid oxidation, deep thermal hydrolysis, and molecular polymerization. These uncontrolled cycles cause the accumulation of hazardous compounds, including Total Polar Materials (TPM), elevated concentrations of Free Fatty Acids (FFA), harmful trans fats, toxic acrylamide, and cyclic monomer structures. Clinical research links the consumption of these breakdown products directly to systemic health conditions, such as acute oxidative cell damage, chronic metabolic disorders, and severe cardiovascular pathologies. Managing this resource effectively is critical for consumer safety and brand risk management.

2.1 The Liabilities of Human Sensory Observation

Historically, food processing lines relied on human operators conducting manual sensory reviews checking color changes, smelling for off-odors, feeling fluid thickness, and looking for visible smoke point drops. While cheap to start, these traditional practices have deep flaws in modern production contexts:

- **High Subjectivity and Volatility:** Environmental factory lighting variance, personal physical fatigue, and operator bias cause high variation in visual assessments, leading to inconsistent tracking between shifts and multiple manufacturing plants.
- **Lagging Structural Indicators:** Visual color shifts and odorous off-gassing are delayed indicators of molecular breakdown. By the time a human operator observes a structural change, the resource has already decayed. Early-stage, high-velocity molecular accumulations of Total Polar Materials (TPM) or Free Fatty Acids (FFA) are invisible to human sight.
- **Regulatory and Legal Compliance**

Vulnerabilities: When processing resources degrade silently, plants risk running production lines that violate national safety regulations, such as those from the Food Safety and Standards Authority of India (FSSAI), European Food Safety Authority (EFSA), and the FDA.

- **Bimodal Economic Penalties:** Lacking exact, real-time chemical data, factory managers often use arbitrary time-based replacement schedules. This leads to a double economic loss: either valuable resources are thrown away prematurely while still usable (inflating factory OPEX), or they are replaced too late, ruining product shelf-life, taste profiles, and consumer brand loyalty.

3. The Structural Components of Cyber-Physical Food Systems

Digital transformation addresses these vulnerabilities by embedding automated hardware-software loops directly into factory production lines. This replaces human guesswork with precise, repeatable, and audit-ready data tracking.

3.1 Inline Sensing Arrays and Multi-Sensor Data Fusion

Modern smart manufacturing uses automated, non-destructive testing arrays to measure the health of process materials at a molecular level without stopping active operations:

- **Continuous Dielectric Constant Sensors:** These sensors pass high-frequency electrical micro-currents through fluid asset lines to measure shifting capacitive properties. Because polar degradation products alter the medium's electrical capacitance, these devices yield highly accurate, real-time tracking of polar material buildup.
- **Total Polar Materials (TPM) Automated Sensors:** These specialized inline units output direct numerical tracking of polarization states, sending immediate alerts to the plant floor the moment the material trends toward regulatory margins.
- **Near-Infrared (NIR) Spectroscopy Sensors:** Light-emitting diodes beam near-infrared spectra through moving fluid streams. Software algorithms translate the returning absorption spectrum to isolate specific chemical bands, calculating exact percentages of

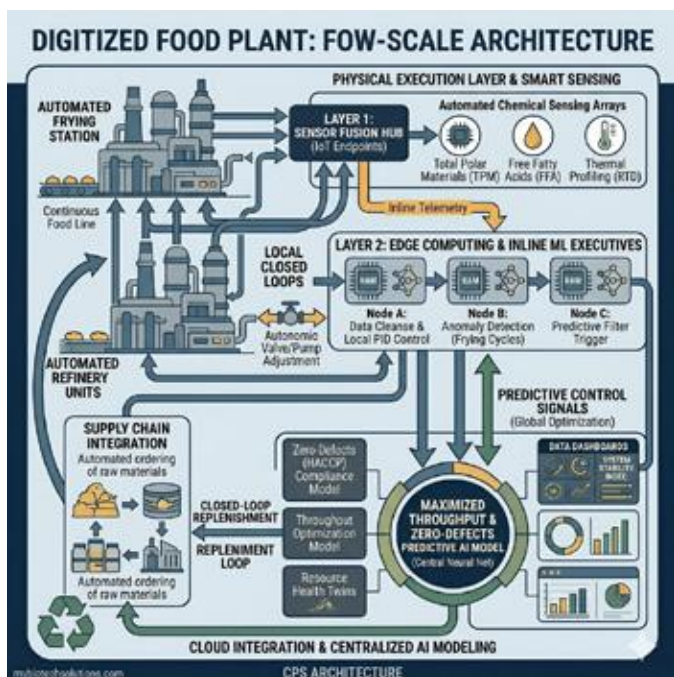


Fig No. 1 A macro-architectural view of a digitized food plant integrating cloud computing, automated chemical sensing arrays, and machine-learning execution layers to maximize throughput and ensure zero food safety defects.

Free Fatty Acids (FFA) and immediate oxidation indexes. Studies show that shifting to a sensor-driven array reduces overall resource waste by 20% to 40% while raising absolute safety margins.

3.2 IIoT-Enabled Autonomic Thermal Management Systems

Thermal volatility is the primary cause of fast material breakdown and high industrial energy waste. Modern IIoT-enabled systems stabilize this variable through tight hardware-software integration:

- Distributed Resistance Temperature Detectors (RTDs): High-precision sensors sample thermal metrics up to hundreds of times per minute across the equipment footprint to monitor temperature consistency.
- Adaptive Energy Modulation & Predictive Heating: Instead of using standard on/off heating profiles which overheat fluid boundary layers, smart systems utilize solid-state relays paired with proportional-integral-derivative (PID) algorithms. These systems model immediate batch load weights and incoming food moisture trends, adjusting power output dynamically to prevent extreme thermal spikes and significantly lower carbon polymer scaling.
- Cloud-Based Automated Logging: Every thermal cycle and parameter shift is

automatically pushed to secure remote databases. This gives plant managers unalterable digital files that streamline regulatory audits and compliance tracking.

3.3 Advanced Autonomous Micro-Filtration Loops

Particulate dropout, free moisture fractions, and carbon residue act as active catalysts that accelerate chemical degradation. Next-generation filtration loops operate dynamically alongside primary processing, utilizing complex mechanical separation techniques:

- Continuous Automated Micro-Filtration: Diverts a continuous sub-stream of fluid through high-density multi-layered porous plates, capturing micro-particles down to sub-micron dimensions before they dissolve.
- Activated Carbon & Adsorbent Absorption: Specialized media elements pull dissolved polar colorants, bitter taste compounds, and oxidation precursors right out of the fluid stream via surface adsorption.
- High-Velocity Centrifugal Purification: Spins the fluid asset to generate high G-forces, separating high-density water pockets and heavy particulate matter instantly from the processing medium.
- Vacuum-Assisted Vapor Extraction:



Fig No.2 Operational workflow showing step-by-step digital collection protocols, temperature management, and secure container management for secondary industrial valorization.

Draws a low-level vacuum over the hot fluid asset, drawing out moisture and dissolved gases to slow down hydrolytic and oxidative degradation loops. Peer-reviewed validation trials reveal that continuous advanced filtration loops extend the functional lifecycle of process oils by up to 50% while protecting flavor and texture profiles.

3.4 Machine Learning Analytics & Predictive Failure Modeling

The intelligence layer of digital transformation resides in predictive analytics. Machine learning frameworks ingest continuous data streams including real-time frying frequencies, raw batch mass variations, cumulative thermal stress indexes, resource turnover rates, and sensor-derived quality coefficients. Advanced machine learning models process this data to project exactly when an asset will reach its critical quality floor or require mechanical intervention. These systems allow plant engineers to move from reactive emergency maintenance to automated, just-in-time scheduling. This ensures unbroken compliance with international frameworks like Hazard Analysis Critical Control Point (HACCP), ISO quality parameters, and FSSAI guidelines.

4. Supply Chain Integration and Circular Economy Models

The value equation of digital transformation

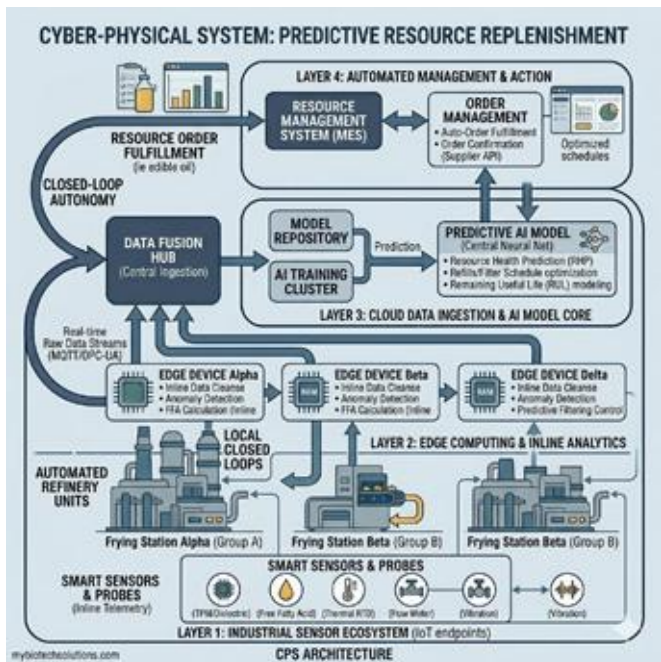


Fig No. 3 Technical architectural blueprint mapping the flow of real-time multi-sensor telemetry to edge computers and centralized AI models to automate predictive resource replenishment.

extends past the borders of the production floor. When a processing fluid reaches the absolute limit of its usable lifespan, it transitions into a digital asset within the circular economy ecosystem, preventing ecological damage and generating secondary revenue streams.

4.1 Digital Logistics and Chain-of-Custody Automation

To combat illegal fluid diversion and satisfy corporate environmental, social, and governance (ESG) targets, the exit pipeline relies on advanced tracking automation:

- GPS-Tracked Transport Fleets: Continuous geographic monitoring ensures waste fluids are moved along authorized routes with no unauthorized drop-offs or illegal handling.
- RFID-Tagged Intelligent Containers: Heavy-duty storage containment blocks use integrated radio-frequency identification tags. This ensures that every drop of waste is tracked from the plant floor straight to the receiving dock of certified recyclers.
- Immutable Blockchain Traceability Records: Transactions, weight validations, and change-of-custody handshakes are logged onto decentralized digital ledgers, establishing an audit-proof chain of custody.
- Automated Weighing and Documentation Systems: In-line

flow meters and automated digital weight bridges capture exact volume balances, matching factory outbound manifests with recycler intake volumes automatically.

4.2 Upcycling Frameworks and Valorization Technologies

Used Cooking Oil (UCO) and process waste streams are no longer treated as overhead costs; they are key feedstocks for modern industrial recycling platforms:

- High-Yield Biodiesel Production: Through advanced catalytic transesterification, collected waste fluids are refined into premium biodiesel. This fuel burns cleaner, generating vastly reduced particulate matter and a lower carbon footprint than fossil fuels. Modern processing uses specialized enzymatic and heterogeneous catalysts to achieve near-perfect conversion efficiency.
- Industrial Bio-Lubricants: Through secondary chemical modification and aesthetic refining, waste oils are upcycled into highly biodegradable lubricants tailored for heavy industrial machinery.
- Saponification & Detergent Synthetics: Waste fractions undergo chemical

5. Comprehensive Implementation Matrix

To help operations teams evaluate the strategic shift from legacy setups to smart digital transformation, the table below maps out the practical trade-offs, technology specifications, and resource requirements:

Operational Domain	Legacy Approach	Smart Digital Integration	Primary Impact Metrics
Quality Monitoring	Manual sensory sampling (color/smell); highly erratic and subjective.	Inline multi-sensor arrays (Dielectric, TPM, NIR) reading data continuously.	20%–40% reduction in resource waste; zero blind spots.
Thermal Regulation	Standard on/off thermostatic loops; causes high temperature spikes.	IIoT PID controllers paired with adaptive energy modulation.	Vastly reduced polymer scaling; minimized energy costs.
Filtration Cycles	Static passive screens; requires line shutdowns to clean or change.	Continuous multi-stage micro-filtration and vacuum extraction.	Extends functional asset lifespan by up to 50%.
Asset Analytics	Reactive response; materials are replaced only after noticeable failure.	Machine learning predictive models that project lifespan curves.	Unbroken compliance with FSSAI, HACCP, and ISO standards.
Outbound Logistics	Manual tracking; high risk of environmental dumping or theft.	RFID containers linked with blockchain ledgers and GPS routing.	100% auditable chain of custody; maximized ESG credits.

saponification, turning fatty acid chains into eco-friendly industrial cleaning solutions and surfactant bases.

- Regulated Secondary Feeds: After undergoing complete chemical purification, neutralizing, and screening, certain waste fractions are safely repurposed into livestock feed supplements under tight regulatory oversight.

6. Barriers to Global Adoption & Mitigation Blueprints

Despite the overwhelming data supporting digital transformation, systemic bottlenecks continue to slow down widespread installation across global processing networks:

- High Initial Capital Requirements (CAPEX): Outfitting legacy facilities with high-end sensor arrays, solid-state controllers, and custom machine learning software can present significant upfront costs. Mitigation: Plants should deploy modular architectures, starting with standalone inline TPM sensors before scaling up to facility-wide cloud analytics dashboards.
- Technical Skill Gaps on the Factory Floor: Frontline operators are often highly skilled in traditional mechanical workflows but lack the data literacy

required to manage complex IoT telemetry systems. Mitigation: Technology providers must deliver simple, color-coded visual interfaces (HMI screens) that turn raw data into clear, actionable commands.

- **Interoperability Bottlenecks with Legacy Machinery:** Integrating cloud-native IoT endpoints with heavy mechanical equipment that has been operating for decades presents tough engineering challenges. Mitigation: Deploying edge computing gateways can bridge the gap, translating legacy analog signals into secure MQTT or OPC-UA data streams for cloud processing.
- **Inconsistent Global Regulatory Enforcement:** In regions where environmental and food safety enforcement is lax, operators lack a strong financial incentive to adopt these advanced solutions. Mitigation: Market forces, driven by strict global brand sourcing standards and consumer demands for transparent supply chains, are increasingly forcing compliance regardless of local gaps.

7. Future Horizons & Next-Gen Innovations

The evolution of digital food processing continues to accelerate, moving from simple real-time monitoring toward true autonomous operation. Key emerging paradigms include:

- **Molecular Digital-Twin Modeling:** Creating virtual, real-time software models of a processing plant's assets. This allows systems to run simulated scenarios to maximize efficiency and predict degradation pathways before they occur.
- **Self-Cleaning Autonomous Systems:** Next-generation processing units that use real-time sensor data to trigger internal micro-filtration loops and adjust parameters completely on their own, removing the need for manual operator adjustments.
- **Enzyme-Based Resource Rejuvenation:** Integrating bio-technological filtration elements that use targeted enzymes to break down polar contaminants and free fatty acids, extending asset lifecycles far beyond current limits.
- **Automated Blockchain Supply Networks:** Smart contracts that track automated recycling systems. When a waste container fills up, the system automatically schedules a pick-up and settles the transaction with verified green fuel processors without human intervention.

8. Conclusion: The Resilient Facility Blueprint

Smart oil management and digital transformation technologies represent a major evolution in the food processing industry. Moving away from subjective manual tracking toward real-time sensor loops and predictive analytics turns a complex operational variable into a highly predictable asset. The economic and strategic benefits are clear: reduced resource waste, lower energy costs, bulletproof regulatory compliance, and verified green credentials for the circular economy. As profit margins tighten and sustainability requirements grow stricter, outfitting production floors with smart digital networks is no longer just a technology option—it is a critical requirement for long-term business resilience.

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Quality Assurance Beyond Visual Inspection in Food & Beverage Manufacturing



On a high-speed food and beverage line, small errors rarely stay small across the wider production environment.

A slightly underfilled tray. A seal that doesn't fully bond. A trace of product caught where it shouldn't be.

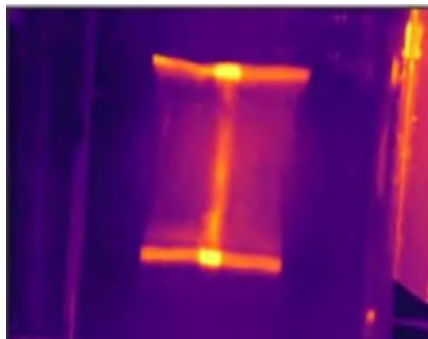
Individually, they seem minor. But multiplied across thousands of units per hour, they turn into waste, rework, complaints and sometimes recalls. And when that happens, it's not just the business that feels it. Production teams face pressure. Quality managers answer difficult questions. Consumers lose trust. Many manufacturers still rely heavily on visual inspection to catch these issues. The reality is simple. What you can see is not always what is happening.

The Real Risk on the Filling Line

Filling and sealing are deceptively complex stages as speeds are high, materials vary, and environmental conditions can shift throughout the day. Even minor temperature inconsistencies at the seal point can affect integrity. Manual inspection and standard vision systems have their place, but have limits; sampling means some packs are never checked. Operators rotate. Fatigue sets in. Opaque or multilayer packaging hides defects that traditional cameras cannot easily detect.

Weak or contaminated seals compromise shelf life and, in the worst cases, food safety, highlighting the importance of seal integrity monitoring.

When an issue escapes the line, the consequences move fast. Production stops, stock is quarantined, and teams work late to contain the damage. But it doesn't end



at the factory gates; products may be pulled from shelves, customers inconvenienced, and in serious cases, consumers put at risk. The financial cost is visible, and the human cost is felt.

Quality Control Without Blind Spots

Thermal imaging adds a different layer of control. Instead of relying on surface appearance, it measures heat distribution as seals are formed and products move through the line. The Flir A70 Smart Sensor captures detailed thermal patterns at production speed. Variations in temperature highlight underfills, trapped product in the seal area and inconsistent sealing pressure, even through opaque or printed packaging. This is not sampling. It is continuous, 100 per cent in-line inspection. Every pack. Every cycle. No sampling gaps. Defects can be rejected immediately, before they progress further downstream or leave the facility, reducing surprises.

From Checking to Controlling

When thermal inspection is integrated into existing control systems, quality shifts from reactive checking to process control. Data feeds directly into the plant's existing

platforms, creating a clear, auditable record and supporting HACCP and BRCGS requirements. Edge processing ensures decisions happen instantly, without slowing the line.

For operations teams, the impact is practical and measurable:

- Less product giveaway
- Fewer seal-related rejects
- Reduced rework and downtime
- Stronger compliance documentation
- Greater confidence during audits

Most importantly, it reduces the stress that comes with uncertainty. When operations teams can see exactly what is happening at the seal point, they make decisions earlier and have confidence that the process is under control.

Protecting More Than Product

In food and beverage manufacturing, quality failures are not just technical events. They affect people, putting reputation at risk and undermining consumer confidence. Filling Line and Seal Inspection using thermal imaging closes a critical gap. It verifies fill levels and seal integrity on every unit without adding manual workload or slowing production.

Because quality assurance should not depend on chance, eyesight, or end-of-line discovery, it should be built into the process, protecting product, performance and, most importantly, people.

Explore how seal integrity and fill accuracy can be improved across your production line.

<https://www.flir.com/campaign/food-beverage-production-monitoring/>

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PPM Technologies and Key Technology Introduce New Fully-Integrated Potato Chip Processing Line

PPM Technologies and Key Technology, both Duravent operating companies, introduce their new fully-integrated potato chip processing line at SNACKEX booth 431. Designed for processors managing raw material variability, labor shortages and the coordination demands of high-volume chip production, the line brings together PPM's frying, seasoning and product handling capabilities with Key's advanced optical sorting technology into a single, unified solution. From slicing through packaging, this integrated line helps achieve consistent product quality, recover more usable product, reduce labor requirements and offer single-source accountability with global support.

"Potato chip processing lines that hold up under challenging conditions aren't just well spec-ed," said Daniel Luna, Director of Processing at PPM Technologies. "They're built by partners who understand what each stage demands, can anticipate future needs and are committed to making those technologies work as one cohesive unit. PPM and Key have two of the longest histories in the potato chip industry, and their depth of expertise doesn't just show up at startup – it's there through the life of the equipment."

PPM's frying technology anchors the line. Processors producing kettle-style chips utilize the BatchWright™ batch fryer, which provides exacting control over the full frying curve to deliver the texture, color and flavor profiles consumers expect from premium kettle chips. Processors producing conventional potato chips utilize the CookWright™ continuous

fryer, which features customizable heating, belt and filtration configurations to meet each processor's application needs and goals. Both fryers are equipped with advanced oil filtration to extend oil life and reduce operating costs, along with clean-in-place capability that limits downtime during sanitation.

After frying, optical sorting is the last opportunity to remove defects and foreign material before product reaches packaging. Combining multi-channel sensor data and multi-wavelength strobing technology, Key's COMPASS sorter identifies dark spots, green discoloration and white knots as well as fryer debris without the more complex laser-based systems that can increase maintenance costs. Recipe-driven operation, simplified controls and an open sanitary design help processors sustain consistent inspection performance while reducing training requirements, cleaning time and maintenance burden across long production runs.

From inspection, product is transferred to PPM's versatile FlavorWright™ All-in-One seasoning system, which applies liquid and/or dry seasoning immediately before the weigh scale and packaging equipment. Since any coating inconsistency at this stage passes directly into the finished product, FlavorWright All-in-One's precise application controls are optimized to achieve consistent coverage across every batch. The system handles the full range of chip seasoning applications, from simple salt to complex multi-stage treatments using specialty oils, slurries and powders. Quick-release components support

changeovers in as little as five minutes, and IP65-rated washdown capability keeps sanitation straightforward across frequent flavor changes.

PPM's slice feeder is at the front of the line and equipped with a dual auger feed conveyor to meter whole potatoes into the slicer at a controlled rate to produce uniform slices for consistent frying. A coordinated network of PPM conveyors then connects each subsequent stage, with horizontal-motion conveyors moving chips gently between steps to minimize breakage and seasoning loss, and vibratory conveyors metering product accurately to multi-head weighers at packaging. Recirculation conveyors can also be integrated to keep product moving when a scale or packaging machine goes offline, helping processors avoid waste and maintain uptime during real production disruptions.

Beyond the conveying network, each element of the line is configured to fit the processor's plant layout and production requirements. Centralized and local controls give operators real-time visibility across the line. Key Discovery™ software collects and analyzes data about every object passing through the COMPASS sorter, helping processors identify and address trends in yield, reject rates, raw material variability and upstream equipment performance.

Processors can learn more about this integrated potato chip line and PPM's and Key's other equipment at SNACKEX 2026, taking place June 17 to 18 at FIL Expo in Lisbon, Portugal.

NETZSCH Pumps USA Highlights NOTOS® Multi Screw Pump and Barrel Emptying System for Food and Consumer Products Applications

NETZSCH Pumps USA, a global leader in complex fluid handling solutions, highlights its advanced NOTOS® multi screw pump technology integrated with its Barrel Emptying System, delivering a complete solution for food and consumer products manufacturers requiring hygienic, gentle, and

efficient product transfer from drums and containers.

NETZSCH Pumps & Systems has engineered the Barrel Emptying System with their NOTOS® 2NSH pump to address the challenges of emptying high-viscosity,

shear-sensitive, and value-added products commonly found in food and consumer goods production. The system is ideal for products such as syrups, flavorings, oils, chocolate, creams, pastes, gels, and other viscous formulations that must be handled carefully to maintain product integrity and



minimize waste. The NOTOS® 2NSH sanitary multi screw pump operates with virtually no pulsations and continuous flow, ensuring gentle product handling and precise dosing. Its design enables consistent pressure and smooth conveying, making it particularly suitable for shear-sensitive or aeration-prone media. The pump's hygienic construction supports compliance with stringent sanitary requirements, while its robust mechanical seal design contributes to long service life and operational reliability.

The Barrel Emptying System is engineered to maximize product recovery and reduce residual waste left in drums. By combining a follower plate system with the NOTOS® pump, the unit ensures near-complete emptying of containers, improving yield and reducing raw material loss. This makes it especially valuable in applications where ingredients are costly or produced in smaller, controlled batches.

Designed with sanitation and maintenance in mind, the system offers clean-in-place (CIP) capability to streamline the cleaning process and easy disassembly to minimize downtime. The system supports consistent dosing and transfer into downstream processes such as mixing, filling, or packaging. With its combination of hygienic design, gentle conveying, and high product recovery, the NOTOS® Barrel Emptying System provides food and consumer product manufacturers with a reliable, efficient solution for handling complex fluids directly from drums to batch and mix tanks and process lines.

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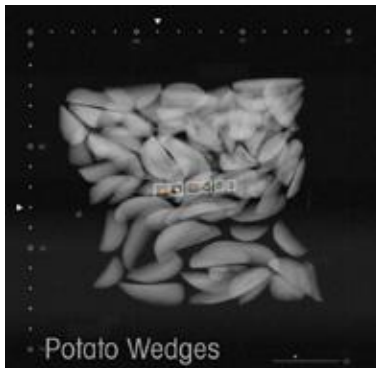
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Inspect. Protect. Comply

Mettler-Toledo Launches X56 DXD+ Dual Energy Photon-Counting X-ray System with AI Capabilities for Detecting Hard-to-Find Contaminants



Mettler-Toledo Product Inspection has announced the global launch of the X56 DXD+ dual energy photon-counting x-ray system with AI capabilities, expanding the innovative X6 Series portfolio. Designed specifically for packaged applications under the “Inspect. Protect. Comply.” ethos, the X56 DXD+ enables manufacturers to inspect every product with confidence by delivering enhanced contamination detection capabilities. This makes the x-ray solution ideal for challenging applications where low-density contaminants, such as rubber and plastics must be reliably detected. Food manufacturers benefit from protecting brand integrity and supporting premium product safety in complex formats, such as pet food, crisps or potatoes. The X56 DXD+ makes compliance with regulatory and retailer requirements easier to achieve.

The X6 Series now offers manufacturers a full range of x-ray inspection solutions to suit different product sizes, from individual packs to large cases or multi-packs. The X56 DXD+ builds on the success of the X16 and X36.2 systems and brings advanced dual energy photon-counting capabilities for medium to large-sized products on single lanes or smaller packages running across multiple lanes, in a 500mm system width.

AI Inspection for Enhanced Quality Checks

AI integration helps to improve the quality and reliability of quality inspection tasks while reducing unnecessary product rejection. This is beneficial to overcoming inspection challenges in complex scenarios like overlapping or mixed products thereby contributing to increasing production process efficiencies. The AI integration is not limited to the X56 DXD+; it is also available

on other x-ray systems within the Mettler-Toledo product range.

Built for High levels of Performance and Flexibility

Powered by DXD+ detector technology and Advanced Material Discrimination Pro (AMD Pro) software, the X56 DXD+ delivers exceptional performance for complex applications that conventional single energy systems may struggle with, particularly when detecting low-density contaminants in packaged products with high variability in thickness, density or overlapping textures, such as multi-packs, bags of crisps or bulkier cartons. This high level of detection sensitivity supports effective quality control, even in noisy or high-contrast products where conventional systems may fall short.

This makes the X56 DXD+ a powerful complement to the X6 Series. The X16 is positioned for inspecting single packages at high speed and the X36.2 is customisable for more advanced, high-throughput environments and is available for multi-lane inspections.

Smart Design for Speed & Productivity

The X56 DXD+ has been designed with operational efficiency in mind. The system combines premium detection performance with an intuitive interface, toolless belt removal for fast cleaning and a robust hygienic design suited to high-speed, high-volume environments. With throughput rates of up to 500 products per minute, the X56 DXD+ matches the demands of production lines, helping manufacturers boost efficiency and combat rising operational costs through enhanced productivity and intelligent design.

Through built-in product quality tools including completeness checks, clip detection and product trapped in seal inspection, the X56 DXD+ also supports effective quality control by enhancing consistency and protecting brand integrity beyond contamination detection alone.

Flexible Integration for a Global Market

Compatible with a wide range of conveyor heights and reject options, and available in single or multi-lane configurations, the X56 DXD+ has been developed as a global solution for manufacturers needing greater flexibility and performance. Its advanced software provides full traceability through a recorded image database, which can be accessed on-screen or integrated with Mettler-Toledo ProdX™ data management software for centralised monitoring and compliance.

This connectivity, along with support for common network protocols, makes compliance easier by enabling real-time monitoring, secure record-keeping and simplified audit readiness across global production environments. ProdX™ automates the monitoring, reporting and collation of all inspection activities in real-time. The securely stored data helps facilitate regulatory compliance, provides clear proof of due diligence to protect brand reputation and enables data-driven decisions that can lead to performance and productivity improvements across the line.

Chris Plant, Head of Market Management, Mettler-Toledo Safeline X-ray, says, “The launch of the X56 DXD+ expands our X6 Series, offering a comprehensive suite of inspection solutions tailored to modern food manufacturing. With its dual energy photon-counting capabilities, the X56 DXD+ delivers new levels of detection performance in complex packages across single and multi-lane formats. This advanced inspection capability will further help customers inspect every product with confidence, protect productivity, brand reputations and profits, plus comply easily with industry requirements.”

To learn how the X56 DXD+ dual energy photon-counting system can transform inspection for your production line, click here or visit: www.mt.com/xray-x56plus-pr

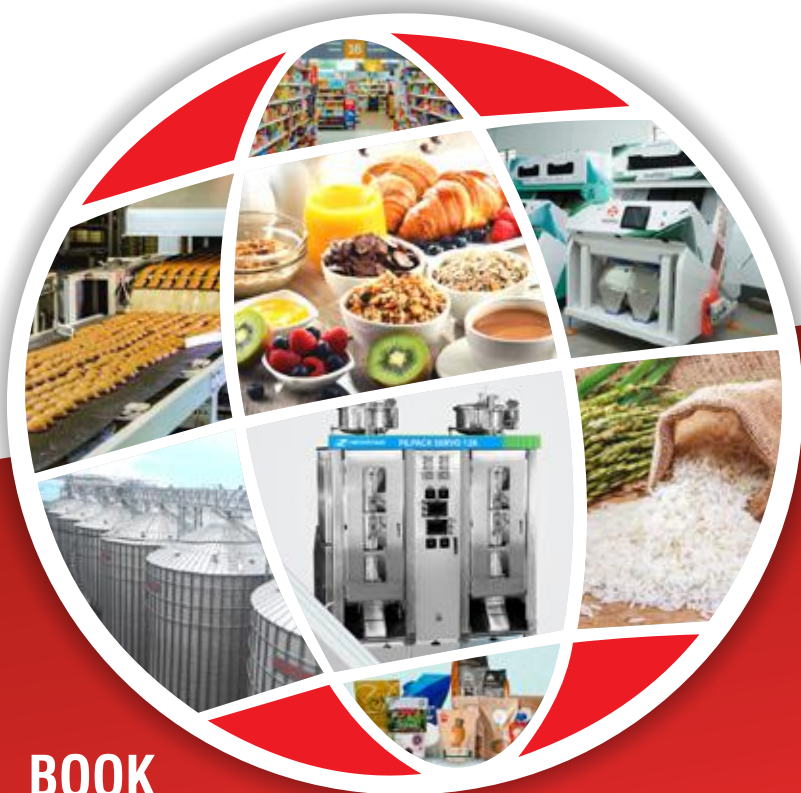
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*Proposed

Edible Packaging Revolution: Integrating Food Safety into Consumable Films

B. L. Jani, B. M. Devani, P. N. Timbadiya



	Polysaccharides	Proteins	Lipids/Waxes
Primary Benefit	Strong films, gas barrier	Mechanical strength, flexibility	Reduces water vapor transmission
Common Sources	Starch, cellulose, chitosan	Gelatin, whey, zein	Beeswax, carnauba wax
Key Properties	Abundant, antimicrobial, gel-forming	Flexible, transparent, nutritious	Hydrophobic, enhances barrier properties
Typical Applications	Dry foods, fresh produce	Confectionery, dairy products	High moisture foods

Preamble

The global food industry is undergoing a profound transformation, with increasing demand for sustainable, safe, and innovative packaging solutions. Traditional packaging materials such as plastic, paper, and aluminum have long served the purpose of preserving food quality and extending shelf life. However, these materials also pose environmental concerns and are often not biodegradable or recyclable. In response, the concept of edible packaging—a packaging solution that can be consumed along with the product—has gained significant traction. Particularly compelling is the emerging trend of combining food safety and packaging in one edible layer, offering dual functionality: protection and consumption.

This article explores the evolution, recent innovations, materials, safety aspects, consumer acceptance, and future potential of this exciting trend.

The Evolution of Edible Packaging

The idea of edible packaging is not entirely new. Early civilizations used natural leaves, beeswax coatings, or animal skins to protect food. In the modern era, the revival of this ancient wisdom has been driven by environmental pressures and food waste reduction goals.

Initial applications of edible films were mainly in fruits and vegetables to reduce moisture loss and oxidation. Over time, the focus has shifted toward more sophisticated multilayered edible coatings that not only preserve food but also enhance its microbial safety, serve as carriers of nutrients or flavors, and replace synthetic packaging in some applications.

Why Combine Packaging and Safety?

Combining packaging and safety into a single edible layer adds a multi-functional advantage to food products. This integrated approach can:

- Eliminate the need for secondary packaging
- Reduce plastic pollution
- Enhance microbial and oxidative stability of the product
- Serve as a carrier of antimicrobial agents, antioxidants, or preservatives
- Allow better control over the food's exposure to external contaminants
- Improve portion control and on-the-go consumption

By acting both as a barrier and a bioactive layer, these films support the broader goals of sustainable packaging and food security.

Materials Used in Edible Packaging

A variety of biopolymers form the backbone of edible films and coatings. These materials, sourced from natural origins, are biodegradable and renewable, making them ideal for developing environmentally friendly packaging solutions. Depending on the nature of the food product and the desired film properties, different types of biopolymers can be tailored to offer optimal performance in terms of barrier properties, flexibility, strength, and functional activity. The three primary categories of biopolymers used in edible packaging are polysaccharides, proteins, and lipids/waxes.

Polysaccharides are the most commonly used class of biopolymers in edible films. These carbohydrate-based substances are capable of forming strong films with

excellent gas barrier properties. One of the most widely used polysaccharides is starch, which is abundant, cost-effective, and offers good oxygen barrier capabilities. It is often preferred in packaging applications for dry or semi-moist foods. Cellulose derivatives, such as methylcellulose and hydroxypropyl methylcellulose, are valued for their mechanical strength, transparency, and biodegradability. These films are especially useful in applications where clarity and durability are needed. Chitosan, a biopolymer derived from chitin in crustacean shells, possesses natural antimicrobial properties, making it highly effective for enhancing the microbial safety of food surfaces. Lastly, alginate and pectin, extracted from seaweed and fruit peels respectively, are known for their strong gel-forming ability and are commonly used to coat fresh fruits, vegetables, and bakery products to reduce moisture loss and spoilage.

Proteins offer excellent film-forming abilities and are often used when mechanical strength and flexibility are essential. Gelatin, derived from the collagen of animal connective tissues, forms flexible, transparent films with good oxygen barrier properties. It is particularly useful for packaging confectionery and dairy products. Whey protein, a byproduct of the cheese-making industry, is recognized for its superior film-forming ability, as well as its nutritional value. It creates glossy, transparent films that also act as excellent carriers of bioactive compounds. Zein, a protein extracted from corn, is water-insoluble and exhibits excellent resistance to moisture. This makes it highly suitable for coating foods that require protection from humidity or water migration, such as nuts, confectionery, and baked goods.



Lipids and waxes are primarily used in edible films to reduce water vapor transmission. Their hydrophobic nature makes them ideal for preventing moisture loss in high-moisture food products. Common lipids used include beeswax, carnauba wax, stearic acid, and monoacylglycerols. These substances are often used in combination with polysaccharides or proteins to enhance the overall barrier properties of the edible film. While lipid-based films may lack mechanical strength on their own, their combination with other biopolymers creates a synergistic effect, improving film integrity, elasticity, and overall functionality in protecting and preserving food.

Together, these natural biopolymer ingredients not only serve the purpose of physical protection but also contribute to improved food safety and environmental sustainability. Their flexibility in formulation and functionality continues to make them an area of active research and innovation in the edible packaging industry.

Bioactive Components: Safety Through Functionality

What distinguishes modern edible packaging trends is the integration of bioactive substances. These can be natural or synthetic compounds incorporated into the edible film to provide antimicrobial, antioxidant, or sensory benefits.

Antimicrobial agents like Essential oils (e.g., clove, thyme, oregano), Plant extracts (e.g., green tea, grape seed, neem), Organic acids (e.g., lactic acid, sorbic acid), Enzymes (e.g., lysozyme) help control bacterial and fungal growth on the food surface. Antioxidants like Ascorbic acid (Vitamin C), tocopherols (Vitamin E), flavonoids, polyphenols from fruits and vegetables slow down oxidative degradation of lipids and pigments, improving shelf life.

Innovations and Emerging Technologies

a) Nanotechnology Integration

Nanoparticles such as nano-silver, zinc oxide, or nano-cellulose enhance barrier properties and provide improved antimicrobial action. Their small size enables better dispersion and controlled release of bioactives.

b) Layer-by-Layer (LbL) Assembly

This technique involves applying multiple ultrathin layers with different functionalities—such as moisture barrier, oxygen barrier, or antimicrobial—on the food surface. It allows precise control over layer thickness and functionality.

c) 3D Printing of Edible Films

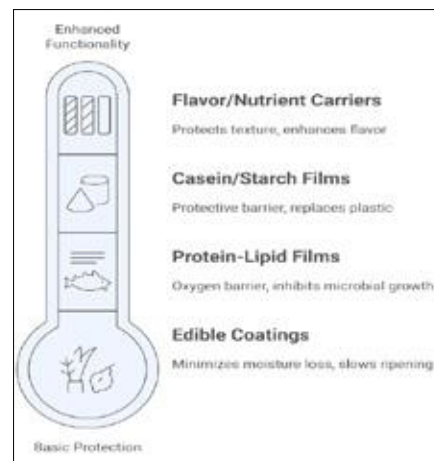
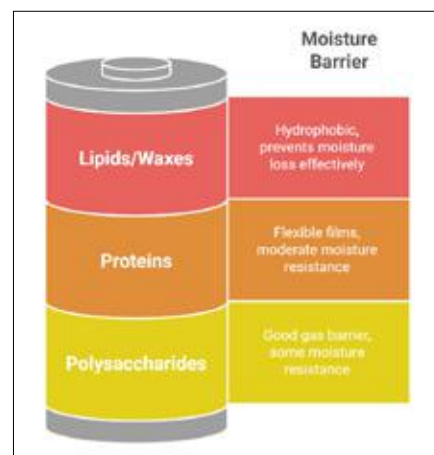
Emerging applications include 3D printing of edible structures onto food surfaces, allowing for customized textures, shapes, or even QR codes for traceability. This can also be used to deposit flavor enhancers or preservatives in specific zones.

d) Smart Packaging Features

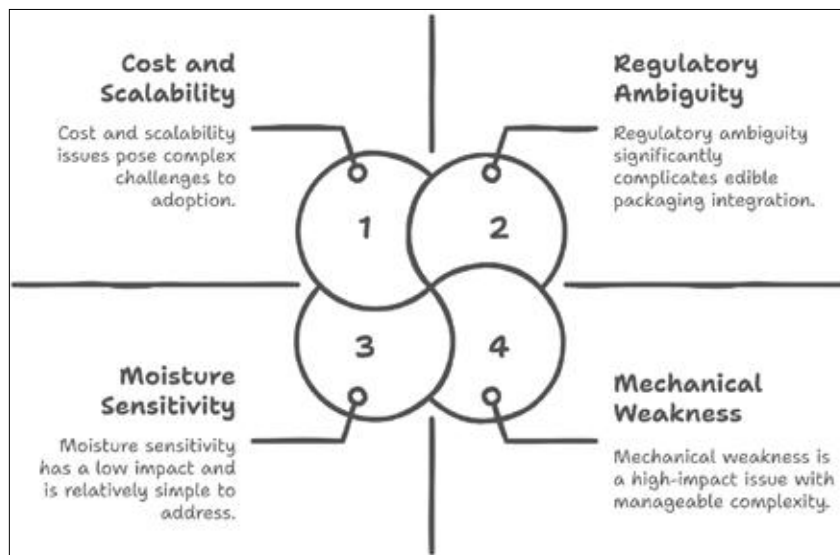
Some edible coatings are now being designed to change color or texture in response to microbial activity or pH changes, acting as freshness indicators.

Applications in Food Industry

Edible packaging has found diverse applications across various sectors of the food industry, offering both protective and functional benefits. In the case of fruits and vegetables, edible coatings are commonly applied after harvest to minimize moisture loss, slow down ripening, and reduce spoilage. For instance, coatings made with chitosan and cinnamon oil have been shown to extend shelf life while also imparting a mild, pleasant aroma that enhances consumer appeal. In meat and fish products, edible films composed of protein-lipid composites serve as effective oxygen barriers, helping to slow down lipid oxidation and maintain freshness. These coatings are often infused with natural antimicrobial agents such as rosemary or thyme extracts, which inhibit microbial growth and extend the product's safety and usability.



In the dairy and confectionery segment, edible films are increasingly used as alternatives to plastic packaging. For example, cheese blocks wrapped in casein films and chocolates coated with starch-based edible films provide a protective barrier while eliminating the need for additional packaging materials like trays or wrappers. Meanwhile, ready-to-eat and snack foods benefit from edible coatings that not only protect texture and freshness—



Challenges and Limitations

especially crispiness—but also act as carriers for flavorings, seasonings, and even nutrients, enhancing both sensory and nutritional quality. These multifaceted applications highlight the versatility and growing relevance of edible packaging solutions in modern food processing and distribution.

Regulatory and Safety Considerations

Despite their promise, edible films must meet food safety and regulatory standards. They must be:

- GRAS (Generally Recognized As Safe)
- Non-toxic and non-allergenic
- Stable during storage
- Free from harmful migration into the food

Labeling is another critical consideration. If the edible film contains bioactive compounds or allergens, it must be declared. Regulatory bodies like FDA (USA), EFSA (EU), and FSSAI (India) are actively working on guidelines for novel edible packaging materials.

Consumer Perception and Market Readiness

Consumer acceptance is a significant factor for the success of edible packaging. Surveys show mixed reactions—some consumers are excited by the innovation and sustainability, while others express concerns over hygiene and safety. Marketing and education efforts play a critical role in shifting perception. Highlighting benefits such as plastic-free convenience, flavor enhancement, and zero-waste can influence buying behavior. Additionally, customization—such as edible films with branded messages or flavors—can serve as a marketing tool and enhance consumer engagement.

Conclusion

The convergence of packaging and food safety into a single edible layer is not just a novel idea—it is a practical response to urgent global needs. By replacing non-degradable materials, reducing food spoilage, and enhancing food security, these innovative films offer a comprehensive solution. Though challenges remain, the momentum in research, sustainability goals, and consumer awareness ensures that edible safety-integrated packaging will play a pivotal role in the future of food.

Author's Bio

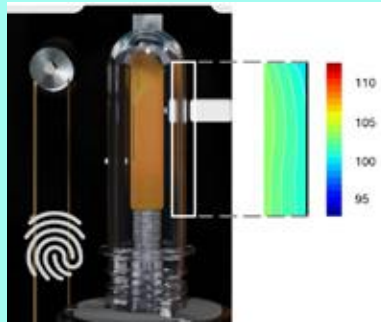
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THERMOSCAN by BMT reveals preform variability behind inconsistent stretch blow moulding results



BMT, a strategic technology provider for the global packaging industry, is showing how its THERMOSCAN preform temperature sensor helps manufacturers identify a key cause of inconsistency in PET production: variations in the thermal behaviour of apparently identical preforms.

Even with the same stretch blow moulding (SBM) recipes, differences introduced during injection moulding can affect how preforms respond to heating, leading to inconsistencies in the final product. By making the true thermal profile of the preform visible, THERMOSCAN enables more consistent and stable outcomes.

Although the process may appear stable, variations in preform behaviour can still lead to inconsistent results. As the use of recycled PET (rPET) increases and lightweighting tightens the process window, this variability becomes more difficult to manage.

THERMOSCAN measures both internal and external temperatures of preforms along their full length, capturing the complete thermal profile rather than relying on oven setpoints or surface readings alone. This makes visible the parameter that directly governs stretch behaviour: how heat is distributed through the preform wall.

Standard process controls, such as oven setpoints, do not guarantee a consistent internal preform temperature. As a result, materials that appear identical in specification can

enter the stretch process in different thermal states, creating variation that is not visible through conventional measurement methods.

“What matters in stretch blow moulding is how the preform actually behaves during heating – not just the settings used to control it,” said David McKelvey, Head of Product at BMT. “By measuring both internal and external temperature, THERMOSCAN gives manufacturers a clearer understanding of the temperature and helps them make more informed process adjustments.”

Injection differences, measurable impact on performance

In an illustrative use case, a PET bottle manufacturer operating a fixed and validated SBM process observed inconsistent performance linked to when preforms were produced. While the SBM settings did not change, preforms from one injection shift ran consistently, whereas those from another resulted in increased blowouts and greater instability.

Measurement with THERMOSCAN showed clear differences in temperature profiles between these preforms. These differences were traced back to subtle variations in injection moulding conditions, including packing behaviour, material history and cooling. Although all preforms met specification, they absorbed and distributed heat differently, resulting in different thermal states going into the stretch process.

Enabling consistent, stable production

By linking these upstream variations to downstream performance, THERMOSCAN enables manufacturers to move from reacting to instability to understanding its root cause. This reduces reliance on trial-and-error adjustments and supports better alignment between injection moulding and stretch blow moulding, helping to deliver more consistent outcomes.

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Why FMCG Brands are Quietly Moving Towards 360 Degree Shrink Sleeve Packaging

Shailesh Sheth – Chairman & Managing Director
Kris Flexipacks



When brands first encounter shrink sleeve labelling, the initial appeal is usually visual. A full-body sleeve looks premium. It makes a product stand out. That is a reasonable starting point, but it undersells what the format actually does. The more significant value of shrink sleeves is structural. They solve problems that other label formats cannot address as effectively, and they do so across several dimensions at once.

The label coverage problem

Conventional pressure-sensitive labels are designed around flat or near-flat surfaces. They work well for standard container profiles and have decades of production infrastructure behind them. But they cover a limited portion of most containers, and they do not adapt well to complex or irregular shapes. This creates a constraint that many brands have simply worked around rather than addressed. The design gets compressed into a label panel. Information competes for space. The container profile, which may have been carefully designed for ergonomic or aesthetic reasons, ends up partially obscured or visually disconnected from the label.

Shrink sleeves remove that constraint. The label conforms to the container rather than the other way around, which means a brand can design a container shape for the right reasons and trust that the label will follow it.

Design integrity across complex shapes

This point is worth dwelling on because it is more commercially relevant than it might initially appear. As packaging design has grown more sophisticated, more brands have invested in distinctive container profiles as part of their brand identity. A bottle with a recognisable silhouette, a jar with an unusual taper, a pouch with a specific structure. When the label format cannot accommodate the shape, the brand ends up making compromises at the design stage that dilute the original intent.

The most common mistake in packaging development is treating the container and

the label as separate decisions. Shrink sleeves make it structurally harder to fall into that pattern, because the format demands that both be considered together from the outset.

Tamper evidence as a functional advantage

Beyond design, shrink sleeves offer a tamper-evident function that is integrated into the format itself rather than added on. For food, beverage, and pharmaceutical brands, this is a meaningful operational advantage.

Tamper evidence has become a baseline consumer expectation in several categories. The question is no longer whether to provide it but how to provide it in a way that does not compromise the pack's visual presentation. A well-executed shrink sleeve addresses both requirements simultaneously, which is part of why adoption has grown steadily in regulated and trust-sensitive categories.

Print Quality Has Changed the Conversation

There was a time when shrink sleeve print quality was considered a genuine limitation, as the format existed but often lacked the consistency required by brands with high visual and design standards. Today, that has changed significantly. Modern shrink sleeve printing delivers high-resolution graphics, precise colour reproduction, and a wide range of specialty finishes, narrowing the gap between what a sleeve can achieve and what a premium rigid container can offer. For most applications, this difference is no longer meaningful. As a result, the last major technical objection typically raised by brand and design teams when shrink sleeves are proposed has largely been eliminated.

The sustainability work in progress

It would be incomplete to discuss shrink sleeves without acknowledging the recyclability question. Multi-layer sleeve materials have presented end-of-life challenges that the industry is actively working through. Progress is being made on mono-material constructions and designs

that facilitate sleeve separation in recycling streams, but this remains an area where technical solutions are still maturing.

Brands adopting shrink sleeves today should be having honest conversations with their packaging suppliers about where material development is heading and how their current choices will sit within future sustainability requirements. Kris Flexipacks treats this as part of the development conversation rather than a separate compliance discussion.

What the format ultimately offers

Shrink sleeves are not the right format for every application. No single format is. But for brands dealing with complex container shapes, demanding shelf environments, category trust requirements, or the need to communicate more within the same pack footprint, they offer a combination of capabilities that is genuinely difficult to replicate otherwise.

India's FMCG market, valued at USD 287.91 billion in 2025 and projected to grow at a CAGR of 16.64 percent through 2034, represents one of the most competitive consumer goods environments in the world. In that context, formats that deliver both functional reliability and visual differentiation will only grow in strategic importance.

The growth in adoption across beverages, dairy, and personal care reflects brands arriving at that conclusion through their own experience. The format has earned its place not through marketing but through performance.

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Actron expands its services into co-packing in the Philippines with SIG's flexible aseptic carton filling technology



In response to rising demand for ready-to-drink beverages and dairy products in the Philippines, Actron Industries, Inc., a leading Philippine food solutions company, is expanding its packaging portfolio with advanced aseptic carton filling technology from SIG. Actron will install a state-of-the-art SIG Midi 12 Aseptic filling line at its plant in Calamba, Laguna. Commercial production is scheduled to begin at the end of the second quarter of 2026.

Once operational, the SIG Midi 12 Aseptic will allow Actron to aseptically fill a broad range of products for its customers on a single high-performance system. These include ready-to-drink juices, teas, dairy beverages, cooking creams and all-purpose cream, sup-

porting brand owners seeking greater flexibility and efficiency in their co-packing supply chain. By expanding its packaging portfolio and technology, Actron can help local brands innovate with new product categories and packaging formats more quickly.

The SIG Midi 12 Aseptic is capable of filling up to 12,000 aseptic cartons per hour. It delivers format flexibility to fill both SIG MidiB-loc and SIG MidiFit on the same filling line, as well as volume flexibility (500ml, 750ml, and 1,000ml) with quick changeovers done in minutes. This allows contract manufacturers to adapt quickly to new market and customer needs and support beverage manufacturers and brand owners with fast product launches in a variety of formats without compromising on speed and output.

Noer Wellington, Commercial Director for Southeast Asia, Japan and Korea at SIG, commented: "This partnership brings our flexible aseptic filling technology closer to the Philippines' dairy and juice industry. Enabled by our packaging system, Actron can support local manufacturers respond to evolving con-

sumer preferences with advanced packaging solutions that enable faster innovation and scalable growth." Actron Industries, Inc. is a Filipino food solutions company with over 40 years of experience in food ingredient trading, product development, and manufacturing. Actron provides outsourcing services for fast-moving consumer goods, including powder and beverages.

Mannito C. Dueñas, EVP Commercial Operations at Actron Industries, Inc., added: "This investment reinforces Actron's position as a leading co-packing partner in the Philippines. By incorporating SIG's flexible filling system, we can offer greater scale, agility, and value to brand owners looking to innovate."

Nicolas Tan, Head of Market for Malaysia, Vietnam and Philippines at SIG, concluded: "This collaboration reflects a shared commitment to accelerating innovation and operational flexibility for local food and beverage brands. We see growing appetite in the region for more agile, scalable packaging systems, especially from emerging brands looking to test and launch quickly."

Thai Coconut grows its global market presence with an aseptic PET line from Sidel



Thai Coconut Public Company Limited (Thai Coconut) adopts Sidel's aseptic PET production line to deliver the safe, efficient and sustainable production of both still and carbonated soft drink (CSD) varieties with distinct packaging designs. Thai Coconut, a leading manufacturer of coconut-based products, traditionally for packaging in cans and cartons, has adopted Sidel's PET packaging solution to expand its exports of coconut juices, while ensuring international standards of line efficiency, low resource consumption and high-performing packaging.



To meet its needs, Thai Coconut turned to Sidel for its complete aseptic PET line – which in turn had to be flexible enough to produce both carbonated and still coconut juices, while also delivering total food safety, operational efficiency and packaging design that is both functionally and visually appealing.

"We chose Sidel due to its strong reputation and proven expertise in the aseptic market. Sidel's packaging team have also developed a new bottle design, which enhances both our marketing impact and shelf presence," said Montri Banraungsanor, Chief Technical



Officer at Thai Coconut Public Company Limited.

Safety and efficiency with real-time monitoring

Thai Coconut's installed line integrates Sidel's Aseptic Combi Predis™ technology, operating at 45,000 bottles per-hour. This advanced system seamlessly combines preform sterilisation, blow moulding, filling and capping into a single, efficient process. Throughout, product integrity is maintained and shelf life for sensitive goods, such as coconut products, is effectively extended.



Predis technology employs a dry preform decontamination method, significantly reducing both water and chemical consumption while never compromising food safety. Consequently, Thai Coconut benefits from the most robust food safety standards while optimising resource usage.

Additionally, Sidel's Evo-ON performance technology is integrated within the line to monitor and optimise production in real-time based on actionable insights for operators and management.

Flexibility and ease for alternative packaging formats

The aseptic line can process both CSD and non-CSD aseptic products on a single line, offering enhanced flexibility in terms of product and packaging formats. It accommodates multiple distinct bottle types of coconut juice, 350ml non-CSD and 350ml CSD using the same filler, further underlining its flexibility. This versatility helps to optimise total cost of ownership (TCO). Aseptic Combi Predis is engineered for operational simplicity, allowing users to manage the sterilisation process with ease, limit downtime and minimise the need for extensive training.

Export readiness

A key driver for Thai Coconut's partnership with Sidel was the need to meet international regulations, particularly those set by the Food and Drug Administration (FDA).

Sidel's aseptic PET production line is FDA-ready, ensuring that products manufactured on the line comply with requirements for export to the US and other global markets. Currently, 90% of production from the new line is designated for international markets, allowing Thai Coconut to access new growth opportunities and reinforce its reputation for quality and reliability in the global beverage industry.

Assured packaging design expertise

Sidel's expertise in both aseptic technology and packaging played a pivotal role in assisting Thai Coconut to introduce a new bottle design, enhancing marketing opportunities and increasing shelf distinction.

"We're recognised by customers as a reliable partner for PET packaging and aseptic solutions. Demonstrating our commitment to the performance of our customers, during customer validation, the recent line installed at Thai Coconut delivered 100% efficiency," said Parkpoom Praprom, Sales Director for Southeast Asia Pacific at Sidel.

To find out more about the Aseptic Combi Predis, and how businesses can access this kind of support, visit the Sidel website.

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Sugar is Not a Commodity - It's Food

Reframing a misunderstood ingredient in India's evolving food safety landscape

Anurag Mishra

The Spoon That We Trust — But Rarely Question

In India, food is never just nourishment—it is memory, ritual, and belief. One of the simplest yet most powerful traditions across households is the act of eating dahi-cheeni before an important moment. Whether it is a school exam, a business deal, or a new beginning, a spoonful of curd mixed with sugar carries a message of optimism—"Sab achha hoga."

But imagine this: shortly after consuming it, the person falls ill—stomach discomfort, nausea, unease. What would be the immediate reaction in most homes? Almost instinctively, the blame would fall on the curd. "The curd must have been spoiled."

This reaction is not surprising. Curd, being a dairy product, is perceived as high-risk—perishable, sensitive to storage conditions, and prone to spoilage. Sugar, on the other hand, escapes scrutiny entirely. It is assumed to be neutral, safe, and inert.

And yet, this assumption is where one of the biggest blind spots in our food system lies.

Because sugar, despite its low moisture content and longer shelf stability, can also carry contamination—physical, microbial, and chemical. And when it does, it doesn't just affect itself; it becomes a vehicle that contaminates the foods it is added to.

This is where the industry must confront a critical truth: ***Sugar is not merely a traded commodity—it is food.***

Breaking the Commodity Mindset

For decades, sugar has largely been treated as a bulk commodity. The parameters that dominate decisions are straightforward: price per kilogram, availability, color grade, and logistics efficiency. This perspective has shaped procurement practices, manufacturing priorities, and even operational discipline across parts of the value chain.

But unlike steel, cement, or petrochemicals, sugar has a fundamentally different end-use profile. It is directly consumed by humans, often without further processing—stirred into tea, sprinkled over fruits, added to milk, or used in home-cooked desserts.

Even when used industrially, sugar becomes a core ingredient in products like sweets, beverages, bakery items, dairy, pharmaceuticals, and nutraceuticals. Any lapse in its quality or safety does not stay confined—it cascades into multiple downstream products.

Continuing to treat sugar as a commodity ignores a simple fact: ***If a product enters the human body, it must be governed by food safety principles, not just trade specifications.***

Understanding the True Risk Profile of Sugar

Sugar is often described as "low risk," and from a microbiological growth perspective, that is largely correct. Its low water activity inhibits the proliferation of many bacteria. However, this should not be confused with immunity to contamination. In reality, sugar presents a unique risk profile—not because it promotes microbial growth within itself, but because it can act as a carrier of contamination.

1. Physical Contamination: The Most Immediate Threat

Sugar manufacturing involves multiple stages—cane handling, crushing, evaporation, crystallization, drying, and packing. At each stage, there is potential for foreign matter to enter the product stream.

Common risks include:

- Metal fragments from worn machinery
- Fibers or threads from packaging materials
- Plastic and rubber particles from components
- Stones or extraneous matter from raw material handling
- Insect parts from inadequate pest control

Unlike microbial contamination, physical contaminants are often immediately visible and can cause direct consumer harm, leading to instant rejection and brand damage.

Microbial Contamination: Low Growth, High Impact

While sugar does not support active bacterial growth, it can still harbor microorganisms such as:

- Yeasts and molds
- Environmental bacteria
- pores that survive adverse conditions

The more critical risk emerges when sugar is added to high-moisture foods—such as curd, syrups, beverages, and desserts. In these environments, any microbes introduced via sugar can activate and multiply, turning sugar into a silent contamination vector.

3. Chemical Contamination: The Invisible Risk

Perhaps the most underestimated risk in sugar manufacturing is chemical contamination. This often arises from lapses in maintenance, cleaning, and material handling.

Potential sources include:

- Non-food-grade lubricants in machinery
- Hydraulic oil leaks
- Cleaning chemical residues
- Pest control agents

- Paint flakes or corrosion inhibitors

Unlike physical contaminants, chemical residues may not be detectable by sight, smell, or taste—making them particularly dangerous.

From Factory to Food System: Why It Matters

Sugar occupies a unique position in the Indian food ecosystem. It is not just an industrial input—it is a household staple, deeply embedded in daily consumption and cultural practices.

This means:

- A single batch of contaminated sugar can affect thousands of homes
- It can enter multiple product categories simultaneously
- Consumers are less likely to suspect it, allowing issues to persist undetected

In such a context, treating sugar casually is not just an operational oversight—it is a systemic risk.

Reimagining Sugar Manufacturing as Food Processing

If sugar is food, then sugar mills and refineries must operate with the same discipline as any modern food processing unit. The transition does not require reinvention—it requires adoption of foundational food safety practices.

1. Physical Control Measures: Engineering Out Risk

- Multi-stage sieving systems to remove foreign particles at different process stages
- Magnetic separators to capture ferrous contamination
- Metal detectors before packing as a final safety checkpoint
- Covered conveyors and enclosed systems to prevent environmental exposure

These interventions ensure that contamination is not just detected, but prevented by design.

2. Eliminating Exposure: Protecting the Product

One of the most important principles in food safety is minimizing product exposure. Open handling increases vulnerability to:

- Airborne dust
- Insects
- Human contact
- Falling debris

Moving toward closed handling systems, protected transfer points, and controlled

environments significantly reduces contamination risk.

3. Personal Hygiene: The Human Factor

In any food system, people are both the strongest asset and a potential risk. Ensuring strong hygiene standards is non-negotiable:

- Mandatory handwashing protocols
- Use of protective gear (hairnets, gloves)
- Restricted access to critical zones
- Training on hygiene and contamination awareness

Food safety is not achieved through policies alone—it requires behavioral consistency.

4. Food-Grade Maintenance Practices

Maintenance teams play a critical role in preventing chemical contamination. Key practices include:

- Use of food-grade lubricants in moving parts near product zones
- Preventive maintenance to eliminate leaks and wear
- Controlled and labeled storage of chemicals
- Avoidance of ad hoc repair practices that introduce risk

In food systems, “maintenance quality” equals “product safety.”

5. Cleaning and Pest Control: Beyond Compliance

- Structured cleaning schedules for equipment, floors, and hard-to-reach areas
- Validation of cleaning processes to ensure no chemical residues remain
- Integrated pest management combining prevention, monitoring, and safe interventions

These are not auxiliary activities—they are core to ensuring product integrity.

Evolving the Definition of Quality in Sugar
Traditionally, sugar quality has been evaluated using parameters such as:

- ICUMSA color value
- Moisture content
- Polarization
- Grain size

While these attributes remain important, they represent only part of the picture. A true “food-grade” definition of sugar must include:

- Absence of foreign matter
- Hygienic processing conditions
- Robust contamination controls

- Traceability and documentation
- Consistency across batches

Because in food systems, quality is not just what you measure—it is what you assure repeatedly.

Business Implications: Safety as a Value Driver

Adopting a food-centric approach to sugar manufacturing is not just about compliance—it is a business strategy.

It delivers:

- Reduced customer complaints and rejections
- Lower cost of non-quality
- Stronger acceptance in organized retail and institutional buyers
- Enhanced brand trust
- Better export readiness

In an increasingly quality-conscious market, safety is no longer a cost center—it is a competitive advantage.

A Cultural Shift for the Industry

India's sugar sector is one of the largest in the world, with deep agricultural roots and significant economic impact. As the industry evolves—from bulk supply to branded and value-added products—it must also evolve in mindset.

The shift required is simple yet profound:
From **“How much sugar are we producing?”**
to
“How safely are we delivering it?”

Conclusion: Rebuilding Trust, One Spoon at a Time

The next time we see a bowl of dahi-cheeni, let us look at it differently. Let it remind us not just of tradition, but of responsibility. The trust that consumers place in food is silent but absolute. And that trust must extend to every ingredient—no matter how simple, how common, or how familiar it may seem.

Sugar may appear harmless, but its reach is vast, and its responsibility is real.

It is not defined by its price on a trading sheet, but by its presence in our daily lives. It sits in our kitchens, our celebrations, our rituals—and ultimately, in our bodies. And that is why it must be treated with care, control, and respect.

Because sugar is not a commodity. It is food—and it must be protected as one.

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Fermented Functional Beverages: Kefir as A Next-Generation Probiotic Drink

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Introduction

Kefir is a fermented functional beverage traditionally produced using milk and kefir grains containing a complex symbiotic consortium of bacteria and yeasts. It originated in the Caucasus Mountains and has gained worldwide attention because of its probiotic potential, nutritional richness, antimicrobial activity, and health-promoting properties. Kefir can be prepared from cow, buffalo, goat, sheep, coconut, soy, or plant-based milk substrates. The fermentation process produces lactic acid, ethanol, carbon dioxide, bioactive peptides, vitamins, and exopolysaccharides such as kefiran, which contribute to its unique sensory and therapeutic properties.

Starter Culture of Kefir

Kefir fermentation is traditionally carried out using kefir grains, which are gelatinous, irregular white-yellow granules composed of Lactic acid bacteria (LAB), Acetic acid bacteria, Yeasts and Polysaccharide matrix (kefiran).

Kefir is increasingly used in Functional beverages, Probiotic dairy products, Nutraceutical formulations, Synbiotic foods, Fermented desserts, Sports nutrition products. Microencapsulation and spray drying technologies are also being explored to improve probiotic stability in kefir products. Despite its benefits, kefir commercialization faces challenges such as variability in microbial composition, shelf-life limitations, standardization issues and sensory acceptability. The future research on kefir is focusing on controlled starter cultures, non-dairy kefir products, personalized probiotic formulations, encapsulation technologies and clinical validation of therapeutic effects.

These microorganisms exist in symbiosis and contribute to flavor, texture, acidity, and probiotic characteristics. Nowadays starter culture for kefir with desirable microbes are also available.



Milk kefir grains



Kefir starter



Water kefir grains

- **Lactic Acid Bacteria:** *Lactobacillus kefir*, *Lactobacillus kefiranoferiens*, *Lactococcus lactis*, *Leuconostoc mesenteroides*, *Streptococcus thermophilus*
- **Yeasts:** *Saccharomyces cerevisiae*, *Kluyveromyces marxianus*, *Candida kefir*
- **Acetic Acid Bacteria:** *Acetobacter aceti*, *Acetobacter pasteurianus*

Types of Kefir

1. **Milk Kefir** : It is prepared using milk and kefir grains. It is the most common form and contains abundant probiotics, proteins, calcium, and vitamins.
2. **Water Kefir** : It is produced using sugar water or fruit juice fermented with water kefir grains. It is dairy-free and suitable for lactose-intolerant individuals.
3. **Coconut Kefir** : It is prepared from coconut milk or coconut water. It possesses probiotic benefits along with medium-chain fatty acids.
4. **Soy Kefir** : It is produced using soy milk and kefir culture. It is popular among vegan consumers and it is rich in plant proteins and isoflavones.
5. **Fruit-Based Kefir** : Fermented fruit juices are used as substrates to develop flavored probiotic beverages.

Nutritional Value of Kefir

Kefir is considered a nutrient-dense functional food containing Kefir also contains essential amino acids, bioactive peptides, organic acids and exopolysaccharides (kefiran)

Nutrient	Approximate Composition
Protein	3–4%
Fat	1–6%
Carbohydrates	4–5%
Calcium	100–150 mg/100 mL
Vitamin B12	Moderate amount
Riboflavin	Rich
Magnesium	Rich
Phosphorus	Rich
Probiotics	10 ⁶ –10 ⁹ CFU/mL



Health Benefits of Kefir

1. **Probiotic Activity:** Kefir improves gut microbiota balance and enhances intestinal health through beneficial microorganisms.
2. **Antimicrobial Properties:** Organic acids, bacteriocins, and kefirin inhibit pathogens such as *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*.
3. **Improved Lactose Digestion:** Kefir contains β -galactosidase enzyme that helps lactose-intolerant individuals digest milk sugars more effectively.
4. **Immunomodulatory Effects:** Kefir stimulates immune responses and may enhance macrophage and lymphocyte activity.
5. **Antioxidant Potential:** Bioactive compounds in kefir reduce oxidative stress and free radical damage.
6. **Anti-inflammatory Activity:** Kefir metabolites may suppress inflammatory mediators and improve metabolic health.
7. **Cholesterol-Lowering Effect:** Certain probiotic strains in kefir can reduce serum cholesterol by bile salt hydrolase activity.
8. **Anticancer Potential:** Studies suggest kefir may inhibit tumor cell proliferation through immune modulation and apoptosis induction.

Commercial applications and challenges

Kefir is increasingly used in Functional beverages, Probiotic dairy products, Nutraceutical formulations, Synbiotic foods, Fermented desserts, Sports nutrition products. Microencapsulation and spray drying technologies are also being explored to improve probiotic stability in kefir products.

Despite its benefits, kefir commercialization faces challenges such as variability in microbial composition, shelf-life limitations, standardization issues and sensory acceptability. The future research on kefir is focusing on controlled starter cultures, non-dairy kefir products, personalized probiotic formulations, encapsulation technologies and clinical validation of therapeutic effects.

Conclusion

Kefir is a multifunctional fermented beverage rich in probiotics, nutrients, and bioactive compounds. Its diverse microbial consortium contributes to numerous health benefits including antimicrobial, antioxidant, immunomodulatory, and gut-health-promoting effects. Growing consumer interest in functional foods and probiotics has increased the commercial importance of kefir in both dairy and non-dairy sectors.

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Functional Food Probiotics Market Size to Reach USD 113.94 Billion by 2034 at a CAGR of 8.05% from 2026 to 2034

Growing Consumer Interest in Preventive Health and Gut Wellness

The global food and beverage industry is witnessing a major shift as consumers increasingly prioritize preventive healthcare, digestive wellness, and immune support. This trend is fueling rapid growth in the functional food probiotics market, which is expected to rise from USD 56.77 billion in 2025 to USD 113.94 billion by 2034, registering a CAGR of 8.05%. As awareness of the gut microbiome and its impact on overall health grows, consumers are turning to probiotic-enriched foods and beverages that offer benefits beyond basic nutrition.

Functional Foods Gain Popularity Across Consumer Segments

The demand for probiotic-fortified products continues to increase as consumers seek nutritional solutions that support digestive health, immunity, and overall well-being. Products ranging from dairy beverages and cereals to infant nutrition and functional snacks are becoming increasingly popular. The growing emphasis on personalized nutrition, clean-label ingredients, and scientifically validated health benefits is further strengthening market demand.

Dairy-Based Products Remain the Leading Probiotic Category

Dairy products continue to dominate the functional probiotics market, accounting for nearly half of global revenue in 2025. Yogurt, kefir, cultured beverages, and fermented milk products remain widely preferred due to their strong association with digestive health and their ability to effectively deliver live probiotic cultures. Their established consumer acceptance and nutritional profile continue to support market leadership.

Plant-Based Alternatives Drive New Opportunities

The rise of vegan, flexitarian, and lactose-intolerant consumer groups is creating strong demand for plant-based probiotic products. Manufacturers are increasingly introducing probiotic formulations based on oat, almond, soy, coconut, and cashew ingredients. These products not only broaden consumer access-

ibility but also align with growing sustainability goals and clean-eating trends, making them a key growth area for the industry.

Innovation Enhances Product Stability and Performance

Technological advancements are playing a critical role in shaping the future of probiotic foods. Companies are investing in advanced encapsulation techniques, strain-specific formulations, and innovative delivery systems to improve probiotic survival during processing and storage. The yeast-based probiotics segment is expected to witness particularly strong growth due to its enhanced stability and versatility in food applications.

Asia Pacific Leads Global Market Expansion

Asia Pacific remains the largest regional market, accounting for approximately 40% of global revenue in 2025. Rapid urbanization, rising disposable incomes, evolving dietary habits, and increasing awareness of digestive health are driving probiotic consumption across countries such as India, China, Japan, and South Korea. The region continues to offer significant opportunities for manufacturers seeking long-term growth.

India Emerges as a Key Growth Market

India is becoming one of the most promising markets for probiotic products. The country's probiotics sector has doubled in size over the past five years, reaching INR 2,070 crore in 2025. Growing consumer focus on immunity, preventive healthcare, and wellness-oriented nutrition is expected to accelerate adoption and create new opportunities for domestic and international brands.

North America and Europe Continue to Expand

Developed markets in North America and Europe are also experiencing steady growth, supported by increasing consumer interest in functional nutrition and microbiome-based wellness solutions. Ongoing investments in research, product innovation, and advanced probiotic delivery technologies are helping expand the range of available products and drive consumer adoption.

Leading Industry Players Focus on Research and Partnerships

Competition within the probiotics sector is intensifying as leading companies invest in innovation, clinical research, and strategic collaborations. Major market participants are expanding their portfolios through the development of clinically validated probiotic strains, advanced fermentation technologies, and targeted health solutions. Recent partnerships and product launches demonstrate the industry's commitment to addressing evolving consumer health needs.

Regulatory and Technical Challenges Remain

Despite strong growth prospects, the industry continues to face challenges related to maintaining probiotic viability throughout manufacturing, transportation, and storage. In addition, varying global regulatory requirements and increasing scrutiny of health claims require manufacturers to support products with robust scientific evidence and transparent communication.

The Future of Probiotics Lies in Personalization

Future growth is expected to be driven by precision probiotics, personalized nutrition, synbiotic formulations, and artificial intelligence-powered health solutions. As scientific understanding of the human microbiome continues to evolve, probiotic products are likely to become increasingly tailored to individual health needs and lifestyle preferences.

A Promising Outlook for Functional Nutrition

With consumers placing greater emphasis on digestive health, immunity, and holistic wellness, probiotics are becoming an integral part of the functional food landscape. The market's projected value of USD 113.94 billion by 2034 highlights its growing importance in shaping the future of food and beverage innovation, creating substantial opportunities for manufacturers, ingredient suppliers, and health-focused brands worldwide.

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Millets vs Millet Microgreens: Which Packs More Nutrition?

Vasanthasri J¹, Geethanjali S², Jayadevi S³ and UmaMaheswari T⁴



Introduction

In recent years, there has been a growing awareness among people about the importance of healthy eating and nutrient-rich foods. As a result, traditional foods such as millets are regaining popularity, while emerging functional foods like millet microgreens are attracting increasing attention as modern “superfoods.” Both millets and millet microgreens originate from the same seeds but are consumed at different stages of growth, resulting in distinct nutritional characteristics and health benefits.

Millets have been cultivated and consumed for centuries, particularly in India, due to their adaptability, affordability and rich nutritional value. They are excellent sources of complex carbohydrates, dietary fiber, proteins, vitamins and minerals, and play an important role in providing sustained energy and supporting digestive health. On the other hand, millet microgreens are young seedlings harvested at an early stage of growth and are known for their concentrated levels of vitamins, antioxidants, bioactive compounds and phytonutrients.

With increasing concerns about lifestyle diseases, nutritional deficiencies and sustainable food choices, both millets and millet microgreens are becoming valuable components of modern diets. Although they differ in nutrient composition and mode of consumption, they should not be viewed as competing foods. Instead, they complement each other nutritionally. While millets serve as an excellent source of energy and fiber, millet microgreens provide enhanced levels of antioxidants and micronutrients. Therefore,

incorporating both millets and millet microgreens into daily diets can help improve overall health, nutrition and well-being.

Millets

Millets are a group of small-seeded cereal crops that have been cultivated and consumed by humans for thousands of years. They are among the oldest traditional grains known to mankind and have played a major role in the dietary habits of people, particularly in Asian and African countries. In India, millets were once widely used as staple foods before the increased consumption of polished rice and wheat. Due to their high nutritional value and adaptability to harsh environmental conditions, millets are now regaining importance as nutritious and climate-resilient crops.

Different types of millets are cultivated across India based on regional food habits and climatic conditions. Commonly consumed millets include finger millet (Ragi), pearl millet (Bajra), foxtail millet, little millet, kodo millet, barnyard millet, proso millet and sorghum. These grains are used in the preparation of various traditional foods such as porridge, rotis, idli, dosa, snacks and beverages. In recent years, millets have also been incorporated into modern food products including biscuits, noodles, bakery items and ready-to-eat health foods.

One of the major advantages of millet cultivation is their ability to grow under adverse environmental conditions. Millets require comparatively less water than major cereal crops and can survive in drought-prone and semi-arid regions. They can grow well in

poor soil conditions with minimal agricultural inputs and are less susceptible to pests and diseases. Because of these characteristics, millets are considered environmentally sustainable crops that support climate-smart agriculture. Their cultivation not only benefits farmers by reducing production costs but also contributes to the conservation of natural resources.

Nutritional Value of Millets

Millets are recognized as nutrient-rich grains due to their balanced composition of carbohydrates, proteins, dietary fiber, vitamins and minerals. Unlike refined cereals, millets provide slow-releasing energy because they contain complex carbohydrates with a low glycemic response. This helps in maintaining blood sugar levels and provides sustained energy throughout the day. Millets are also excellent sources of dietary fiber, which plays an important role in improving digestive health. Fiber helps in proper bowel movement, prevents constipation and supports gut health. The high fiber content also promotes a feeling of fullness, which may help in weight management and reduce overeating. Protein present in millets contributes to body growth, tissue repair and muscle maintenance. Although the protein content varies among different millet species, many millets provide significant amounts of essential amino acids that are beneficial for human health.

In addition to macronutrients, millets are rich in important minerals such as iron, calcium, magnesium, phosphorus and zinc. Finger millet is particularly known for its high calcium content, which supports bone and teeth health. Iron present in millets helps in the formation of hemoglobin and prevents anemia, while magnesium contributes to nerve and muscle function. Another important feature of millets is that they are naturally gluten-free. This makes them suitable for individuals suffering from gluten intolerance or celiac disease. Their gluten-free nature, combined with their rich nutritional profile, has increased their popularity among health-conscious consumers. Due to these nutritional and health-promoting properties, millets are widely regarded as functional foods that support overall well-being and help reduce the risk of lifestyle-related disorders such as diabetes, obesity, cardiovascular diseases and digestive problems.

Millet Microgreens

Millet microgreens are tender, immature seedlings produced from millet seeds. They are usually collected 7 to 14 days after germination, when the shoots are young, delicate, green, and highly fresh. These microgreens can be cultivated easily at home

using small trays with soil or hydroponic methods. Since they require very little space, water, and maintenance, they are becoming increasingly popular, especially in urban households.

Nutritional Importance of Microgreens

Although microgreens are tiny in size, they are packed with valuable nutrients and health-promoting compounds.

- They are excellent sources of vitamins A, C, E, and K.
- They contain abundant antioxidants that help protect the body against harmful free radicals and diseases.
- They possess natural enzymes that support efficient digestion.
- They are rich in chlorophyll, which assists in detoxification and overall body cleansing.
- The nutrients present in microgreens are easily absorbed and utilized by the human body.

Due to their dense nutritional composition and health benefits, microgreens are widely recognized as “superfoods.”

Bioavailability

Mature millets are naturally rich in important minerals such as iron, zinc, and calcium. However, these minerals are often bound to phytic acid, an anti-nutritional factor that can reduce their absorption in the human body. In millet microgreens, the sprouting process helps break down phytic acid and activates several beneficial enzymes. As a result, nutrients such as iron, zinc, and folate become more bioavailable and easier for the body to absorb, even when their total concentration may be comparatively lower. Thus, microgreens can provide better nutrient utilization.

Digestibility and Gut Health

Mature Millets

Mature millets contain high amounts of dietary fiber, which supports long-term digestive health and helps maintain stable blood sugar levels. They are naturally gluten-free and suitable for people with gluten intolerance. However, if millets are not properly soaked or cooked, they may sometimes cause bloating or digestive discomfort in sensitive individuals.

Millet Microgreens

Millet microgreens are tender, fresh, and easy to digest. During sprouting, some complex starches are partially broken down, improving digestibility. They also contain natural enzymes and bioactive compounds that may support healthy digestion and gut function.

Nutritional factors	Millets(Grains)	Millet Microgreens
Energy content	High	Low
Carbohydrates	High	Low
Protein	Moderate	Moderate
Fiber	High	Moderate
Vitamins	Moderate	Very high
Minerals	High	High with better bioavailability
Antioxidants	Present	Very high
Digestibility	Requires proper cooking and digestion takes longer time	Easy to digest
Enzyme activity	Low	High due to sprouting
Water content	Low	High
Chlorophyll content	Absent	Rich in chlorophyll
Glycemic index	Moderate	Lower

Nutritional Changes During Germination

The conversion of millet seeds into microgreens brings about several important biochemical and nutritional changes:

- Stored starch molecules are broken down into simpler sugars, making them easier to utilize.
- Complex proteins are partially converted into free amino acids.
- Anti-nutritional compounds, such as phytic acid, decrease during sprouting.
- Enzymatic activity increases significantly during germination.
- The levels of certain vitamins and bioactive compounds increase considerably.

Because of these transformations, millet microgreens become easier to digest and may offer improved nutrient availability and enhanced nutritional quality in several aspects.

Which Provides More Nutrition?

The nutritional value depends on the type of nutrients being considered.

- When comparing macronutrients such as energy, carbohydrates, and dietary fiber, mature millet grains are superior because they serve as excellent staple foods and provide sustained energy.
- In terms of micronutrients such as vitamins, antioxidants, enzymes, and certain bioactive compounds, millet microgreens are comparatively richer. Therefore, millet microgreens are considered more nutrient-dense per gram, whereas mature millets are more energy-dense and provide greater satiety.

Best Dietary Approach

Including both millets and millet microgreens in the daily diet can provide balanced nutrition.

- Millets can be consumed as staple foods similar to rice or wheat.
- Millet microgreens can be added to salads, soups, sandwiches, smoothies, or breakfast preparations to improve the nutritional quality of meals.

Conclusion

Millet microgreens cannot completely replace mature millets because they do not provide sufficient calories and carbohydrates required for daily energy needs. Likewise, mature millets do not contain the same abundance of fresh vitamins, antioxidants, and bioactive compounds found in microgreens. Therefore, millets and millet microgreens should not be viewed as substitutes, but as complementary components of a healthy diet. Millets supply essential energy, dietary fiber, and important minerals necessary for regular body functions, while millet microgreens provide concentrated vitamins, antioxidants, enzymes, and easily digestible nutrients. Rather than choosing one over the other, incorporating both into the daily diet is the most beneficial approach. This balanced combination can support overall health, improve nutritional intake, and help maintain an active and disease-resistant lifestyle.

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Humidity Control in Modern Food Storage: Protecting Quality, Safety, and Shelf Life

Introduction: The Invisible Factor Behind Food Quality

Food storage has always been a critical component of the food supply chain. From raw agricultural commodities and processed ingredients to finished consumer products, maintaining optimal storage conditions is essential to preserving quality, safety, and market value. While temperature management often receives the greatest attention, another equally important factor frequently operates in the background—humidity.

Humidity, or the amount of moisture present in the air, has a profound impact on food products throughout storage and distribution. Excessive moisture can encourage microbial growth, accelerate spoilage, damage packaging, and compromise product quality. Conversely, insufficient humidity can cause dehydration, weight loss, texture deterioration, and reduced shelf life. As food manufacturers face increasing demands for quality assurance, regulatory compliance, sustainability, and waste reduction, effective humidity control has become a strategic necessity rather than an optional enhancement.

Modern food storage facilities are increasingly adopting advanced humidity management technologies to create stable environments that protect products, optimize inventory life, and improve operational efficiency.

Understanding the Relationship Between Food and Humidity

Most food products interact continuously with the surrounding environment. Moisture naturally moves between food and air until equilibrium is reached. This exchange can significantly alter the physical, chemical, and microbiological characteristics of food.

Products such as grains, cereals, spices, dried fruits, dairy powders, confectionery items, and packaged snacks are particularly sensitive to humidity fluctuations. High humidity levels can cause these products to absorb moisture, leading to clumping, texture changes, microbial contamination, and loss of functionality. On the other hand, products like fresh produce, meat, and bakery goods can suffer from

moisture loss in low-humidity environments, resulting in shrinkage, reduced freshness, and diminished consumer appeal. The challenge for food storage operators is to maintain optimal humidity levels specific to each product category. This requires a detailed understanding of product characteristics, storage conditions, and environmental controls.

Why Humidity Control Matters in Food Storage

Preserving Product Quality

One of the primary reasons for controlling humidity is to maintain product quality. Moisture fluctuations can significantly impact texture, appearance, flavor, and nutritional value. For example, crackers, breakfast cereals, and snack foods are highly susceptible to moisture absorption, which can lead to loss of crispness and consumer dissatisfaction. Similarly, powdered ingredients such as milk powder, cocoa, and protein concentrates can form lumps and become difficult to process when exposed to excessive humidity. In fresh produce storage, maintaining appropriate humidity helps retain moisture within fruits and vegetables, preserving firmness, color, and freshness. Consistent humidity levels ensure products reach consumers in optimal condition.

Enhancing Food Safety

Humidity plays a direct role in microbial activity. High moisture environments create favorable conditions for mold, yeast, and bacterial growth. These microorganisms can compromise food safety, trigger product recalls, and damage brand reputation. Warehouses storing grains, nuts, spices, and dry ingredients are particularly vulnerable to mold development when humidity levels rise beyond recommended limits. Some molds can produce mycotoxins, posing serious health risks and regulatory challenges. By maintaining controlled humidity levels, food businesses can significantly reduce the risk of microbial contamination and improve compliance with food safety standards such as HACCP, GMP, and international food safety certifications.

Extending Shelf Life

Shelf life is a key performance indicator for

food manufacturers and retailers. Every additional day of product stability translates into reduced waste, improved logistics flexibility, and enhanced profitability. Humidity control helps slow quality degradation by minimizing unwanted moisture exchange. Products remain closer to their intended specifications for longer periods, reducing spoilage and preserving consumer acceptance. In an era where sustainability and food waste reduction have become major priorities, extending shelf life through environmental control represents a valuable opportunity for the entire food supply chain.

Common Humidity-Related Challenges in Food Warehouses

Condensation Formation

Condensation occurs when warm, moisture-laden air comes into contact with cooler surfaces. Water droplets can form on ceilings, walls, equipment, and packaging materials. In food storage environments, condensation presents multiple risks, including microbial growth, packaging damage, corrosion, and product contamination. Facilities that experience temperature fluctuations or inadequate ventilation are particularly susceptible to this issue.

Product Caking and Clumping

Powdered and granulated food ingredients often absorb moisture from humid air. This can result in caking, hardening, and reduced flowability. Manufacturers handling products such as sugar, flour, starches, seasonings, and dairy powders frequently invest in humidity control systems to maintain ingredient quality and production efficiency.

Mold and Fungal Growth

Excess humidity creates ideal conditions for mold development. Storage areas containing organic materials are especially vulnerable. Beyond food safety concerns, mold contamination can result in inventory losses, regulatory violations, and costly warehouse sanitation measures. Prevention through humidity management is significantly more effective than remediation after contamination occurs.

Packaging Degradation

Packaging materials can also be affected by humidity fluctuations. Paperboard, corrugated cartons, labels, adhesives, and flexible packaging structures may weaken, deform, or lose integrity under high-moisture conditions. Compromised packaging not only impacts product presentation but may also reduce barrier performance and increase the risk of contamination.

The Growing Role of Dehumidification Technology

As food storage operations become increas-

ingly sophisticated, dehumidification systems have emerged as essential tools for environmental control. A dehumidifier removes excess moisture from the air, helping maintain stable humidity levels throughout storage facilities. Modern industrial dehumidification systems are designed to operate continuously in demanding environments and can be integrated with broader warehouse management and climate control systems.

Refrigerant Dehumidifiers

Refrigerant dehumidifiers work by cooling air below its dew point, causing moisture to condense and be removed. These systems are effective in moderate-temperature environments and are commonly used in food processing and storage facilities.

Desiccant Dehumidifiers

Desiccant dehumidifiers utilize moisture-absorbing materials to remove water vapor from the air. They perform exceptionally well in low-temperature environments and applications requiring very low humidity levels. Desiccant technology is particularly valuable in cold storage facilities, pharmaceutical-grade food production, freeze-drying operations, and ingredient warehouses.

Smart Humidity Control Systems

Advancements in digital technologies have introduced intelligent humidity management solutions. Modern systems incorporate sensors, data analytics, automation platforms, and remote monitoring capabilities. These technologies enable real-time tracking of environmental conditions, automated adjustments, predictive maintenance, and comprehensive reporting for regulatory compliance.

Humidity Control in Different Food Categories

Grain and Cereal Storage

Grains are highly sensitive to moisture changes. Elevated humidity can lead to mold growth, insect infestation, and spoilage. Maintaining appropriate relative humidity levels helps preserve grain quality, reduce storage losses, and protect economic value throughout long-term storage.

Dairy and Powdered Ingredients

Powdered food ingredients require stringent humidity management. Moisture absorption can affect particle structure, solubility, processing performance, and shelf stability. Manufacturers increasingly rely on controlled storage environments to ensure consistent ingredient quality and minimize waste.

Fresh Fruits and Vegetables

Fresh produce presents a unique challenge because it continues to respire after harvest. Proper humidity levels help reduce water loss

while preventing excessive moisture accumulation that could encourage microbial growth. Different produce categories require tailored humidity settings to maximize freshness and shelf life.

Meat and Seafood Products

Humidity control is essential in chilled and frozen storage environments. Proper management helps prevent surface dehydration, freezer burn, weight loss, and quality deterioration. For high-value protein products, maintaining ideal humidity conditions can significantly impact profitability and customer satisfaction.

Confectionery and Snack Foods

Products such as chocolates, candies, biscuits, and snacks are highly vulnerable to humidity fluctuations. Moisture exposure can affect texture, appearance, and product stability. Controlled storage environments help preserve sensory quality and protect brand reputation.

Sustainability Benefits of Humidity Management

Humidity control contributes directly to sustainability goals across the food industry.

Reducing Food Waste

Food loss due to spoilage remains a major global challenge. Effective environmental control helps preserve product quality and extend shelf life, reducing waste throughout the supply chain.

Improving Energy Efficiency

Modern dehumidification technologies are becoming increasingly energy efficient. Smart systems optimize operation based on real-time conditions, reducing unnecessary energy consumption while maintaining target humidity levels.

Minimizing Product Recalls

Humidity-related contamination can lead to costly recalls and disposal of large product volumes. By preventing quality and safety issues, humidity control supports more sustainable manufacturing and distribution practices.

Supporting Circular Economy Initiatives

Reducing spoilage and extending product usability aligns with broader industry efforts to improve resource efficiency and minimize environmental impact.

Regulatory and Quality Considerations

Food manufacturers operate within increasingly stringent regulatory frameworks. Environmental monitoring has become a critical component of food safety management systems.

Humidity control supports compliance with:

- Hazard Analysis and Critical Control Point (HACCP) programs
- Good Manufacturing Practices (GMP)
- Food Safety Management Systems (FSMS)
- Global food safety certification standards
- Retailer quality assurance requirements

Documented humidity monitoring and control demonstrate a proactive approach to risk management and continuous improvement.

The Future of Humidity Control in Food Storage

As food supply chains become more complex and consumer expectations continue to rise, humidity management will play an even greater role in storage and logistics operations. Emerging technologies such as Internet of Things (IoT) sensors, artificial intelligence, machine learning, cloud-based monitoring platforms, and predictive analytics are transforming environmental management. These innovations enable more precise control, early detection of potential issues, and data-driven decision-making.

Future food warehouses are likely to operate as fully connected environments where humidity, temperature, airflow, and inventory management work together seamlessly to optimize product protection and operational performance.

Conclusion

Humidity may be invisible, but its impact on food quality, safety, and shelf life is undeniable. From preventing microbial growth and preserving product integrity to reducing waste and supporting sustainability goals, effective humidity control has become a fundamental requirement in modern food storage. As the food industry continues to prioritize quality assurance, efficiency, and consumer satisfaction, investment in advanced humidity management solutions will remain a critical competitive advantage. Whether through industrial dehumidifiers, smart monitoring systems, or integrated climate control technologies, maintaining the right moisture balance is essential to protecting food products from storage to consumption.

In today's increasingly demanding food landscape, controlling humidity is no longer simply about environmental management—it is about safeguarding value, ensuring safety, and delivering consistent quality across the entire supply chain.

The Author, Mr. Ritesh Verma is a freelance writer with over 10 years of experience delivering high-quality, industry-focused content.

Tate & Lyle expands collaboration with BioHarvest to accelerate next-generation sweetener innovation



Global ingredient solutions leader Tate & Lyle PLC has announced a major expansion of its collaboration with BioHarvest Sciences Inc., broadening the scope of their joint sweetener development program to target multiple plant-based sweetener molecules. Building on an initial agreement signed in 2024, this scaled-up partnership follows strong technical progress and addresses an evolving food and beverage market where taste, cost, and clean labeling demands vary wildly by product category. Recognizing that no single sweetener can solve all formulation challenges, Tate & Lyle aims to build a flexible, versatile toolkit of complementary sweetening options. These science-led solutions can be used independently or blended together to optimize specific recipes while supporting ambitious sugar and calorie reduction goals.

The collaboration draws heavily on BioHarvest's proprietary Botanical Synthesis™

platform, a cutting-edge technology that supports the development of plant-based, non-GMO ingredients. By growing specific plant cells in a controlled environment, this method produces rare or hard-to-source botanicals without relying on traditional agricultural extraction. This approach directly aligns with Tate & Lyle's commitment to ingredient innovation that balances high sensory performance with scalability and responsible sourcing, bypassing the land-use requirements and supply chain volatility associated with traditional farming.

This initiative marks the latest chapter in Tate & Lyle's extensive history of sweetener innovation, which includes the discovery of sucralose in 1976, the commercialization of allulose in 2015, and the launch of high-purity bioconverted stevia (Reb M) in 2018. The company's current development pipeline is heavily informed by over a decade of global research into consumer perceptions.

Reinforcing this strategy, a proprietary 2025 Tate & Lyle survey of 7,000 consumers across seven global markets—the US, Brazil, Germany, the UK, the UAE, China, and India—revealed that over half of all respondents planned to reduce their sugar intake over the next 12 months. Notably, the consumer intent to cut back on sugar outpaced the desire to reduce overall calories or fat, with a strong preference for great-tasting alternatives explicitly derived from fruits and plants.

According to executive leadership, the expanded partnership provides the exact flexibility required to meet these shifting market demands. Victoria Spadaro-Grant, Chief Science and Innovation Officer at Tate & Lyle, noted that next-generation sweeteners must simultaneously deliver a sugar-like taste, reduced calories, and a responsible use of resources—unmet market needs that are highly unlikely to be solved by a single ingredient. Zaki Rakib, Chief Executive Officer of BioHarvest Sciences, added that broadening the program demonstrates immense confidence in the versatility of their synthesis platform, ultimately allowing food and beverage manufacturers access to differentiated, sustainable solutions engineered to meet strict sensory, application, and economic requirements.

IFF opens Vanilla Innovation Center in Madagascar

Advancing science-led flavor innovation where vanilla is grown



IFF, a global leader in flavors, fragrances, food ingredients, and health & biosciences, has inaugurated its new Vanilla Innovation Center in Toamasina, Madagascar, reinforcing vanilla as a strategic focus area for the company. Located near key vanilla-growing regions and post-harvest processing facilities, the

650-square-meter center integrates laboratory analysis, extraction, flavor and fragrance creation, and application development, enabling IFF to innovate closer to the source of one of the world's most valuable natural ingredients.

The facility is designed to enhance understanding of vanilla's natural variability, which is influenced by climate, curing methods, and post-

harvest handling. By combining in-field testing, advanced analytical capabilities, and flavor development under one roof, IFF aims to accelerate innovation, improve product consistency, and create tailored solutions for customers across global markets. The center also strengthens sustainability efforts

through closer collaboration with farmer networks, enhanced traceability, ethical sourcing practices, and faster adaptation to climate-related challenges.

Key features of the center include advanced contaminant and disease-detection laboratories, scalable extraction facilities, a flavor creation unit with application labs for dairy, bakery, and confectionery products, and "The Bloomery," a research greenhouse dedicated to exploring vanilla varieties and post-harvest techniques. The site will also serve as a hub for training, workshops, and knowledge-sharing initiatives through IFF's RE-MASTER VANILLA™ program. Fully integrated into IFF's global vanilla network, the new center is expected to drive future advancements in flavor innovation while supporting a more resilient, sustainable, and high-quality vanilla supply chain.

Biospringer by Lesaffre acquires selected IP & technology of PTX Food

Biospringer by Lesaffre, a global player in fermentation and microorganism-solutions, announces the acquisition of selected intellectual property and technology of PTX Food Corp, a company specialized in bacteria fermentation. With this acquisition, Biospringer accelerates growth in the food ingredients scope beyond yeast fermentation.

Biospringer's strategic acquisition of PTX Food Corp. will unlock transformative opportunities to deliver innovative solutions that delight existing and new customers worldwide and establishes Biospringer as a global leader in yeast-based and non-yeast fermented solutions. By combining the newly acquired knowledge in fermented bacterial solutions and specialized technology with Biospringer's extensive industrial network, Biospringer is poised to accelerate the development of cutting-edge, customer-centric offerings for the global food sector.

This acquisition illustrates the company's unwavering commitment to providing innovative solutions that address the evolving needs of today's market and anticipate the opportunities of tomorrow. As a leader in fermentation-based solutions across taste, nutrition, texture, and preservation, Biospringer sets itself apart through its collaborative approach, co-creating tailored solutions with customers around the world, with important footprint in Brazil, China, Europe, and North America.

"At Biospringer, we are driven by a clear vision to inspire joy, nourish communities, and protect our planet through better food for all. This acquisition is fully aligned with our commitment to delivering game-changing products that make a positive impact. From ingredient innovation to biotech platforms, from tradition to transformation, Biospringer is poised to be a key player in the industry,



leveraging our robust global footprint and strong local collaborations to bring groundbreaking ideas to market and solidify our role as a trusted partner in the pursuit of a more sustainable and nourishing future," says Carmen Arruda, Biospringer General Manager.

Biospringer's next step will be to transfer the acquired technology and equipment to its global plant network. PTX Food Corp. was an American food ingredient manufacturer specializing in bacteria fermentation products. The acquisition includes selected assets related to the Bioenhance product line.

AWL Agri Business Limited strengthens Food portfolio through strategic collaboration with Shree Renuka Sugars Limited



AWL Agri Business Limited (AWL), one of the largest Food FMCG companies in India, today announced a strategic arrangement with Shree Renuka Sugars Limited (SRSL), to further strengthen market reach and accelerate growth in the packaged foods business.

Under this arrangement, SRSL will license its flagship brand "Madhur" to AWL, enabling the brand to leverage the extensive pan-India distribution, marketing capabilities,

and scale in the packaged food business of AWL. AWL will undertake the sales, marketing and distribution of the refined sugar under "Madhur" brand.

The brand is licensed to AWL under a mutually agreed royalty arrangement between AWL and SRSL, in accordance with the licensing agreement. This arrangement will enable AWL to access SRSL's existing distribution network, which can also be leveraged over time to expand the reach

of "Fortune" products. The addition of the brand "Madhur" will further accelerate the scale and growth of AWL's Food & FMCG segment, while also strengthening its position in the branded sugar business.

Commenting on the announcement, Mr. Shrikant Kanhere, MD & CEO, AWL Agri Business Limited (formerly Adani Wilmar Limited) said: "This arrangement allows us to further leverage our strong distribution infrastructure, marketing capabilities and large food portfolio to scale 'Madhur' brand across India. The addition of this strong brand complements our existing product offerings and strengthens our fast-growing packaged food business. We see significant opportunities to expand market reach and drive category growth by combining the strong brand equity with our extensive distribution network."

Mr. Susheel Kumar Kamboj, MD & CEO, Shree Renuka Sugars Limited said: "SRSL has successfully created 'Madhur' brand as a flagship consumer brand. We are pleased to collaborate with AWL, whose strong distribution platform and marketing capabilities will help to unlock the next phase of growth for 'Madhur' in India."

TPCI and VA Exhibitions join hands to organise Liquid Processing & Packaging Trade Show - Liqui ProPac in New Delhi



Trade Promotion Council of India (TPCI) and VA Exhibitions Pvt Ltd. is launching a pioneer show Liqui ProPac- a Liquid Processing & Packaging Trade Show. This show arrives as a dedicated platform that brings together the entire liquid food ecosystem. Future trends in Dairy, Alcoholic beverages, Water and Non-alcoholic beverages manufacturing will unfold at Liqui ProPac.

Trade Promotion Council of India, the organiser of India's leading food industry exhibition, INDUS FOOD, and VA Exhibitions Pvt Ltd, the organiser of India's premier food processing & packaging technology exhibition, INTER FOODTECH, join hands to create a one-of-its-kind platform for beverage & liquid food manufacturing — Liqui ProPac. Liqui ProPac will be held in September 28–30, 2027, at Yashobhoomi, New Delhi. This exhibition is designed as an integrated platform to showcase end-to-end solutions, from ingredients to processing, filling, packaging, storage, distribution, and

automation for sustainable manufacturing. The MoU was signed by Shri Sandip Das, Deputy Director General, TPCI and Shri Ashwani Pande CEO of VA Exhibitions, in New Delhi on 15th May 2026.

The two bodies unite to bring strength to the show, which is the pressing need of the industry. As industries increasingly adopt advanced processing, packaging, automation, and energy-efficient technologies, the need for a dedicated platform focused on the complete liquid ecosystem has become more important than ever.

Speaking on the need to host this show, Mr Mohit Singla, Chairman TPCI said, "As India emerges as a major global hub for food processing and value-added manufacturing, the industry requires specialised platforms that can foster innovation, technology adoption, quality compliance, and global partnerships. Liqui ProPac will serve as a catalyst for driving investments, enhancing competitiveness, and promoting advanced manufacturing practices aligned with the vision of Hon'ble Prime Minister Shri Narendra Modi for 'Make in India' and food processing-led growth."

The Indian dairy industry, currently valued at over USD 140 billion, is projected to surpass USD 290 billion by 2033, while the alcoholic beverages market is expected to grow beyond USD 120 billion by 2034. Simultaneously, India's water and wastewater treatment sector is witnessing

rapid expansion, driven by infrastructure investments and rising industrial demand. The non-alcoholic beverages market is also experiencing robust growth, fuelled by health-conscious consumers shifting towards functional drinks and low-sugar options. The sector is projected to grow at a CAGR of approximately 7–9% through 2033, with non-carbonated beverages continuing to gain strong consumer preference.

Mr Sandip Das, Deputy Director General, TPCI said, "We would like the learnings and strengths of Indusfood to be put to best use in establishing this pioneer show in India, which will not only strengthen the F&B value chain but will also help a large number of MSME exporters to connect with the global buyers here in India."

Speaking about the ensuring show Mr. Ashwani Pande CEO of VA Exhibitions, said, "Addressing this growing industry demand, Liqui ProPac emerges as a specialised technology exhibition for the beverages & liquid food sector. Bringing together the complete value chain under one roof, the exhibition will showcase end-to-end solutions ranging from ingredients, processing technologies, filling systems to packaging, storage, distribution, automation, recycling, and sustainable manufacturing solutions."

Visit our website www.liquipropac.com to know more. For further information, write tovj@vaexhibitions.com; sunil.c@tpci.in



DS Group Joins Hands with Ben's Cookies to Launch Premium British Cookie Experience in India

Dharampal Satyapal Group (DS Group), a leading FMCG conglomerate and multi-business corporation, has announced an exclusive partnership with Ben's Cookies, the iconic British artisanal cookie brand renowned for its freshly baked gourmet treats. Founded in 1983 at Oxford's historic Covered Market, Ben's Cookies has built a loyal global customer base with its signature chunky and gooey cookies crafted using

simple, high-quality ingredients. Through this collaboration, the brand is set to make its debut in India with a bakery-first retail concept focused on freshness and authentic baking experiences.

Ben's Cookies will introduce a wide range of its globally popular flavours in the Indian market, including Milk Chocolate Chunk, White Chocolate & Macadamia, Ginger &



Dark Chocolate, along with specially curated eggless variants for Indian consumers. The brand will also offer premium gifting options designed for festive celebrations and corporate occasions. Individual cookies will start from ₹325, while curated gift boxes and assortments will be priced upwards of ₹1500.

Speaking about the collaboration, Sanskriti Gupta, Ben's Cookies India, said that the partnership marks an important milestone in DS Group's expansion into the premium food retail segment. She highlighted that the brand combines over four decades of British artisanal baking heritage with DS Group's understanding of Indian consumer preferences. She further revealed that the company plans to open eight to ten physical stores across India during the current financial year as part of its aggressive retail expansion strategy.

To strengthen accessibility and consumer convenience, Ben's Cookies products will also be available through major e-commerce and food delivery platforms. Each boutique will feature live-oven baking to ensure fresh batches are prepared throughout the day. In addition to cookies, the stores will offer an indulgent menu including cookie shakes, coffees, and cookie ice cream sandwiches.

Luke Menezes from Ben's Cookies expressed enthusiasm about entering the Indian market through the partnership with DS Group. He stated that the company aims to maintain its traditional quality standards in India while becoming a cherished part of the country's evolving dessert culture.

The partnership comes at a time when India's premium cookie and dessert segment is witnessing rapid growth, driven by increasing urban affluence and consumer demand for authentic, handcrafted indulgences. India's cookie market, valued at USD 1.3 billion in 2024, is projected to reach USD 2.3 billion by 2033, creating strong opportunities for premium international brands in the country.

Mespack and Spookfish Formalize a Strategic Partnership to Integrate Thermal Inspection Technology into Flexible Packaging Machinery



Mespack, a leading international manufacturer of innovative and sustainable flexible packaging machinery and turnkey solutions, and Spookfish, a deep-tech company specializing in multi-spectral vision and AI powered process monitoring for in-line quality control, have formalized a strategic partnership to integrate advanced thermal inspection technology into Mespack's flexible packaging equipment.

As part of this collaboration, Spookfish thermal cameras and software technology will be seamlessly integrated into Mespack's Athena digital platform, enabling Mespack's Inline Thermographic Inspection (ITI) solution. The system allows 100% non-destructive, in-line inspection of pouch seals, thus helping manufacturers ensure consistent seal quality while avoiding production losses.

Inline Thermographic Inspection uses infrared imaging to analyze the thermal profile of seals immediately after the sealing process. By detecting deviations related to seal integrity, contamination, or process variability, the solution makes it possible to identify potential defects in real time. As a result, higher product quality and greater process efficiency is achieved.

Fully integrated into the Athena environment, the ITI solution offers a user-friendly interface and leverages AI-based algorithms to simplify operation and reduce the need for advanced operator expertise. Furthermore, the solution is designed to be retrofittable, making it compatible with both new and existing Mespack machines, with or without Athena. Consequently, customers are provided with a flexible and scalable quality inspection option.

This partnership reinforces Mespack's strategy of collaborating with specialized technology partners to deliver value-added solutions that respond to the evolving needs of the flexible packaging market. By combining Mespack's packaging knowledge with Spookfish's expertise in thermal imaging and software, the companies jointly offer a robust inspection solution for global consumer packaged goods manufacturers. With the incorporation of Spookfish as a Stellar Partner, Mespack continues to expand its open innovation ecosystem, hence strengthening its portfolio of in-line inspection technologies and supporting customers with their continuous improvement, quality assurance, and efficiency objectives.

In words of Guillem Clofent, President of Mespack: "This partnership with Spookfish represents an important step in our strategy to integrate advanced inspection technologies directly into the packaging process. By combining Mespack's packaging expertise with Spookfish's thermal imaging and AI capabilities, we are able to offer our customers a robust, in-line quality inspection solution that enhances efficiency, reliability, and product integrity."

For its part, Dr Anupriya Balikai, Managing Director of Spookfish states: "Collaborating with Mespack allows us to bring our thermal inspection technology into real industrial packaging environments at scale. Integrating our solution into the Athena platform brings us one big leap closer to realizing the values of Industry 5.0. This human-centric, proactive AI-driven approach increases value in the production chain through continuous data-driven process validation."

UPM and BASF accelerate the transition to recyclable, fiber-based packaging



UPM Specialty Materials (UPM) and BASF are collaborating to help brand owners, converters and formulators accelerate the transition to recyclable*, fiber-based packaging solutions. By combining UPM's barrier and barrier base papers with BASF's Joncryl® HPB (high performance barrier) barrier technology resins, the collaboration enables high-performance, fiber-based materials while supporting the transition away from conventional mixed packaging structures.

Driven by increasing regulatory requirements and ambitious recyclability

targets (e.g. Regulation (EU) 2025/40 on packaging and packaging waste), the packaging industry is increasingly moving towards design-for-recycling concepts. The collaboration between UPM and BASF demonstrates how carefully matched materials and barrier technologies can deliver excellent protection performance while enabling recyclable, fiber-based packaging.

UPM's barrier and barrier base papers, such as UPM Solide™ Lucent and UPM Asendo™, are specifically designed for demanding packaging converting and printing

applications. When combined with coatings based on BASF's Joncryl® HPB polymers, they enable the development of packaging materials suitable for a wide range of food and non-food applications that meet demanding regulatory requirements.

"The transition to recyclable fiber-based packaging requires both advanced barrier performance and close collaboration across the value chain. Our barrier papers are developed to support co-creation with partners, enabling new, high-performance packaging applications. The collaboration with BASF demonstrates how combining innovative barrier technologies with barrier papers can deliver functional, recyclable solutions that accelerate the packaging transformation," said Mika Uusikartano, Senior Manager, Product Portfolio Management, UPM Specialty Materials.

"The demand for sustainable packaging solutions is growing rapidly along the value chain – from brand owners to converters and formulators. UPM's premium paper grades for flexible packaging, combined with barrier coatings based on waterborne Joncryl® HPB resins from BASF form a strong and credible reference approach for the development of paper-based alternatives designed to replace plastic-based or PE-laminated structures," said Rolf Alles, Director of Sales Resins EMEA at BASF.

Gentlebrand launches its SmartWeighting approach, introduced via the MINERA still water bottle



Gentlebrand is introducing its SmartWeighting approach, demonstrated through the MINERA SmartWeighting still water bottle, showing how lightweighting can be achieved without compromising performance, aesthetics or brand positioning in the beverage sector. SmartWeighting is a design and development approach created by Gentlebrand that focuses on optimising how material is distributed and expressed within a bottle structure, rather than simply reducing material weight. By combining structural engineering with considered design language, the approach enables lighter packaging to maintain both functional reliability and a premium on-shelf presence.

"MINERA SmartWeighting allowed us to demonstrate that reducing weight does not have to mean making compromises," commented Andrea Rizzardi, Director of Gentlebrand. "SmartWeighting focuses on how material is used, not simply how much, ensuring structural reliability, visual quality and brand positioning are preserved."

The SmartWeighting approach was developed in response to a common industry

challenge. Lightweight bottles are often associated with low-cost products, making it difficult for beverage producers to pursue lightweighting without affecting perceived quality. SmartWeighting addresses this by carefully balancing weight optimisation with structure and visual design, allowing lighter bottles to retain a refined look and feel. The MINERA SmartWeighting water project applies these principles to the design of a still water bottle intended to deliver both functional performance and aesthetic distinction. The objective was to achieve an optimal container weight while guaranteeing strength and stability throughout every stage of production, from blowing and filling through to transport and storage.

The MINERA still water bottle was developed by Gentlebrand in collaboration with Competek, an engineering partner specialising in beverage packaging, who supported the technical and industrial development of the project. In order to meet performance requirements, the bottle design alternates clean, minimalist areas with technical and functional elements that discreetly reinforce the structure. Further optimisation was applied to the neck finish, reducing excess material while improving handling and user experience. Development was supported through collaboration with international partners across the beverage supply chain to ensure industrial compatibility.

The MINERA bottle also reflects the SmartWeighting approach's material strategy. The packaging is produced using 100% BioPET supplied by UPM Biochemicals, while the label uses UPM Raflatac Vanish™ PCR film. This creates a no-label look that enhances visual purity and perceived premium quality, while supporting material reduction and recyclability.

For beverage producers, SmartWeighting delivers benefits across the supply chain, including reduced PET usage and improved logistics efficiency, without compromising bottle performance or perceived quality. By integrating visual aesthetics, engineering and material optimisation, SmartWeighting establishes a balanced relationship between responsible material use and brand expression.

Looking ahead, Gentlebrand views its SmartWeighting approach as representative of the direction beverage packaging continues to take, with smarter, more considered solutions that support environmental and economic objectives while remaining aligned with brand identity. In this context, lightness becomes a deliberate design choice rather than a limitation for packaging producers.

Amcor introduces recycle-ready dip cup packaging to help brands meet sustainability regulations



Amcor, a global leader in developing and producing responsible packaging solutions announced the commercial availability of PP Revolution™, a new portfolio of polypropylene (PP) recycle ready dip cup arrays and lidding solutions for condiments, dressings and sauces for foodservice. Amcor's PP Revolution™ platform is designed to help brands transition from traditional polystyrene while maintaining performance, efficiency and consumer appeal.

"PP Revolution™ is designed to help brands move forward as Extended Producer Responsibility (EPR) requirements evolve," said Sarah Paleg, sustainability director, Amcor Flexibles North America. "Our PP Revolution™ platform is a recycle-ready solution that supports improved recyclability claims today and prepares our customers for the regulatory realities of tomorrow."

The more sustainable dip cup array and lidding solution delivers high performance and compatibility with existing filling equipment for a seamless transition. In addition, the dip cups have an improved barrier compared to traditional solutions and are available with Amcor's comprehensive EZ Peel® lidding portfolio, including metallized, foil and AmPrima® recycle-ready options. The arrays are available in 10 sizes, from 0.5 oz to 2.0 oz in clear, white opaque and custom colors.

"Today's consumers expect packaging that's easy to use, locks in freshness and is aligned

with their sustainability values," said Kevin Glaser, vice president and general manager – liquid, Amcor Flexibles North America. "PP Revolution™ was designed to elevate the dip cup experience, from easy open lidding and portion appropriate sizes to premium aesthetics, while helping brands move forward with recycle ready packaging."

PP Revolution™ dip cup solutions are designed for recyclability, with select sizes rated "Preferred" under the APR Design® Guide for Size Sorting Potential. This evaluation can support stronger recyclability claims and potential EPR fee advantages, with How2Recycle® prequalification available for select sizes.

The PP Revolution™ solution expands Amcor's portfolio of more sustainable film technologies, which includes the recycle-ready PET Revolution™ recycle ready barrier cup stock.

"Amcor's innovations support the foodservice industry as it prepares for evolving regulatory requirements," said Aimee Johns, senior marketing manager – liquid, Amcor Flexibles North America. "We're ready to help customers begin testing and scale-up within as little as six weeks."

This new product launch underscores the company's commitment to leading the way to a more sustainable packaging future through material innovations, high quality products and access to packaging expertise to navigate changing regulations.

UPM, Michelman, and BOBST Introduce Bio-Based Paper Packaging Concepts Aligned With EU Packaging Rules



UPM Specialty Materials, Michelman, and BOBST have joined forces to develop two validated paper-based packaging concepts for brands navigating the EU packaging rules, such as the Single-Use Plastics Directive (SUPD). By combining fiber-based materials, bio-based coatings, and coating line expertise, the three companies have built ready-to-implement structures that deliver strong barrier performance and heat sealability over a wide sealing window.

"Fulfilling strict expectations demands scalable solutions. Our base papers are developed to support co-creation and reduce unnecessary complexity. Combining them with the right chemistry enables partners to arrive at fit-for-purpose packaging solutions faster." —Mika Uusikartano, Senior Manager, Product Portfolio Management, UPM Specialty Materials

The concepts combine UPM's packaging papers with Michelman's bio-based coating solutions and BOBST's application know-how to deliver functional performance while supporting recyclability and, where relevant, compostability across selected applications.

"There is a growing market demand for SUPD-compliant packaging solutions. At the same time, barrier performance must remain equivalent to existing market solutions, and proposed materials must be fully compatible with current packaging lines, without the need for major equipment modifications." —Iulia Mihai, Ph.D., Senior Scientist, Michelman From an implementation perspective, the collaboration takes into account process requirements and runnability to support efficient industrial production.

"When materials and application parameters are developed together, packaging converters can implement new solutions more easily while achieving stable performance and production efficiency." —Luca Nespolo, Competence Center Manager, BOBST

The collaboration showcases two solution concepts. The first concept[1] supports SUPD-compliant paper packaging for applic-

ations such as tea bags, oatmeal, and sugar stick-packs, incorporating bio-based coatings that impart good moisture and mineral oil barriers along with good heat sealability. Packets and wrappers are among the product categories in the scope of the EU's SUPD, which aims to reduce the environmental impact of certain plastic products that are used once and discarded.

The second concept[2] is designed for applications requiring an improved oxygen barrier level, such as single pack cookies and chocolate, while enabling lower coat weights and improved material efficiency.

1 Michelman coatings are Certified OK Bio-based Class 5 (TÜV Austria) and SUPD compliant (PTS; Directive (EU) 2019/904) and components are home compostable (per raw material suppliers). UPM base paper is home compostable (NF T51-800:2015). The structure has been certified as recyclable (Cepi/4evergreen v2).

2 Michelman coatings are Certified OK Bio-based Class 5 (TÜV Austria) and components are home compostable (per raw material suppliers). UPM base paper is home compostable (NF T51-800:2015, AS 5810:2010). The structure has been certified recyclable (Cepi/4evergreen v2).



Stora Enso is introducing two significant developments to its Trayforma tray board range: a basis weight reduction across the existing range, and the launch of Trayforma Brown, an entirely new unbleached product. Together, they extend what Trayforma offers by delivering greater material efficiency and adding a new option for brands seeking a natural look on shelf.

The new lighter Trayforma delivers the same strength, forming performance, and converting reliability as the current base board, but uses less raw material. Less material per tray means better yield throughout the value chain, and a lower board weight naturally

Stora Enso launches Trayforma Brown and reduces basis weight across the Trayforma range

contributes to reduced carbon footprint in production and transport. Trayforma Brown responds to demand for a premium natural appearance in tray packaging. Its technical performance meets the same demands as the rest of the Trayforma family, and it is the first brown tray board to support oven heating, withstanding temperatures up to 220°C with a transparent PET coating. It is also available with a high-barrier BarrPeel solution for vacuum-skin packaging.

"For our customers, the natural look of brown board is increasingly relevant, but not at the cost of performance. With Trayforma Brown, they don't have to make that trade-off. And with our advancements in lightweighting Trayforma, everyone in the value chain benefits from better yield," says Jaana Tani, Tech-

nical Account Manager, Trayforma.

Both products are built on a three-ply structure incorporating CTMP in the middle layer, which enables reduced basis weight while maintaining board thickness. Trayforma Brown is well-suited for ready meals, bakery, and chilled and frozen food.

Stora Enso is a global leader in renewable materials with a strong focus on packaging. Our purpose is to replace non-renewable materials with renewable solutions. Together with our customers, we design and deliver competitive, high-quality packaging materials and solutions, made from fresh and recycled fibers, accelerating the transition to a circular bioeconomy. Stora Enso has approximately 19,000 employees and our sales in 2025 were EUR 9.3 billion.

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