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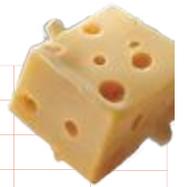
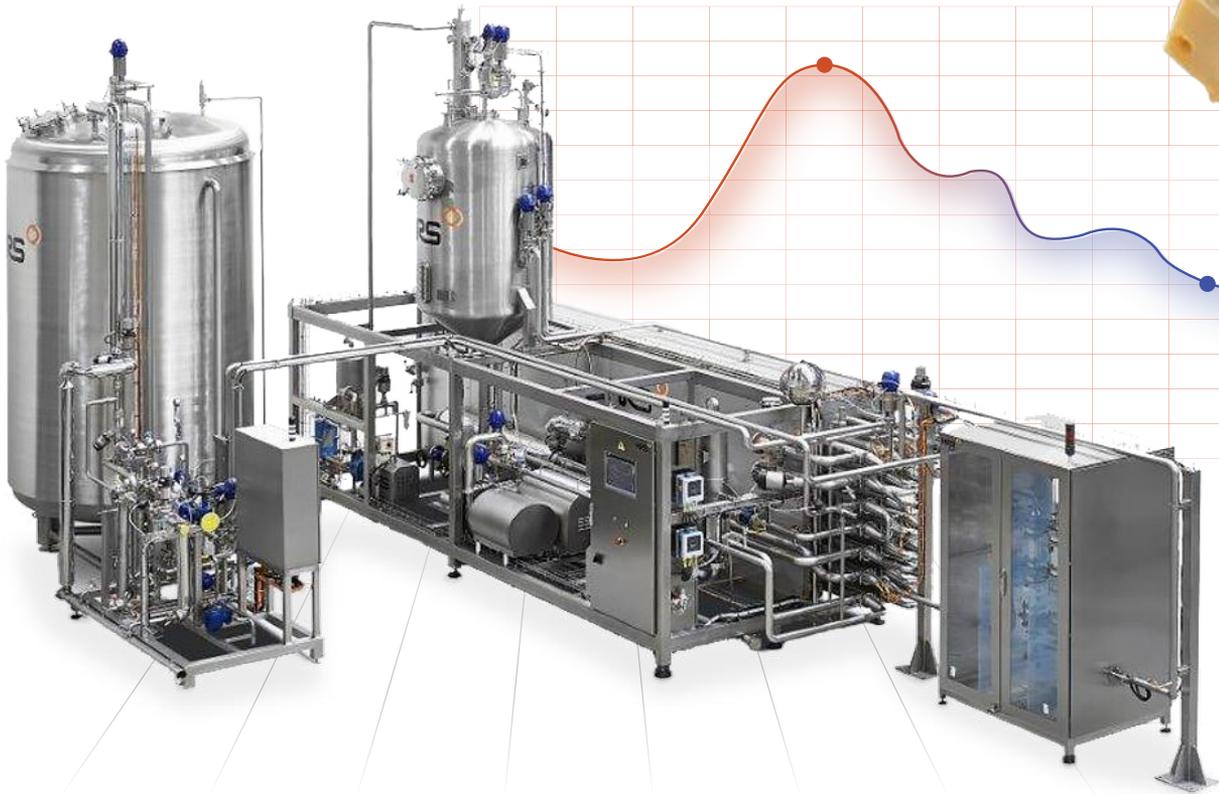
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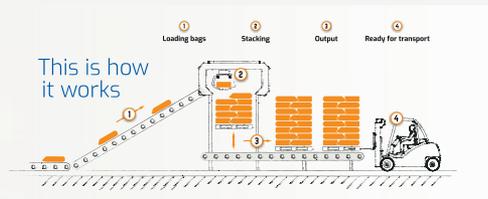
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Dear Readers,

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

As we step into March, we are thrilled to present a special edition of our magazine dedicated to AAHAR 2025 – The International Food & Hospitality Fair. This prestigious event, now in its 40th edition, is one of Asia's largest and most influential B2B platforms in the food and hospitality sector. Organized by the India Trade Promotion Organisation (ITPO), AAHAR 2025 will take place from March 10-14, 2026, at Bharat Mandapam, New Delhi. Over the years, AAHAR has established itself as a dynamic platform for global vendors, sourcing professionals, and industry stakeholders, fostering unparalleled opportunities for networking, collaboration, and business expansion.

To mark this milestone event, our March edition features a compelling collection of articles covering diverse industry segments, providing readers with an in-depth exploration of the latest innovations, emerging trends, and market advancements.

In our processing segment, we explore the transformative potential of Next-Generation Food Industry: Powered by Artificial Intelligence (AI), highlighting how intelligent systems are enabling smarter production, predictive quality control, and improved operational efficiency. We also present an analysis of India's Booming Snack Economy, examining the market's growth trajectory, evolving consumer preferences, and opportunities leading up to 2034. Complementing these insights is an important feature on Detection of Pesticides in Fruits and Vegetables Using Advanced Technology, which focuses on the role of modern analytical tools in strengthening food safety and ensuring regulatory compliance.

Our packaging technology segment highlights the innovations redefining how food products are protected, presented, and delivered. Future of Food Packaging: Smart, Sustainable, & Intelligent Solutions explores emerging materials and digital technologies that are shaping next-generation packaging systems. Alongside this, Custom Printed Packaging: A Strategic Guide for Food & Beverage Brands discusses how tailored packaging solutions can enhance brand identity, ensure regulatory compliance, and improve market competitiveness.

In the ingredients segment, we revisit traditional and premium ingredients gaining renewed attention in modern food formulation. Black Salt (Kala Namak): An Ancient Ayurvedic Ingredient with Modern Culinary and Health Significance highlights its unique properties and growing relevance in contemporary food products. Meanwhile, Olive Oil: A Premium Ingredient Powering Clean-Label and Functional Foods examines its expanding role in healthier and value-added food innovations.

Along with these features, this edition also includes updates and insights from the corporate happenings and sustainability segments, offering readers a broader perspective on industry developments and responsible business practices shaping the global food ecosystem.

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

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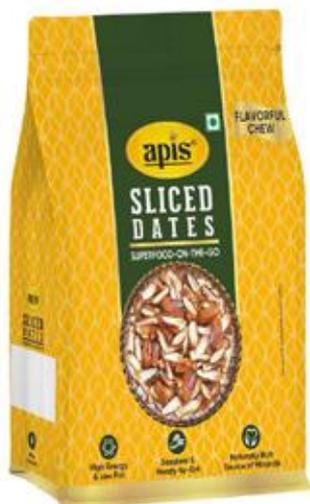
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Apis India, a leading FMCG brand incorporated in 1983, has announced the launch of Sliced Dates, a thoughtfully prepared, ready-to-eat, guilt-free superfood that blends natural sweetness and convenience.

Eating dates can sometimes feel like more

Apis India Simplifies Healthy Snacking with Ready-to-Eat Sliced Dates

effort than it should be – checking for seeds, cleaning them, or cutting them before use. Recognising this everyday inconvenience, Apis India has introduced Sliced Dates to make healthy snacking simpler and more accessible. Ready to eat and conveniently packed, the product preserves the natural taste and nutrition of dates while offering everyday affordability.

With the launch of Sliced Dates, Apis India Ltd strengthens its clean nutrition portfolio under health & wellness while expanding its value-added offerings for modern consumers. This move furthers the brand's effort to make healthy snacking both effortless and accessible. Crafted for everyone across age groups and lifestyles, Sliced Dates caters both to premium, variety-seeking, health-conscious consumers and to value-driven families looking for reliable and convenient packaged dates. The deseeded and sliced dates reduce preparation time, making it an easy

addition to breakfast bowls, with milk, sweets preparation, snack breaks, or quick energy boosts during the day, while maintaining the natural taste and goodness of the superfood.

Commenting on the launch, Mr Amit Anand, Managing Director, Apis India Limited, said, "Consumers today are looking for snacks that deliver on taste, nutrition, and convenience simultaneously. Sliced Dates is one of the choices to the growing demand for clean, convenient, guilt-free snacking."

He further added, "Dates are packed with nutrients, and are a great alternative for snacking. However, the deseeding and cleaning process makes consumers vary. The Sliced Dates addresses these concerns, without compromising on the quality." The newly launched product will be available PAN India across local stores and leading e-commerce platforms such as Amazon, JioMart, Blinkit, BigBasket & DMart.

Anmol Industries Introduces Anmol Top Treat – A New Benchmark in Savory Snacking



Anmol Industries Limited, one of India's leading FMCG companies, has expanded its innovative snacking portfolio with the launch of Anmol Top Treat, a premium range of savory crackers designed to offer consumers a delightful blend of taste, crunch, and versatility. Crafted to satisfy modern-day snacking needs, Anmol Top Treat aims to redefine everyday indulgence with its distinctive Creamy Onion & Chive flavor.

Designed for today's dynamic lifestyles, Anmol Top Treat crackers are crispy, light, and perfectly seasoned, making them an ideal

companion for mid-day hunger pangs, tea-time snacking, or light evening indulgence. The Creamy Onion & Chive variant delivers a unique fusion of creamy richness, subtle saltiness, and refreshing herbal notes, creating a flavorful snacking experience that appeals to both adults and young consumers.

What sets Anmol Top Treat apart is its versatility. These savory crackers can be enjoyed straight from the pack or enhanced with toppings such as fresh vegetables, herbs, and spices, allowing consumers to personalize their snack moments. Whether

served at home, during casual gatherings, or paired with dips and spreads, Anmol Top Treat offers endless snacking possibilities.

Commenting on the launch, Aman Choudhary, Executive Director – Marketing & Innovation, Anmol Industries Limited, said: "At Anmol, innovation is driven by evolving consumer preferences and modern snacking habits. With Anmol Top Treat, we aimed to create a product that delivers superior taste, exciting flavors, and everyday versatility. The Creamy Onion & Chive variant reflects our commitment to bringing globally inspired flavors tailored to Indian palates. We believe this launch will strengthen our presence in the savory biscuit segment and offer consumers a refreshing new snacking choice."

With this launch, Anmol Industries Limited continues to reinforce its leadership in the bakery and snacking category, expanding its portfolio with products that combine innovation, taste excellence, and value. Anmol Top Treat will be available across major retail outlets, modern trade stores, and e-commerce platforms nationwide.



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Britannia Jim Jam Unveils an Exciting Marvel-Inspired range



Special Edition pack designs feature Marvel Super Heroes, including Captain America, Thor, Iron Man, Deadpool and Wolverine. From shields and hammers to claws and quick comebacks, Marvel Super Heroes are always in the middle of action. Bringing this high-energy world into your hands, Britannia Jim Jam announces the launch of its Marvel-themed special edition packs with designs inspired by epic storytelling and larger-than-life characters.

Launching across Britannia Jim Jam and Britannia Jim Jam Pops, the new range features fan-favorites Captain America, Thor, Iron Man, Deadpool and Wolverine. Each pack will appeal to Marvel fans using signature bold graphics and striking visual cues – from

Captain America's shield and Thor's hammer to Iron Man's suit, Deadpool's twin katanas and Wolverine's claws, each iconic element adds a fun twist to your snacking experience.

At the heart of the campaign launch is a simple, cheeky take: Super Heroes almost always have their hands full – ready to save the world. Easily enjoyed with one hand, Britannia Jim Jam are the ideal snack for any adventure.

This idea comes alive in a new ad featuring five Marvel cosplayers holding a fictional Super Hero press conference; they are then faced with an unexpected question from Jimmy and Jammy, which sparks a humorous realization – Super Heroes (even cosplayers!) rarely have a free hand to enjoy a snack! The moment sets up Britannia Jim Jam's key proposition, showcasing that it can be enjoyed effortlessly with one hand.

Siddharth Gupta, Vice President – Marketing, Britannia Industries, said, "Our focus has always been on staying closely connected to culture and finding relevant ways to show up where consumer interest exists, especially

among younger Gen-Z audiences who shape what is current and relevant today. Pop culture collaborations are one of the ways we bring this to life, with a focus on delivering connected experiences across multiple touchpoints. Our collaboration with Marvel stands out as a unique opportunity for us to translate this thinking into a cohesive brand experience for our consumers that remains rooted in the product."

Taking this a notch higher is the No-twist challenge, where consumers can scan the special edition pack to unlock an interactive game where they step into the shoes of their favourite Super Heroes. Players take on enemies using one hand while enjoying Jim Jam with the other, mirroring the central idea of the campaign.

Each scan and play earns Jim Jam Coins, giving participants a chance to win special Marvel merchandise, along with the chance to win a trip to Hong Kong Disneyland* So grab your pack and unlock the ultimate Super Hero battle with Britannia Jim Jam.

Steps to play the No-Twist Challenge

- Scan a Britannia Jim Jam or Jim Jam Pops
- Get battle ready
- Stand a chance to win Marvel-themed merchandise or a trip to Hong Kong Disneyland*

*T&C apply

Anmol Industries Launches YOLO Choco Donut Cakes – A Fun twist to Indulgent Snacking



Anmol Industries, one of India's leading FMCG food brands, has announced the launch of its latest indulgent innovation — Anmol YOLO Choco Donut Cakes, a delightful fusion of rich chocolate cake and the playful shape of a donut. Crafted to appeal to consumers across age groups, the new offering promises a soft,

moist, and fluffy texture, delivering a perfect anytime-snacking experience.

Designed for today's young and dynamic consumers, Anmol YOLO Choco Donut Cakes combine premium quality ingredients such as refined wheat flour, sugar, eggs, cocoa solids, palm oil, liquid glucose, and carefully selected raising agents to ensure consistent taste, freshness, and quality. The donut-shaped cakes offer a unique visual appeal, making them ideal for on-the-go snacking, school tiffins, work breaks, and casual indulgence.

Speaking on the launch, Aman Choudhary, Executive Director – Marketing & Innovation, Anmol Industries, said, "At Anmol, innovation is driven by evolving consumer preferences and changing lifestyles. With YOLO Choco Donut Cakes, we aim to bring together fun, flavor, and indulgence in a format that resonates strongly with Gen Z and millennial



consumers. This product reflects our commitment to delivering exciting snacking options without compromising on quality, taste, and affordability."

The launch of YOLO Choco Donut Cakes further strengthens Anmol Industries' robust product portfolio, reinforcing its leadership in the Indian bakery and confectionery segment. With a focus on innovation, quality, and consumer-centric product development, Anmol continues to expand its footprint across modern trade, general trade, and e-commerce platforms nationwide.

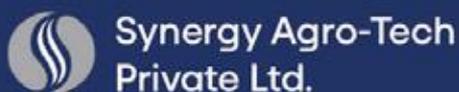


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PepsiCo expands food portfolio with new Alvalle hot soups



PepsiCo is entering into a new food category with the launch of a ready-to-heat range of vegetable soups under its Alvalle brand. The range builds on Alvalle's pioneering success in the packed gazpacho soup category, and aligns with consumer trends toward convenience, health, and plant-based eating and those seeking ready-to-eat, nutritious meals.

Produced in the heart of Murcia, the soups are made with 100% Spanish-sourced natural ingredients – vegetables, olive oil and salt – no

additives or gluten, and will be listed in the chilled aisle. Customers will be able to enjoy two brand new recipes – Vegetable Cream, made with zucchini, carrot, potato, and onion – and Pumpkin Cream, filled with pumpkin, carrot, onion and sweet potato. The hot soups will launch initially in Spain with plans to expand into Portugal and other markets in Western Europe.

Currently sales of gazpacho largely happen during warmer months, however with consumers looking for convenient, healthy meals during colder periods, the expansion harnesses a growth opportunity for the brand. The two new hot soups will also complement the seasonal nature of Alvalle's business as it will utilize available production capacity in the winter.

"PepsiCo is seizing a strategic opportunity for Alvalle to become an all-year fixture by

responding to how consumers eat across seasons, with simple, convenient meals made with natural ingredients that fit lunch and dinner occasions. It is a natural evolution for our Alvalle brand and opens the door to growth to even more geographies by appealing to a wider range of consumers" said Lluís Crespo, Alvalle General Manager within PepsiCo's Food Ventures Business Unit.

The category expansion aligns with PepsiCo's focus as a food company rooted in agriculture and is the latest move into broadening its food portfolio across the globe, following recent acquisitions such as Siete Foods and Sabra dips. Alvalle's hot soups embody PepsiCo's positive agriculture and supply chain commitments, offering consumers a delicious, sustainable choice for every season.

The soups are sold in 600ml bottles and made from 100% recycled plastic (rPET)¹ which supports PepsiCo's efforts to use more sustainable packaging solutions. Earlier this year, Alvalle and the PepsiCo Foundation launched the VivaOliva program in Jaén, Spain, a region from which the brand sources olive oil used in its gazpacho, aiming to help 150 olive farmers adopt more regenerative agriculture practices and improve their business. (1x-excluding the cap and label)

TBH Enters Coconut Water Segment as Ghodawat Consumer Limited Broadens Better-for-You Offerings



of TBH Coconut Water, marking the brand's entry into the rapidly growing natural hydration market. The launch broadens the 'To Be Honest' portfolio beyond its core healthy snacks made from 100% real fruits and vegetables, extending the brand's clean-label philosophy into beverages. This new offering contains extracts from fresh coconuts sourced from Tamil Nadu with no added sugar, no concentrates and no added flavours, maintaining the natural taste and electrolyte content of coconut water.

The product is available in a 200 ml pet bottle priced at ₹60, reinforcing Ghodawat Consumer Limited's focus on making quality, ingredient-led products accessible to everyday consumers. The launch aligns with a broader shift in consumer preferences, as Indian consumers increasingly seek functional beverages that support active and health-conscious lifestyles. Industry estimates indicate that the Indian functional beverages market, valued at USD 6.9 billion in 2025, is projected to reach USD

18.8 billion by 2034, growing at a CAGR of 10.74% between 2026 and 2034. Within this landscape, the packaged coconut water segment is witnessing faster growth than traditional beverage categories, driven by rising demand across general trade, modern trade, and e-commerce channels.

Salloni Ghodawat, CEO, Ghodawat Consumer Limited, said, "TBH was created on the belief that better everyday choices should be built on real ingredients. As the brand evolved, hydration emerged as a natural extension of healthy consumption alongside snacking. The launch of coconut water marks TBH's first step into beverages and reflects a natural progression rather than a strategic shift. It is simple, functional, and firmly aligned with our ingredient-first philosophy."

Ghodawat Consumer Limited will follow a measured and disciplined scale-up strategy, prioritising distribution strength, consumer relevance, and repeat consumption over

Ghodawat Consumer Limited (GCL), the FMCG arm of Sanjay Ghodawat Group (SGG), announced the launch

rapid line expansion. The product will be rolled out initially through general trade, leveraging TBH's established distribution network across India. Marketing efforts will focus on strong point-of-sale visibility, pack-led communication, and clear ingredient messaging, aimed at enabling transparency and driving organic adoption.

TBH Coconut Water is produced through minimal processing, with emphasis on rapid extraction, stabilisation, and packaging to preserve freshness. The product is not reconstituted from concentrate and contains no artificial boosters or additives, responding to growing consumer demand for authentic, clean-label functional beverages. The coconut water category itself is undergoing a structural shift—from largely unorganised, informal consumption to branded and packaged formats that offer consistency, safety, and transparency. This evolution presents a strong opportunity for credible FMCG players with robust sourcing and clean-label credentials. For TBH, the entry represents a clear and complementary growth pathway, supported by an existing consumer base that values ingredient transparency and is well-positioned to drive trial, repeat, and cross-category consumption.

ITC Limited's Sunfeast Launches Breakfast Smoothie

In response to the growing demand for convenient and nutritious breakfast solutions, ITC Limited has expanded its portfolio under the Sunfeast umbrella with the launch of its all-new Breakfast Smoothie. Crafted for today's fast-paced lifestyles, the ready-to-drink beverage combines the goodness of banana, oats, almonds, dates, and four super seeds. With no added sugar and delivering 6g of protein per serving, the smoothie is positioned as a balanced and wholesome start to the day.

Designed specifically for busy mornings—whether it's professionals heading to work, students rushing to college, or individuals juggling tight schedules—the Breakfast Smoothie offers a convenient, grab-and-go option without compromising on taste. By blending familiar, trusted ingredients into an enjoyable format, the brand aims to tap into the rising preference for functional beverages that align with evolving urban consumption habits.

The product is currently available across leading metro cities through quick-



commerce platforms and nearby Reliance retail stores, strengthening its accessibility in high-demand urban markets. Best served chilled, the new Sunfeast Breakfast Smoothie reflects ITC's continued focus on innovation in the ready-to-consume nutrition segment, catering to consumers seeking quick, tasty, and reliable morning solutions.

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CERTIFICATIONS



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Cornitos Unveils Energy-Led Packaging for Its Nuts & Seeds Range



Cornitos, one of India's leading premium snacking brands, has introduced a refreshed packaging design for its Nuts & Seeds range, built around a bold, energy-driven and consumer-centric approach. The redesign reflects the brand's commitment to supporting modern lifestyles with convenient, wholesome, and high-quality snacking solutions.

The new packaging features a cleaner, more contemporary visual identity that highlights

vitality and everyday energy. Designed with improved functionality and enhanced shelf appeal, the packs are easier to carry, store, and consume on the go — making them ideal for office breaks, travel, fitness routines, and daily mindful snacking moments.

Cashews, Almonds, Party Mix, Pistachios, Super Seeds, and Pumpkin Seeds anchor the refreshed portfolio — offering nutrient-rich options crafted for consumers seeking smarter snack choices without compromising

on flavour or convenience. Each pack reflects energy, freshness, and modern relevance. While the look has evolved, the promise remains unchanged — the same premium quality, satisfying crunch, and trusted taste that consumers associate with Cornitos.

Commenting on the refresh, Manoj Singh, Head of Marketing, Cornitos, said: "Today's consumers are increasingly conscious about what they snack on. With our new energy-led packaging, we wanted to create a design that reflects vibrancy, modern lifestyles, and convenience — while continuing to deliver the same quality and taste that our consumers trust. This refresh strengthens our connection with evolving snacking habits."

With this upgrade, Cornitos reinforces its commitment to innovation and consumer-first thinking — ensuring that better-for-you snacking seamlessly fits into everyday life. Price Range: Starting from Rs. 145. Available at: www.shop.cornitos.in and leading retail and modern trade outlets across India.

Parle Agro Launches SMOODH Kesar Badam, Bringing a Classic Indian Flavour to Its Dairy Beverage Line-Up



Parle Agro, the largest Indian beverage company known for driving innovation in the Indian beverage market, launches Smooth Kesar Badam the newest addition to its flagship dairy beverage brand, Smooth. The new offering brings the classic Kesar Badam taste to Smooth's flavoured milk portfolio, adding another choice for consumers seeking a rich and indulgent dairy beverage experience.

A flavour combination loved across India, Kesar Badam is known for its familiarity and richness. Smooth Kesar Badam brings together the goodness of almonds and the warmth of saffron, blended with smooth, creamy milk to deliver a premium indulgent experience in Smooth's signature style. It captures the classic Kesar Badam flavour

making it perfect for any occasion — whether it's a festive celebration, a family gathering, an evening indulgence, or simply a refreshing treat during the day. Priced at INR 10 for 80 ml and INR 20 for 150 ml, it is designed to be convenient and accessible for everyday consumption.

Commenting on the launch of Smooth Kesar Badam, Nadia Chauhan, Joint Managing Director and CMO, Parle Agro, said, "Since its launch, Smooth has redefined the dairy beverage category by making indulgent dairy-based beverages more accessible. The Smooth flavoured milk range has quickly become a favourite among young consumers and families alike. Kesar Badam is a flavour that carries strong cultural relevance and wide appeal, which made it a natural addition to our portfolio. With Smooth Kesar Badam, we are bringing this familiar taste in a contemporary, on-the-go format while further strengthening our leadership in the category. This launch reflects our continued focus on building products that align with evolving consumer preferences, while staying rooted in flavours India genuinely connects with."

Smooth Kesar Badam will be available in

multiple pack formats across urban and rural markets, spanning general trade, modern trade and emerging digital and quick commerce platforms.

The introduction of Smooth Kesar Badam is a strategic move by Parle Agro to capitalize on the strong consumer affinity for traditional Indian flavours in the rapidly growing flavoured milk segment. Kesar Badam, with its rich heritage and wide appeal across age groups, represents a significant opportunity to deepen consumer engagement and expand the brand's footprint.

The launch will be supported by an integrated marketing campaign spanning OOH, digital platforms, social media, influencer partnerships, and in-store visibility. The campaign is designed to build strong awareness and drive trial at scale, positioning Smooth Kesar Badam as the go-to choice for consumers seeking a premium, indulgent dairy beverage that combines tradition with contemporary taste.

With Smooth, Parle Agro continues to expand its dairy beverage presence across flavoured milk and lassi, with flavoured milk variants including Chocolate, Chocolate Hazelnut, Toffee Caramel and the newly launched Kesar Badam.

Britannia Celebrates 30 Years of 50-50 with the launch of the New Cheese Dipped Crunchy Layered Sandwich

For over three decades, Britannia Industries' iconic brand 50-50 has shaped everyday snacking in India through its distinctive dual flavour proposition. Adding another milestone to this journey is the launch of the Britannia 50-50 Cheese Dipped Crunchy Layered Sandwich, a premium new format designed to bring alive the idea of 50 percent crunchy and 50 percent melty indulgence.

The Britannia 50-50 Cheese Dipped Crunchy Layered Sandwich carries forward the brand's signature idea of duality in a new format. Crafted with 22 baked layers that create a structured crunch and enrobed with cheese that creates the melt, the product delivers contrast through texture. By bringing crunch and melt together in a single, defined bite, it offers a complete and satisfying snack on its own. This launch builds on 50-50's long-standing focus on evolving with consumer preferences while staying rooted in its distinctive dual identity. Over the years, the brand has



expanded from flavour innovation to format expansion, strengthening its presence in the snacking category. Cheese Dipped reflects the next phase of that journey, introducing a more premium expression within everyday snacking while remaining accessible.

Siddharth Gupta, Vice-President, Marketing, Britannia, said, "When we look at how India snacks today, it is clear that consumers are looking for more innovative and engaging ways to enjoy their favourite products. With Cheese Dipped, we have taken the 50-50 idea beyond flavour and expressed it through texture, bringing together crunch and melt in a more premium format. As the brand continues to build on over three decades of celebrating contrast, this launch reflects our continued focus on evolving

with consumer needs while strengthening our credentials in the snacking segment."

The product story comes alive in the campaign featuring Rishabh Pant and Jemimah Rodrigues, where the contrast between Crunchy and Melty is expressed through their on-screen energy and playful interactions. Just as the crunchy-layered sandwich unites contrasting textures, the film highlights two distinct snack personalities that naturally complement each other in a way that feels fun, relatable, and true to 50-50's long association with cricket.

Cheese Dipped marks an important addition to the 50-50 portfolio. The launch reflects Britannia's ongoing focus on strengthening everyday snacking with formats that make snack time more enjoyable.

Britannia 50-50 Cheese Dipped Crunchy Layered Sandwich is currently available across select cities at leading retail outlets and Q-commerce platforms.



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Next-Generation Food Industry: Powered by Artificial Intelligence (AI)

¹ Dr. G. Pandidurai, Ph.D. & ² Dr. M. Aasif, Ph.D.



Introduction

Artificial Intelligence (AI) is redefining the food industry from production and processing to distribution, retail, and consumption. What was once the realm of human intuition and experience is now increasingly driven by data, automation, and intelligent decision systems. AI technologies such as machine learning, computer vision, robotics, and predictive analytics are empowering food businesses to enhance efficiency, improve quality and safety, reduce waste, customize nutrition, and build sustainable practices. Together, these innovations are unlocking new levels of productivity, profitability, and responsiveness in an industry that feeds billions.

1. Transformative Applications of AI in the Food Value Chain

AI's influence spans all major stages of the food system from farms and factories to shelves and consumers.

Precision Agriculture and Smart Farming

AI is deeply transforming agriculture the foundational stage of the food supply chain. Through sensors, drones, satellite imagery, and machine learning models, AI systems can monitor soil conditions, crop health, water needs, pests, and weather in real time. These insights allow farmers to:

- Optimize irrigation and fertilizer use,
- Detect disease and pest threats early,

A rapidly growing trend in food technology is AI-driven personalized nutrition. Using biometric information, dietary preferences, and health data, AI can generate custom meal plans and nutrition recommendations. Major brands are partnering with AI startups to offer tailored dietary advice and functional food solutions that cater to lifestyle goals, dietary restrictions, and health outcomes. This trend intersects with computational gastronomy, where data analytics and AI are used to optimize culinary experiences, ingredient combinations, and flavor profiles to maximize consumer satisfaction and health benefits.

- Predict yields with greater accuracy,
- Improve resource efficiency and sustainability.

Quality Control and Food Safety

Ensuring food quality and safety is a critical priority for companies and regulators alike. AI-powered systems enable faster, more accurate inspection than manual methods:

- Computer vision systems detect defects, contaminants, and inconsistencies on production lines,
- Hyperspectral imaging combined with AI can identify foreign materials invisible to traditional cameras, improving sorting accuracy in high-speed processes.

- Sensors and machine learning continuously monitor temperature, humidity, and hygiene in facilities.

For example, AI-enabled inspection systems can process thousands of images per minute and flag defects in real time far beyond human capability helping prevent product recalls and protect public health. AI can also monitor microbial growth risks and predict potential contamination, enabling preventive action instead of reactive responses.

Automated Processing, Robotics, and Smart Manufacturing

AI and robotics are significantly improving efficiency, speed, and consistency in food manufacturing:

- Robots manage repetitive tasks like sorting, packaging, and material handling,
- Automated production lines are monitored using AI systems to detect deviations or potential failures,
- Predictive maintenance uses machine learning to pre-empt equipment breakdowns, reducing downtime and production loss.

These technologies help maintain high hygiene standards and consistent product quality, while optimizing labor costs and production capacity. In kitchens and food service, AI-powered robots are streamlining meal preparation and delivery logistics from autonomous delivery vehicles (such as those used by Domino's) to intelligent kitchen automation systems.

Intelligent Supply Chain and Inventory Management

AI's data-driven insights are transforming food supply chains by optimizing inventory levels, logistics, and demand forecasting:

- Demand forecasting uses historical data and external signals like weather or events to reduce stockouts and overproduction,
- Route optimization minimizes transportation time, fuel costs, and delivery delays,
- Real-time tracking improves

- transparency and coordination across global logistics networks.
- Retailers like Tesco and Walmart use AI analytics for demand forecasting and inventory planning, enabling them to anticipate shopping patterns and reduce food waste.

By aligning supply with demand more accurately, businesses can both enhance profitability and reduce spoilage a major sustainability goal in the food sector.

Personalization and Consumer Experience

AI enhances consumer engagement through personalization and digital experiences:

- Chatbots and virtual assistants handle customer queries, order placements, and menu suggestions,
- Recommendation engines tailor product suggestions based on individual tastes and dietary needs,
- Smart kiosks and apps enable personalized nutrition planning and meal recommendations tailored to health metrics or preferences.

AI technologies such as natural language processing (NLP) and machine learning power these intelligent systems, improving satisfaction and loyalty among consumers.

Personalized Nutrition and Health Optimization

A rapidly growing trend in food technology is AI-driven personalized nutrition. Using biometric information, dietary preferences, and health data, AI can generate custom meal plans and nutrition recommendations. Major brands are partnering with AI startups to offer tailored dietary advice and functional food solutions that cater to lifestyle goals, dietary restrictions, and health outcomes. This trend intersects with computational gastronomy, where data analytics and AI are used to optimize culinary experiences, ingredient combinations, and flavor profiles to maximize consumer satisfaction and health benefits.

2. Research Focus: AI in Food Science

Beyond commercial applications, academic and institutional research is advancing AI's role in food science particularly in flavor analysis, nutritional optimization, sensory profiling, and product innovation. At initiatives like the AI for Food Science research program at TCG Crest's Food Technology and Science Institute (FTSI), AI is used to explore:

- Aroma mapping and flavor profiling at the molecular level,
- AI algorithms to predict sensory experiences and simulate flavor combinations,
- Database development for aroma compounds to support product innovation,
- Quality control of sensory attributes and detection of contaminants,
- Consumer preference analysis for personalized product design.

This research aims to enhance the sensory qualities of food products while supporting sustainability and regulatory compliance strengthening the link between scientific innovation and commercial food development.

3. Reducing Waste & Driving Sustainability

One of AI's most impactful contributions is its ability to reduce food waste and promote environmental sustainability:

- Predictive demand models help restaurants and supermarkets forecast consumption, reducing overproduction and spoilage,
- AI-driven inventory systems adjust pricing and stock levels to minimize expiry losses,
- Supply chain analytics reduce inefficiencies and optimize production planning.

For instance, pilot AI systems have cut food waste by targeting patterns in inventory data and employee disposal trends, helping companies adjust menus and stock levels before waste occurs. Sustainability is further enhanced when AI supports resource optimization — lowering water, energy, and fertilizer use in farming — and environmental impact assessment using data analytics that measure emissions and resource consumption.

4. Future Trends and Emerging Directions

Integration with IoT, Blockchain, and Big Data

AI is increasingly integrated with IoT sensors, enabling real-time farm and factory data feeds, and blockchain, which secures supply chain transparency and traceability. This convergence enhances data integrity from farm to fork.



AI-Enabled 3D Food Printing

Advanced AI models are beginning to support 3D food printing enabling customized textures, shapes, and nutrition profiles particularly for special dietary groups or personalized products.

Multi-Omics and Predictive Biosciences

AI will increasingly integrate with multi-omics data — including genomic, metabolomic, and proteomic profiles to predict food safety or nutritional outcomes with high accuracy.

Consumer-Driven Food Systems

Emerging research suggests a future where AI systems integrate demand and preference data across populations, shaping agricultural output and food design to match evolving nutritional needs creating dynamic, consumer-driven food systems.

Conclusion

Artificial Intelligence is ushering in a new era for the food industry one characterized by intelligent automation, data-driven decisions, sustainability, and personalization. From precision agriculture and automated food processing to optimized supply chains, personalized nutrition, and AI-assisted food science research, the technology's impact is profound and accelerating. However, ethical governance, workforce training, regulatory standards, and equitable access are essential to ensuring that AI's benefits are realized responsibly and inclusively. As AI technologies continue to advance and integrate with other innovations such as IoT, blockchain, and multi-omics science, they will not only help feed the world more efficiently but also contribute to healthier, safer, and more sustainable food systems for future generations.

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India's Booming Snack Economy

Market Growth, Consumer Trends, and the Road to 2034

Introduction: Snacking Becomes a Powerful Consumption Trend

India's snack industry is undergoing a significant transformation as evolving consumer lifestyles, urbanization, and rising disposable incomes reshape eating habits across the country. Once viewed merely as small bites between meals, snacks have now become an integral part of daily consumption patterns for millions of Indians. From traditional namkeens and bhujia to global snack formats such as chips, biscuits, and chocolates, the Indian snacking landscape is vast, dynamic, and rapidly expanding.

Recent market estimates suggest that the India snacks market will grow from INR 48,543.1 crores in 2025 to approximately INR 104,649.54 crores by 2034, registering a compound annual growth rate (CAGR) of 8.91% between 2026 and 2034. This strong growth trajectory is supported by increasing demand for convenience foods, the expansion of organized retail and online platforms, and continuous innovation in flavors and product formats. As consumers seek quick, portable, and indulgent food options that fit into their busy routines, the snack sector is emerging as one of the most vibrant segments within India's food and beverage industry.

The Expanding Definition of Snacks in India

Snacks are typically small food items consumed between meals to curb hunger, provide energy, or offer indulgent taste experiences. In India, the snack category encompasses an exceptionally diverse range of products. These include savory snacks such as chips and namkeens, baked goods, cookies, chocolates, ethnic snacks, and increasingly, healthier alternatives such as roasted nuts, millet-based snacks, and protein-rich items.

One of the key reasons behind the popularity of snacks is their convenience. Most snack products are portable, require minimal preparation, and have relatively longer shelf

lives. These characteristics make them ideal for busy urban lifestyles, workplace consumption, travel, and on-the-go eating. In recent years, the snacking segment has evolved beyond indulgence to include nutrition-oriented offerings. Consumers today are showing increasing interest in snacks that combine taste with health benefits, prompting manufacturers to explore innovative ingredients, alternative cooking techniques, and functional formulations.

Cultural Roots: Snacking as a Way of Life

Snacking is deeply embedded in India's cultural and culinary traditions. Across the country, snacks are often consumed during tea time, social gatherings, travel, or evening relaxation. Traditional foods such as samosas, bhujia, chivda, and a wide range of regional namkeens continue to hold strong emotional and cultural significance. At the same time, Western-style packaged snacks such as potato chips, biscuits, and chocolates have gained widespread popularity, especially among younger consumers and urban populations. This coexistence of traditional and modern snack formats has created a unique market environment where heritage flavors meet global trends.

Urbanization and changing food habits have further accelerated the shift toward packaged snacks. Consumers increasingly prefer ready-to-eat products that offer convenience without compromising on taste. Additionally, the growing interest in regional flavors and healthier snack options has expanded the diversity of products available in the market.

Changing Lifestyles Driving Demand

Rapid urbanization and evolving lifestyles are among the most influential factors driving the growth of India's snack market. With more people living in cities, working longer hours, and commuting greater distances, the demand for quick and convenient food solutions has increased dramatically.

The rise of nuclear families and a growing

population of working professionals and college students have also contributed to the surge in snack consumption. Many consumers now rely on snacks as quick meal substitutes during busy schedules or as convenient options for office breaks and travel. India's dietary patterns also influence the market. According to a 2023 report in The Times of India, nearly 38% of Indians follow a purely vegetarian diet. This has encouraged snack manufacturers to design products that cater to vegetarian consumers while also aligning with evolving health and lifestyle preferences.

As a result, ready-to-eat snacks have become an essential part of everyday consumption, reinforcing the category's long-term growth potential.

Rising Disposable Income and the Expanding Middle Class

Another powerful growth driver for the snack market is India's expanding middle class and increasing disposable income levels. Over the past few decades, India's middle-income population has grown significantly, creating a large consumer base with greater purchasing power.

The middle class accounted for about 31% of India's population in recent years, and this figure is expected to rise to 38% by 2031 and nearly 60% by 2047. This demographic shift is reshaping consumption behavior across multiple sectors, including food and beverages. Consumers today are more willing to spend on branded and premium snack products compared to unbranded alternatives. Premiumization is particularly visible in metropolitan cities where consumers are exploring gourmet flavors, international snack formats, and visually appealing packaging. At the same time, rising incomes in Tier II and Tier III cities are expanding the overall snacking base. As modern retail formats and digital commerce reach smaller cities, snack brands are witnessing broader market penetration and increasing per capita consumption.

Product Innovation Fuelling Market Growth

Innovation has become a defining feature of the Indian snack industry. Companies are constantly introducing new products, flavors, and formats to attract diverse consumer groups and maintain competitive advantage. Flavor experimentation is one of the most visible aspects of innovation. Manufacturers are combining regional Indian spices with global snack formats, creating fusion products that resonate with local tastes while offering novelty. Health-oriented innovations

are also gaining traction. Baked snacks, low-fat alternatives, millet-based products, and protein-rich snacks are becoming increasingly popular among health-conscious consumers. These products appeal particularly to urban buyers who seek better-for-you snacking options without sacrificing flavor.

A notable example of product innovation occurred in September 2024, when Parle Products introduced "Nakli Bhujija" under its Parle Chatkeens range, designed to deliver bold flavors and a unique snacking experience for adventurous consumers. Such product launches demonstrate how innovation continues to expand the boundaries of the Indian snack category.

Distribution Evolution: From Kirana Stores to E-Commerce

Distribution plays a crucial role in the success of snack brands in India. The country's snack market relies on a multi-channel distribution network that includes traditional retail outlets, modern supermarkets, convenience stores, and rapidly expanding online platforms.

Convenience stores and neighborhood kirana shops remain the most dominant retail channels. These outlets provide easy accessibility and are often the primary point of purchase for impulse snacks such as chips, biscuits, and namkeens. Their widespread presence across urban and semi-urban areas ensures high product visibility and frequent sales. At the same time, supermarkets and hypermarkets are emerging as important platforms for premium and differentiated snack products. Modern retail environments allow consumers to explore a wide variety of brands, experiment with new flavors, and purchase products in larger quantities. E-commerce platforms and quick-commerce services have further transformed the snack distribution landscape. Online grocery platforms now enable consumers to order snacks instantly, contributing to greater product availability across regions.

Health Concerns and Regulatory Challenges

Despite its rapid growth, the snack market also faces several challenges. Increasing awareness about health and nutrition is prompting consumers to scrutinize packaged foods more carefully. Concerns about excessive salt, sugar, and fat content in snacks have raised questions about the long-term health impact of certain products. Government initiatives promoting healthier diets and improved labeling transparency may also influence consumer behavior in the coming years. As a result, snack manufactur-

ers are under growing pressure to reformulate products, reduce unhealthy ingredients, and offer nutritionally balanced alternatives. For companies operating in this space, maintaining the right balance between taste, convenience, and nutrition will be crucial for sustained growth.

Intense Competition and Price Sensitivity

India's snack industry is highly competitive, with numerous domestic brands competing alongside multinational companies. In addition to organized players, a vast network of small-scale manufacturers and regional producers contributes to the market's complexity. Price sensitivity remains a significant factor influencing consumer choices. Many buyers prioritize affordability, leading to frequent price wars and promotional discounts among competing brands. To remain competitive, companies are increasingly focusing on brand differentiation, innovative packaging, unique flavor offerings, and targeted marketing strategies. Building strong brand loyalty is essential in a market where consumers have access to a wide range of alternatives.

The Role of the Unorganized Snack Sector

The unorganized sector continues to play a major role in India's snack ecosystem. Local snack vendors and small-scale producers supply a wide variety of traditional snacks, including freshly prepared namkeens, fried savorys, sweets, and street foods. These products remain popular due to their affordability, familiar taste profiles, and deep-rooted connection with regional cuisines. In many rural and semi-urban areas, locally produced snacks dominate consumption patterns. However, the organized snack industry is gradually gaining ground as consumers increasingly value hygienic packaging, standardized quality, and longer shelf life. Branded companies are also repackaging traditional snack formats in modern packaging, making them more accessible to urban consumers.

Potato Chips: A Fast-Growing Snack Segment

Among the many snack categories in India, potato chips have emerged as one of the fastest-growing segments. Their widespread popularity can be attributed to factors such as convenience, appealing marketing campaigns, and the introduction of localized flavors tailored to Indian tastes. Organized players have played a significant role in expanding this category through efficient distribution networks, attractive packaging, and strong brand presence. The introduction of

baked and lower-calorie chip variants has also attracted health-conscious consumers. Potato chips are often considered impulse purchases, making them a key driver of repeat sales within the snack market.

Ethnic Namkeen and Traditional Snacks

Ethnic namkeen products remain an essential part of India's snack culture. Popular items such as sev, mixtures, chivda, and various regional snacks are widely consumed across the country. These products benefit from strong cultural familiarity and emotional connection among consumers. Many households regularly consume namkeen during tea breaks, social gatherings, or travel. Organized companies are increasingly entering this segment by offering branded and hygienically packaged versions of traditional snacks. Urban consumers, in particular, are drawn to the idea of enjoying authentic flavors with the assurance of quality and safety.

Bhujia: A Timeless Indian Favorite

Bhujia holds a special place in India's snack market. Originally from Rajasthan, this crispy gram flour snack has become a national favorite and is widely consumed across urban and rural markets alike. Bhujia's popularity stems from its distinctive flavor, crunchy texture, affordability, and long shelf life. It is commonly eaten on its own or as part of snack mixtures. Large snack brands have played a significant role in standardizing production and expanding the product's distribution across the country. Today, flavored and premium versions of bhujia are also gaining traction, adding new dimensions to this traditional snack category.

The Road Ahead for India's Snack Industry

The future of India's snack market appears highly promising as consumer demand continues to grow across demographic and geographic segments. The combination of lifestyle changes, rising incomes, product innovation, and expanding retail networks will continue to drive market expansion in the coming decade. At the same time, manufacturers will need to address emerging challenges such as health awareness, regulatory scrutiny, and intense competition. Companies that successfully combine taste, nutrition, convenience, and strong branding will be best positioned to thrive in this evolving landscape. As India's food culture continues to evolve, the snack industry will remain a powerful driver of innovation and growth, transforming everyday consumption into a dynamic and thriving market opportunity.

This article was written by Editor Mr. Kiran Kumar, with reference to information from www.renub.com.

Detection of Pesticides in Fruits and Vegetables using Advanced Technology

Addanki Mounika², Saipranavi Mullapati¹, Tamminana Jeeviteswara Rao¹, Akalya Shanmugam^{1*}



Introduction:

Crops need pesticides to minimize the loss caused by pests (insects, mites, rodents, etc.). Each farmer must follow some protocols and levels to spray pesticides, especially food commodities. These practices are called good agriculture practices. Increasing these residual limits leads to food contamination. By using various instruments such as High-performance liquid chromatography (HPLC), gas chromatography (GC), raman spectroscopy (RS), and capillary electrophoresis (CE), one can determine the percentage of these pesticides. Although they provide accurate results, these methods take time and high-cost maintenance. Also complicated to handle these well-trained personnel are required for any minute damages that may lead to a considerable loss and cost more time and money to replace them. Recently there have been portable machines that can detect pesticide levels, mainly fruits and vegetables (F&V); these machines are less messy and easy to handle. There are various types of portable pesticide detection, such as bioactive paper biosensors, screening cards, and smartphone sensors [1].

Methods:

Pesticides are identified using a calorimetric technique; Guo et al. made a screening card for the detection. It is based on colour changes in the card caused by pesticides inhibiting acetylcholinesterase action and increasing chromogenic reagents on the surface membrane owing to its rapid

evaporation. This method is implemented in fruits such as grapes, apples, and oranges. Omethoate insecticide injected into the above fruits and tested the pesticide residue, with the help of a screening card, results in color changes in the card up to 1µg/ml limit of detection (LOD). This card is portable and can rapidly detect pesticide residues in the field and house. Some of the pesticides detected and their values are dichlorvos, 0.1 mg/mL, and methamidophos, 2 mg/mL. These results are like GC analysis, indicating that these test cards can be an alternative, fast, low-cost procedure for pesticide detection [2].

In another study, surface-enhanced raman scattering (SERS) systems were developed for the trace identification of pesticides.



Adapted from [3]

Figure 1: Smartphone-based pesticide detection with chip holder.

This SERS chip was directly inserted into the cell phone, detecting the residues with just one click. The trace amount of the sample was poured on the surface of the chip, which sees the deposition based on raman signals by laser. These signals were collected in sequence after the drying of the sample. After detection, these chips can be removed for easier cleaning. Figure 1 depicts the process. This LOD is ten parts per million and can detect up to twelve pesticides. This portable system was modified by replacing the ordinary planar reflective grating with grating and concave mirrors size 4.0 [3].

SERS detection of common pesticide residues (carbaryl) was done on gold nanoarrays on silicon substrates, and linear regression of carbaryl concentrations in aqueous acetone solution, apple juice, and cabbage was performed ($R > 0.97$). Carbaryl has a LOD in apple juice of 2.5 ppm and 0.1 ppm in cabbage of acetone. At 3-33 and 4-34 mg/L, Liu et al. used a gold Au colloid-modified SERS system to detect phosmet and chlorpyrifos residues in navel orange. For phosmet and chlorpyrifos, the predicted correlation coefficient (R) range was 0.9 to 0.7 mg/L, respectively, while the root mean square error prediction range was 4 - 6mg/L. This method detects pesticide residues in fruit and vegetable juice [4].

In another work, SERS-based silver nanoparticle swabs or sheets are generated using RS figure 3 with a resolution of 5 cm⁻¹ and a beam of 10 mm, an excitation of 780 nm for all measurements, and tested on various fruits and vegetables. Yadan et al. sprayed thiram pesticide on four varieties of fruits and vegetable peels at 10 ng/cm² and subjected them to dry. After some time, silver nanoparticle papers were wetted in ethanol. They wiped the surface of the peels and concluded that the presence of sprayed pesticide on the surfaces of apples, oranges, tomatoes, and green vegetables at 10.0 ng/cm², 10.2 ng/cm², 11.2 ng/cm², 9.8 ng/cm², respectively [5].

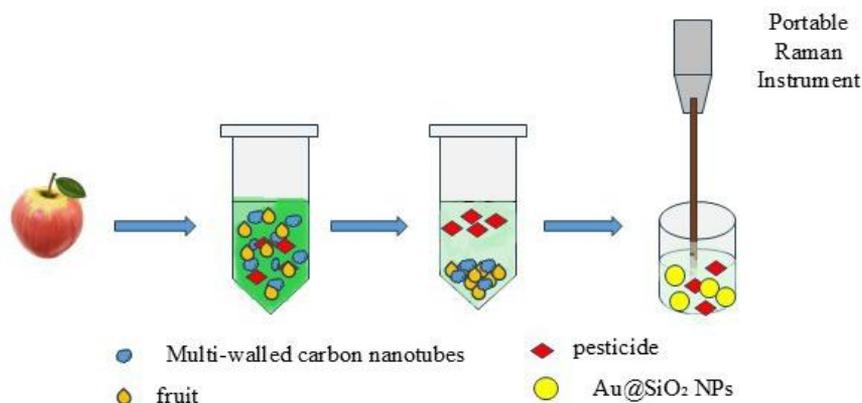
In a similar study, HXSpec is a handheld RS using a laser diode with 785 nm as an excitation source. This resolution is 7 cm⁻¹ in the 200-2700 cm⁻¹ spectral range.

In this study, the drop wipe test Figure 4 was used where wiping fruit peel with the help of a SERS wiper is the central part. Initially, the filter paper was loaded with silver nanoparticles. Then, Wang et al. They selected some fruits, like grapes, which were subjected to washing to ensure no residues on the surface of the fruits. Then drop the selected pesticide residue of thiram on fruit peels, wipe with the wiper filter paper, and finally analyze the pesticide content with the RS. It showed the amount of pesticide residue on the fruit peels in histograms. The intensity of peaks decreased with decreasing thiram content, and firm peaks were observed at 560 cm⁻¹. The LOD of some fruits, including grapes, was 4 -5 ng.cm², respectively [6].

In a different work, a portable RS and SERS substrate-based on-chip Raman spectroscopy device was created for the on-site detection of trace pesticides. The chosen portable RS used a thermoelectrically cooled CCD spectrometer for detection and a 785 nm laser diode for excitation. The low-cost SERS substrates with a structure of scattered Ag nanorods were made using the low-energy magnetron sputtering technique. Portable SERS for pesticide detection was made using a magnetron-sputtered silver nanorod film. The concentration of organophosphorus chemical agents adsorbed on the produced SERS substrates, such as methyl parathion, chlorpyrifos, and malathion, was measured. The findings suggested the proposed portable SERS system provided sensitive detection for organic trace studies of dangerous chemical compounds [7].

Another RS-based study developed a flexible jelly-like substrate made of nanocellulose covered with silver nanoparticles. It used SERS to examine its usefulness for fast in-house pesticide detection in F&V. Performance of the Ag/NC substrate (R6G) was evaluated using Rhodamine 6G. The detection limit of a portable RS is 108 M. After 60 days in storage. The substrate's sensitivity was not lost. The jelly-like and slightly sticky Ag/NC substrate is well suited for in-situ SERS detection due to its excellent flexibility to sample surfaces. The non-invasive and rapid in-situ SERS method with silver substrate found two pesticides on apple peels and cabbages. Apple and cabbage had relative standard deviations of 10.27% and 9.19%, respectively, and have good reproducibility and uniformity [8].

Another research was based on detecting



Adapted from [4]

Figure 2: SERS-based pesticide residue detection in fruits by portable raman spectrometer



Adapted from [5]

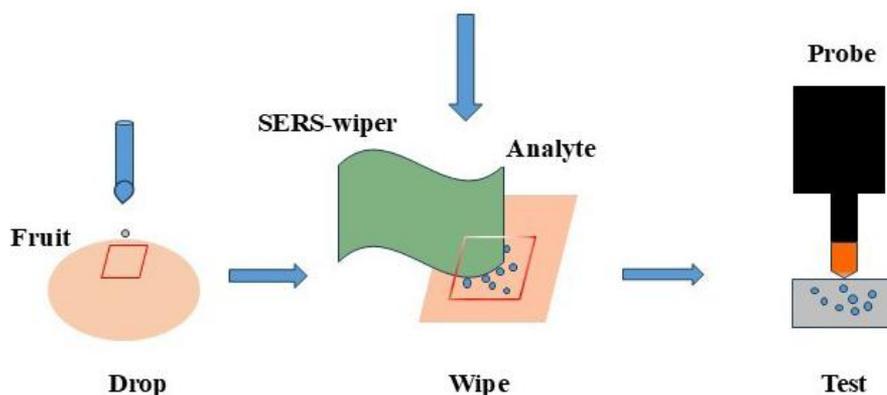
Figure 3: Portable raman spectrometer with wavelength adjustment.

pesticide residues on the surface of tomatoes based on flexible SERS tape using a portable RS. The LOD for thiabendazole is 8 ng/cm², carbendazim is 20 ng/cm², and chlorpyrifos is 40 ng/cm² on the glass surface. This method suggested that this approach might be used for quick, non-destructive online semiquantitative detection of several pesticides, particularly during the early stages like screening. This work also gives an advanced opportunity

for detecting trace pesticides on complex surfaces, including but not limited to these three pesticides [9].

In recent years, the development of quantum dot (QD) sensors for pesticide monitoring has increased. QD materials outperform other fluorophores regarding optical properties and fluorescence quantum yields. As a result, they've been employed in a range of research to construct organic contamination probes. In their study, Nsibande et al. focused on their use as fluorescence probes for pesticide spotting in various media, including water, fruits, and vegetables. Reduced LOD demonstrates that these technologies can be cost-effective and time-consuming alternatives to standard techniques. They also talked about the possible limits of these probes in common usage. QD drops enzyme films was done to detect organophosphorus pesticides on apples with a LOD of 3 pg/ml [10].

A colorimetric system that works on a microfluidic mixer chip was manufactured



Adapted from [6]

Figure 4: Drop-wise-test for the detection of fruit samples



Adapted from [12]
Figure 5: Smartphone-based electrochemical detection.

to detect organophosphorus pesticide residues. High-precision dynamics modeling was quickly used to identify the microchannel shape with the highest mixing efficiency; the microfluidic chip was developed for this purpose. It was made utilizing a photo-curing system for LCD masks that was custom-built. The impact of printing parameters on chip accuracy was explored. Testing was done to investigate the relationship between the fluid storage level and sensor limit using absorption spectrum measurement to identify the light source with the correct wavelength for the device. It was discovered that pesticide content and induced voltage are related. It provides a minimal detection concentration that may reach 0.045 mg/L, and the detection time has been decreased to a minute. It provides the experimental and theoretical basis for immediate, hand-based detection to get the precise amount of pesticide residues [11].

Another study is based on the smartphone detection of electrochemical detection, as shown in Figure 5. It contains a molecular printing method to detect thiamethoxan (TMX) in mangoes and legume samples. This smartphone-based technique consists of a tiny Bluetooth based workstation model for connection. An In-built Android application sends signals after the detection between the circuit board and the smartphone. The detected values for the pesticide mentioned above for water, mango, and cowpea samples were 97 - 106 percent, 98 - 100 percent, and 100 %, respectively. Similarly, 4.45% was the relative standard deviation for all food items. The outcomes match with the national norm for physical and chemical food detection (NFPCDS), which indicates that the molecularly imprinted sensor that has been constructed can satisfy the requirements for fast detection of TMX in actual samples [12].

Conclusion:

This essay outlined different portable methods for finding pesticide residue levels

In recent years, the development of quantum dot (QD) sensors for pesticide monitoring has increased. QD materials outperform other fluorophores regarding optical properties and fluorescence quantum yields. As a result, they've been employed in a range of research to construct organic contamination probes. In their study, Nsibandé et al. focused on their use as fluorescence probes for pesticide spotting in various media, including water, fruits, and vegetables. Reduced LOD demonstrates that these technologies can be cost-effective and time-consuming alternatives to standard techniques.

in fruit and vegetables. It concludes that these types of procedures are accurate and fitted to use in on-field analysis of pesticide detection in less time. These portable techniques are elementary to handle and manage, and the cost of these is very reasonable in the market. Almost anyone can use these; even researchers can use them to save time, energy, and money, not only for pesticide detection but also for detecting food adulteration and contamination. These methods can mainly test for trace contaminants in fruits and vegetables. These can be used in other areas, such as environmental fields that are subject to rain, temperature, soil nutrient analysis, and food nutrients estimation [13].

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Affordable, Hygienic, Scalable: Transforming Value-Priced FMCG in India

In this exclusive interaction, Prabhu Gandhikumar, Founder & CEO of TABP Snacks and Beverages, shares insights with the editorial team of Food & Beverages Processing Magazine on the company's founding philosophy, its success in the value-priced FMCG segment, and how it balances affordability with quality, taste, and safety. He also discusses the role of regional consumer preferences, operational efficiency, and supply chain strength in scaling a high-volume business model while maintaining consistent product standards.

PRABHU GANDHIKUMAR - FOUNDER & CEO, TABP SNACKS AND BEVERAGES

Please brief us about TABP Snacks and Beverages, its founding vision, and the range of products currently offered under your portfolio.

TABP Snacks and Beverages was founded with a singular vision: to democratize access to high-quality, hygienic packaged foods for the "bottom of the pyramid" consumer. We believe that price should not be a barrier to quality. Our mission is to convert the unorganized market into an organized, aspirational one by offering premium packaging and standardized taste at accessible price points.

Currently, our portfolio spans three major verticals:

- Beverages: We offer a variety of fruit-based drinks and carbonated beverages that cater to regional tastes.
- Snacks: Our range includes extruded snacks and fryums that bring distinct local flavors to the fore.
- Water: We have recently started our water division which has shown sales growth in a very short span.

TABP has built a strong presence in the ₹5 to 10 price segment, a space where many large FMCG players remain cautious. What makes this segment both viable and scalable for your business model?

The ₹5 to ₹10 segment is indeed challenging due to thin margins, but it is massively scalable if you get the unit economics right. Large FMCG players often struggle here because of their heavy overheads and general trade structures.

For us, viability comes from high volume and operational austerity.

In the rapidly evolving food and beverage landscape, the demand for affordable yet high-quality packaged products continues to grow, particularly among value-conscious consumers across emerging markets. Bridging this gap between affordability and quality is TABP Snacks and Beverages, a company that has carved a distinct niche in the highly competitive ₹5-₹10 FMCG segment. Founded with the vision of making hygienic, well-packaged food and beverages accessible to the "bottom of the pyramid," the company has steadily expanded its footprint across Southern and Eastern India with a diverse portfolio spanning beverages, snacks, and packaged water. Through strong supply chain networks, localized product innovation, and a sharp focus on operational efficiency, TABP is transforming traditionally unorganized categories into aspirational packaged offerings.

We focus on:

- Volume-led Growth: We operate on the philosophy that small margins multiplied by millions of units create sustainable profit.
- Lean Operations: We keep our corporate overheads low and focus our spending on the product and distribution, ensuring the consumer gets maximum value for every rupee.

How do you view the competitive landscape in the value-priced FMCG segment, and what would you define as TABP's key differentiators or unique strengths?

The landscape is crowded but largely fragmented with unorganized regional players. Our key differentiator is bringing "organized quality" to this unorganized space.

Our strengths include:

- Supply Chain Depth: We penetrate deep into Tier 3 and Tier 4 markets where larger brands often have gaps.
- Agility: We can adapt to regional flavor trends much faster than national conglomerates.
- Value Proposition: We offer a product experience—packaging, taste, and

hygiene—that rivals premium brands but at a fraction of the cost.

Safety and hygiene are paramount in food manufacturing. Could you elaborate on your processing and packaging infrastructure, and the quality and safety standards followed across your operations?

Safety is non-negotiable for us. We have invested in robust processing and packaging infrastructure to ensure that every pack leaving our factory meets stringent safety norms.

- Automation: We utilize automated packing lines to minimize human contact and ensure consistency.
- Compliance: We strictly adhere to FSSAI standards. Our internal quality control protocols test raw materials and finished goods rigorously, ensuring that "affordable" never means "unsafe."

Converting popular street drinks and snacks into hygienic, standardized packaged formats is a distinctive strategy. How do you maintain the balance between affordability, taste authenticity, and quality compliance?

Our core philosophy is simple: "We are good in taste and palatability". If the product doesn't taste good, the price doesn't matter.

To maintain this balance:

- **Authenticity:** We reverse-engineer popular street flavors to retain their "zing" while removing the hygiene risks associated with street food.
- **Affordability via Engineering:** We don't cut corners on ingredients; instead, we optimize our manufacturing processes and packaging costs to keep the price down while maintaining the authentic taste profile consumers love.

Your expansion across southern and eastern states reflects a strong regional focus. How critical are local taste preferences and regional consumption patterns in shaping your product development and brand strategy?

India is not one market; it is a collection of micro-markets. Regional preference is the bedrock of our strategy.

We don't try to force a single "pan-India" taste. Instead, we tailor our products to local palates. For instance, the spice levels in our snacks or the sweetness in our beverages are calibrated specifically for the regions we serve—whether it's the specific preferences in Tamil Nadu or the distinct tastes of the Eastern states. This hyper-localization creates strong brand loyalty.

Operating a high-volume, low-margin FMCG business requires operational precision. What are the key drivers such as sourcing, manufacturing efficiency, supply chain, or distribution that ensure sustainable profitability?

As a Director, I see this precision as our survival kit. Sustainable profitability relies on:

- **Strategic Sourcing:** We procure raw materials during peak seasons to hedge against price fluctuations.
- **Logistics Optimization:** We focus on a tight distribution radius around our manufacturing hubs to keep logistics costs low.
- **Asset Utilization:** Our manufacturing lines run at high efficiency to ensure the fixed cost per unit is minimized. Every fraction of a rupee saved in operations is a rupee added to the bottom line.

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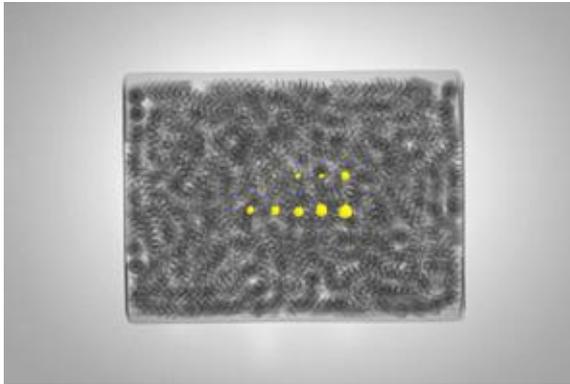
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Improving Contaminant Detection with Dual Energy X-ray and Photon Counting

With certain products, food manufacturers can realise great benefits from using dual energy x-ray detection, especially when paired with advanced photon counting technology. Mike Pipe, Head of Product Inspection of Mettler-Toledo Product Inspection, explains how these technologies together can significantly improve both contaminant detection accuracy and overall business performance.



Applications Suited to Dual Energy X-Ray

But what are the applications in which dual energy x-ray excels compared to the more commonplace single energy detection systems? In simple terms, there are two key aspects of a product that make it suitable for inspection by dual energy x-ray. The first is where there is a large degree of overlap within the package, or where there are variations in thickness. Examples of the

types of packs where products overlap include packs of pasta, rice, nuts, and frozen goods such as French fries or potato wedges. Packs with variations in product thickness include chicken breasts and other fresh cuts of meat. Both scenarios produce an x-ray image with high levels of contrast.

The second type of application where dual energy x-ray is most suitable is where the likely contaminant in a food product is a low-density material, such as glass, plastic, rubber and calcified bone.

If a product application has one or both of these aspects, then a case can be made for dual energy x-ray. However, it is important to understand how this technology works. Here, the key concept is material discrimination.

How Dual Energy Works

Dual energy x-ray works by using high and low x-ray energy levels to discriminate between materials of different densities. A single generator produces the photon beam, which is then split into high and low energy levels either by a physical barrier before reaching the detector or electronically within the detector. This process allows the system to differentiate between the food product and any potential contaminants.

Rather than using machine learning, the

system relies on proprietary software algorithms. These algorithms don't just analyse the pixel's grey level but instead assess the relationship between the grey levels of the same pixel in both the high and low energy images. This enables the system to remove the food product from the x-ray image, leaving behind any material identified by the second energy level, which is most likely a contaminant.

Photon Counting Technology

Photon counting represents a significant advancement in x-ray detection. A photon is a single particle of light, and in traditional silicon-based x-ray detectors, x-ray photons are initially converted into visible light by a phosphor screen. This visible light is then converted into an electrical signal by a silicon photodiode. While this process produces good x-ray images, some dispersion occurs during the light conversion, resulting in slightly "fuzzy" images.

With photon counting in advanced systems like DXD+, x-ray photons are directly converted into electrical signals using cadmium telluride (CdTe) crystals. When a photon above the energy bandwidth interacts with the CdTe crystal, it excites an electron from the valence band to the conduction band, creating an electron-hole pair. The energy absorbed by the crystal determines the energy of the excited electron in the conduction band, which produces the electrical signal. This direct conversion method eliminates the intermediate step of converting x-ray photons to visible light, resulting in sharper images compared to silicon-based detectors.

In silicon-based dual energy detectors, the x-ray spectrum is split using a physical barrier, such as a copper filter in HiGain+ DE. However, in DXD+, the spectrum is split electrically, using the signal obtained from the CdTe crystal. This electrical splitting is more precise and consistent, leading to clearer images and better material discrimination.

Photon counting also allows for a sharper separation of low and high energy components, which enhances image



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

The detection of foreign body contaminants is part of the critical quality assurance process to improve food safety standards. X-ray inspection has long been a key technology in this process, but there are different types of x-ray detection with which food manufacturers can inspect their products, depending upon the nature of the application.

Traditionally, manufacturers have used single energy x-ray detectors, but dual energy technology is becoming more commonplace, and is more powerful, effective, and easy to use than ever before. It works using the concept of 'material discrimination', with dual x-ray beams of different energy able to identify materials of different densities. Advances in detection sensitivity mean that dual energy x-ray is now even more discerning, allowing ever-smaller contaminants to be detected in a wider range of applications.

resolution, particularly in products with overlapping materials. CdTe detectors have a faster response time due to higher charge mobility, but because of how photon counting technology is applied, these detectors may have a slightly lower maximum speed compared to silicon detectors.

Applications and Benefits of Photon Counting

Photon counting technology offers superior resolution and contrast, particularly in complex applications involving loose or overlapping products (e.g., frozen potato wedges or loose chicken breasts with bone).

Mettler-Toledo offers different technologies to meet these challenges, such as X52 (a conventional dual energy system) and photon counting dual energy systems like the X36, in the US and Europe, or the X35 in Asia. The X52 x-ray inspection system provides reliable contaminant detection with enhanced resolution, while the X36 and X35 systems take advantage of photon counting technology for even sharper imaging and greater detection accuracy.

Photon counting dual energy systems can detect smaller physical contaminants (as small as 0.2mm), which gives manufacturers an edge when competing for contracts that require strict detection standards. It's the small gains that lead to big wins. Further, these advanced systems also help to reduce false rejects, leading to fewer wasted products and improved operational efficiency.

Advanced Detector Technology

The most advanced dual energy technology available today features an enhanced detector that collects detailed data about the product being inspected. In these systems, the enhanced detector uses cadmium telluride (CdTe), while standard dual energy systems use silicon (Si) detectors. CdTe-based detectors provide clearer, higher resolution images due to their ability to directly convert x-ray photons into electrical signals, reducing noise and improving image quality. When this is combined with sophisticated image analysis software and the algorithms mentioned above, the result is even clearer, higher resolution images that enable the best levels of physical contaminant detection possible today.

Best fit

Mettler-Toledo dual energy x-ray

systems are capable of detecting significantly more difficult-to-find physical contaminants than single energy x-ray systems. The most common example would be poultry bones, which are often challenging to detect due to their low density. To be sure that a manufacturer's application is best suited to dual energy x-ray manufacturers should look for a "Test Before You Invest" service. This is where a manufacturer can send product samples to be tested in real-life environmental conditions and receive a full analysis report of the findings.

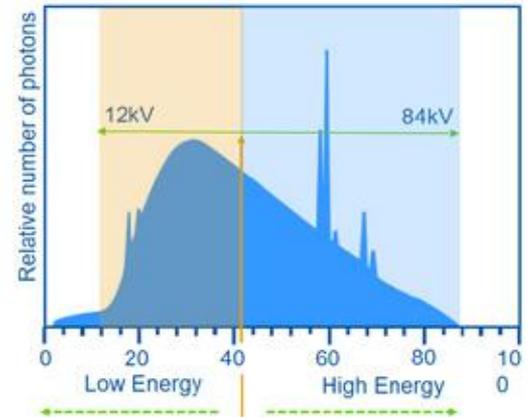
Photon counting represents a significant advancement in x-ray detection. A photon is a single particle of light, and in traditional silicon-based x-ray detectors, x-ray photons are initially converted into visible light by a phosphor screen. This visible light is then converted into an electrical signal by a silicon photodiode. While this process produces good x-ray images, some dispersion occurs during the light conversion, resulting in slightly "fuzzy" images.

The general rule of thumb is that dual energy is best suited to applications where some or all of these factors exist:

- The product being inspected is one with high contrast, caused by overlapping products or products with variable thicknesses.
- The expected physical contaminants are low density materials such as glass, rubber, plastic and calcified bone. It's important to note that this is a relative measure; for instance, steel is considered high density, whereas plastic is classified as low density, as the density of plastic is only a fraction of that of steel.
- The packaging material used is low density, allowing low energy x-rays to pass through and inspect the product inside.

Improving the effectiveness of physical contaminant detection with dual energy x-ray that is optimised to the product application is clearly beneficial to food quality and consumer safety standards, but it also helps the food manufacturer's business.

Consider, for example, the degree to



which the sensitivity of a single energy x-ray system would have to be fine-tuned to detect very small contaminants such as 0.8mm pieces of stainless steel in packs of nuts. The sensitivity required for such an application would very likely cause many false rejects, which would result in a great deal of product throwaway. Turning down the sensitivity to reduce the false reject rate might mean that contaminated products pass undetected, leading to a product recall and damage to reputation. Using dual energy x-ray would very likely enable the manufacturer to optimise detection around this application, without the resulting surge in false rejects and wasted products. In turn, this makes the business case for dual energy x-ray much stronger.

Balancing wants and needs

Dual energy x-ray systems, enhanced by advanced photon counting technology, represent the cutting edge of food safety and contaminant detection. By offering superior resolution and clearer images, they allow manufacturers to detect even the smallest physical contaminants, which is crucial for meeting stringent quality requirements. The increased sensitivity and material discrimination of these systems provide manufacturers with the tools to achieve the highest standards of safety without excessive false rejects. In a competitive industry where safety and efficiency are top priorities, investing in these innovations not only improves detection but also reduces waste, enhances operational efficiency and strengthens a manufacturer's position in securing new contracts. Ultimately, these small yet significant advances can lead to substantial rewards in both product safety and business performance.

For more information, please visit www.mt.com/xray-de-wp-pr.

Sidel delivers Britannia's first-ever aseptic PET packaging line for Winkin' Cow business



Britannia Industries Limited, one of India's leading food companies, selected pioneering packaging experts Sidel to deliver its first-ever aseptic PET packaging line for its dairy drinks portfolio. This strategic partnership enabled Britannia to scale its dairy beverage brand presence under the Winkin' Cow portfolio.

Britannia entered the dairy drinks business in 2018, with value-added dairy drinks under the Winkin' Cow portfolio. Britannia made a strategic decision to partner with Sidel, a global leader in packaging innovation with five decades of expertise in aseptic PET packaging. The objective was to deliver a complete aseptic PET packaging solution at Britannia's greenfield dairy factory in Ranjangaon, Maharashtra, India.

"Sidel offered Britannia end-to-end support, enabling them to unlock the full potential of their dairy beverage," comments Harbinder Kathuria, Vice President, Sales, South Asia. "From bottle and label design to product-packaging validation, the line has empowered Britannia to expand its dairy beverage portfolio and offer safe, high-quality products with enhanced packaging flexibility to Indian consumers since 2023."



Sidel's aseptic global expertise

As technology and solutions partner, Sidel supported Britannia throughout the entire journey, taking care to always meet their expectations and timing. From the initial line design and technical planning to the installation, commissioning and final ramp-up, this close partnership ensured a smooth, efficient and fully aligned execution throughout the entire process.

"The support from Sidel wasn't limited to the line equipment; it went much further," explains Abhishek Sinha, Chief Sales Transformation Officer, Britannia (formerly CBO – Dairy & CEO, BBFPL). "Sidel offered a comprehensive range of services, including new packaging concept design, packaging validation, label recommendations, custom filling tests and shelf-life studies. They provided everything we needed to enter the aseptic PET segment and bring our new product to market with maximum confidence."

Simplest and fastest aseptic solution

To ensure the highest levels of food safety, Sidel installed a complete line with integrated Aseptic Combi Predis at the Britannia plant. The solution, running at



24,000 bph, integrates preform sterilisation, blow moulding, filling and capping into a unique process that ensures product integrity and a longer shelf life for sensitive products.

Aseptic Combi Predis is the market's simplest and fastest aseptic solution with Predis™ dry preform decontamination. Predis™ technology employs the injection of Hydrogen peroxide (H₂O₂) into the preform just before it enters the oven. This results in activation of the H₂O₂ by the existing preform heating stage, ensuring a high level of decontamination while minimising the sterile zone and controlling all risk of potential contamination. Critical parameters are continuously monitored to ensure full production sterility, beverage integrity and food safety, regardless of liquid type or beverage characteristics.

Simple, flexible and sustainable

Sidel's Aseptic Combi Predis is extremely easy to use, allowing the operator to manage the sterilisation process without the need for extensive training or lengthy downtimes. It is also exceptionally flexible, offering the ability to switch between three different formats for dairy drinks – from 180ml to 1L – while maintaining the highest levels of efficiency.

By employing dry preform decontamination, no water and almost no chemicals are used in the process. This significantly reduces water and chemical consumption, allowing Britannia to reach total food safety using fewer resources and with a lower impact on the environment.

Aseptic Combi Predis also facilitates the lowest total cost of ownership (TCO) without compromising food safety or production simplicity, while delivering high uptime and packaging versatility across multiple SKUs.

<https://www.sidel.com/en>



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Future of Food Packaging: Smart, Sustainable, & Intelligent Solutions

Mr. Karan Chechi, CEO and Founder, TechSci Research



The global food packaging industry is at a critical inflection point, shaped by powerful structural forces that are redefining how food is produced, distributed, and consumed. Rapid urbanization, growth in packaged and ready-to-eat foods, expansion of global food trade, and rising food safety concerns have significantly increased the complexity of food supply chains. At the same time, regulators across major economies are tightening norms related to food safety, traceability, and environmental impact, while consumers are becoming more informed and demanding greater transparency, convenience, and sustainability from the brands they trust. According to ScienceDirect, food packaging accounts for over 60% of total packaging demand globally, underscoring its central role in the broader packaging ecosystem. However, the sector also faces mounting scrutiny, as food packaging represents one of the largest sources of plastic waste worldwide. These converging pressures are compelling food manufacturers, packaging converters, and retailers to fundamentally rethink packaging, not merely as a protective layer, but as a strategic interface between the product, the supply chain, regulators, and end consumers. In January 2026, Sacmi acquired a majority stake in the France-based Groupe Emballage Technologies, reinforcing its strategic presence in the food packaging sector and broadening its footprint across key European markets.

Also, according to TechSci Research, the Global Food Packaging Technology and Equipment Market will grow from USD 51.89

Billion in 2025 to USD 76.92 Billion by 2031 at a 6.78% CAGR. In this evolving landscape, the future of food packaging is being shaped by three interconnected pillars: smart packaging that enhances safety and reduces waste, sustainable packaging that minimizes environmental impact, and intelligent packaging that enables digital connectivity and data-driven decision-making.

India's Packaged Convenience Food Industry

India's food packaging industry is entering a decisive phase of transformation, shaped by rapid urbanization, changing consumption patterns, regulatory tightening, and increasing environmental awareness. According to TechSci Research, India Packaged Food Market was valued at USD 116.85 Billion in 2025 and is expected to reach USD 175.61 Billion by 2031 with a CAGR of 7.03%. With a growing middle class, rising demand for packaged and ready-to-eat foods, expansion of modern retail, and the surge of food delivery and e-commerce platforms, packaging has become a critical enabler of India's food ecosystem. India's rapid expansion in food delivery has brought significant environmental challenges, particularly the widespread use of single-use plastic packaging that is seldom recycled. In response, Zomato is partnering with more than 200 restaurants across 400 cities to systematically reduce

plastic consumption, delivering sustainability improvements one meal at a time.

At the same time, the country faces persistent challenges related to food safety, post-harvest losses, plastic waste, and fragmented supply chains. According to national estimates, a significant share of food loss in India occurs between harvest and consumption due to inadequate storage, transportation, and packaging practices. In this context, food packaging is no longer viewed merely as a protective layer; it is increasingly seen as a strategic tool to improve food safety, reduce waste, ensure regulatory compliance, and build consumer trust. At present, the food segment accounts for approximately 45.9% of India's overall consumption basket, making it a core driver and a resilient pillar of the country's consumption-led growth story.

India's regulatory apparatus is catching up. The Food Safety and Standards Authority of India (FSSAI) has sharpened guidance on packaging materials and labelling to protect consumers and encourage safer packing practices. At the same time, state and municipal crackdowns on single-use plastic and enforcement of bans are creating immediate commercial pressure on brands to find alternatives or face fines and reputational risk. These policy signals mean suppliers and FMCG firms must factor regulatory compliance and traceability into product and packaging design, rather than treat them as downstream add-ons. In June 2025, PPRDC released a comprehensive study on the safety of food-grade packaging made from recycled polypropylene. The findings were formally unveiled at the 6th PPRDC Summit through a pioneering industry report aimed at advancing circularity and sustainable practices in food packaging.

Indian researchers and startups are producing viable alternatives to conventional plastics. Laboratory-to-startup stories, for



example work by researchers at IIT Madras to convert agricultural and paper waste into mycelium-based, biodegradable packaging, demonstrate that locally sourced, circular feedstocks can meet mechanical and barrier requirements for many packaging applications. As these technologies mature and scale, they can both reduce dependency on virgin polymers and convert abundant agricultural residues into value, a powerful synergy for rural economies. Brands should watch pilot projects and form early partnerships to test lifecycle performance and cost parity. In April 2025, researchers at National Institute of Technology Rourkela, led by Preetam Sarkar from the Department of Food Process Engineering, unveiled an innovative natural-material-based food packaging solution. The team developed an intelligent, biodegradable film using kodo millet starch and beetroot peel extract that provides a real-time visual indication of seafood freshness.

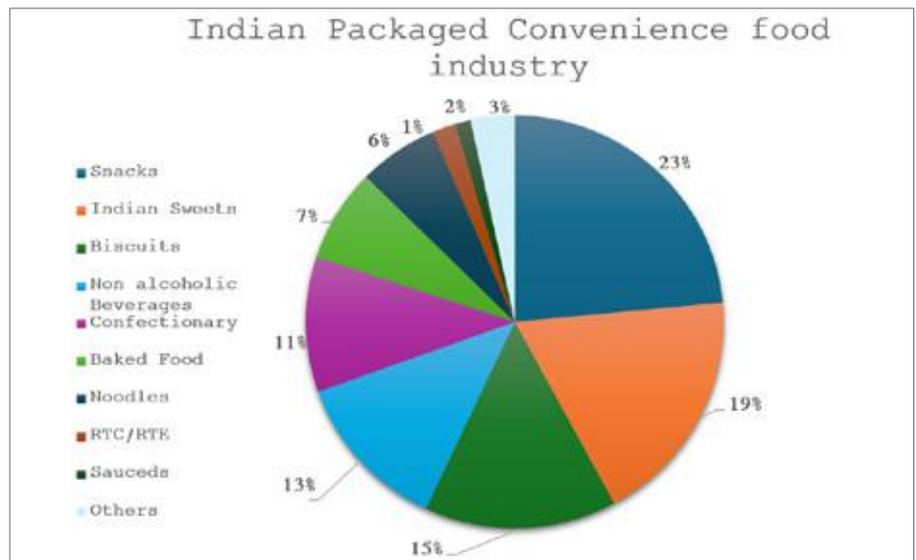
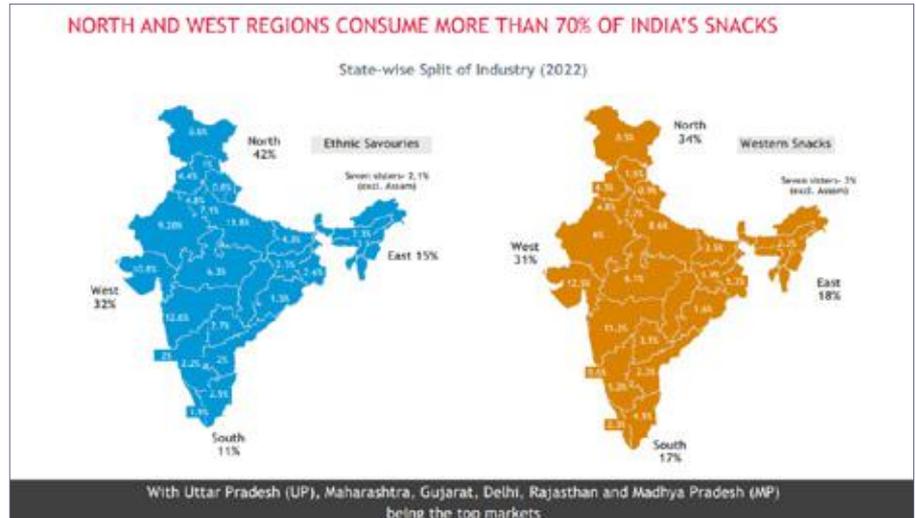
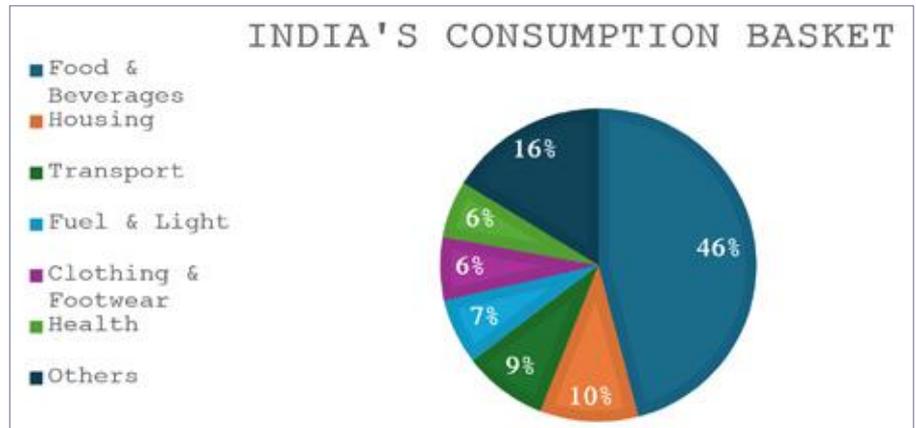
A Brief Timeline of Food Packaging Materials



Present day: The food industry is increasingly adopting sustainable packaging solutions—biodegradable, compostable, and recyclable as part of broader efforts to reduce waste and support environmental sustainability.

Smart Packaging: Improving Food Safety and Reducing Waste

Smart packaging technologies are designed to monitor the condition of food products



and provide real-time or visual information about quality, freshness, and safety. These solutions include time-temperature indicators, freshness labels, gas sensors, and tamper-evident features. Their relevance is growing as food supply chains become longer and more complex, increasing the risk of spoilage during transportation and

storage. In August 2025, research undertaken at the University of Vaasa advanced the development of smart packaging solutions that signal product condition through the use of color-changing printing inks. The study, led by doctoral researcher Jari Isohanni, examined how machine learning techniques can be optimally applied to color

recognition, enabling more accurate and reliable interpretation of visual indicators in intelligent packaging systems.

Food waste remains a critical global challenge, with a significant share of losses occurring after harvest due to improper handling and storage. Smart packaging directly addresses this issue by enabling early detection of temperature abuse or product degradation. For example, freshness indicators used in meat, seafood, and dairy packaging can change colour if products are exposed to unsafe conditions. Retailers can then remove affected products before they reach consumers, reducing health risks and minimizing large-scale recalls. For manufacturers, this translates into better quality control, lower return rates, and improved supply chain accountability.

Sustainable Packaging: From Environmental Responsibility to Business Strategy

Sustainability has become one of the most influential forces shaping the future of food packaging. Governments across regions are introducing stricter rules on plastic waste, recycling targets, and extended producer responsibility, while consumers increasingly expect brands to demonstrate environmental accountability. Studies consistently show that a majority of consumers prefer products with environmentally responsible packaging, and many are willing to adjust purchasing decisions based on sustainability claims. In response, food companies are accelerating the shift toward recyclable, compostable, and bio-based packaging solutions. Key trends include the replacement of complex multi-layer plastics with recyclable mono-material structures, increased adoption of paper-based and molded fiber packaging, and the use of bio-based plastics derived from renewable resources such as plant starch and cellulose. In November 2025, UK-based Mondi expanded its food packaging portfolio by adding corrugated and solid board solutions, supported by advanced digital printing capabilities.

Lightweighting reducing material use without compromising performances also gaining importance as a cost-effective way to lower carbon emissions across logistics and transportation. In January 2026, an innovative sustainable food-packaging solution developed by an Imperial College startup was rolled out across university campuses. Notpla, the award-winning innovator in sustainable packaging, returned to its roots at Imperial College London*to support the reduction of single-use plastics across the

Important food packaging materials and their functionalities

Packaging material	Functionality
Poly glycolic acid (PGA)	Barrier property
Nanofiller blended biopolymer	Barrier property and hydrophobicity
Plastic films	Printability, barrier property and sealing
Cellophane	Excellent elasticity and mechanical property
PLA reinforced with cellulose nano whiskers	Water vapor and oxygen barrier properties
Chitosan reinforced with bacterial cellulose micro- and nanofibers	Bactericidal, mechanical, water vapor barrier and bacteriostatic
Paper	Printability
Paper processed in biopolymer coating	Good barrier property
Paper sheet containing polyaniline (PANI) and polystyrene (PS), in the presence of dispersed bagasse pulp fibres	Antibacterial property
Inorganic nanoparticle	Antimicrobial
Organic nanoparticle	Good tensile strength, mechanical property, environmental friendly, barrier property and reduced cost
Bio nanocomposite	Good mechanical, heat resistance property and barrier property



university's catering operations.

Importantly, sustainable packaging is no longer viewed solely as a compliance requirement. Companies are increasingly treating it as a source of competitive advantage, strengthening brand reputation, improving alignment with retailer sustainability goals, and reducing long-term regulatory and material risks. At the ElitePlus 2025 Conference held in Mumbai, Robert Cotton, R&D director – packaging sustainable materials at PepsiCo, took the stage to shed light on the company's ambitious journey toward sustainable packaging solutions.

Intelligent Packaging: Connecting Physical Packaging with Digital Ecosystems

Intelligent packaging represents the

convergence of packaging and digital technology. By integrating tools such as QR codes, NFC tags, RFID, and digital watermarks, intelligent packaging enables interaction between physical products and digital platforms. Consumers can scan packaging to access information on ingredient sourcing, nutritional values, allergen details, recycling instructions, and brand stories. In February 2025, Kezzler, a global leader in traceability innovation and digital product experiences, significantly strengthened its global presence and broadened its product portfolio through the acquisition of Scanbuy's Smart Packaging and QR code-based consumer engagement business. As a result of this transaction, Scanbuy's customers gain access to Kezzler's advanced, world-class traceability platform, enabling them to address the rising demand for enhanced product transparency, end-to-

end traceability, and regulatory disclosure. For businesses, intelligent packaging offers powerful advantages. It enhances traceability across the supply chain, supports anti-counterfeiting measures, and provides valuable insights into consumer engagement and usage patterns. In export-oriented food categories and premium products, digital traceability has become particularly important as regulators and retailers demand higher levels of transparency.

Conclusion

The future of food packaging in India will be defined by its ability to respond effectively to the country's unique combination of scale, diversity, regulatory evolution, and sustainability challenges. As food supply chains become longer and more complex, packaging will play an increasingly critical role in safeguarding food quality, reducing post-harvest losses, and ensuring compliance with strengthening food safety norms set by institutions such as the Food Safety and Standards Authority of India. Smart packaging solutions will be instrumental in addressing gaps in cold-chain infrastructure and improving accountability across fragmented distribution networks, particularly for perishable and high-risk food categories.

At the same time, environmental considerations are reshaping packaging strategies across the Indian food industry. Regulatory pressure on single-use plastics, combined with rising consumer awareness, is accelerating the transition toward recyclable, compostable, and bio-based materials. Sustainable packaging is no longer a niche or premium concept; it is steadily becoming a mainstream expectation across urban and semi-urban markets. In parallel, intelligent packaging is unlocking new opportunities for transparency, traceability, and digital engagement, leveraging India's high smartphone penetration and growing comfort with QR-based information access. Looking ahead, success in India's food packaging sector will depend on balancing cost efficiency with innovation, and compliance with differentiation. Companies that integrate smart, sustainable, and intelligent packaging into their core strategies, while collaborating across the value chain will be best positioned to enhance consumer trust, reduce operational risk, and build long-term resilience in one of the world's most dynamic food markets.



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1 - 3, July - 2026
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PackMach Asia Expo - 2026

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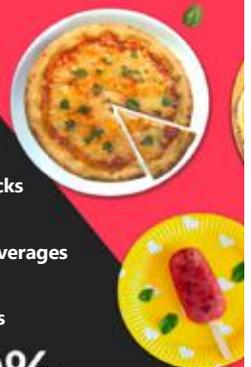
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Custom Printed Packaging: A Strategic Guide for Food & Beverage Brands to Enhance Identity, Compliance, and Market Success

Kiran Kumar



Introduction: Packaging Beyond Protection

In the modern food and beverage industry, packaging has evolved far beyond its traditional role of protecting products during transportation and storage. Today, packaging functions as a powerful communication tool that reflects a brand's identity, values, and quality. Among the many innovations in this space, custom printed packaging has emerged as one of the most effective ways for companies to differentiate their products in an increasingly competitive marketplace.

For food and beverage brands, packaging is often the first interaction a consumer has with the product. In supermarkets, convenience stores, and e-commerce platforms, visually appealing packaging can instantly capture attention and influence purchasing decisions. Custom printed packaging allows companies to incorporate branding elements, product information, regulatory labels, and marketing messages directly onto the packaging material, creating a cohesive and engaging consumer experience. As consumer expectations rise and competition intensifies, businesses across the food value chain, from small startups to multinational manufacturers are investing in custom packaging solutions to build stronger brand recognition, enhance product appeal, and ensure compliance with food safety regulations.

Understanding Custom Printed Packaging

Custom printed packaging refers to packaging materials that are specifically designed and printed with unique graphics, logos, product information, and branding elements tailored to a particular product or brand. Unlike generic packaging, custom printed solutions enable businesses to create packaging that reflects their brand identity while also communicating essential information to consumers.

In the food and beverage sector, custom printing can be applied to a wide range of packaging formats such as flexible pouches, cartons, labels, wrappers, bottles, cans, and corrugated boxes. The printing process may involve technologies like flexographic printing, digital printing, rotogravure, or offset printing depending on the packaging material and production volume.

Through these technologies, brands can achieve vibrant colors, intricate designs, and high-resolution graphics that enhance shelf visibility. At the same time, custom printed packaging can incorporate functional elements such as barcodes, nutritional information, ingredient lists, manufacturing details, and traceability codes required by regulatory authorities.

In essence, custom printed packaging combines design, technology, and

functionality to create packaging that not only protects the product but also strengthens brand communication.

The Role of Packaging in Consumer Decision-Making

Packaging plays a critical role in influencing consumer behavior. Studies consistently show that a significant percentage of purchasing decisions are made at the point of sale. In such scenarios, packaging becomes the silent salesperson that communicates the product's value proposition. Consumers are naturally drawn to packaging that is visually attractive, informative, and easy to recognize. Colors, typography, imagery, and layout all contribute to how a product is perceived. Custom printed packaging allows brands to carefully craft these visual elements to evoke specific emotions or associations, whether it is freshness, premium quality, health benefits, or indulgence.

For example, clean and minimalist designs may appeal to health-conscious consumers, while vibrant and playful graphics may attract younger audiences or families. By aligning packaging design with target demographics, brands can significantly improve their chances of standing out on crowded retail shelves.

In the digital era, packaging also plays a role in online visibility. Products displayed on e-commerce platforms rely heavily on packaging visuals to attract clicks and conversions. A well-designed custom package can therefore influence both offline and online purchasing decisions.

Strengthening Brand Identity Through Custom Packaging

One of the most important advantages of custom printed packaging is its ability to strengthen brand identity. For food and beverage companies, consistent branding across all packaging formats helps build familiarity and trust among consumers. Brand elements such as logos, color palettes, taglines, and typography can be seamlessly integrated into the packaging design. Over time, these elements become associated with the brand, enabling consumers to

recognize the product instantly even from a distance.

Custom packaging also allows brands to communicate their story and values. For instance, companies can highlight their commitment to sustainability, locally sourced ingredients, organic certifications, or ethical sourcing practices directly on the packaging. This type of storytelling helps create a deeper emotional connection with consumers.

For emerging food startups and artisanal producers, custom printed packaging can be particularly valuable. It allows smaller brands to present their products with the same level of professionalism and visual impact as established competitors.

Enhancing Product Information and Regulatory Compliance

Food packaging must comply with strict regulatory requirements related to labeling and product information. Authorities across the world mandate the inclusion of details such as ingredient lists, nutritional values, allergen declarations, manufacturing and expiry dates, and storage instructions.

Custom printed packaging enables brands to incorporate all of this information in a structured and visually clear manner. By integrating regulatory information directly into the design, companies can ensure compliance while maintaining aesthetic appeal.

Additionally, custom packaging can include features that support product traceability and transparency. QR codes, batch numbers, and digital tracking elements can be printed onto packaging to provide additional information about the product's origin, manufacturing process, or supply chain journey. This level of transparency is becoming increasingly important as consumers demand greater visibility into how their food is produced and distributed.

Improving Shelf Impact and Market Visibility

In the highly competitive food retail environment, shelf space is limited and brands must compete for consumer attention. Custom printed packaging can significantly enhance a product's shelf impact by using distinctive colors, textures, and design elements that make the product stand out.

Strategic design choices such as bold graphics, clear typography, and unique

packaging shapes can increase product visibility even from a distance. For instance, metallic finishes, matte coatings, or embossed elements can create a premium appearance that immediately draws attention. Packaging design can also help differentiate product variants within the same brand portfolio. Different flavors, sizes, or formulations can be represented through variations in color schemes or design patterns, making it easier for consumers to identify their preferred option.

For brands entering new markets, custom printed packaging becomes a powerful marketing tool that communicates the product's uniqueness and value proposition without relying solely on advertising.

Supporting Marketing and Promotional Campaigns

Custom printed packaging offers a flexible platform for marketing and promotional initiatives. Brands can incorporate limited-edition designs, seasonal themes, or campaign-specific graphics directly onto the packaging to create excitement among consumers.

For example, special packaging for festive seasons, product anniversaries, or collaborative promotions can attract attention and encourage impulse purchases. Such limited-time packaging also adds a sense of exclusivity, motivating consumers to try the product before the promotion ends.

Packaging can also be used to direct consumers toward digital engagement. QR codes printed on packaging can lead customers to websites, social media platforms, recipes, or brand storytelling content. This integration between physical packaging and digital experiences helps brands build stronger relationships with their audiences.

Cost Efficiency and Production Flexibility

Advancements in printing technologies have made custom packaging more accessible and cost-efficient than ever before. Digital printing, in particular, allows brands to produce smaller batch sizes without the need for expensive printing plates. This is especially beneficial for startups, seasonal product lines, or limited-edition releases.

Shorter production runs reduce the risk of excess inventory and allow companies to update designs more frequently. Businesses can respond quickly to changing consumer trends, regulatory updates, or product reformulations without incurring high costs. Additionally, modern printing technologies enable faster turnaround times and improved production efficiency, helping brands bring new products to market more quickly.

Sustainability and Eco-Friendly Packaging Innovations

Sustainability has become a key priority for both consumers and food manufacturers. Custom printed packaging plays an important role in supporting environmentally responsible practices.

Many packaging manufacturers now offer printing solutions that are compatible with recyclable, biodegradable, or compostable packaging materials. Water-based inks, low-migration inks, and eco-friendly coatings help minimize environmental impact while maintaining high-quality printing results. Custom printing also enables brands to communicate sustainability commitments directly on the packaging. Certifications, recycling instructions, and environmental messaging can be integrated into the design to educate consumers and encourage responsible disposal.

By combining sustainable materials with thoughtful design, companies can create packaging that aligns with both regulatory requirements and consumer expectations.

Custom Packaging for E-Commerce and Direct-to-Consumer Sales

The rapid growth of e-commerce has transformed packaging requirements in the food and beverage industry. Products sold online must not only be visually appealing but also durable enough to withstand transportation and handling.



Custom printed packaging designed for e-commerce can incorporate protective features while maintaining strong branding elements. Shipping boxes, protective inserts, and branded tapes can all be customized to create a cohesive brand experience from the moment the package arrives at the consumer's doorstep. Unboxing experiences have become an important part of online brand engagement. Attractive packaging can encourage customers to share their purchases on social media, generating organic marketing and expanding brand visibility.

Future Trends in Custom Printed Food Packaging

The future of custom printed packaging is closely tied to technological advancements and evolving consumer expectations. Innovations such as smart packaging, augmented reality, and interactive labels are beginning to transform how consumers interact with food products. Smart packaging technologies can include

printed sensors that monitor freshness or temperature conditions during transportation. Augmented reality features can allow consumers to scan packaging with their smartphones to access digital content such as product stories, recipes, or sustainability information.

Artificial intelligence and data-driven design tools are also enabling brands to create packaging that is optimized for consumer engagement and market trends. These technologies allow companies to test different design elements and predict which packaging styles are most likely to attract consumers. As the food and beverage industry continues to innovate, custom printed packaging will remain a critical component of brand differentiation and consumer communication.

Conclusion: A Strategic Investment for Food & Beverage Businesses

Custom printed packaging has become an essential element of modern food and beverage branding. By combining

visual appeal, regulatory compliance, marketing potential, and sustainability considerations, custom packaging offers significant advantages for businesses seeking to strengthen their market presence.

From improving shelf visibility to supporting digital engagement and sustainable practices, custom printed packaging provides a versatile platform for communicating brand values and product quality. For companies operating in an increasingly competitive and consumer-driven market, investing in thoughtful and well-designed packaging is no longer optional—it is a strategic necessity. As technologies continue to evolve and consumer expectations grow, food and beverage brands that leverage custom printed packaging effectively will be better positioned to capture attention, build trust, and drive long-term business success.

Author's Bio: Mr. Kumar serves as a Supporting Editor for FBP Magazine.

Packaging fish and seafood – with zero compromises!



whole gilt-head bream, smoked trout, shelled crayfish, sharp-edged mussels, or even shrimp skewers may be part of your daily business – but it's anything but routine. Delicate surfaces, irregular shapes, sharp edges, and moisture all need to be managed, along with short shelf lives and stringent hygiene and food safety requirements. Especially in the seafood segment, where these factors can quickly drive up loss rates,

packaging becomes an effective lever for economic profitability and competitiveness – and ultimately for reducing food waste.

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... means high-performance films that can be processed efficiently into reliable packaging solutions and deliver the convenience consumers expect. To achieve this, skin, MAP, and vacuum packaging are the industry's go-to technologies. Whatever the format, it must deliver a secure seal even if the seal area is contaminated, resist punctures from heavy or sharp-edged



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Developed by SÜDPACK specifically for shrimp skewers, salmon fillets, and whole fish, SKINPro® is an innovative, visually appealing vacuum skin packaging system built around a high-performance skin top web and matching bottom web designed to work together perfectly. The thin top web wraps around the product like a second skin, reliably handling even high product protrusions, sharp or pointed contours,

Packaging fresh salmon fillets, tuna chunks,

and extreme undercuts. The product is held securely on the bottom web, preventing juicing and allowing flat, upright, or hanging presentation at the point of sale. Most importantly, the system helps extend the food's shelf life by removing oxygen, ensuring reliable sealing, and delivering barrier properties matched to the product. For the "counterpart," SÜDPACK offers a range of PE-, PP-, and APET-based bottom webs designed specifically for SKINPro top webs and engineered to ensure reliable sealing. This also includes bottom webs made from the corresponding mono-materials that meet recyclability requirements. All SKINPro material structures run efficiently and reliably on skin packaging machines.

With premium optics and outstanding convenience, this packaging system also makes an impact at the point of sale: The wrinkle-free top web, with enhanced transparency and gloss, delivers maximum product visibility, a fresher appearance, and a premium look and feel. The clean, smooth, and easy opening behavior further reinforces the positive consumer experience.

Multifol® Extreme – high performance for extreme packaging applications

Multifol® Extreme is another proven flexible film that combines maximum functionality with minimal added weight. Due to its outstanding sealing performance and high puncture resistance, this SÜDPACK product family is ideally suited for MAP or vacuum packaging of fatty, protein-rich, or sharp-edged products such as fresh salmon fillets, white fish, or herring portions, as well as frozen goods.

In addition, the film is about 30% lighter than conventional PA/PE structures, delivering benefits across the entire logistics chain. Specifically, without any compromises on product protection, Multifol Extreme in a thickness of just 150 µm can replace a conventional thermoforming film with a thickness of 200 µm. Further material savings can be achieved by combining a Multifol Extreme base film with a lidding film from the same product family. Despite the material's low thickness, the perishable food stays well protected inside the package.

Another plus: This packaging concept also shines during the packaging process itself – with outstanding thermoforming properties that support deep draws, as well as good processability on standard thermoforming packaging machines.

www.suedpack.com

Pacapime Hungary and Mondi's containerboard are keeping fruit and vegetables fresh and protected with high-quality packaging

Mondi, a global leader in sustainable packaging and paper, builds on its long-standing partnership with Pacapime Hungary to deliver high-quality corrugated packaging for fresh fruit and vegetables across Central and Western Europe. Pacapime Hungary operates a 42,000 m² corrugated production site in Mórahalom with an annual capacity of up to 180 million m². The company supplies customers in Hungary, Romania, Croatia, Serbia and Western Europe, with a strong focus on fresh produce boxes for apples, pears, tomatoes and bell peppers.

Packaging for fresh fruit and vegetables requires reliable strength, durability and effective ventilation to protect produce during transport while maintaining attractive presentation at retail. To meet these requirements, Pacapime Hungary relies on Mondi's ProVantage SmartKraft Brown containerboard grade. ProVantage SmartKraft Brown features a 100% fresh fibre top ply, ensuring high surface integrity and consistent quality. Its strength properties support reliable burst and tear resistance, while consistent runnability and processing properties enable efficient production and dependable box performance.

"High-quality kraftliners are important in fresh produce applications," says Tom Pissens, Managing Director at Pacapime Hungary. "The paper must consistently support box performance, as our customers rely on us to deliver quality packaging every time."

Since 2024, Pacapime Hungary has been led by Lynn and Tom Pissens, representing the fourth generation of the family in the corrugated packaging industry. The company combines decades of expertise with a modern, lean production setup, enabling fast decision-making and flexibility, particularly during peak agricultural seasons.

The collaboration between Mondi and Pacapime Hungary is built on a long-term partnership approach, including close technical cooperation and on-site containerboard support. Joint trials, data-driven optimisation and continuous knowledge exchange help ensure paper choice and packaging solutions are fit for purpose



From left to right: Lynn Pissens, Managing Director Pacapime Hungary; Gunnar Nyqvist, Sales Manager Containerboard Benelux; Tom Pissens, Managing Director Pacapime Hungary.

(Photo: Mondi, PR354)

and aligned with evolving customer requirements.

"Business is about people and long-term trust," says Lynn Pissens, Managing Director at Pacapime Hungary. "Our collaboration with Mondi provides the stability and technical expertise that allow us to deliver consistent quality and drive innovation together."

Sustainability is a shared priority for both companies. Pacapime Hungary has invested in water treatment systems, solar panels and transparent certification processes to meet growing customer and consumer expectations. Mondi's full fibre mix containerboard portfolio supports circular packaging solutions designed to protect products while optimising material efficiency. Through the combination of high-quality containerboard, technical expertise and long-term collaboration, Mondi and Pacapime Hungary provide reliable and sustainable corrugated packaging solutions that reduce food waste, create value across the supply chain and protect fresh produce from field to shelf.

<https://www.mondigroup.com/>

Tetra Pak extends paper-based barrier packaging to high-speed packaging lines in Asia



Tetra Pak® A3/Speed filling machine

Tetra Pak has taken another step forwards in sustainable packaging by expanding its innovative paper-based barrier technology to high-speed Tetra Pak® A3/Speed filling lines, with Maeil Dairies becoming the first producer globally to implement the solution for its soy milk. This milestone aligns with a broader shift across the food and beverage industry, where producers are accelerating the transition towards low-carbon, renewable packaging materials.

Developed to replace the aluminium foil layer used in aseptic cartons, the new paper-based barrier maintains comparable levels of food protection and shelf life. When combined with plant-based polymers derived from sugarcane, the Tetra Brik® Aseptic 200 Slim carton used with Maeil Soy Milk 99.9 product in South Korea achieved 87% renewable content and delivered a 26% reduction in package carbon footprint, as verified by the Carbon Trust.¹

A key milestone of this launch in Asia is that Maeil Dairies is the first producer globally to implement packaging material with the

new paper-based barrier on a Tetra Pak® A3/Speed filling machine, demonstrating that the technology is now fully compatible with high-speed industrial production. The Tetra Pak® A3/Speed delivers high package outputs of up to 24,000 packages per hour with low operational costs, enabling large-scale deployment while keeping high food safety standards. Moreover, existing Tetra Pak® A3/Speed lines can be easily upgraded with a high-frequency induction-heating sealing system, allowing producers to adopt the new packaging material without significant capital investment.

Tatiana Liceti, Executive Vice President, Packaging Solutions at Tetra Pak said: "Scaling sustainable packaging solutions should go hand in hand with operational efficiency. By bringing our paper-based barrier to high-performing Tetra Pak® A3/Speed packaging lines, we are offering beverage producers an opportunity to adopt low-carbon packaging solution based on renewable materials while maintaining food protection and cost-competitiveness."

The new package for Maeil Soy Milk 99.9 marks the first use of Tetra Pak's paper-based barrier in the plant-based beverages category. Maeil Dairies, a longstanding innovator in the plant-based beverage market, sees the move as a natural continuation of its sustainability journey.

Inki Lee, Chief Operating Officer at Maeil Dairies commented: "Maeil Dairies has pioneered the domestic low-sugar soy milk segment, establishing a leading

position in the market. Introducing new packaging on our Soy Milk 99.9 line reflects our ongoing commitment to innovation and environmental responsibility. Our collaboration with Tetra Pak enables us to drive meaningful, forward-looking change that will benefit consumers and future generations alike."

The world's first aseptic beverage carton where the traditional aluminium foil layer was replaced with the innovative Tetra Pak paper-based barrier was launched in 2023, setting a new benchmark for sustainable packaging. This new technology simplifies the packaging material structure, reducing it from three to just two main components. This creates opportunities for recycling infrastructure, with downstream benefits such as maximising the recovery of paper content during the recycling of cartons delivering high-quality fibre and non-fibre fractions. Furthermore, by combining a paper-based barrier with plant-based polymers in the material coatings, the renewable content of the packaging is maximized, resulting in a significant reduction in carbon footprint¹.

¹Compared to the same reference package. Source: Carbon Trust™-verified Tetra Pak 'Carton CO2 Calculator' model version 12 (valid from 2026-01-01). Scope: cradle-to-grave measurement of a Tetra Brik® Aseptic 200 Slim carton with plant-based polymers in coating and paper-based barrier compared to a standard Tetra Brik® Aseptic 200 Slim package with aluminium foil and fossil-based polymers. Geography: global data.

utilities processes and expand the company's engineering depth as FPS continues to scale to meet increasing global demand.



"It was only a matter of time before adding QES as a valuable partner to enhance our engineering capabilities to new heights. With their expertise, they will strengthen our growth in food and industrial plant ventilation systems," says Jeffrey Chang, President, FPS Food Process Solutions Corp.

FPS Food Process Solutions

Partners with Quality Engineered Solutions to Strengthen Global Utilities Expertise

FPS Food Process Solutions ("FPS"), a global leader in turnkey food processing technologies, announces a strategic partnership with Quality Engineered Solutions (QES) to further expand its growing portfolio, with a strengthened focus on utilities-driven services. With more than 25 years of experience, QES specializes in industrial ventilation projects for food and beverage processing plants as well as industrial manufacturing facilities. Their deep expertise and reputation for excellence

significantly enhance FPS's ability to deliver a fully integrated, global product offering.

Recognized as "utilities experts" within industrial engineering, QES brings extensive capabilities in ventilation infrastructure and MEP design for complex industrial and commercial environments. As part of this integration, Rick Allen joins FPS as Director of Global Utilities. In his new role, he will build a strong technical foundation for

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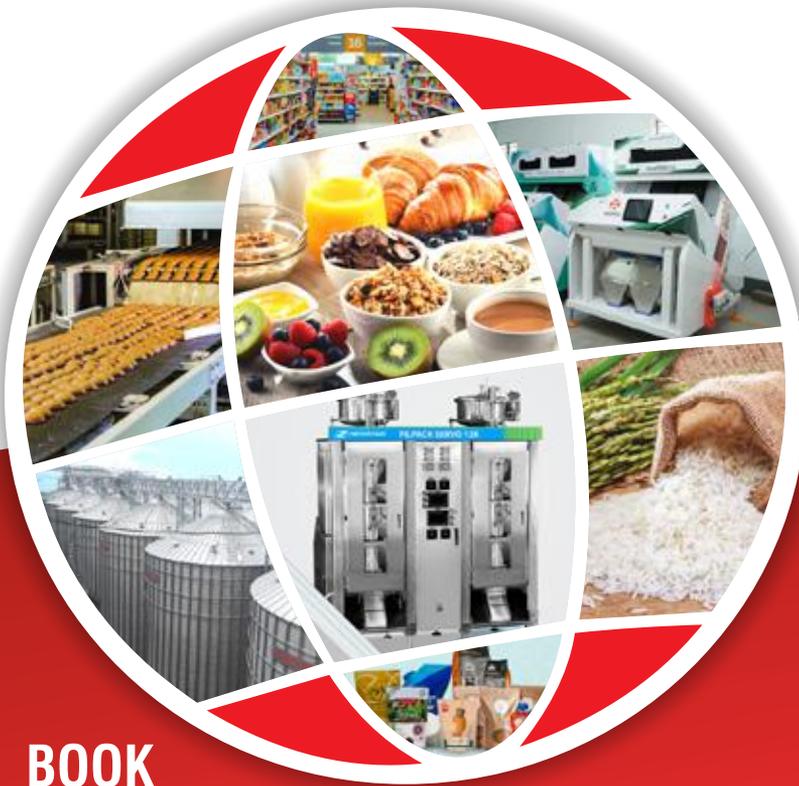
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*Proposed

Beyond Sweetness: Therapeutic Secrets of Manuka Honey

T. Uma Maheswari*, M. Shanmugapriya,
S. Geethanjali and J. Selvi

Introduction

Honey, a natural, sweet, and flavorful product, is produced by bees from plant nectars, secretions, and the excretions of plant-sucking insects. Usually honey rich in fructose and glucose and phenolic compounds, in addition to macro and micro nutrients. These compounds also contain a good source of antioxidants and have many proven anti-bacterial, anti-inflammatory, and anti-microbial properties. Manuka honey, a special type of honey, is described as a monofloral, dark viscosity liquid produced primarily from small white/pink flowers of Manuka trees (*Leptospermum scoparium*). The *Leptospermum scoparium* trees are native to New Zealand and Eastern Australia. Manuka honey is rarer and more expensive than regular honey because of its limited supply and is primarily known for its elevated antimicrobial and antioxidant compounds. The manuka tree can only thrive in a specific climate in certain parts of the world (mainly remote regions in New Zealand). Moreover, this tree only flowers for two to six weeks a year, leaving a very narrow window for bees to pollinate it.

Speciality of Manuka honey

Manuka honey, a richly flavoured, thick and dark coloured honey is valuable than the regular honey; due to the high concentration of other active compounds it contains, in particular, methylglyoxal (MGO). MGO was first identified by German scientist, Thomas Henle in 2008. MGO has been shown to have antibacterial and anti-inflammatory effects, which can be beneficial for a wide range of health conditions, including fighting infections, healing wounds, and easing pain and inflammation. The higher the concentration of MGO, the more potent the health benefits.

Manuka honey possess 50 fold higher antibacterial activity compared to other types of honey due to the non-peroxide activity of methyl glyoxal (MGO), a compound produced by non enzymatic conversion of dihydroxyacetone (a compound found in Manuka nectar in unusually high quantity). It is considered a good source of phenolic compounds, including phenolic acids namely protocatechuic, syringic and genistic acids and flavonoids viz., quercetin, luteolin, kaempferol isorhammetin, apigenin, galangin, chrysin, pinobanksin, pinocembrin. These phytochemicals are responsible for antimicrobial, antioxidative, anti-inflammatory, anticancer, immunomodulatory and wound healing properties of Manuka honey.

Health benefits of Manuka honey

As like other honey, Manuka honey is well known for its antibacterial property. It is reported to be active against viruses such as Herpes simplex, Adenovirus which commonly known to cause cold sores and mouth ulcers. It is also used for fabricating wound dressing and also incorporated in tissue engineering biomaterials. Manuka honey is becoming more popular due to its effectiveness against antibiotic resistant strains of yeast that causes infection. The other health benefits are tabulated below. (Table-1)

Role of Manuka Honey in Gut Health

Manuka honey supports gut health primarily through its non-peroxide antibacterial activity, anti-inflammatory effects, and prebiotic potential. Unlike broad-spectrum antibiotics, it selectively inhibits pathogenic microbes while supporting beneficial gut bacteria. It does, contain sugars called fructo-oligosaccharides, which have a

prebiotic effect. Studies have shown that the prebiotics in this honey stimulate and maintain the growth of probiotics, including *Lactobacillus* and *Bifidobacterium*.

- **Antiulcer property:** High MGO suppresses gut pathogens such as *Helicobacter pylori*, *E. coli*, and *Clostridium* spp.
- **Gut lining protection:** Reduces inflammation and promotes mucosal healing.
- **Prebiotic-like effect:** Supports growth of beneficial microbes (*Lactobacillus*, *Bifidobacterium*).
- **Antioxidant activity:** Reduces oxidative stress in the gastrointestinal tract.
- **Acid regulation:** Helps maintain gut pH favorable for beneficial bacteria.

Parameters to ensure quality of Manuka honey

Manuka Honey contains a Unique Manuka Factor (UMF), which is associated with honey quality and market value. This value indicates the contents of four chemical markers in MH, namely methylglyoxal, a major antibacterial indicator, dihydroxyacetone, a honey aging indicator, leptosperin, pollen source indicator and 5-hydroxymethylfurfural, a honey freshness indicator. The UMF grading system for Manuka honey is highly regulated and audited by the Unique Manuka Factor Honey Association (UMFHA) of New Zealand. MGO and Active Manuka Factor (AMF) ratings, imply the amount of MGO (in mg/kg) and overall antimicrobial activity respectively. (Table-2)

Other types of honey with functional properties

Certain other types of honey are also reported to possess medicinal value closely

Benefit Category	Key Benefits	Underlying Bioactive Factors	Common Applications
Antibacterial activity	Effective against a wide range of bacteria including <i>Staphylococcus aureus</i> and <i>E. coli</i>	High methylglyoxal (MGO), low pH	Wound dressings, topical antiseptic
Wound healing	Promotes faster healing and tissue regeneration	MGO, hydrogen peroxide, osmotic effect	Burns, ulcers, surgical wounds
Antioxidant property	Reduces oxidative stress	Phenolic compounds, flavonoids	General health, anti-aging support
Anti-inflammatory effect	Reduces inflammation and edema	Polyphenols, cytokine modulation	Skin disorders, inflammatory conditions
Immune modulation	Enhances immune response	Bioactive phytochemicals	Immune support supplements
Oral health	Inhibits plaque formation and oral pathogens	MGO, antibacterial peptides	Mouth ulcers, gingivitis
Antiviral and anti-fungal effects	Suppresses certain viruses and fungi	MGO, phenolic acids	Throat infections, skin infections
Food preservation	Inhibits spoilage microorganisms	Natural antimicrobial compounds	Functional foods, natural preservatives

Table-1

Quality Parameter	What It Indicates	Method / Marker Used	Quality Significance
Botanical origin	Confirms true Manuka source (<i>Leptospermum scoparium</i>)	Pollen analysis, DNA markers	Prevents mislabeling and blending
MGO content	Antibacterial potency	HPLC (mg/kg)	Higher MGO is related to stronger antimicrobial activity
UMF rating	Overall quality and authenticity	Composite index (MGO, leptosperin, DHA)	Standardized grading system
Leptosperin	Authenticity marker	LC-MS / HPLC	Unique to Manuka honey
DHA content	Future MGO formation	HPLC	Predicts shelf-life and potency increase
Moisture content	Storage stability	Refractometry	<20% prevents fermentation
pH	Antimicrobial environment	pH meter	Low pH enhances bioactivity
Electrical conductivity	Mineral content	Conductivity meter	Indicates purity and origin
HMF level	Heat damage / aging	Spectrophotometry	Low HMF = fresh, unheated honey
Microbial safety	Consumer safety	Plate count methods	Free from pathogens
Adulteration check	Detects added sugars	Isotope ratio, sugar profiling	Ensures purity

Table-2

Honey Type	Botanical Source	Geographical Origin	Key Bioactive Components	Major Functional Properties
Kanuka honey	<i>Kunzea ericoides</i>	New Zealand	MGO, hydrogen peroxide, phenolics	Antibacterial, anti-inflammatory, wound healing
Jelly bush honey	<i>Leptospermum</i> spp.	Australia	High MGO, leptosperin	Strong antimicrobial, antioxidant
Irish heather honey	<i>Calluna vulgaris</i>	Ireland	Flavonoids, phenolic acids	High antioxidant activity, antimicrobial
Tualang honey	<i>Koombassia excelsa</i>	Malaysia	Phenolics, enzymes, organic acids	Antimicrobial, antioxidant, wound healing
Ulmo honey	<i>Eucryphia cordifolia</i>	Chile	Phenolics, hydrogen peroxide	Strong antibacterial, antioxidant
Buckwheat honey	<i>Fagopyrum esculentum</i>	USA, Canada	Polyphenols, minerals	Very high antioxidant capacity, antibacterial

Table-3

comparative to Manuka honey which is listed below. (Table-3)

Author's Bio

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Black Salt (Kala Namak): An Ancient Ayurvedic Ingredient with Modern Culinary and Health Significance

Kiran Kumar



Introduction: A Unique Mineral Salt from Ayurvedic Tradition

Black salt, popularly known as Kala Namak, is a distinctive mineral salt widely used across South Asia for both culinary and medicinal purposes. Recognized for its strong pungent aroma and unique taste, this traditional ingredient has been a part of Indian kitchens and Ayurvedic remedies for centuries. Unlike regular table salt, which is highly refined and composed almost entirely of sodium chloride, black salt is produced through a specialized process that incorporates natural rock salt and herbal ingredients. The result is a mineral-rich seasoning with complex flavor characteristics and potential health benefits.

Kala Namak is known for its unusual color variations that range from dark violet and brownish crystals to pinkish powder once ground. Its characteristic sulfur-like smell and tangy taste make it easily distinguishable from other salts. Traditionally, black salt has been valued in Indian street food, spice blends, digestive drinks, and herbal formulations. In recent years, it has also gained popularity in global cuisines, especially in vegan cooking, where it is used to replicate the flavor of eggs. As interest in traditional and functional ingredients continues to grow, black salt is increasingly being explored for its nutritional composition and potential health advantages.

Traditional Production Process of Black Salt

The uniqueness of black salt lies largely in the way it is produced. The manufacturing process begins with natural rock salt, often sourced from Himalayan regions. This raw salt is combined with small amounts of herbal ingredients and then heated in sealed containers or kilns at high temperatures. During this roasting process, the salt undergoes chemical transformations that give it its characteristic color, aroma, and flavor.

Among the herbal ingredients commonly used in this process are Amla (Indian gooseberry), Harad, and Behera, along with babul bark. These ingredients belong to a traditional Ayurvedic formulation known as Triphala, which means “three fruits.” When heated together with rock salt, these herbal components interact with the salt minerals, producing sulfur compounds responsible for the distinctive smell and taste of Kala Namak. After the heating process is completed, the salt is allowed to cool and solidify into dark-colored crystals. These crystals are then stored and aged before being ground into powder for commercial use. Although the salt appears dark or black in crystal form, the powdered version often has a pinkish hue. This traditional kiln-firing technique transforms ordinary rock salt into a unique herbal mineral salt widely appreciated in culinary and medicinal applications.

Chemical Composition and Mineral Profile

Black salt contains sodium chloride as its primary component, but it also includes a variety of other compounds that contribute to its unique properties. Several sulfur-containing compounds are formed during the roasting process, including sodium sulfate, sodium sulfide, sodium bisulfate, sodium bisulfite, and iron sulfide. These compounds are responsible for the salt’s characteristic sulfurous aroma, often described as similar to the smell of boiled eggs.

The presence of iron sulfide also contributes to the salt’s dark violet or purplish color. In addition to sulfur compounds, black salt contains trace minerals such as iron, calcium, magnesium, and potassium. Although these minerals are present in small amounts, they contribute to the overall nutritional value of the salt.

Another interesting aspect of black salt is that its sodium content is slightly lower than that of refined table salt. Combined with the presence of trace minerals and phytochemicals derived from herbal ingredients, this composition makes Kala Namak a distinctive seasoning with potential functional benefits. Research studies have also identified antioxidants such as tannins, phenols, and alkaloids in black salt, which may help reduce oxidative stress in the body.

The Role of Ayurvedic Herbs in Black Salt

One of the most significant features of herbal black salt is the inclusion of Triphala, an important formulation in Ayurvedic medicine. Triphala consists of three medicinal fruits—Amla, Harad, and Behera—each of which contributes unique therapeutic properties.

Amla, also known as Indian gooseberry, is widely recognized for its high vitamin C content and strong antioxidant properties. It has traditionally been used to support immunity, improve skin health, and promote overall vitality. The inclusion of Amla in black salt adds nutritional value and enhances its potential health benefits.

Harad, or Terminalia chebula, is often referred to as the “king of medicines” in traditional healing systems. It is known for supporting digestive health, improving gut function, and helping detoxify the body. Harad is also believed to possess antibacterial and anti-inflammatory properties, which may

contribute to oral and gastrointestinal health.

Behera, or Terminalia bellerica, is another important component of Triphala. This fruit is known for its ability to support respiratory health, improve digestion, and assist in detoxification processes within the body. It is also believed to help regulate metabolism and support liver function.

The combination of these three fruits creates a synergistic blend that enhances the nutritional and therapeutic value of black salt. The herbal compounds released during the roasting process integrate with the salt minerals, resulting in a seasoning that reflects both culinary and medicinal traditions.

Potential Health Benefits of Black Salt

Black salt has long been valued in Ayurvedic medicine for its health-promoting properties. While modern research on Kala Namak is still limited, several studies on its herbal components provide insights into its potential benefits. One of the most well-known uses of black salt is for digestive support. It is commonly included in spice blends and beverages intended to stimulate digestion and relieve bloating. The mineral and sulfur compounds present in the salt may help activate digestive enzymes and improve gut function.

Another potential benefit relates to cardiovascular health. The sulfur compounds present in black salt can produce small amounts of hydrogen sulfide when metabolized in the body. Hydrogen sulfide is recognized as a signaling molecule involved in regulating blood vessel function, reducing inflammation, and protecting heart tissues. Researchers have found that it may help support healthy blood pressure and cardiovascular performance.

The antioxidant properties of Triphala also contribute to the potential health advantages of black salt. Antioxidants help neutralize harmful free radicals in the body, which are associated with aging and various chronic diseases. By reducing oxidative stress, these compounds may help protect cells and promote overall health.

Black salt may also provide benefits for oral health due to the antibacterial properties of its herbal ingredients. Studies have shown that extracts from Amla and Harad can help reduce harmful bacteria in the mouth and improve oral hygiene. Traditional practices sometimes include using saltwater rinses for

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oral care, and black salt may offer additional advantages due to its herbal composition. Furthermore, the herbs present in Triphala are known to support metabolic balance. Research suggests they may help regulate cholesterol levels, improve lipid profiles, and support healthy blood sugar management. Although more direct studies on black salt are needed, its herbal ingredients suggest promising potential in this area.

Expanding Culinary Applications

While black salt has long been associated with traditional Indian cuisine, its culinary applications are expanding rapidly in global kitchens. In South Asia, it is widely used to enhance the flavor of popular street foods known as chaat. These dishes often combine sweet, sour, spicy, and tangy elements, and the addition of Kala Namak provides a distinctive savory taste. Black salt is frequently sprinkled on fruit salads, chutneys, yogurt-based dishes such as raita, and spice mixes like chaat masala. It is also commonly added to refreshing beverages such as lemon water, jal jeera, and fruit juices to enhance flavor and aid digestion.

In recent years, Kala Namak has gained international attention for its use in vegan cuisine. The sulfur compounds in the salt create a flavor that closely resembles eggs, making it a popular ingredient in plant-based recipes. Vegan chefs often use black salt in dishes such as tofu scrambles, vegan omelets, eggless salads, and plant-based sandwiches to replicate the taste of eggs without using animal products.

Because of its strong aroma, black salt is usually added at the end of cooking to preserve its flavor. Even a small quantity can significantly enhance the taste of a dish, making it a versatile seasoning in both traditional and modern recipes.

The Growing Interest in Functional Food Ingredients

The increasing demand for natural and functional ingredients in the food industry has brought renewed attention to traditional products like black salt. Consumers today are seeking foods that not only provide flavor but also offer nutritional and health benefits. In this context, ingredients with a long history of traditional use are being re-evaluated through modern scientific research.

Black salt fits well into this trend because it combines mineral nutrition with herbal components derived from Ayurveda. Its distinctive flavor profile also makes it attractive for culinary innovation, particularly in the growing plant-based food sector. Food manufacturers, chefs, and nutrition researchers are now exploring the potential of Kala Namak as a functional seasoning that bridges traditional wisdom and modern food science.

Conclusion: A Timeless Ingredient with Modern Relevance

Black salt represents a remarkable example of how traditional food practices can remain relevant in contemporary times. Rooted in Ayurvedic knowledge and culinary heritage, Kala Namak has long been valued for its distinctive taste and therapeutic properties. Its unique production process, involving natural rock salt and herbal ingredients, creates a seasoning that is far more complex than ordinary table salt.

The presence of Triphala components such as Amla, Harad, and Behera enhances its potential nutritional and medicinal value. These ingredients contribute antioxidants, digestive support, and possible cardiovascular benefits, making black salt an intriguing subject for further research.

At the same time, its growing popularity in global cuisines, especially vegan cooking, demonstrates how traditional ingredients can adapt to modern dietary trends. Whether used to enhance street foods, flavor beverages, or create plant-based dishes, black salt continues to hold a special place in both kitchens and health traditions. As scientific exploration into functional foods continues to expand, Kala Namak stands as a powerful reminder that ancient culinary wisdom can still inspire modern innovation in food and nutrition.

Author's Bio: Mr. Kumar serves as a Supporting Editor for FBP Magazine.

Olive Oil: A Premium Ingredient Powering Clean-Label and Functional Foods

Kanika Banga

Introduction: From Ancient Tradition to Modern Food Industry Essential

For centuries, olive oil has been revered across civilizations as a symbol of nourishment, purity, and longevity. Often referred to as “liquid gold,” this natural oil has played a central role in Mediterranean diets, traditional cooking, and holistic wellness practices. Today, olive oil has moved far beyond its historical culinary roots to become a powerful ingredient driving innovation across the global food and beverage industry.

As consumers increasingly prioritize healthier lifestyles, clean-label ingredients, and sustainable food systems, olive oil has emerged as one of the most preferred edible oils worldwide. Its natural composition, minimal processing requirements, and exceptional nutritional profile make it a compelling choice for both consumers and food manufacturers. From premium culinary applications to advanced product formulations, olive oil is influencing modern food development in ways that align with evolving dietary preferences and wellness trends.

Nutritional Excellence: A Foundation for Preventive Health

One of the primary factors behind the rising popularity of olive oil is its remarkable nutritional composition. Among edible oils, extra virgin olive oil stands out due to its high concentration of monounsaturated fatty acids, particularly oleic acid. These healthy fats are widely recognized for supporting cardiovascular health by helping reduce harmful LDL cholesterol while maintaining beneficial HDL cholesterol levels.

In addition to healthy fats, olive oil contains a rich array of bioactive compounds such as polyphenols, antioxidants, and vitamin E. These natural components help protect cells from oxidative stress and contribute to anti-inflammatory effects within the body. Research in nutritional science has consistently associated regular consumption of olive oil with improved metabolic health, better digestion, and enhanced immune response.

These health benefits have positioned olive oil as a cornerstone ingredient in preventive nutrition and functional diets. Health professionals frequently recommend olive oil as a healthier alternative to saturated fats and highly refined cooking oils.

As a result, consumers seeking wholesome and minimally processed food ingredients are increasingly turning toward olive oil as part of their daily dietary routines.

A Culinary Powerhouse: Flavor, Aroma, and Texture

Beyond its health advantages, olive oil is highly valued for its sensory appeal. It offers a distinctive combination of aroma, taste, and mouthfeel that enhances the overall culinary experience. The flavor of olive oil can range from mild and buttery to bold and peppery, depending on the olive variety, harvesting stage, and processing method.

In professional kitchens and food manufacturing facilities alike, olive oil plays an essential role in elevating the flavor profile of various dishes and products. It is widely used in salad dressings, marinades, sauces, dips, and spreads, where it contributes richness and depth. The oil also performs exceptionally well in baking, roasting, and sautéing, allowing chefs and home cooks to achieve balanced textures and enhanced flavors. Premium food brands increasingly rely on olive oil to create authentic Mediterranean-inspired products that appeal to modern consumers seeking both taste and health benefits. As global culinary preferences evolve, olive oil continues to bridge traditional cooking methods with contemporary gastronomy.

Expanding Product Innovations in the Food Industry

The versatility of olive oil has opened new opportunities for innovation across the food processing sector. Manufacturers are incorporating olive oil into a diverse range of products, including ready-to-eat meals, gourmet sauces, snack foods, and bakery items. Its natural flavor stability and nutritional value make it particularly attractive for developing high-quality food formulations.

One of the most notable areas of growth is in the plant-based food segment. Olive oil is increasingly used in plant-based dairy alternatives such as vegan cheeses, spreads, and non-dairy creams, where it helps replicate the creamy texture typically



associated with animal fats. In addition, olive oil is being incorporated into protein bars, functional beverages, and fortified nutrition products designed to support active lifestyles.

Even in premium confectionery and chocolate formulations, olive oil is being explored as a unique ingredient that adds smoothness while enhancing nutritional appeal. Its ability to align with clean-label expectations further strengthens its position as a preferred ingredient in modern product development, as it requires minimal additives and maintains a natural ingredient profile.

The Rise of Flavored and Gourmet Olive Oils

As consumer tastes become more adventurous, the olive oil market is witnessing a surge in specialty and infused variants. Flavored olive oils infused with herbs, spices, and citrus extracts are gaining popularity among culinary enthusiasts and gourmet food brands. Common flavor infusions include basil, garlic, rosemary, chili, lemon, and truffle, each offering a distinctive taste experience. These products enable chefs and home cooks to add complexity and creativity to dishes without the need for additional ingredients. For food manufacturers, flavored olive oils provide an opportunity to diversify product portfolios and appeal to premium market segments seeking innovative flavor experiences.

The growth of gourmet olive oil products is also contributing to the expansion of specialty retail channels, including artisanal food stores and online marketplaces that cater to discerning consumers.

Sustainability and Responsible Cultivation

Sustainability has become a defining factor in modern food production, and olive oil stands out as an environmentally responsible agricultural product. Olive trees are naturally resilient and can thrive in challenging climates with relatively low water requirements. Their deep root systems help prevent soil erosion while supporting long-term land sustainability. Many olive-growing regions are adopting sustainable farming practices such as organic cultivation, regenerative agriculture, and integrated pest management. These approaches not only improve soil health but also enhance biodiversity and reduce environmental impact.

Traceability and transparency are also



becoming key priorities in the olive oil industry. Producers are implementing digital monitoring systems and certification programs that allow consumers to trace the origin of the oil from the olive grove to the final packaged product. Such initiatives strengthen trust while reinforcing the authenticity of high-quality olive oil brands.

Advancements in Processing and Packaging Technology

Technological innovation is playing an increasingly important role in preserving the quality and nutritional integrity of olive oil. Modern extraction techniques such as cold pressing ensure that the oil retains its natural antioxidants and flavor compounds without exposure to excessive heat or chemical processing.

Advanced filtration systems, oxygen-controlled storage facilities, and inert gas packaging methods are also helping protect olive oil from oxidation and degradation. These technologies extend shelf life while maintaining consistent flavor and nutritional properties. Packaging innovations are equally important. Dark glass bottles, UV-protective containers, and airtight caps are widely used to shield olive oil from light and air exposure. Smart packaging solutions that monitor freshness and storage conditions are also emerging, offering new possibilities for maintaining product quality across the supply chain.

Global Market Growth and Premiumization Trends

The global olive oil market is experiencing steady growth as awareness of its health and culinary benefits continues to expand. While Mediterranean countries such as Spain, Italy, and Greece remain dominant producers, demand is rapidly increasing across emerging markets, including Asia and Latin America.

One of the most significant trends shaping the industry is premiumization. Consumers are increasingly willing to invest in high-quality extra virgin olive oils that offer

superior taste, authenticity, and nutritional value. Geographical indication certifications, estate-grown oils, and single-origin products are gaining traction as buyers seek transparency and authenticity. Premium olive oils from renowned producing regions are celebrated not only for their quality but also for the cultural heritage and craftsmanship associated with their production. This trend is helping transform olive oil from a basic cooking ingredient into a premium lifestyle product.

Olive Oil and the Future of Health-Centric Food Systems

As the global food industry shifts toward healthier and more sustainable consumption patterns, olive oil is uniquely positioned to play a central role in the future of food innovation. Its combination of nutritional excellence, culinary versatility, and environmental sustainability aligns perfectly with the evolving expectations of modern consumers.

For food manufacturers, olive oil represents an ingredient that delivers both functional and marketing advantages. Its positive health perception, natural origin, and clean-label appeal help brands build trust and credibility with increasingly conscious consumers. At the same time, continued research and product development are expanding the potential applications of olive oil in functional foods, nutraceutical products, and advanced food formulations. As technology, sustainability practices, and consumer awareness continue to advance, olive oil will remain a key driver in shaping a healthier and more innovative global food ecosystem.

Conclusion: A Timeless Ingredient for a Progressive Food Industry

Olive oil's journey from ancient olive groves to modern food laboratories reflects its enduring value as both a culinary and nutritional powerhouse. It is more than just an edible oil—it represents a harmonious blend of tradition, science, and sustainability. With its ability to enhance flavor, improve health outcomes, and support environmentally responsible agriculture, olive oil continues to inspire innovation across the global food industry. Whether incorporated into gourmet recipes, functional food products, or everyday meals, this golden ingredient remains a symbol of quality, authenticity, and mindful living. As consumers and manufacturers alike embrace healthier and more sustainable food choices, olive oil will undoubtedly continue to shape the future of food innovation for generations to come.

From Manual to Smart:

Automation and Robotics Redefining Food Warehousing

Ritesh Verma



Introduction: Transforming Food Logistics Through Intelligent Automation

The food and beverage industry is witnessing a profound transformation as supply chains become more complex, demand patterns shift rapidly, and consumer expectations for faster delivery continue to rise. Warehousing and distribution, once considered backend operations, have now emerged as critical components in ensuring product quality, safety, and timely delivery. In this evolving landscape, automation and robotics are playing a central role in modernizing food logistics operations.

Food warehousing presents unique operational challenges such as strict hygiene requirements, limited shelf life of products, temperature-sensitive storage conditions, and the need for complete traceability. Traditional manual handling systems often struggle to meet these requirements efficiently. Automation and robotic technologies are enabling food companies to streamline operations, enhance productivity, and maintain high levels of accuracy while ensuring compliance with stringent food safety standards. As digital transformation accelerates across industries, automated systems, artificial intelligence, robotics, and smart warehouse management solutions are becoming indispensable tools for building resilient and efficient food supply chains.

The Growing Need for Automation in Food Warehousing

Food supply chains are becoming increasingly complex due to globalization, diverse product portfolios, and the rapid growth of e-commerce grocery platforms.

Manufacturers and distributors are required to manage a wide range of products including fresh produce, frozen foods, dairy, ready-to-eat meals, and packaged goods each with specific storage and handling requirements.

Manual warehouse operations can lead to inefficiencies, delays, and higher operational costs. Human error during sorting, picking, and inventory management can also result in incorrect shipments, product damage, and wastage. Automation addresses these challenges by enabling precise and consistent handling of products throughout the warehousing process. Automated systems also improve inventory visibility and allow real-time monitoring of stock levels. This capability helps food companies manage demand fluctuations, optimize storage capacity, and reduce the risk of overstocking or product expiry. In an industry where freshness and timeliness are critical, automation provides the reliability needed to maintain smooth supply chain operations.

Robotics Transforming Warehouse Operations

Robotic technologies are increasingly being deployed across food warehousing facilities to perform repetitive and labor-intensive tasks. These systems are designed to operate with high precision and speed, significantly improving efficiency compared to manual processes.

Robotic palletizers and depalletizers are commonly used in food warehouses to handle heavy loads and stack products on pallets for storage or transportation. These robots reduce the need for manual lifting while ensuring uniform pallet configurations

that enhance storage efficiency and transport stability. Robotic picking systems equipped with machine vision and artificial intelligence are capable of identifying and selecting products from shelves with remarkable accuracy. These systems are particularly valuable in high-volume distribution centers where thousands of orders must be processed daily. By automating order picking, companies can reduce processing times while improving order accuracy.

Autonomous mobile robots (AMRs) are another major innovation transforming warehouse operations. These robots navigate through warehouse environments independently using sensors and mapping technologies. They transport goods between storage areas, picking stations, and packing zones, thereby improving internal logistics efficiency and reducing the reliance on forklifts and manual transport systems. Collaborative robots, or cobots, are also gaining traction in food warehousing environments. Unlike traditional industrial robots that operate in isolated zones, cobots are designed to work alongside human employees. They assist workers with repetitive tasks such as packaging, sorting, and labeling, allowing human staff to focus on more complex and value-added activities.

Automated Storage and Retrieval Systems Enhancing Efficiency

Automated Storage and Retrieval Systems (ASRS) represent one of the most significant technological advancements in warehouse automation. These systems utilize computer-controlled mechanisms to automatically place and retrieve goods from designated storage locations.

ASRS technology enables warehouses to maximize vertical storage space by using high-density racking systems. This is particularly beneficial in urban distribution centers where space is limited and operational costs are high. Automated cranes, shuttles, and conveyor systems work together to move products efficiently within the warehouse. In temperature-controlled environments such as cold storage facilities, automation plays an especially critical role. Working in extremely cold conditions can be physically demanding and unsafe for human workers. Automated systems can operate efficiently in such environments while maintaining precise temperature control and minimizing the need for human exposure.

The use of ASRS also improves inventory

accuracy by eliminating manual stock handling and enabling real-time tracking of product movements. This level of control is essential for managing perishable goods and ensuring proper stock rotation practices such as first-in-first-out (FIFO).

Integration of Smart Warehouse Management Systems

Automation and robotics in food warehousing are supported by advanced Warehouse Management Systems (WMS) that coordinate and optimize operations across the facility. These digital platforms integrate various warehouse technologies, enabling seamless communication between robots, conveyors, sensors, and human operators. A modern WMS provides real-time visibility into inventory levels, product locations, and order processing status. It also enables data-driven decision-making by analyzing warehouse performance metrics such as order fulfillment rates, storage utilization, and operational efficiency.

In addition, smart warehouse systems are increasingly incorporating artificial intelligence and predictive analytics. These technologies allow warehouses to anticipate demand patterns, optimize picking routes, and schedule equipment usage more efficiently. As a result, companies can reduce operational costs while improving service levels and delivery reliability.

Enhancing Food Safety and Traceability

Food safety and regulatory compliance are critical priorities in the food supply chain. Automation and robotics play a significant role in maintaining strict hygiene standards and ensuring product traceability. Automated handling reduces direct human contact with food products, thereby minimizing the risk of contamination. Robotic systems also maintain consistent handling processes, ensuring that products are stored and transported under controlled conditions. Digital tracking systems integrated with automated warehouses allow companies to trace products throughout the supply chain. In the event of a product recall, this traceability enables companies to quickly identify affected batches and remove them from distribution channels. Such capabilities are essential for protecting consumer safety and maintaining brand trust.

Addressing Labor Challenges in Food Logistics

Labor shortages have become a growing

concern in warehouse operations worldwide. Food distribution centers often struggle to recruit and retain workers for physically demanding tasks such as lifting heavy loads and operating in cold storage environments. Automation and robotics help address these challenges by reducing the reliance on manual labor for repetitive and physically intensive activities. Instead of replacing human workers entirely, automated systems complement human capabilities and create safer working environments.

Employees can be redeployed to supervisory roles, system management, quality control, and other specialized tasks that require human expertise. This shift not only improves workforce efficiency but also enhances job satisfaction by reducing physically strenuous workloads.

Sustainability Benefits of Automated Warehousing

Sustainability is becoming a major focus in food supply chains, and automation contributes significantly to achieving environmental goals. Automated warehouses optimize energy usage by improving operational efficiency and reducing unnecessary equipment movement. High-density storage systems reduce the physical footprint of warehouses, allowing companies to store more products within smaller spaces. This efficient use of infrastructure lowers construction and operational energy requirements.

Automation also helps reduce food waste by improving inventory management and ensuring proper stock rotation. Real-time monitoring systems can track product shelf life and prioritize the dispatch of items approaching expiration. Such capabilities are critical for minimizing losses in the food supply chain. Additionally, automated logistics systems enable better route planning and transportation coordination, which can help reduce fuel consumption and carbon emissions across distribution networks.

Future Outlook: The Rise of Intelligent Food Warehouses

The future of food warehousing and distribution will be shaped by increasingly advanced technologies that combine automation, artificial intelligence, and data-driven insights. Smart warehouses are expected to become more autonomous, with interconnected systems capable of making real-time

operational decisions.

Artificial intelligence will play a larger role in optimizing warehouse operations by analyzing large volumes of data to improve demand forecasting, inventory planning, and equipment performance. Predictive maintenance technologies will allow companies to identify potential equipment failures before they occur, minimizing downtime and operational disruptions.

Robotics will also continue to evolve, with more flexible and adaptive systems capable of handling delicate food products and diverse packaging formats. Innovations in machine vision and gripping technologies will enable robots to handle complex tasks such as sorting fresh produce and fragile packaged goods.

Another emerging trend is the integration of the Internet of Things (IoT) in warehouse environments. Connected sensors will monitor temperature, humidity, equipment performance, and product conditions in real time. This data will enhance transparency and allow companies to maintain optimal storage conditions throughout the supply chain. As digital transformation progresses, fully automated distribution centers—often referred to as “lights-out warehouses”, may become more common. These facilities operate with minimal human intervention, relying on robotics and intelligent systems to manage the entire workflow from product storage to shipment preparation.

Conclusion: Automation as the Backbone of the Future Food Supply Chain

Automation and robotics are rapidly redefining the operational landscape of food warehousing and distribution. By enhancing efficiency, accuracy, and safety, these technologies enable food companies to meet the growing demands of modern supply chains while maintaining high standards of quality and compliance.

For the food industry, the adoption of automated warehouse technologies is no longer merely an option but a strategic necessity. Companies that invest in intelligent logistics infrastructure will be better positioned to manage supply chain complexities, respond to market changes, and deliver superior service to customers. As the global food ecosystem continues to evolve, automation and robotics will remain at the forefront of innovation, shaping a smarter, more resilient, and more sustainable future for food warehousing and distribution.

Roquette launches breakthrough clean-tasting pea protein isolate



Roquette, a global leader in plant-based ingredients, is expanding its NUTRALYS® portfolio with the launch of NUTRALYS® Pea 850F, a new pea protein isolate designed to unlock superior sensory performance in plant-based formulations. Developed to address common formulation challenges, this next-generation ingredient enables food and beverage manufacturers to create plant-based alternatives with cleaner, more neutral taste profiles.

Taking pea protein formulation to the next level

The launch responds to accelerating consumer demand for high-protein products, with three in five consumers worldwide actively increasing their protein intake*. At the same time, brands and formulators face growing pressure to deliver plant-based alternatives that match conventional products on taste – a challenge that has historically required extensive use of flavoring systems as masking agents.

Pea protein has emerged as formulators' preferred choice for plant-based innovation**, thanks to its strong nutritional profile, regional sourcing availability and competitive pricing. However, its characteristic taste has remained a

persistent formulation barrier, requiring manufacturers to invest in complex masking strategies which can compromise clean label positioning.

NUTRALYS® Pea 850F provides the complete nutritional benefits of pea protein while significantly reducing vegetal or pea notes. Expert sensory panel analysis confirms the ingredient's more neutral and smooth taste profile, enabling formulators to develop higher-protein products without sacrificing flavor quality. Importantly, this improved sensory performance is achieved by directly addressing pea protein's taste issues, without the need for additional ingredients or processing aids. As a result, products formulated with NUTRALYS® Pea 850F can be labeled simply as 'pea protein' or 'pea protein isolate', simplifying reformulation requirements in a consumer-friendly way.

Formulation flexibility

NUTRALYS® Pea 850F delivers functional performance comparable to Roquette's established NUTRALYS® S85F benchmark, while offering enhanced sensory characteristics. The new ingredient provides high emulsion capacity for stable formulations, moderate gelling and viscosity and excellent solubility, making it particularly well-suited for ready-to-mix and ready-to-drink applications. Its versatility extends across dairy alternatives, beverages, and specialized nutrition categories.

This combination of technical functionality and sensory performance enables formulators to tap into emerging market opportunities, including high-protein

products designed for GLP-1 users. This rapidly-expanding segment has driven 29% growth in food and beverage launches featuring protein and weight management claims in 2024 / 2025, compared to the previous year*.

Overcoming historical taste barriers

"Pea protein provides excellent nutrition and functionality in plant-based and high protein foods and beverages, but sensory performance has remained a critical barrier to wider adoption. Consumers understandably want the protein hit without the overpowering vegetal taste," comments Benjamin Voiry, Global Protein Product Marketing at Roquette. "With NUTRALYS® Pea 850F, we have tackled the problem at ingredient level, rather than just masking it. This is an important milestone for manufacturers, giving them the freedom to create products that consumers genuinely enjoy, with cleaner formulations and simplified labels."

"From a formulation standpoint, reducing off-notes at source makes an immediate difference," adds Adeline Morcet, Application Scientist at Roquette. "It allows producers to focus on texture, nutrition and overall product experience, rather than compensating for flavor challenges. That efficiency can significantly shorten development timelines – creating plant-based products that stand out for the right reasons." NUTRALYS® Pea 850F, which is not listed as a major allergen, forms part of the wider NUTRALYS® portfolio, which now includes proteins from pea, wheat, and fava bean – supporting a wide variety of use in plant-based, hybrid, and high-protein foods and beverages. The NUTRALYS® protein range combines functional and nutritional performance, together with high quality standards.

*Innova Trends Survey, 2026, **Innova, 2024.

Brenntag expands Nutrition innovation capabilities in Asia Pacific with new Innovation & Application Center in Mumbai, India

Brenntag, the global market leader in chemicals and ingredient distribution, today announced the opening of its new, state-of-the-art Innovation & Application Center in Andheri East, Mumbai, marking a major expansion of its technical and development capabilities for the food and beverage industry across the region.

Located in Andheri East, a major commercial hub, the new facility offers strong transport connectivity, including access to Chhatrapati Shivaji Maharaj International Airport. Designed as a substantial expansion of Brenntag's previous laboratory, the center has been purpose-built with dedicated laboratories for multiple food and beverage

categories, enabling more focused development, faster project turnaround and deeper technical support.

Kenneth Keh, Regional President, Nutrition APAC, Brenntag Specialties, said, "This investment reflects our continued commitment to strengthening Brenntag's Nutrition business in Asia Pacific and being closer to our customers. By expanding our technical and innovation capabilities in Mumbai, we are enhancing our ability to support local and regional food and beverage manufacturers with solutions that meet evolving mar-



ket, regulatory and consumer demands.” Winnie Koh, Director, Innovation & Application Nutrition APAC, Brenntag Specialties, added, “Our new high-tech, leading-edge facility in Mumbai will help to bring innovative, complete solutions and ready-to-launch, consumer-desired concepts to our important customers across multiple food segments. This will also be an important facility for us to support and work closely with our numerous partners and suppliers.”

Designed as a comprehensive innovation hub, the center brings together advanced processing, formulation, blending and analytical capabilities to accelerate product development and technical problem-solving across a wide range of applications.

Advanced Dairy and Beverage Applications

The new facility supports the development of liquid and frozen products, including neutral and acidified dairy, fruit and nutraceutical beverages, carbonated drinks, and ice cream. It is equipped with Ultra-High Temperature processing systems, aseptic filling lines, high-pressure homogenizers, as well as can sealing machines to enable pilot-scale trials and practical process validation from concept to commercial readiness.

Confectionery, Snacks and Convenience Foods

The laboratory supports confectionery, breads and cakes, noodles and pasta, sauces and dressings, and coated and ready-to-eat snacks. Features industrial ovens, proofers, dough molders, pasta and noodle processing systems, wafer sheet lines, and confectionery equipment to refine texture, flavor, and process performance with precision.

Powder Blending and Analytical Capabilities

The laboratory enables the creation of bespoke ingredient blends using pilot-scale blending equipment, vibro-shifters, and particle size analyzers that mirror full-scale production. Analytical instruments, including texture analyzers, viscometers, titrators, density meters, refractometers, moisture analyzers, and water activity meters, provide detailed insight into product quality and performance.

The laboratory serves as a platform for the development and optimization of flavors for alcoholic, low-alcohol, and non-alcoholic beverages, including IMFL (Indian Made Foreign Liquor), wine, beer, and brewing applications, enabling the creation and evaluation of market-ready flavor profiles aligned with regional and global consumer trends.

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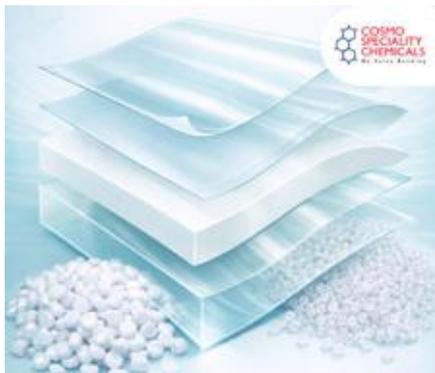
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Cosmo Speciality Chemicals Announces Launch of Advanced Masterbatches Portfolio



Cosmo Speciality Chemicals, a subsidiary of Cosmo First Limited, has announced the launch of its expanded range of high-performance masterbatches, further strengthening its Specialty Chemicals portfolio and reinforcing its presence in value-added polymer solutions.

The newly introduced portfolio includes CosmoWhite, a premium portfolio of advanced white masterbatches for polypropylene (PP) and polyethylene (PE). Developed with high concentrations of Titanium Dioxide (TiO₂), CosmoWhite provides exceptional opacity, brightness, UV protection, and thermal stability. These

qualities ensure reliable performance in demanding applications such as BOPP films, blown films, extrusion coating, injection moulding, non-wovens, raffia, and pail containers.

In addition to this, Cosmo Speciality Chemicals has also unveiled CosmoAdd which is a complementary portfolio of additive masterbatches engineered to enhance processing efficiency, product durability, and end-use functionality. Tailored for flexible packaging in BOPP, CPP, and blown film applications, the CosmoAdd portfolio encompasses a wide range of solutions including cavitating agents (inorganic and organic), antiblock additives (inorganic and organic), antistatic and slip additives, polymer processing aids (standard and PFAS-free), antioxidants, clarifiers, matt compounds, and specialized solutions for synthetic paper. Additionally, CosmoAdd addresses industry challenges, reinforcing its role as a comprehensive and forward-looking portfolio for modern packaging needs.

Commenting on the launch, Mr. Raj Sharma, Business Head, Cosmo Speciality Chemicals, said, "Our expanded masterbatch portfolio

reflects our focus on innovation-led specialty solutions. We remain committed to delivering high-performance, sustainable, and application-specific masterbatches that enhance both functionality and aesthetics for our customers across the polymer and packaging industry. Together, CosmoWhite and CosmoAdd embody Cosmo Speciality Chemicals' commitment to delivering engineered excellence and practical innovation, ensuring manufacturers achieve superior product quality, efficiency, and sustainability."

This development is closely aligned with Cosmo First's strategy of expanding its Specialty Chemicals vertical, which has been steadily scaling alongside its core specialty films business. Initiated in FY21, the specialty chemicals division operates with strong R&D capabilities and continues to build a growing presence in external markets.

With this launch, Cosmo Speciality Chemicals reinforces its position as a trusted Indian manufacturer of innovation-driven masterbatch solutions, offering tailored formulations backed by rigorous research, advanced technology, and sustainable manufacturing practices.

FPS Food Process Solutions Welcomes Southern Fabrication Works to Expand Rapidly Growing Portfolio



FPS Food Process Solutions ("FPS"), a global leader in turn-key food processing solutions, announces the addition of Southern Fabrication Works (SFW) to further strengthen and expand its rapidly growing portfolio.

SFW is widely recognized for its expertise in designing and manufacturing custom industrial food processing equipment. Well established in the potato processing industry, the company has built a strong reputation for delivering integrated, high-precision systems supported by meticulous engineering and seamless project execution.

By joining the FPS global family, SFW enhances FPS's capabilities with advanced hydro-cutting systems, cutting-edge water knife technology, innovative water recycling and waste-handling solutions, and comprehensive plant engineering expertise. These additions further strengthen FPS's ability to offer robust, end-to-end processing

solutions to customers worldwide.

"The SFW family is super excited to partner with a progressive company such as FPS, who shares similar ideology. The FPS team has been extremely welcoming and respectful. We appreciate the value they place in all their partnerships and look forward to contributing to their global initiatives," says Neil Justesen, President and Owner of Southern Fabrication Works.

"FPS has always aimed to provide full End-to-End solutions for our customers," says Jeffrey Chang, President, FPS Food Process Solutions Corp. "The timing was right to join forces. We're pleased to welcome a trusted and respected name into our group."

General Mills Opens New Manufacturing Plant in Nashik



General Mills India, part of General Mills Inc., a U.S.-based Fortune 500 food company, today announced the inauguration of a new manufacturing facility in Nashik, Maharashtra. The new, state-of-the-art plant marks a significant expansion of the company's manufacturing footprint in India and reinforces its long-term commitment to serving the fast-growing food and bakery sector in India.

General Mills invested approximately INR 100 crore to build this plant, and it serves as the company's second manufacturing facility in Nashik. The facility has been built using advanced manufacturing technologies and global quality standards, with a strong focus on food safety, high quality, and responsible resource use. The new plant at Nashik will also ensure a more efficient supply chain, reducing lead times and enhancing the availability of Pillsbury products across the country. This improved accessibility will empower thousands of bakeries in India to leverage Pillsbury's consistent quality, thereby contributing to their own growth and the overall development of the bakery sector.

Beyond manufacturing scale, the plant is expected to deliver meaningful economic impact in the region. It has already created numerous direct and indirect employment opportunities across manufacturing, logistics, and support services, providing a boost to local livelihoods and skill development in the Nashik region of Maharashtra. Furthermore, the increased demand for raw materials and ancillary services will stimulate growth for local suppliers and businesses.

"We're extremely proud to increase the availability of Pillsbury products across the country with the opening of our new plant in Nashik," said Balki Radhakrishnan, Vice President and Managing Director of Global Emerging Markets at General Mills. "Since 1999, our Pillsbury brand has been offering delicious, quality and convenient baking mixes in India. This expansion allows us to serve our consumers and bakery partners better, faster, and at greater scale."

The inauguration event to celebrate this milestone, was attended by senior company representatives, officials from the U.S. Consulate in Mumbai, and the Government of Maharashtra. Their presence underscores the strategic importance of this investment and the broader collaboration between global companies and Indian manufacturing ecosystems. The new plant represents a commitment to the economic prosperity of the region and a strategic move to further embed Pillsbury within India's evolving culinary landscape.

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Cosmo Films Launches Anti-Fog Transparent BOPET Lidding Films for Advanced Food Packaging Applications



Cosmo Films, a global leader in specialty films, has announced the launch of its Sealable Peelable Transparent Anti-Fog BOPET (PET) Lidding Film, engineered to enhance product visibility, extend shelf life and improve packaging performance across refrigerated and fresh food categories.

Condensation remains a key challenge in food packaging, especially in cold-chain environments where temperature variations lead to moisture build-up inside packs. This fog formation can obscure the product's appearance and impact consumer perception at the point of sale. Cosmo Films' new anti-fog PET lidding film incorporates an advanced coating on the sealable side that delivers an excellent cold antifogging effect,

preventing droplet formation and maintaining consistent clarity throughout storage and display.

Designed for performance and versatility, the film offers low sealing temperature, ensuring compatibility with high-speed packaging lines while optimizing energy efficiency. It is sealable and peelable, enabling strong yet easy-open seals without compromising pack integrity. The film is microwaveable, adding convenience for ready-to-eat and prepared food applications. Importantly, it enhances shelf life by 4–5 days for fresh salads and vegetables by helping maintain internal pack conditions. The lidding film is compatible with a wide range of substrates including PP, HIPS, PET (APET, CPET), PVC and LDPE containers, making it suitable for diverse packaging formats. In line with sustainability goals, the film is recyclable in the mainstream recycling stream when used with PET trays.

Commenting on the launch, Mr. Kulbhusan Malik, Global Business Head, Cosmo Films said, "In food packaging, visibility is directly linked to consumer trust and purchase

decisions. With our Anti-Fog Transparent BOPET Lidding Films, we are addressing a key pain point for brands by combining condensation control with superior clarity, strong sealing performance and ease of use. This launch reinforces our commitment to expanding our specialty portfolio with high-performance, value-added solutions that support both product protection and brand differentiation."

The new lidding films are suitable for a wide range of applications such as refrigerated and frozen foods, prepared fruits, fresh-cut vegetables, ready-to-eat meals, bakery items, dairy products including yogurt and butter, pasta, fresh meat and salami. It also performs effectively in fresh produce packaging for vegetables, herbs, berries, fruits and mushrooms—categories where clear visibility and freshness perception are critical to purchase decisions.

This launch further strengthens Cosmo Films' specialty product portfolio, aligned with its strategic focus on innovation-led growth and higher value-added offerings. With continued investments in R&D and advanced film technologies, the company remains committed to delivering solutions that enhance shelf life, improve packaging efficiency and elevate consumer experience.

Thermoformed Solutions Designed to Maximize Market Opportunities



Amcor, a global leader in developing and producing responsible packaging solutions, is continuing to invest in its thermoforming capabilities to meet strong demand from the ready meals and dairy foods sectors.

According to Euromonitor, the market has a steady growth rate of around 5%, reflecting ongoing consumer requirements for reliable and affordable food packaging solutions. The report says that for many brands thermoformed packaging has become a 'strategic asset', helping them to 'extend shelf life (by up to 50%), cut waste and deliver convenience without compromising sustainability'.

The Amcor thermoformed portfolio has been developed in line with these benefits, offering a range of solutions for a wide variety of products and applications, with features such as recycle-ready designs, extended shelf-life and lightweight constructions, as well as high-quality decoration options to create effective brand identity and on-shelf impact.

“The convenience food sector is very competitive, and the right packaging can play an important role in terms of ensuring product quality, creating a strong brand image and encouraging consumer loyalty,” said Katrina Burrett, product line director, containers & reusables, Amcor Global Rigids Packaging Solutions. “Our extensive choice of standard packs, as well as our ability to develop customized solutions, mean we can tailor solutions to meet the precise needs of individual customers.”

The Amcor portfolio includes a variety of round cups, pots and multi-component trays, available with inserts and in different heights and shapes to offer a versatile solution for many different applications. For products requiring an extended ambient shelf-life, an EVOH barrier can be incorporated to provide effective protection from oxygen ingress and preserve food freshness.

Amcor’s technical expertise is able to create lightweight containers that still deliver excellent long-term performance and durability, while their mono-material construction means they are recycle-ready and can be recycled in countries where the appropriate collection and recycling infrastructure is in place. For extended shelf-life products, the EVOH barrier is accepted in recycling streams.

Premium decoration options include pre-printed lids which use a patented printing process that is able to print over the rim for all-over coverage. Another innovation is thermoformed in-mold labelling for tubs, where pre-printed labels are applied to a container during the thermoforming process. This allows intricate, multi-colored designs to be incorporated to achieve a better level of finish and greater coverage than with direct printing.

“Our latest solutions aim to support customers’ sustainability objectives while delivering attractive, functional and brand-enhancing packaging,” said Katrina Burrett.

www.amcor.com

hubergroup brings ink system TINKREDIBLE MGA to worldwide markets

hubergroup Print Solutions is expanding the availability of its well-established metal decoration ink system TINKREDIBLE MGA to global markets. Already successfully used by leading manufacturers in Europe and India, the mineral oil-free, BPA-free, and PFAS-free ink series is now being rolled out worldwide. Designed for monobloc and three-piece metal cans, TINKREDIBLE MGA combines outstanding print quality, high process stability, and compliance with the strictest international food safety standards.

Food safety and durability without compromise

As global demand for sustainable and safe food packaging rises, hubergroup strengthens its position in metal decoration with TINKREDIBLE MGA. The low-migration ink series is recognised for its brilliant colours, high durability, and reliable performance in demanding production environments – making it the ideal solution for offset printing on metal cans used in food, pet food, and beverage packaging. Developed to meet the thermal, mechanical, and regulatory demands of modern food packaging, TINKREDIBLE MGA offers high flexibility, low yellowing, and excellent resistance to heat and sterilisation on both coated and uncoated substrates. Its advanced chemical composition ensures excellent resistance to scratches, moisture, and external influences, ensuring consumer safety while maintaining premium visual quality.

Proven performance – now available worldwide

TINKREDIBLE MGA has earned the trust of leading European manufacturers through years of consistent performance, outstanding process reliability, and stable colour results. The ink series has proven particularly effective for applications such as tuna cans, where shelf life, compliance, and uniform print quality are critical. Building on this track record, hubergroup is now making this established technology accessible to customers around the globe.

“TINKREDIBLE MGA is not a new development, but a proven ink system with



a long-standing reputation for quality and reliability,” says Jan Museler, Product Manager Metal Decoration at hubergroup. “With its global rollout, we are enabling printers and brand owners worldwide to achieve the highest standards of safety, performance, and design excellence.”

Flexible portfolio for individual production needs

The TINKREDIBLE MGA range comprises process colours, opaque whites, metallics, and special colours, complemented by customised solutions via the hubergroup mixing system. This comprehensive portfolio allows printers and brand owners to create distinctive, compliant metal packaging designs tailored to specific production requirements and regulatory frameworks.

With the global launch of TINKREDIBLE MGA, hubergroup continues to support the metal packaging industry with future-ready solutions for both monobloc and three-piece can applications, combining safety, performance, and design excellence. At METPACK 2026, printers and converters can learn more about TINKREDIBLE as well as NewV tin, hubergroup’s UV series first-hand at METPACK 2026 in Essen, Germany (May, 5-8, 2026, Hall 1, Stand 1B11).

hubergroup is an international leader in speciality chemicals and print solutions with a history stretching back 260 years. Within its two divisions, the company develops innovative, sustainable products and services to enable its customers to achieve first-class results. The Print Solutions Division produces inks, varnishes, and printing auxiliaries for packaging, commercial, and newspaper printing. The Chemicals Division produces speciality chemicals such as resins, pigments, and additives in its facilities in India. hubergroup employs more than 3,000 people in nearly 30 countries and generated annual sales of around €743 million in 2024.



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