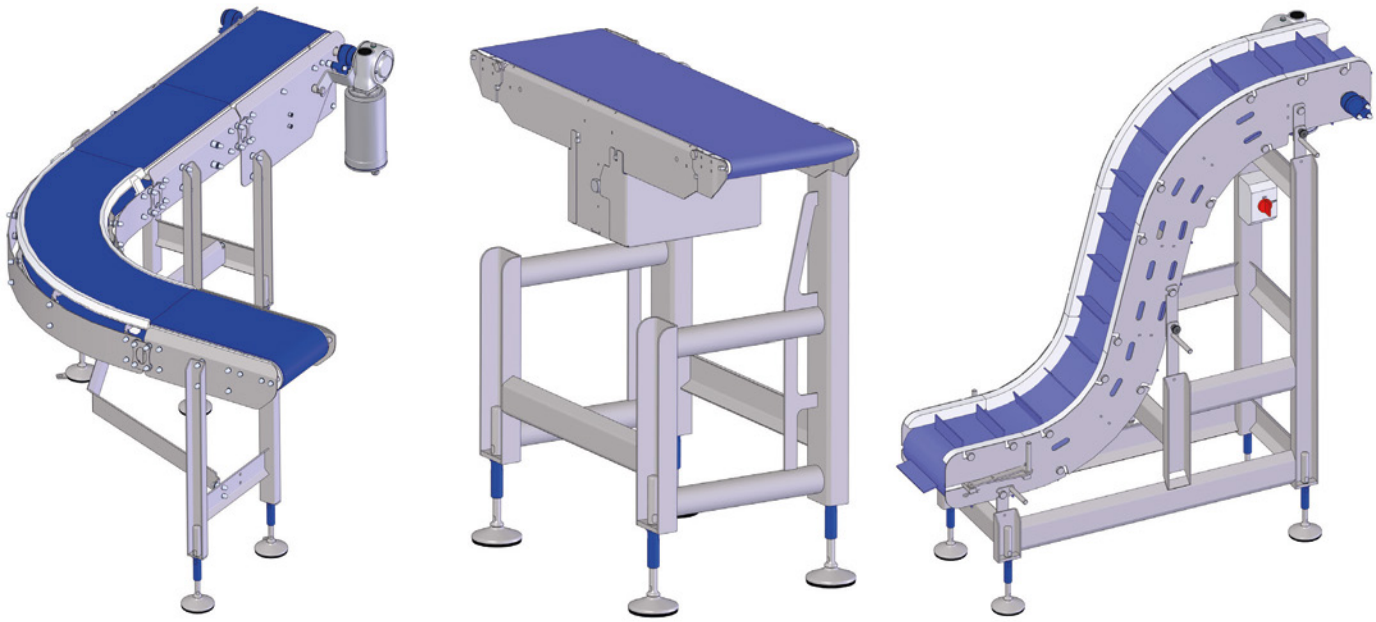
n. 113 - September 2026
ISSN 1590-6515

ITALIAN FOOD & PACKAGING TECHNOLOGY

MATERIAL HANDLING

EFFICIENCY UNLEASHED

SANI-LINE
Hygienic Design CONVEYORS



MEET US
27-30.10.2026 Parma

CIBUSTEC
27|30 OCT. 2026 | PARMA | ITALY

Hall 2 - Booth H055

Supplemento al n. 08, settembre 2026 di Industrie Alimentari - Sped. in A.P. - D.L. 353/2003 (Conv. in L. 27/02/2004 n° 46) art. 1 comma 1 DCB TO - n. 113 anno 2026 - IP

CHIRIOTTI EDITORI
10064 PINEROLO - ITALIA
Tel. +39 0121393127
info@chiriottieditori.it

PROMACH



P.E. LABELLERS™

Flexible design makes the difference.

P.E. Labellers innovation adds value to your products.

Leader in design and production of labeling machines and solutions, today also enhanced by AI.

50 years of experience in every market & application.

To Learn More Visit: PELabellers.com


Modular SL


SkyLine


Aurora 5.0

Join us at
CIBUSTEC
27-30 Oct. 2026
Parma

Find Us on the Floor
3/E038

Partner with Performance. Partner with ProMach.

promachbuilt.com

DEPARTMENTS

3 **PRODUCT TRENDS** - 5 Mega-Trends for the Food & Beverage Sector - Global Fruit and Vegetable Juices Market to Reach USD 221.1 Billion by 2030 - The snack market reaches USD 693 billion in retail sales - Global Milk Chocolate Market Expected to Reach USD 87 Billion by 2034

14 **FOOD PROCESSING** - When digital twins and AI are rethinking food production - Dairy Processing Technologies: Market Growth Driven by Automation and Sustainability - 90% fewer mechanical parts and drives, less operational complexity. LMR chocolate moulding line, already patented in the USA - Accumulation Systems: where line performance is really decided - Perfect Creamy Soups with Fristam Technology - When innovation inspires imitation - A comparison between microwave and conventional baking on bread quality - High pressure processing *vs* thermal pasteurization in oat milk - Innovative infrared autoclaves for more sustainable production - Comparison of HTST and UV-C treatments on the quality attributes of milk - Ultrasound-assisted Fermentation of Ricotta Cheese - Flash freezing of ice cream with dense phase carbon dioxide

30 **PACKAGING TRENDS** - Innovation Is Essential to Keep Pace with Global Packaging Regulations - Packaging and Processing: Global Markerts Accelerate Towards Automation and Advanced Materials - FAO warns about potential risks linked to recycled plastic food packaging

36 **HYGIENE AND SAFETY** - Food Safety: Global Market for Pathogen Testing Continues to Grow - Resistance of multispecies biofilms to sanitization

40 **NUTRITION** - Development and characterization of pistachio yogurt analog - A novel fermented milk with anti-aging and anti-oxidative properties - Valorizing press cakes as ingredients in textured vegetable proteins - Animal- and plant-derived coagulant in Caciotta cheesemaking - Potential of brewer's spent grain as a nutritional ingredient in bakery products - Acid whey retentate as fat replacer in cream cheese - Enhancing meat aroma in thermally treated chicken carcass hydrolysate - Detection of saffron adulteration - Cranberry pomace in functional biscuits - High protein yogurt alternative using pea protein hydrolysate - Yellow pea ingredients for pan bread applications - Debittered pomelo seed powder as a functional ingredient in low-fat ice cream - Valorization of acid whey to produce sourdough bread starter - Enhancing the bioactive profile of dark chocolates with berry peel extracts - Green coffee powder as a clean-label functional ingredient in meat systems - Tomato pomace powder as a bioactive ingredient in semi-hard cheese - Arichoke and broccoli by-products for gluten-free bread - Sunflower phospholipid fractions in ice cream - Preservation of antioxidant phytochemicals in fruit ice cream with ultrasound - Development of high-fibre biscuits using brewers' spent grain - Clean-label stabilization of plant-based emulsions - Food functional properties of chickpea protein sources as egg replacers in bakery - Development of a functional olive oil-based spread - Aquafaba and plant extracts for a better structure of the whipped cream

56 **RESEARCH** - Influence of ultrasonic parameters on osmotic dehydration of pork loin - Effects of high-voltage electrospray on orange juice - Low-frequency magnetic field for improving marination - Thawing frozen pork with vacuum steam and microwave - Sous-vide technique for the technological quality of marinated chicken - Concentration of skim milk using a multistage filtration cascade - Improving functionality of the milk protein concentrates with improved functionality - Improvement of physicochemical and flavor properties of brined beef - Enhancing soak resistance of ready-to-eat cooked noodles - Improved rehydration characteristic of micellar casein powder - Effe3ct of freezing and cooking on sodium nitrite content in processed meat - 24-month shelf-life achievement in frozen whole milk concentrate - Relationships between gluten proteins and texture in low-hydration dough

64 **NEWS** - Upcycled ingredients: from waste reduction to a new frontier of food value - FoodTech Village: The Digital Ecosystem Connecting Innovation - Technology and the Food Industry - Ipack-Ima 2028, a Global Ecosystem for Packaging and Processing - Cibus Tec 2026 Accelerates Growth and Strengthens Its Internatinal Dimension - International events in Italy

72 **COMPANY INDEX**



SEPTEMBER 2026 - issue 113

ITALIAN
FOOD & PACKAGING
TECHNOLOGY

Four-monthly - ISSN 1590-6515

September 2026
issue 113

Questa testata è associata a USPI Unione Stampa Periodica Italiana

Copyright Clearance Center

CHIRIOTTI EDITORI















OUR WEBSITES

chiriottieditori.it
foodtechvillage.com
pasticceriainternazionale.it
tuttogelato.it
alimentifunzionali.it
foodexecutive.com

Chiriotti Editori s.r.l.
Viale Rimembranza 60
10064 Pinerolo - To - Italia
Tel. 0121 393127
info@chiriottieditori.it
www.chiriottieditori.it

Publisher
Alberto CHIRIOTTI
Direttore Responsabile
alberto@chiriottieditori.it

Contributing Editors
Laura SBARATO,
Rossella CONTATO, Matteo BARBONI

Assistant Editor
Chiara MANCUSI
mancusi@chiriottieditori.it

Layout Designer
Anna BOSCOLO

Marketing Manager
Monica PAGLIARDI
pagliardi@chiriottieditori.it

Advertising Manager
Luca RUSSO
russo@chiriottieditori.it

Advertisement
Federico BREUSA
breusa@chiriottieditori.it

General Manager
Giuseppe CHIRIOTTI

FOR FREE SUBSCRIPTIONS

call to +39 0121 378147
or send an e-mail to:
abbonamenti@chiriottieditori.it

La riproduzione, anche parziale, di articoli ed illustrazioni pubblicati sulla rivista è riservata e non può avvenire senza espressa autorizzazione scritta dell'Editore. L'Editore non assume alcuna responsabilità per quanto riguarda eventuali errori contenuti negli articoli e per quanto espresso dagli Autori.

All Rights reserved. Reproduction, even partial, of articles and illustrations published in the journal is forbidden and can not take place without written permission of the Publisher. The Publisher assumes no responsibility for any errors contained in the articles and for what is expressed by the Authors and/or by the companies.

PRINTED
by Tipografia Bona Digital Print
Torino

MISTO
Carta | A sostegno della gestione forestale responsabile
FSC® C124627

COPYRIGHT:
© 2026 Chiriotti Editori srl
Supplemento del mensile
"Industrie Alimentari"

AUTORIZZAZIONE:
n. 262 (19-11-1962)
del Tribunale di Pinerolo

PERIODICITÀ:
mensile - sped. in A.P. comma 20/B, art. 2, legge 662/96 - Torino

INTERNET:
chiriottieditori.it

5 Mega-Trends for the Food & Beverage Sector

Mintel, with its new division Black Swan Data – specialised in analysing millions of social and online posts to understand consumer behaviour – has identified five key trends set to shape the food & beverage sector in 2026/27.



GLP-1 and the End of Emotional Snacking

Consumers using GLP-1 (Glucagon-Like Peptide-1) – a natural or synthetic hormone that regulates appetite and blood sugar and has become central in obesity treatments – are concentrating more nutrients into fewer calories, but at an emotional cost, opting for snacks that are "blander and less satisfying."

Consumers are increasingly turning to nutrient-dense foods to compensate for deficiencies in low-calorie diets, prioritising snacks rich in protein, fibre, and healthy fats.

Every bite must deliver both nutrients and satiety, leading to growth in snacks made from whole, minimally processed ingredients at the expense of fatty, additive-rich options.

Research data also reveals an emotional deficit among GLP-1 users, not just a nutritional one.

Nutrient-rich snacks often lack satisfying flavours and textures and are perceived as too "clinical." Snacking is also an emotional experience, and those using GLP-1 report a sense of disconnection and a loss of pleasure in eating. While cravings and impulsive consumption decrease, these consumers still miss the gratification provided by indulgent snacks, resulting in lower mood and anhedonic sensations – a phenomenon referred to as the "Ozempic personality," named after one of the best-known GLP-1 drugs.

To make snacks more "joyful," five factors can be addressed. Nutrient density remains key: snacks should be small in size but high in impact, combining protein, fibre, and healthy fats for lasting nourishment. Single-portion or resealable formats are important to avoid perceptions of waste.

Secondly, brands can deliver satisfaction through texture. GLP-1 users are particularly sensitive to mouthfeel but appreciate creamy yogurts, soft bites, molten centres, and light crunch.

Another important aspect is nostalgia for comforting flavours such as cinnamon, cocoa, vanilla, and peanut butter, which can help rebuild an emotional connection to food while remaining aligned with health goals.

It is also essential to consider the gut–brain axis, as GLP-1 users often experience digestive issues such as bloating and constipation. These can be addressed with probiotics, prebiotics, and gentle fibres like chia, flax, and oats, supporting both gut health and mood. To further enhance mood and manage stress, snacks can be enriched with adaptogens such as ashwagandha or maca root, or functional ingredients like tryptophan and magnesium.

Ultra-Processed Foods: The Problem of "Health-Washing"

While consumers are aware of junk food and its health effects, many believed they could distinguish healthy options – yet closer inspection of labels reveals that many seemingly healthy foods are actually ultra-processed.

Products with a "health halo" (such as high-protein, gluten-free, or "natural" claims) often contain hidden and less healthy additives. Plant-based meat substitutes, for example, frequently feature long ingredient lists that seem more laboratory-designed than kitchen-made.

Consumers perceive this as "health-washing" and feel confused and misled, undermining trust in their healthy choices. As a result, they are demanding greater transparency, simpler ingredients, and products that truly deliver on their promises.

To win back "clean eaters," brands must focus on ingredient transparency, clearly communicating what is in a product, how it is made, and why key ingredients are included – avoiding vague health-driven marketing language.

In addition, as sceptical consumers increasingly question health claims, third-party certifications become essential to substantiate them, providing credibility beyond marketing promises.

Finally, since consumers do not want to trade health for convenience, brands must focus on shorter, more functional ingredient lists, using nat-



ural preservatives to make healthy eating simple and accessible.

Functional Beverages: Beauty from Within

Consumers are fully aware of the link between gut health and skin health – but the market has yet to catch up. Most beauty drinks today focus on superficial outcomes such as clear skin and shiny hair, without addressing the underlying causes, particularly gut health.

Although the gut–skin connection is well established and intestinal imbalances can affect the skin microbiome – leading to acne, dullness, or sensitivity – current products tend to treat symptoms rather than root causes, leaving consumers to experiment through trial and error.



Food & drink products that focus on the gut–skin axis and the underlying causes of skin issues will be best positioned for success in 2026/27.

Beverage brands can leverage the concept of "beauty from within" by offering dual-benefit solutions that integrate into wellness routines. This means going beyond superficial claims to highlight functional benefits for beauty, digestion, and overall wellbeing.

A key opportunity lies in dual-action formulations, combining skin-supporting ingredients (such as collagen or hyaluronic acid) with prebiotics, probiotics, or postbiotics for gut balance in a single drinkable format.

Another area is supporting the full gut–skin cycle through daily routines (e.g. morning and evening beverages) designed to improve digestion, microbiome balance, and skin health. Clear guidance on the gut–skin axis, personalised to skin type or wellness goals, can enhance engagement, while ready-to-drink (RTD) formats encourage consistent consumption.

Finally, measurable and personalised results can be achieved through scientifically validated ingredients and by encouraging personal tracking via apps and wearable devices.

Alcoholic and Savoury Flavours = Premium

US consumers find sweet flavours predictable and are increasingly drawn to umami, herbal, and roasted notes. While many alcoholic beverages focus on sweetness or the alcohol itself, there is growing demand for more complex alternatives.

Smoky, spicy, and umami notes can provide layered, chef-inspired experiences. These flavours are subtle and develop gradually, unlike the immediate gratification of sugary snacks or alcopops, making consumption more intentional and premium.

Taste is becoming a marker of values and identity – especially for Gen Z, for whom niche and savoury flavours signal cultural awareness, individuality, and status. Brands that leverage this can also meet consumers' aesthetic expectations.

Within savoury flavour profiles – perceived as more exclusive and distinctive than sweet or fruity ones – five elements are key. For example, peated



street food is about experiences to live, capture, and share.

To engage this audience, brands must capture the soul, spices, and spontaneity of street food – moving beyond the familiar and embracing ethnic flavours, spice blends, and creative fusions.

They can also create "adventure" experiences through limited editions, rotating flavours, and surprising combinations, while highlighting real people and stories and collaborating with street chefs, local vendors, and cultural figures to build authenticity and trust.

Finally, a key strength of street food is its accessibility – it is for everyone – offering intense, engaging flavour experiences at affordable prices.

mintel.com

malts, charred woods, and Mizunara casks can impart rare smoky notes, while techniques such as fat-washing – infusing spirits with fats like butter or olive oil– create rich, smooth textures.

Intense sensory experiences can also be achieved with spice profiles such as sansho, cardamom, and pepper; freshness and complexity with herbal infusions (Thai basil, jasmine); or deep umami and saline notes with olives, balsamic vinegar, and sea salt. These profiles are associated with curated, premium experiences suited to special occasions.

The Street Food Revolution for Gen Z

Gen Z is gravitating towards authentic, "rooted" snacks, with street food becoming the benchmark – as evidenced by content on Instagram and TikTok.

Young consumers are attracted to colourful food markets and street vendors offering flavours from around the world, embracing unexpected and chaotic fusions. They are also keen to support local vendors and value the story and experience behind products, not just taste.

Bright colours, sounds, and behind-the-scenes moments are ideal for social media, and for Gen Z,



PINCO SA

GULFOOD MANUFACTURING

3–5 NOV 2026

DUBAI WORLD TRADE CENTRE

Booth S1-H3
Sheikh Saeed Hall

Dedicated drying solutions, no matter where you are...





WWW.PINCO-SA.COM

VIA LAVEGGIO, 9 - 6855 STABIO (SWITZERLAND)
+41 91 6400800 @INFO@PINCO-SA.COM

Global Fruit and Vegetable Juices Market to Reach USD 221.1 Billion by 2030

According to **Global Industry Analysts** agency, the global market for Fruit and Vegetable Juices estimated at US$184.0 Billion in the year 2024, is expected to reach US$221.1 Billion by 2030, growing at a CAGR of 3.1% over the analysis period 2024-2030. Fruit Juices, one of the segments analyzed in the **report**, is expected to record a 3.1% CAGR and reach US$104.0 Billion by the end of the analysis period. Growth in the Fruit & Vegetable Blends segment is estimated at 3.4% CAGR over the analysis period.

The U.S. Market is Estimated at US$37.2 Billion While China is Forecast to Grow at 7.8% CAGR

The Fruit and Vegetable Juices market in the U.S. is estimated at US$37.2 Billion in the year 2024. China, the world`s second largest economy, is forecast to reach a projected market size of US$32.8 Billion by the year 2030 trailing a CAGR of 7.8% over the analysis period 2024-2030. Among the other noteworthy geographic markets are Japan and Canada, each forecast to grow at a CAGR of 2.3% and -0.4% respectively over the analysis period. Within Europe, Germany is forecast to grow at approximately -1.1% CAGR.

Key Trends & Drivers

What Constitutes the Broad Spectrum of Fruit and Vegetable Juices in Today's Market?

Fruit and vegetable juices comprise a significant segment of the beverage industry, offering a wide array of products that cater to diverse consumer tastes and nutritional needs. These juices range from pure, single-fruit offerings to complex blends that include a mix of fruits and vegetables, often enhanced with added vitamins, minerals, and other functional ingredients like probiotics and plant-based proteins. The appeal of these juices lies in their convenience as a source of essential nutrients, making it easier for consumers to achieve their daily dietary recommendations for fruits and



vegetables. Manufacturers have refined their processing techniques to preserve the natural flavors and nutritional profiles of the raw ingredients, using methods like cold-pressing and high-pressure processing, which maintain the integrity of vitamins and enzymes without the need for preservatives.

How Are Innovations Shaping Product Development and Consumer Preferences?

Technological innovations in juice production have not only expanded the variety and quality of products available but have also aligned with changing consumer preferences towards health and wellness. Advanced extraction and preservation technologies allow for the production of juices that retain more of the natural nutrients and enzymes from fruits and vegetables, catering to health-conscious consumers seeking functional beverages. Moreover, the trend toward organic and clean-label products has led manufacturers to adopt practices that ensure their juices are free from additives and artificial ingredients, using organic produce as a base. The industry has also seen a rise in sustainability practices, with brands increasingly focusing on reducing waste and carbon footprint by utilizing every part of the fruit and vegetable, and investing in eco-friendly packaging solutions.



What Role Do Market Trends Play in Influencing Juice Consumption?

Market trends significantly influence the dynamics of fruit and vegetable juice consumption, with health trends being particularly impactful. As more people adopt healthier lifestyles, there is a growing demand for juices that not only provide essential nutrients but also support health goals such as weight management, immunity boosting, and improved digestive health. This has led to the proliferation of vegetable juices and blends that are lower in calories and sugars compared to traditional fruit juices. Additionally, the rise of personalized nutrition and wellness as a lifestyle choice has spurred interest in bespoke juice offerings that cater to individual dietary needs and preferences, such as keto-friendly, low-glycemic, or allergen-free options. Seasonal and exotic fruit offerings are also becoming popular as consumers become more adventurous in their tastes and seek new flavor experiences.

What Drives the Growth of the Fruit and Vegetable Juice Market?

The growth in the fruit and vegetable juice market is driven by several factors, including rising health awareness among consumers globally and the associated demand for nutritious dietary options. This trend has been bolstered by the increasing prevalence of lifestyle diseases such as diabetes and obesity, which motivate individuals to choose healthier beverage options. Technological advancements in juice processing that enhance flavor and nutritional content without compromising on natural quality also contribute significantly to market expansion. Additionally, innovative packaging solutions that extend shelf life and improve convenience – such as resealable and portable formats – enhance consumer appeal and practicality. The market has also benefited from aggressive marketing campaigns by manufacturers that position juice as a key component of a modern healthy diet. Furthermore, the expansion of retail distribution channels, including online platforms that offer greater visibility and accessibility to a wide array of juice products, supports the market`s upward trajectory. Together, these dynamics continue to propel the fruit and vegetable juice industry forward, making it a staple in the beverage market landscape.

marketresearch.com

The snack market reaches USD 693 billion in retail sales

The global snack market continues its upward trajectory, reaching USD 693 billion in retail sales in 2024, according to data analytics company Euromonitor International. Driven by factors such as shifting economic power and changing consumer values, the industry is poised for further growth despite challenges from legislative uncertainties and consumer price sensitivity.

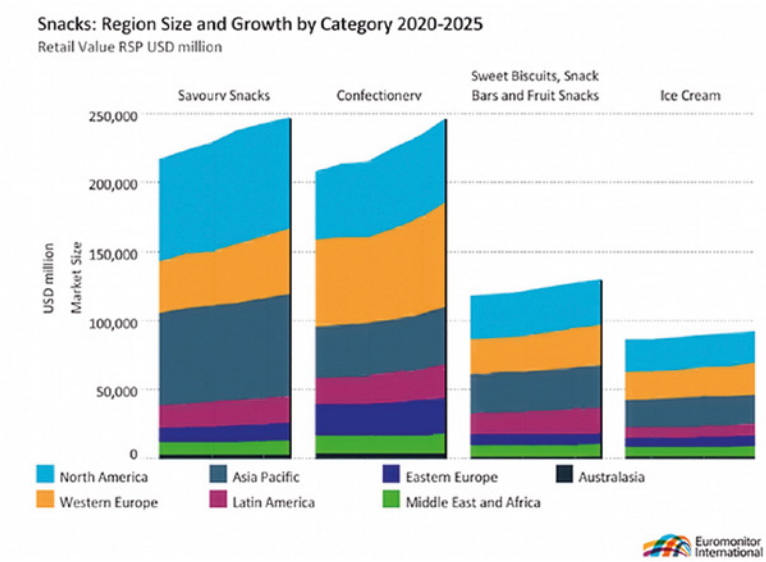
Euromonitor International's World Market of Snacks Report 2025 highlights the industry-wide efforts and projects that the category's five-year forecast outlook (2025–2030) will outpace its historic performance (2019–2024), as the sector moves beyond pandemic-related strains and intensifies its focus on value-driven upgrades.

Citing the latest findings on snack insights and trends from Euromonitor International's Passport knowledge hub **Carl Quash III, global insight manager at Euromonitor International,** said: "In the midst of turbulent tariffs and politics, rising producer costs and dynamic consumer habit shifts, the industry continues to realise a rise in value, resulting in a **4.2% growth to reach USD679 billion in retail sales in 2024."**

Savoury snacks lead global consumer preferences, followed by confectionery

In 2024, savoury snacks remained the leading snack category, accounting **for 35% of global value sales,** while confectionery ranked second worldwide. Savoury snacks continue to be a consumer favourite; however, a growing appetite for affordable indulgences is also shaping demand, with confectionery serving as a key outlet for value-conscious consumers seeking small moments of treat-driven snack consumption.



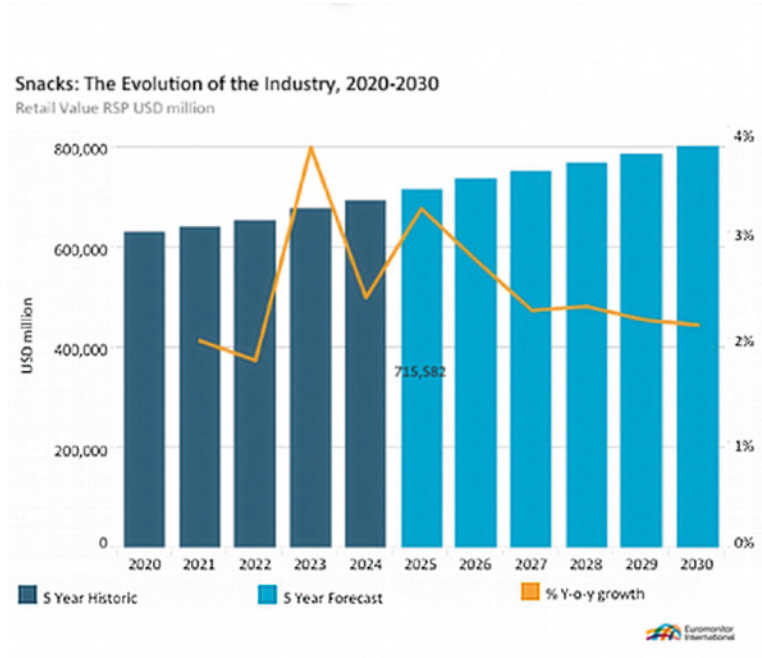


Ice cream experienced the sharpest decline of any snack category, while sweet biscuits, snack bars and fruit snacks remained steady due to offering a stronger balance of perceived affordability and value. These shifts highlight consumers' growing emphasis on cost-effectiveness without compromising enjoyment, suggesting that affordable indulgence will be a key driver of snack choices in the coming years.



Snack brands branch into health and beauty

Snack brands are increasingly extending into the health and beauty sector, using innovation to address consumer wellbeing needs from a fresh perspective. This reflects a broader blurring of category boundaries, where food and personal care intersect to support holistic health.



Notably, **one in three global consumers expect to increase their spending on health and wellness in the year ahead,** creating opportunities for snack brands to position themselves as lifestyle partners rather than just food providers. By leveraging trust, functionality and innovation, these brands can strengthen consumer loyalty while tapping into new growth avenues.

Quash III commented: "The world is undergoing rapid societal shifts that are reshaping consumerism and redefining the standards that make a snack a worthy purchase. To stay relevant, brands must be proactive and agile, continually evolving to meet changing consumer expectations."

euromonitor.com

Global Milk Chocolate Market Expected to Reach USD 87 Billion by 2034

The global milk chocolate market continues to demonstrate steady growth, driven by evolving consumer preferences, ongoing product innovation, and the expansion of digital sales channels. According to the latest market analysis conducted by **IMARC Group**, the sector, valued at USD 67 billion in 2025, is projected to exceed USD 87 billion by 2034, registering a compound annual growth rate (CAGR) of 2.87% during the 2026–2034 period.

Premiumization and Emotional Indulgence Drive Consumption

Milk chocolate remains one of the world's most popular confectionery products due to its strong association with pleasure, indulgence, and emotional comfort. Demand is fueled not only by everyday snacking occasions but also by the important role chocolate plays during holidays, celebrations, and special events. At the same time, consumer interest in premium and artisanal products continues to rise, with increasing demand for high-quality ingredients, innovative recipes, and sophisticated packaging.

Manufacturers are responding to changing market expectations by introducing reduced-sugar formulations, organic ingredients, and raw materials sourced from certified sustainable supply chains. The search for a balance between indulgence and wellness has become one of the industry's key development drivers.

E-commerce and Gifting Support Market Expansion

One of the major growth factors is the increasing use of chocolate as a gift. Milk chocolate is increasingly associated with holidays, personal celebrations, and corporate gifting, thanks to its ability to combine symbolic value, affordability, and customization. Premium packaging, limited-edition collections, and personalized products further enhance the segment's attractiveness.



Additional momentum comes from the rapid expansion of e-commerce. Digital platforms enable consumers to access a broader product range, compare prices, and shop at any time. The growth of online sales is benefiting both large international brands and artisanal producers, allowing them to reach new customer segments through direct-to-consumer business models.

Western Europe Leads While Asia-Pacific Gains Momentum

Western Europe continues to dominate the global milk chocolate market thanks to its long-standing chocolate-making tradition, high per capita consumption, and strong preference for premium, organic, and certified products. Seasonal festivities such as Easter and Christmas remain crucial sales periods. Furthermore, growing consumer attention to sustainability is encouraging the development of products made with ethically sourced cocoa and reduced-sugar formulations.

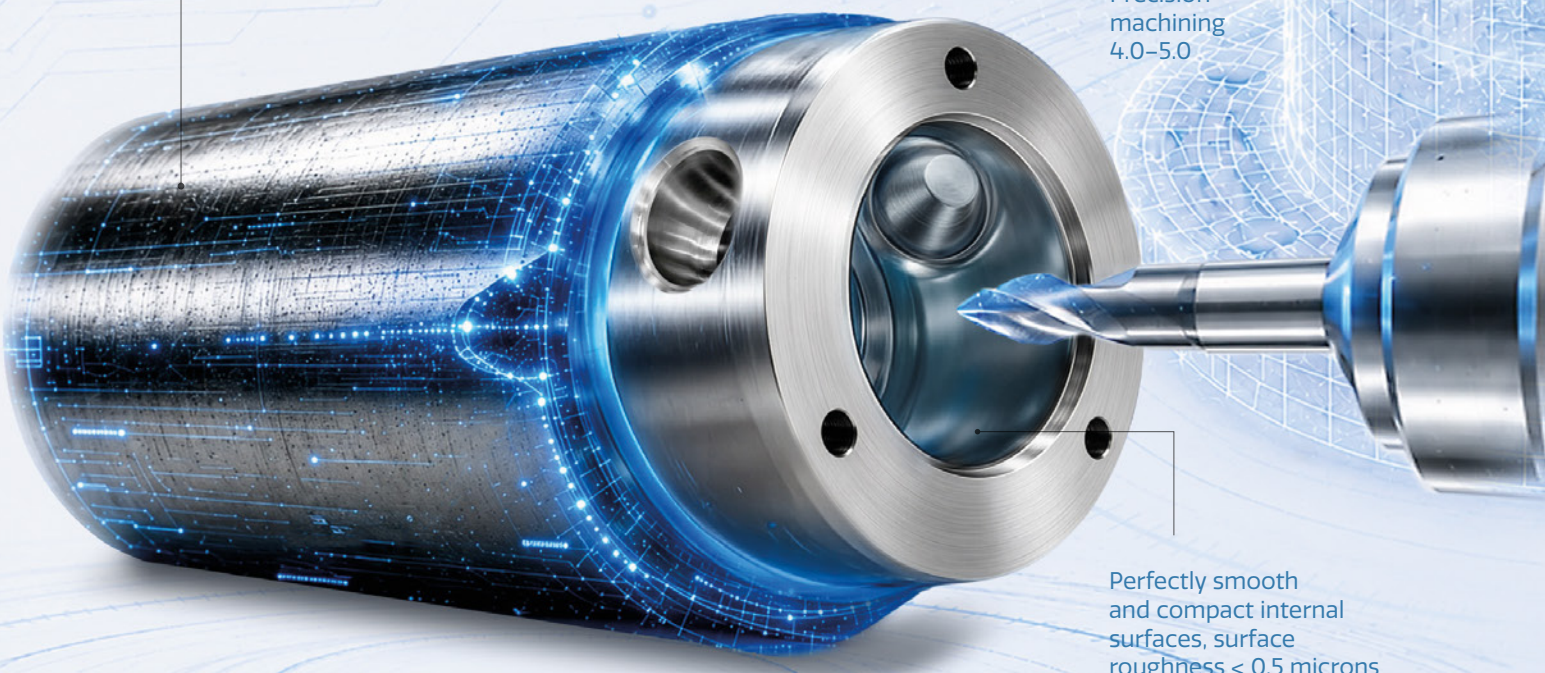
Meanwhile, the Asia-Pacific region is experiencing particularly strong growth, driven by urbanization, rising disposable incomes, and the expansion of the middle class. Markets such as China and India are witnessing increasing westernization of dietary habits, accompanied by growing interest in chocolate as both a snack and a premium indulgence. To address local consumer preferences, manufacturers are introducing regional flavors and customized product formulations.

From a distribution perspective, supermarkets and hypermarkets remain the leading sales channel, accounting for 42% of the market thanks to their broad product assortment, promotional activities, and ability to stimulate impulse purchases. However, the growth of online retail and continuous product innovation are reshaping the competitive landscape, creating new opportunities for both major industry players and specialized manufacturers.

imarcgroup.com

WOLHFARTh®

PUMPS AND FILTERS



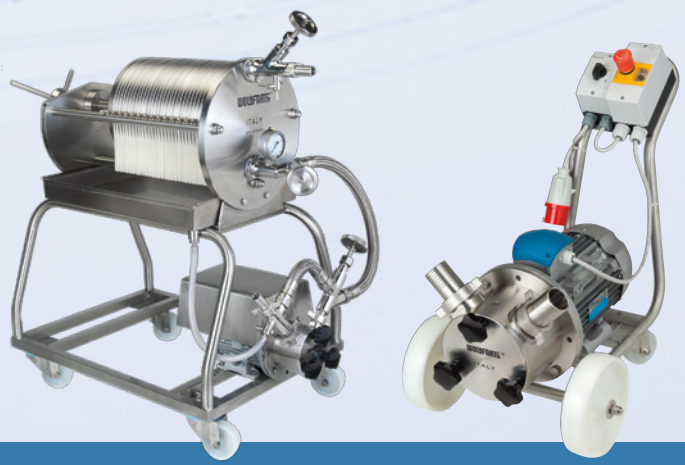
High standards for demanding sectors

Quality of materials

Guaranteed hygiene and durability

CIBUSTEC
27|30 OCT. 2026 | PARMA | ITALY
Hall 3 - Stand E 55

Advanced fluid transfer and filtration technologies from solid stainless steel bars.



BRUNO WOLHFARTH s.r.l. - V. Cavour, 31 - 26858 Sordio (LO) - Italy - Ph. +39 02 9810153 - info@wolhfarth.it - **www.wolhfarth.it**

When digital twins and AI are rethinking food production

The transformation of the food industry is proceeding. Digital twins are developing into the central interface between simulation, automation and data-based production models. Interesting here is that the first approaches are in the meantime also being tried out in food production, thus bringing the interaction between digital processes and precise prediction to an especially dynamic industry. In connection with artificial intelligence and predictive maintenance, models are being created that not only visualise processes but also predict their behaviour and make them systematically optimisable – from planning through commissioning to running operations.

The focus is increasingly shifting to digital twins in the food industry. They provide an answer to the growing complexity of production. "It is gradually becoming less possible to deal with increasing requirements for efficiency, sustainability and product variety separately from one another. Required instead is a pervasive understanding of processes – from development through production to the use of resources", says Roland Thiemann, Director of **Anuga FoodTec**. With this in mind, technology providers like Siemens, ABB or Rockwell Automation combine process design, simulation and plant operation in consistent digital models. "Especially in batch-based processes, as are typical for the food industry, this results in new possibilities for testing production processes virtually and already optimising them prior to real operation", according to Thiemann.

Simulation is shifting commissioning

What is often still perceived purely as an IT theme, is increasingly developing into an operative tool of production – and is shifting the boundaries of what is possible in the context of running operations. Instead of isolated machines, integrated systems result, in which process, quality and operating data flow together. This becomes clear in the system planning and commissioning. The exhibitors of Anuga FoodTec use virtual models to already visualise machines, lines and control systems prior to real installation. The focus is thereby not only on the mechanical layout, but primarily on the interplay of automation, software and process management.

"Control logics, movement sequences and interfaces can be tested under close-to-real conditions and optimised step by step in the digital space. Many work steps that were to date only first possible during commissioning on the shop floor are in this way being shifted into an upstream virtual phase", says Carola K. Herbst, Deputy Managing Director of the Competence Center Agriculture and Food of the German Agricultural Society (DLG.) At the same time, new possibilities are opening up for already preparing operating staff and maintenance teams for real processes and systems in the virtual model.

AI makes digital twins able to act

The extent to which digital twins are currently developing further is shown by the use of AI-supported simulation models. Companies are working together with technology partners on AI agents that link physically exact, real time simulations with artificial intelligence. The goal is to not only visualise production processes virtually, but rather to automatically derive optimisations from this and transfer them to real filling systems.

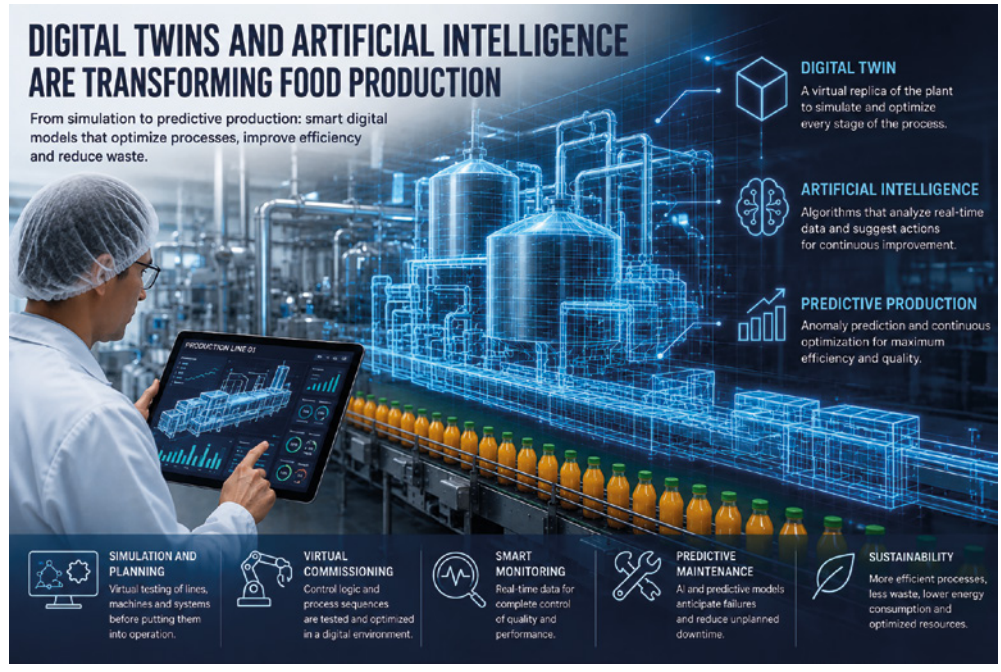
The benefits of such systems become apparent in beverage production, where filling speeds, bottle designs and flow quantities mutually influence one another and continually change the process conditions. Digital twins make it possible to simulate these interactions in real time, to play through various scenarios and directly evaluate the impacts of parameter changes. This applies both to product flows and to cleaning media. This makes it possible to dynamically adapt production processes, use resources more efficiently and improve process stability.

Automation is becoming predictive

Concomitant with this is the continuing development of classic automation systems. While dashboards and control systems long primarily served the visualisation of statuses, the focus is shifting to model-based and predictive systems. The digital twin thereby goes beyond classic monitoring: it links current operation data with simulation and forecast models and dynamically visualises the behaviour of systems and processes. This approach becomes especially clear in predictive maintenance. Through continual evaluation of status data, wear development, deviations in system behaviour or critical process statuses can be identified early on. Artificial intelligence thereby plays a key role: it recognises patterns and anomalies that would hardly be measurable with classic methods and links these with physical models and empirical values. As a result, maintenance measures no longer take place at fixed intervals, but rather on the basis of the actual system condition.

Particularly in complex production environments with many networked aggregates, a transition from reactive process monitoring to predictive and increasingly self-optimising production control takes place. The converging of planning, commissioning and operation makes digital twins a central theme of Anuga FoodTec 2027. They thus become the foundation of a holistic understanding of production – and an important driver of industrial transformation.

anugafoodtec.com



Dairy Processing Technologies: Market Growth Driven by Automation and Sustainability

Milk processing is becoming increasingly technological, automated, and focused on energy efficiency. According to recent market analysis published by **Markets and Markets**, the global dairy processing equipment market is expected to reach US$17.36 billion by 2031, up from an estimated US$12.73 billion in 2026, with a compound annual growth rate (CAGR) of 6.4%.

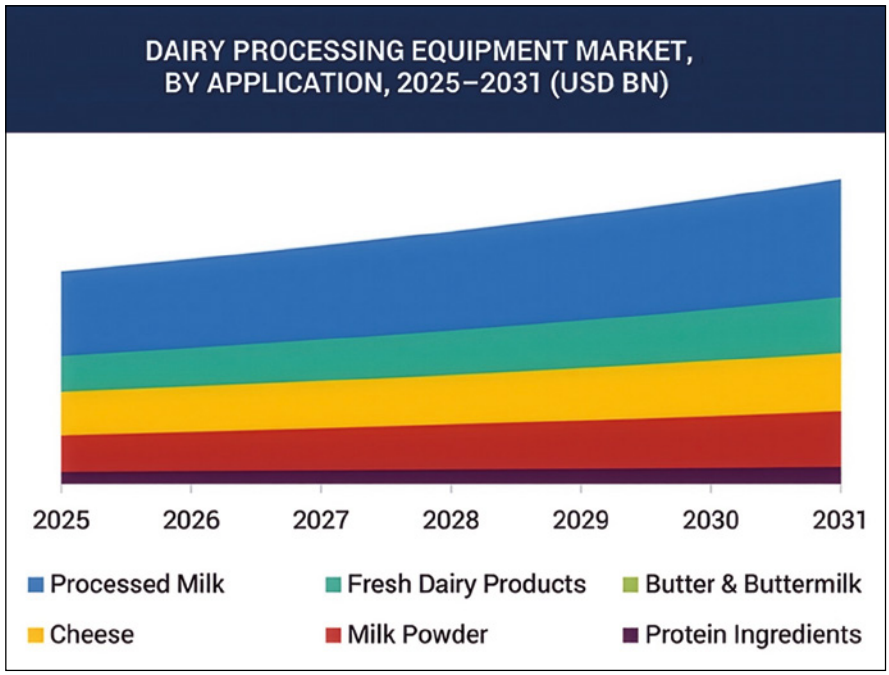
The sector is being primarily driven by the growing worldwide demand for processed dairy products, ranging from milk-based beverages to yogurt, cheese, butter, and milk powder. To meet rising consumption levels and increasingly stringent quality standards, manufacturers are investing in new technologies capable of improving production efficiency, food safety, and product shelf life.



Among the most in-demand solutions are pasteurizers, homogenizers, separators, evaporators, drying systems, and membrane filtration technologies. Pasteurization, in particular, continues to represent the core stage of most dairy processing operations, with pasteurizers currently holding the largest market share within the sector.

Automation and smart dairy plants

One of the most significant trends is the growing adoption of automated plants and digital monitoring systems. Smart technologies enable dairy processors to optimize production parameters, reduce energy consumption, and contain operating costs.



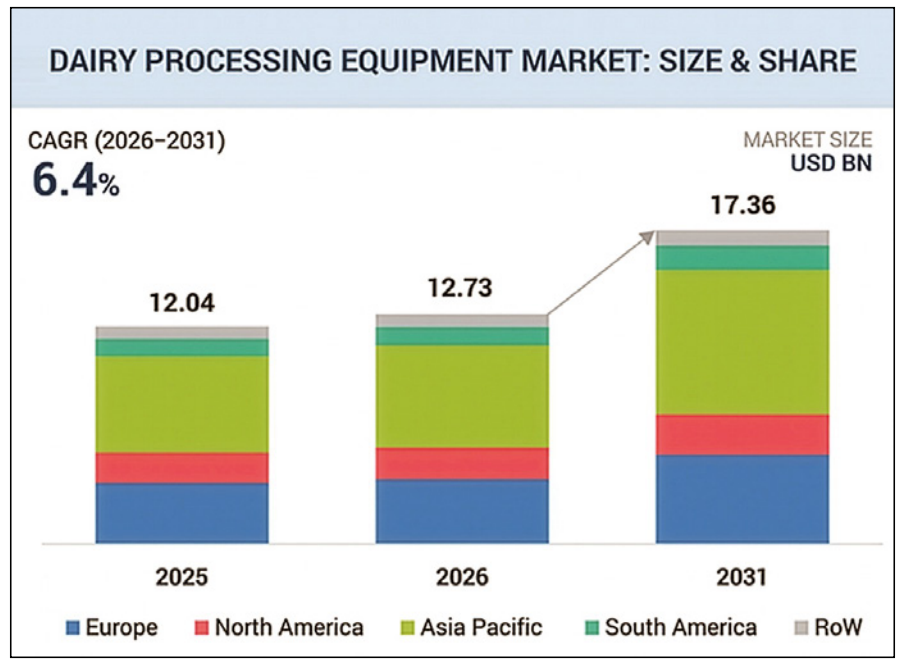
Modern dairy companies are increasingly evolving toward Industry 4.0 models through the integration of IoT, SCADA systems, predictive maintenance, and automated process control.
Strong attention is also being paid to technologies for energy recovery, water recycling, and carbon emission reduction, which have become central themes in the sustainability strategies of the global dairy industry.
At the same time, demand is increasing for modular and customizable systems capable of adapting both to large industrial facilities and to small- and medium-sized dairy operations.

Asia-Pacific driving market expansion

From a geographical perspective, Asia-Pacific represents the most dynamic market area and already accounts for more than 44% of the global market share. China and India are experiencing strong growth in milk processing capacity, supported by rising dairy production and increasing demand for packaged and value-added dairy products.
In these markets, companies are making major investments in advanced technologies for the production of processed milk, yogurt, cheese, and milk powder, with particular attention to automated systems and cold chain infrastructure.

Food safety and high-value dairy ingredients

Another factor supporting market growth is the increasing demand for functional dairy ingredients, such as whey proteins, casein, and milk powder intended for the food, nutraceutical, and infant nutrition industries.
Demand for high-protein and long shelf-life products is accelerating investments in evaporation, drying, and advanced filtration systems.
At the same time, the industry must comply with increasingly strict regulations regarding food safety, hygiene, and traceability, pushing manufacturers toward technologically advanced and easily sanitizable equipment.
marketsandmarkets.com



90% fewer mechanical parts and drives, less operational complexity

LMR chocolate moulding line, already patented in the USA

A 90% reduction in mechanical parts, drives, and synchronization systems is not a minor technical detail.

It's the difference between traditional moulding systems and a technical and technological evolution that combines multiple advantages at once – from cleanability to recipe changeovers to flexibility.

This is the practical outcome that gave rise to LMR, the Robotic Molding Line for chocolate developed by **Tecno 3**, now already patented in the United States.

The principle is simple to state, far harder to achieve: replace complex mechanics and drive systems with anthropomorphic robots that manage the entire molding cycle automatically and continuously, adapting to the type of product being processed.



LMR, the Robotic Molding Line for chocolate (Tecno 3).

The results come down to three concrete points:

- Fewer mechanical components, synchronizations, and drives. Over 90% fewer than traditional lines. Fewer parts mean less wear, less scheduled maintenance, and less unplanned downtime.
- Suspended architecture. Cleaning and access without endless disassembly. For food production managers, this translates into shorter cleaning and recipe-changeover times and easier compliance.
- Custom configurations. Optimized use of space and the ability to produce multiple product types – even simultaneously – keeping pace with a faster-moving market, unlike lines designed for a single format.

The U.S. patent doesn't certify an idea. It certifies a process already validated by partners using it in production every day.

For anyone evaluating an investment in new molding lines, the question isn't whether traditional mechanics still work. It's how much it costs, every single day, to keep running them.

(Tecno 3 - Via Mastri Cestai 2 - 12040 Corneliano d'Alba - CN - Italy - Tel. +39 0173 610564 - email: a.mattis@tecno-3.it - tecno-3.it)

IFP PACKAGING

THE GLOBAL SHRINK FORCE

Where unmatched power meets
worldwide reliability



DIAMOND 500 BM + TF 40 20
State-of-the-art shrink
packaging technology

IP67
Stainless steel
automatic plant



TECNOPACK GROUP

Via Lago di Albano, 70 - 36015 Schio (VI) Italy
sales@ifppackaging.it - www.ifppackaging.it
+39 0445 605 772

Accumulation Systems: where line performance is really decided

In modern packaging lines, performance is often measured in speed. Higher outputs, faster machines, tighter cycles. Yet, in real production environments, efficiency is rarely limited by speed alone.

What truly defines the performance of a line is its ability to remain stable over time.

Even the most advanced machines cannot prevent micro-stops, small slowdowns or temporary imbalances between upstream and downstream sections. These events are unavoidable. What makes the difference is how the line reacts to them. This is where accumulation systems become a decisive factor.

At **MH Material Handling**, accumulation is not considered a secondary element, but a core design lever. Buffers are the point where variability is absorbed and controlled, preventing disturbances from spreading across the entire line.

Without accumulation, a downstream stop immediately propagates upstream, forcing the entire system to slow down or stop. With a properly designed buffer, that same event becomes manageable: production continues, interruptions are contained, and the line maintains its continuity. In other words, accumulation does not increase theoretical performance: it protects real performance.



The BAT Buffer (M.H. Material Handling).

Today, this role is becoming even more critical. Production environments are evolving: higher speeds, more product variations, increasing attention to hygiene and traceability, and often limited space in existing plants. These factors make it impossible to rely on a single standard solution.

Choosing the right accumulation system requires a comprehensive analysis of the application. Product characteristics, resistance to pressure, required flow logic (FIFO or LIFO), available layout space and line dynamics must all be considered together.

In high-speed lines, compact LIFO systems allow large storage capacities within reduced footprints. In applications where product integrity and sequence must be preserved, FIFO solutions ensure full control of the flow. Multi-level and vertical systems offer effective alternatives where space becomes a constraint.

However, the real difference does not lie in the individual technology, but in how accumulation is distributed and integrated within the line. A single centralized buffer is not always the most effective solution. In many cases, multiple accumulation points, strategically positioned, allow better management of variations and significantly improve overall stability.

At the same time, correct sizing is essential. An undersized buffer quickly loses its effectiveness, while an oversized one may introduce unnecessary complexity. The goal is not maximum capacity, but the right balance between flexibil-

ity and control. This is why accumulation shouldn't be treated just as an addition to an existing line.

When introduced after the design phase, systems are often forced into limited spaces, leading to compromises in performance and integration. When planned from the beginning, instead, accumulation becomes a structural element that shapes the entire line behaviour.

And in a context where efficiency is no longer defined by peak speed but by consistency over time, accumulation systems are no longer just supporting components, they are where real performance is decided.

(M.H. Material Handling - Via G. Di Vittorio, 3 - 20826 Misinto - MB - Italy - Tel. +39 0296720176 - email: info@mhmaterialhandling.com - mhmaterialhandling.com)

Perfect Creamy Soups with Fristam Technology

In the food industry, transforming heterogeneous products like chunky vegetable soups into silky creams represents a complex technological challenge. **Fristam Pumpen** high-shear mixers are at the forefront of this sector, guaranteeing process time reductions of up to 90%.

The Core of the Technology: Rotor/Stator

Once inside the mixer, the product is pushed outward by centrifugal force, passing through minute gaps between the rotor (moving part) and the stator (fixed part). Here, solids undergo intense mechanical and hydraulic shear action, being expelled through the head at high speed. This continuous cycle ensures that 100% of the product is processed.

Case Study: From Chunky Vegetables to Velvety Creams

Preparing a creamy soup starting from a minestrone requires more than simple mixing; it demands true disintegration of solids. Different Fristam Pumpen rotor/stator combinations act on the toughest vegetable fibers (such as celery, leeks, or legume skins), breaking them down completely.

Practical Application Results:

Absolute Homogeneity: Thanks to the forced passage through the gaps, every single piece of vegetable is reduced to an extremely fine particle size. The result is a silky texture that eliminates the need for subsequent processing steps, reducing raw material waste.

Color and Flavor Stability: The absence of aeration during the process protects the product from oxidation. Vegetable colors remain vivid and natural flavors are not altered, keeping organoleptic properties intact.

Drastic Time Reduction: Moving from a chunky soup to a cream ready for packaging takes a fraction of the time compared to traditional cutters or standard immersion systems. The process speed allows for continuous treatment of large volumes, optimizing production lines.

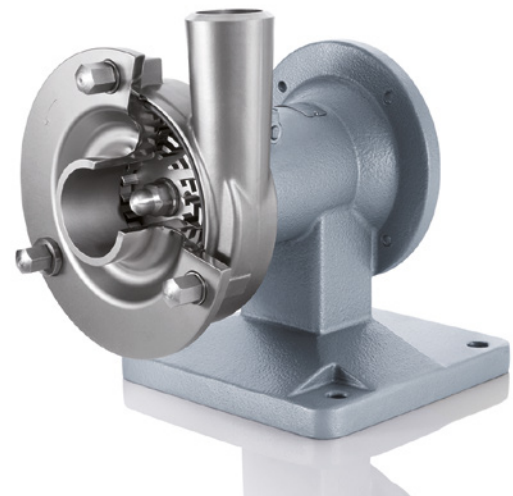
Elimination of Lumps and Agglomerates: Even when thickeners or starches are added to adjust density, the Fristam mixer ensures instantaneous dispersion, eliminating any risk of lumps in the final product.

"Plug & Play" Versatility

An operator can switch from producing a rustic soup to a fine gourmet cream simply by using a different rotor/stator combination, which can be replaced in just a few minutes. This versatility makes Fristam In-Line mixers an indispensable tool for companies needing to respond quickly to diverse market demands with a single system.

www.fristam.de

(Fristam Pumpen - Kurt-A.-Körber-Chaussee 55 - 21033 Hamburg - Germany - Tel. +39 011 4500087 - email: sales@fristam.it - fristam.com)



High Shear mixer mod. FSP (Fristam).

Join Megadyne at Cibustec to Explore High-Performance VFFS Packaging Solutions

In food production, packaging plays a critical role in preserving product freshness, ensuring safety, and maintaining quality standards. To meet these demands, manufacturers rely on packaging equipment that can operate with speed, precision, and consistency.

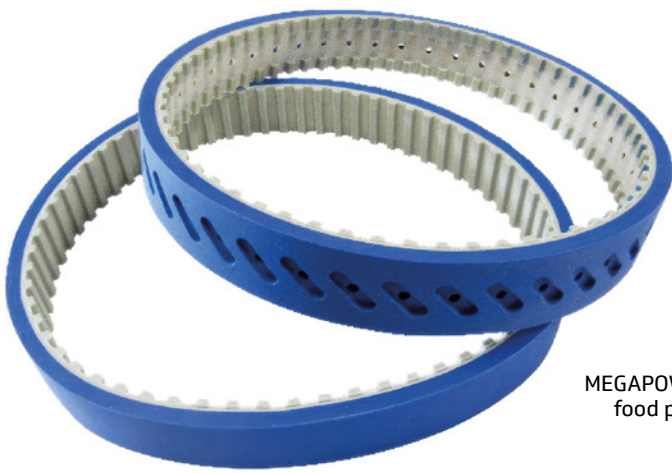
Among the most widely used solutions are **Vertical Form Fill Seal (VFFS) machines**, which support the forming, filling, and sealing of packaging. The efficiency of these systems depends heavily on the performance of the timing belts responsible for transmitting power and controlling product movement throughout the process.

Megadyne's Pull Down synchronous belts have been specifically engineered to support these demanding applications. Used across several industries, including food and chemical processing, they are particularly effective in packaging products such as confectionery, chips, tea, coffee, biscuits, and pasta.

Designed to deliver **reliable performance** over time, these belts offer uniform wear, helping maintain consistent operation throughout their service life. Their durable coatings provide constant friction while extending belt longevity, and their **high abrasion resistance** further contributes to reduced maintenance requirements. In addition, precision machining of holes, grooves, and profiles with reduced tolerances ensures optimal performance within production lines.

According to Roberto Ala, Packaging Industry Segment Manager at Megadyne: *"The key feature of Megadyne's Pull Down synchronous belts is their unmatched ability to maintain constant speed and continuous vacuum between the belts and the packaging film. This allows precise and efficient product movement, which is critical in food production lines where every machine stop causes delays and waste."*

He further explains: *"Megadyne's wide range of engineered belts includes rubber and polyurethane models to suit the various needs of food packaging. In addition, their continuous and uniform coatings, designed for high abrasion resistance, also offer high wear resistance, ensuring a longer belt lifespan."*



MEGAPOWER Silcoat belt for food packaging machines (Megadyne).

MEGAPOWER Silcoat: Advanced Belt Technology for Food Packaging

A standout solution within Megadyne's packaging portfolio is the **MEGAPOWER Silcoat**, developed using an **innovative cast technology** process.

Unlike conventional belt manufacturing methods, where the silicone cover is applied in a separate production phase, the silicone coating in MEGAPOWER Silcoat is moulded directly during belt production. This integrated manufacturing process provides **exceptional resistance to delamination**.

The result is a highly reliable belt capable of delivering performance levels beyond those of conventional solutions, helping manufacturers maximise machine uptime and production efficiency.

The silicone coating has been specifically designed for VFFS applications. It combines **excellent abrasion resistance** with a firm grip on packaging

films while **preventing damage to the material**. The belt also maintains consistent performance in humid environments and across a wide temperature range. Furthermore, its **blue food-grade certified coating** supports hygiene and safety requirements commonly found in food production facilities.

To accommodate different operational requirements, MEGAPOWER Silcoat is available in two versions:

- A standard, non-reworked (*glossy*) version for applications that do not require extreme performance levels.
- A high-performance (*grinded*) version that can be customised with holes, slots, rough surfaces, and vacuum features to match specific production line needs.

Heading to Cibustec 2026?

Visit Megadyne in **Hall 2, Stand N025**, in Parma, and discover how MEGAPOWER Silcoat can help maximise uptime, improve packaging reliability, and support efficient VFFS operations.

Our team will be on hand to discuss your application challenges and the latest innovations in food packaging solutions.

(Ammega Italia - Via S. Lucia 114 - 10075 Mathi - TO - Italy - Tel +39 011 9268052 - email: info@megadynegroup.com - info@ammeraalbeltech.it - ammega.com)

When innovation inspires imitation
Competition as a driving force

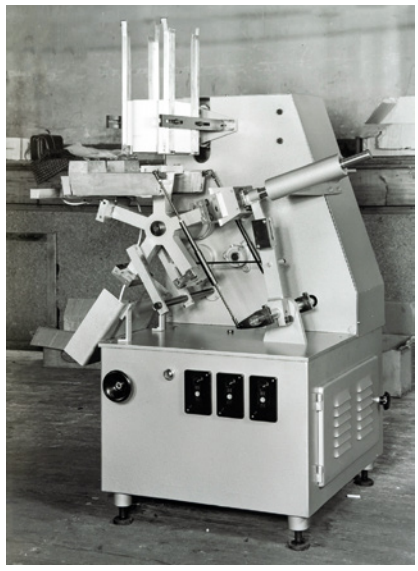
Anyone who sets standards must be prepared for two things: first, that others will follow suit; and second, that the bar must constantly be raised. At Schubert, standing still remains a foreign concept to this day. Consequently, new innovations from Crailsheim have consistently shaped the industry. This stems from the conviction that healthy competition spurs peak performance.

Examining machines closely has long since become second nature at trade fairs, and with it comes the occasional ban on photography. However, to describe both as absolutely essential would be an exaggeration. At least, this is the case if one views the coexistence of technologies as an opportunity rather than a threat.

In Crailsheim, this attitude is a tradition. **Gerhard Schubert GmbH** has continuously refined its own developments since 1966 precisely because of the intense competitive pressure. The company has always viewed this as an incentive rather than a risk. Against this backdrop, it goes without saying that neither copying nor secrecy form part of the packaging machinery manufacturer's strategy.

However, openness does not mean revealing every technical detail: patents, intellectual property rights and confidential design details remain important. The key is to secure a competitive edge through continuous development.

In this regard, the company has often been a pioneer of technologies that are now standard features in packaging systems. Key innovations, such as hot-melt gluing units in carton erecting machines, pick-and-place robots for packaging individual items and image-processing systems for quality control, all originate



The SKA and similar machines were often imitated, showing that these developments captured the spirit of the times.



The pick-and-place robots that are so widely used today can be traced back to the early ideas of Gerhard Schubert.

from Crailsheim. This is simply because the company recognised the need early on and implemented possible solutions pragmatically. Drawing on Schubert robots, products from other manufacturers now make packaging machines worldwide faster, more precise and more flexible. Rather than being driven by protectionism, the creators of the technology have always had confidence in their approach: after all, being copied usually means you are on the right track.

Instead of keeping competitors at arm's length, the company prefers to focus on cooperation. Through licence agreements, selected competitors can incorporate solutions such as the counterflow principle, which was patented in 1996 and expired in 2016, into their machines.

Legal action cannot be entirely ruled out, particularly in the case of patented technologies where there is no licence agreement governing their use. However, for the Crailsheim-based innovator, technological leadership is far more important than warning letters.

The company's founder, Gerhard Schubert, is credited with the saying: "If our competitors stop copying us, we've done something wrong. What matters is that we're always a step ahead in technical terms". This conviction remains true to this day: competition and imitation are both necessary. Without them, progress lacks momentum.

(Gerhard Schubert - Industriegebiet Südost - Hofäckerstraße 7 - 74564 Crailsheim - Stuttgart - Tel. +49 7951400-0 - email: info@gerhard-schubert.de - schubert.group)



Although patents have shaped Schubert's history of development, they have never simply become a "defence mechanism".

MEGADYNE

MEGAPOWER Silcoat



The perfect mix of innovation and performance by Megadyne



MEGAPOWER Silcoat is designed transform the food packaging ind

This belt offers **unparalleled resistance to delamination** and **superior perfomance -** a clear advantage for manufacturers looking to maximise reliability and production uptime.

MEGAPOWER Silcoat is perfectly suited for VFFS (Vertical Form Fill Seal) applications: it offers outstanding abrasion resistance, excellent grip on packaging film without causing damage, and reliable performance even at extreme temperatures or in humid environments.

Join us at CIBUSTEC 27|30 OCT. 2026 | PARMA | ITALY

Meet our team at **Hall 2 | Booth N025.**

The local partner of choice for sustainable power transmission belting solutions around the globe.

Discover Your Local Contacts

Megadyne
Via Trieste, 16
Via S. Lucia 114 - 10075 Mathi
(Torino)
Italy

Scan the QR code and find your local contact

A comparison between microwave and conventional baking on bread quality

A French study examines the effects of baking conditions, specifically microwave and conventional methods at varying heating rates, on bread crumb microstructure, starch behaviour, texture, water mobility, and staling kinetics.

Environmental scanning electron microscopy (ESEM) revealed significant structural differences between microwave- and conventionally baked bread. Microwave baking caused incomplete starch disintegration and heterogeneous structures, with higher heating rates resulting in severe granule disruption. Starch retrogradation and amylose recrystallization during storage were accelerated in microwave-baked crumbs, particularly at higher heating rates, leading to increased firmness over time. These changes were linked to water migration and the formation of crystalline starch structures. Texture analysis showed that microwave baking increased crumb firmness more rapidly compared to conventional methods, attributed to greater water loss and stronger starch-protein interactions. Molecular water mobility, measured using T2 relaxation times, demonstrated significant dehydration of gluten and water migration from gluten to starch during microwave baking. Higher heating rates reduced water mobility, forming rigid starch networks that trapped bound water. Desorption isotherms highlighted differences in water retention and molecular structure, with microwave-baked crumbs exhibiting more porous matrices and less



bound water compared to conventionally baked crumbs.

The findings, published in **Journal of Food Engineering**, underscore the impact of microwave heating rates on bread quality, with implications for optimizing baking conditions. Microwave baking accelerates starch gelatinization, amylose crystallization, and staling but alters water distribution, texture, and microstructure differently than conventional baking. These insights are essential for achieving desired bread quality while balancing texture, structure, and moisture retention.

High pressure processing *vs* thermal pasteurization in oat milk

A Chinese study compared the multifaceted characteristics of oat milk treated by high pressure processing (HPP) and thermal pasteurization. Structural characteristics were assessed using scanning electron microscopy (SEM), laser diffraction particle size analysis, X-ray diffractometry (XRD), and Fourier-transform infrared spectroscopy (FTIR). SEM analysis revealed slight granule swelling in samples treated with HPP while maintaining intact granular morphology. HPP treatment induced a significant increase in zeta potential absolute values ($p < 0.05$) and enhanced relative crystallinity from 23.26 % to 33.69 %. Notably, XRD patterns indicated a crystalline structure transition from A-type to V-type polymorphism compared to control (CK) samples.

These structural modifications correlated with reduced starch hydrolysis rates. Concurrently, HPP processing elevated resistant starch (RS) content from 19.57 % to 37.41 % through starch retrogradation mediated recrystallization.

This investigation, published in **LWT – Food Science and Technology** journal, provided novel theoretical and technical insights for engineering nutritionally optimized oat milk products.

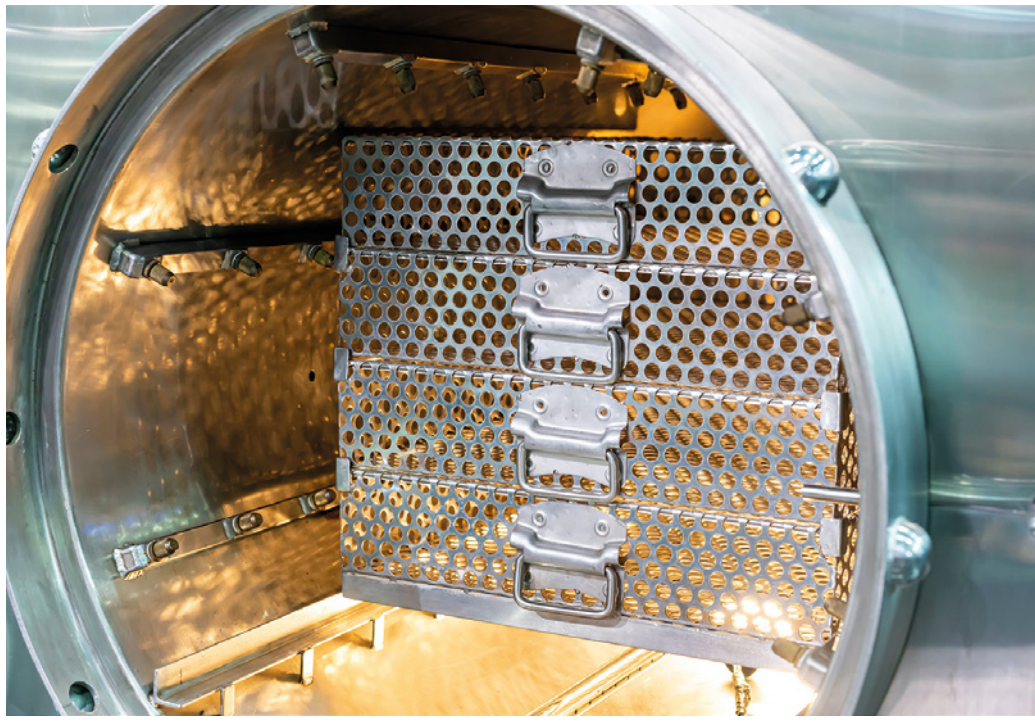


Innovative infrared autoclaves for more sustainable production

A Korean study published in **Journal of Food Process Engineering** aims to reduce energy consumption and processing time in the canning process by employing an alternative sustainable heating approach.

A pilot-scale retort powered by an infrared-heating steam generator (RIR) equipped with the Internet of Things (IoT) was developed, followed by verification for the fish can sterilization process at various times (10-20 min), temperatures (110°C-121°C), and input powers (1.7-2.7 kW). The system's thermal performance and steam's physicochemical properties were analyzed and compared with conventional retorting (CR), followed by process prediction by an adaptive neuro-fuzzy inference system (ANFIS). According to the results, specific energy consumption (SEC) for steam generation by RIR and CR was 14,544 and 21,429 kJ/kg, indicating a substantial enhancement in energy utilization efficiency (> 32%). At 2.7 kW, RIR was superior to CR with 22% higher steam generation efficiency (66.93% vs. 54.92%), 30% faster heating rate (2.92°C/min vs. 2.25°C/min), and 38% shorter time for delivering 116°C steam (20.01 vs. 32.20 min). Increasing power enhanced steam electrical conductivity and productivity. Longer sterilization time and higher temperatures enhanced cumulative lethality, with a maximum value of 26.39 and 17.26 min for RIR and CR, respectively. The optimal RIR temperature and time to achieve the highest sterilization degree with reduced consumed energy were 116°C and 15 min. The come-up time for the can's cold point was 21 min in RIR, about 48% of CR.

The proposed RIR system can contribute to sustainable canned food production by increasing process efficiency (66.93%), reducing operation costs (17.58%), and reducing greenhouse gas emissions (17.60%) while enhancing product quality and safety through process innovation.



Comparison of HTST and UV-C treatments on the quality attributes of milk

Ultraviolet (UV-C) treatment is a proposed alternative to conventional high temperature-short time (HTST) processes for milk pasteurization. However, little information is available on its impact on the chemical composition of milk, as well as a comparison with HTST treatment. Consequently, the aim of this Canadian study was to compare the effects of HTST (72°C, 16 s) and UV-C (coil diameters of 5- and 7-mm, 1 or 2 passes) with turbulent flow on the proximate composition, protein profiles and surface properties, as well as off-flavor development in whole milk (WM), skim milk (SM), skim milk generated from whole milk (SM_{WM}), and whey protein concentrate (WPC).



The results on proximate composition showed that only the UV-C treatment with 2 passes using a 7-mm coil resulted in lower lipid content in SM_{WM} compared to HTST. Protein profiles, free thiol content, surface hydrophobicity, and aromatic amino acid levels remained similar between the control, HTST and UV-C treated samples. However, higher alcohol levels were detected in HTST-treated samples, while UV-C-treated dairy fluids had increased levels of free fatty acids and ketones. In addition, hexanal concentration increased only after HTST treatment of WM.

This study, published in **International Dairy Journal**, highlights the potential of UV-C treatment in the dairy industry, demonstrating its ability to preserve nutritional quality while also offering valuable insights into lipid oxidation and the formation of light-induced off-flavor compounds.

Ultrasound-assisted Fermentation of Ricotta Cheese

A Brazilian study published in **Food and Bioprocess Technology** journal investigated the technological potential of ultrasound (US) application during milk fermentation with autochthonous lactic acid bacteria (LAB) (*Lactococcus lactis* AQLM2 and *Lacticaseibacillus rhamnosus* 6QLR4) and evaluated its effects on the development of value-added ricotta cheese by analyzing volatile compounds in both fermented milk and ricotta. In addition, the physicochemical, microbiological, and sensory attributes of the final product were assessed.

US treatment on fermented milk was evaluated through viable cell counts and volatile compound profiling following sonication at 25 kHz and 150 W for 0, 5, 10, and 15 min. Principal component analysis (PCA) indicated that 10 min of US treatment enhanced the production of volatile compounds such as ketones, aldehydes, and carboxylic acids, reflecting increased metabolic activity of *Lcb. rhamnosus* 6QLR4 and *Lc. lactis* AQLM2. The major aromatic compounds identified in the fermented milk were ethanoic acid (acetic acid), butane-2,3-dione (diacetyl), and 3-hydroxybutan-2-one (acetoin).



Ricotta samples were produced in triplicate under the following conditions: C (control, no LAB), WM (with *Lc. lactis* AQLM2 and *Lcb. rhamnosus* 6QLR4), and WM-U (same LAB strains, pretreated with US for 10 min). Ricottas produced with LAB (WM and WM-U) showed aromatic profiles distinct from the control (C). Although the ricotta samples exhibited different volatile compound profiles, minimal differences were detected in the sensory attributes assessment, likely due to the limited diversity of compounds in ricotta and the use of untrained panelists. Nevertheless, the WM-U sample showed a higher purchase intention.

While US treatment of LAB did not enhance the ricotta's sensory attributes in this study, the use of these microorganisms improved its aromatic profile, offering a promising biotechnological strategy to enhance the sensory characteristics of fermented dairy products.

Flash freezing of ice cream with dense phase carbon dioxide

A novel supercritical CO_2-based flash freezing system was developed and evaluated by US Researchers as an innovative, efficient, and on-demand solution for place-of-use flash freezing of liquids, specifically for clean label ice cream production. This technology addresses the limitations of conventional systems, including the use of hazardous refrigerants, complex mechanical components, and high energy consumption.

The study, published in **Journal of Food Engineering**, examined the pivotal role of nozzle design in generating vacuum via the Bernoulli principle, enabling the entrainment of viscous ice cream mix into the Joule-Thomson-induced cooling stream. Flash-frozen clean label ice cream produced using this system exhibited a lower overrun (15.3%) compared to commercial premium ice cream (26.3%) and a higher melting rate (0.6 g/min vs. 0.4 g/min) at a similar draw temperature of approximately -10°C, attributed to differences in ice crystal size and overrun. Additionally, initial mix temperature and viscosity were inversely related to both ice cream production rate and system freezing efficiency. Compared to conventional mechanical refrigeration, the flash freezing unit demonstrated a 65-223% higher coefficient of performance, 20.6% lower energy consumption, and a 24.8% reduction in carbon footprint.



Innovation Is Essential to Keep Pace with Global Packaging Regulations

The rapid evolution of packaging regulations worldwide is creating significant challenges for packaging manufacturers and food and beverage companies. Driven primarily by environmental concerns and the need to accelerate the transition towards more sustainable packaging systems, the new regulatory framework is forcing companies to adapt their strategies, materials and production technologies. According to **GlobalData** innovation will be essential for remaining competitive as important regulatory deadlines, particularly in the European Union, draw closer.

Measures such as the EU Packaging and Packaging Waste Regulation (PPWR), together with national initiatives introduced or planned in countries including Canada, Mexico, China and Indonesia, demonstrate that packaging sustainability is becoming a global priority. Extended Producer Responsibility (EPR) legislation and Deposit Return Schemes (DRS) are particularly important, as they require manufacturers to rethink packaging materials and design while developing increasingly sophisticated systems for collecting and managing compliance data.

Sustainability Pressure Drives Packaging Innovation

Environmental concerns surrounding packaging waste are generating increasing pressure from consumers, brands, governments, NGOs and the media. As a result, sustainability is no longer considered an additional packaging attribute but is becoming a fundamental design requirement alongside protection, functionality, convenience and product preservation.

Regulations are encouraging manufacturers to adopt circular economy principles throughout the packaging value chain. One of the most immediate priorities is compliance with recycled-content targets. In the United Kingdom, for example, plastic packaging containing less than 30% recycled material is subject to the Plastic Packaging Tax. This creates an incentive for manufacturers to secure reliable sources of recycled raw materials and, where feasible, develop closed-loop systems capable of providing greater transparency, traceability and quality control.

Reuse and refill requirements will also have significant consequences for production lines and packag-



ing portfolios. At the same time, redesign is becoming increasingly important. Difficult-to-recycle multi-material structures are progressively being replaced by mono-material alternatives, while design-for-disassembly concepts can facilitate material separation, increase recovery rates and improve the quality of secondary raw materials.

New Materials and Digital Compliance

Material substitution represents another major field of innovation. Regulatory pressure to reduce conventional plastics is stimulating research into bio-derived polymers as well as paper- and board-based solutions. New barrier coatings and films can potentially extend the use of fibre-based packaging to applications traditionally dominated by plastics while improving recyclability.

Digitalization will play an equally important role. Packaging regulations are expected to require increasingly standardized information both on the package and through digitally traceable systems, strengthening transparency and accountability throughout the supply chain. Labels and digital identification technologies are therefore becoming essential tools for demonstrating regulatory compliance.

Production processes themselves are also under scrutiny. Packaging manufacturers must improve the efficiency with which they use water, natural gas and electricity. This is particularly relevant for materials such as glass and aluminium, whose manufacturing and recycling processes can be highly energy intensive. Consequently, innovation in processing and recycling equipment will be necessary alongside innovation in packaging materials.



EPR schemes create an additional challenge because manufacturers must manage increasingly complex reporting obligations while absorbing or transferring additional compliance costs. Reducing packaging weight, simplifying structures and optimizing material consumption can help contain these expenses. However, regulatory requirements differ considerably among countries, making a single global packaging strategy increasingly difficult to implement.

Brands Prepare for Future Regulatory Targets

Several major brands are already adapting their packaging ahead of upcoming legislation. In preparation for the UK Deposit Return Scheme scheduled for October 2027, beverage companies have started modifying labels and barcodes to ensure compatibility with reverse vending systems. Suntory and PepsiCo, for example, have worked on barcode redesigns following UK technical specifications intended to support deposit identification and reduce fraudulent refund claims.

Evian has pursued a different approach by expanding its development of label-free bottles made entirely from recycled PET and using embossed branding instead of conventional labels. Eliminating the label helps maintain a mono-material structure and facilitates recycling.

Packaging manufacturers are also integrating circularity more deeply into their long-term strategies. Companies including Tetra Pak, Elopak and SIG are developing solutions based on plant-derived polymers, lower-carbon materials and aluminium-free aseptic carton technologies.

According to GlobalData, sustainability regulations should therefore be regarded not simply as compliance obligations but as drivers of technological development. Consumer expectations reinforce this trend, with almost 80% of consumers globally reportedly stating that they already use or would be willing to use local deposit return systems. However, sustainable packaging solutions must remain economically viable and continue to deliver the functional benefits expected from the packaged product.

For packaging producers and user industries, circular economy strategies are consequently becoming an integral part of business planning. Companies capable of anticipating regulatory requirements through material innovation, packaging redesign, digital traceability and more resource-efficient production will be better positioned to control compliance costs and maintain competitiveness as global packaging legislation becomes increasingly demanding.

globaldata.com

Packaging and Processing: Global Markets Accelerate Towards Automation and Advanced Materials

According to the latest analyses from the **Ipack-Ima** Monitor, the global market for packaging, processing and materials technologies continues to show a stable growth trajectory, driven by the expansion of global consumption, industrial automation and the increasing demand for efficient and sustainable solutions. In 2025, the combined value of the three sectors is expected to reach €222.9 billion and, with a CAGR of +2.7% between 2025 and 2029, is forecast to grow to €247.9 billion by 2029.

The packaging machinery segment remains one of the key drivers of the entire industrial ecosystem. Estimates indicate growth from €57.4 billion in 2025 to €64.6 billion in 2029, with an average annual growth rate of +3.0%. At the same time, the food and beverage processing machinery sector is expected to reach €82.7 billion by 2029, compared with an estimated €72.6 billion in 2025. The packaging materials sector also confirms positive development, increasing from €92.9 billion to €100.6 billion over the same period.

Asia Leads Global Growth

From a geographical perspective, Asia continues to be the main engine of industrial development in packaging and processing. In the packaging machinery sector, the region accounts for 37.1% of the global market in 2025 and records a 2025-2029 CAGR of +3.6%, outperforming both North America and Europe.

The largest markets in absolute terms remain the United States, China and Japan, while the strongest growth dynamics are emerging in economies such as Argentina (+5.6%), South Korea (+5.2%) and Pakistan (+5.0%). This trend highlights the progressive geographical redistribution of technological demand, with emerging markets playing an increasingly central role.

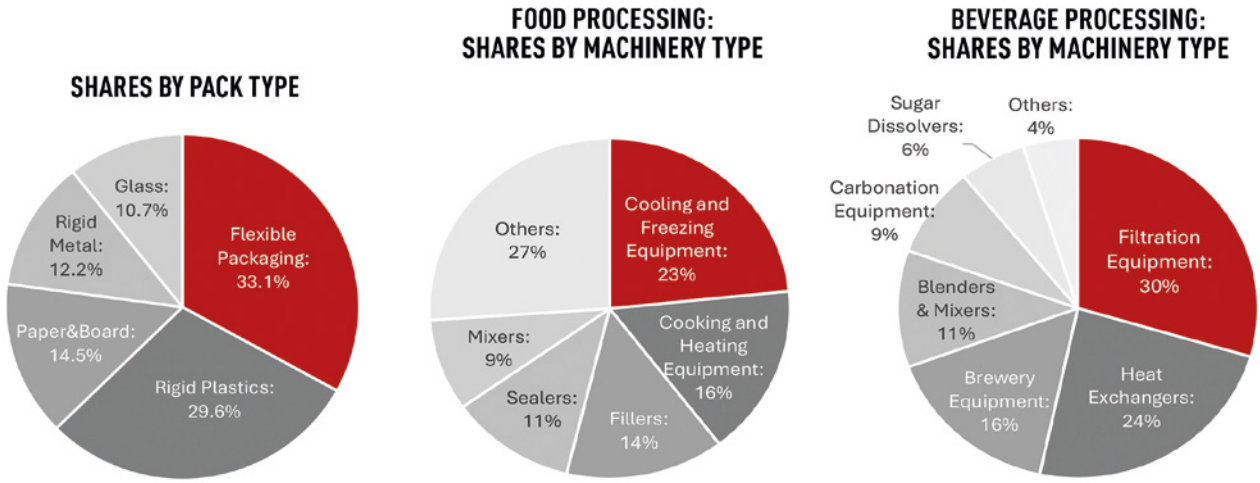
Asia also leads growth in packaging materials, with a CAGR of +3.2%, mainly driven by the expansion of flexible packaging, which in the region is expected to achieve growth rates of +4.4%.

Flexible Packaging and Metal Containers Drive Materials Growth

Among packaging materials, flexible packaging continues to dominate in terms of volumes, increasing from 1.5 trillion units in 2025 to 1.6 trillion units in 2029, with a CAGR of +3.2%. Rigid plastics are expected to grow more moderately (+2.4%), while rigid metal packaging records the highest growth rate (+3.5%), reflecting renewed interest in solutions offering high mechanical performance and superior barrier properties.

In contrast, paper & board and glass show more limited growth, with increases close to or below 1%, indicating a mature phase for these markets. Within the global materials mix, flexible packaging represents 33.1% of the total, followed by rigid plastics (29.6%), paper & board (14.5%), metal containers (12.2%) and glass (10.7%).

In the non-alcoholic Liquid Food & Beverage sector, rigid plastics remain dominant, with around 909 billion units in 2025, more than 70% of which are used



in beverages. However, flexible packaging shows the most dynamic growth, with a CAGR of +3.9%.

Automation and Digitalisation at the Core of Processing

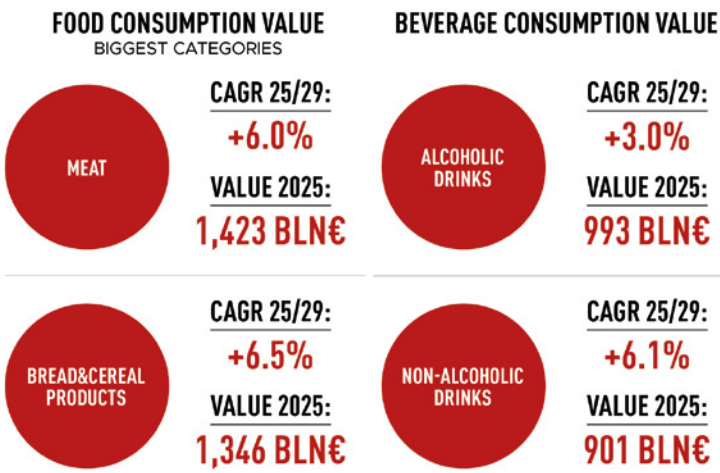
The evolution of processing machinery confirms a growing focus on automation, energy efficiency and digital integration. In food processing, cooling and freezing equipment accounts for 23% of market value, followed by heating and cooking systems (16%), filling machines (14%) and sealing equipment (11%). In the beverage sector, filtration systems (30%) and heat exchangers (24%) dominate.

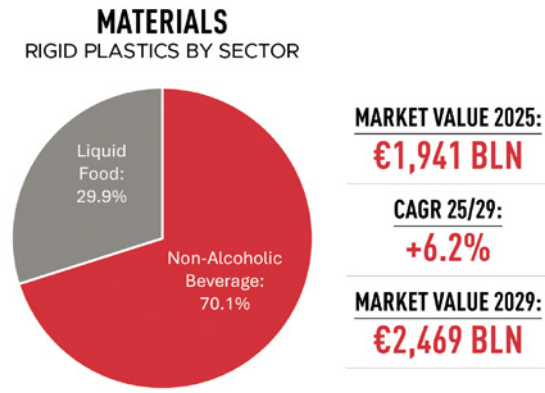
A particularly significant figure concerns the level of automation: 53% of installed machinery consists of fully automatic systems, while 30% is represented by semi-automatic machines. Only 17% of the market still relies on manual technologies.

This increasing automation reflects the need to improve productivity, quality standardisation and operational sustainability, especially in a context characterised by rising energy costs, waste reduction requirements and increasingly complex global supply chains.

Global Food and Beverage Consumption Continues to Grow

The expansion of packaging and processing technologies is closely linked to rising global consumption. In 2025, the global Food market is estimated at €8.418 trillion and could reach €10.708 trillion by 2029, with a CAGR of +6.2%. The largest categories remain meat, cereals & bakery products, dairy products & eggs, and vegetables.





The Beverage sector is also showing positive dynamics, with global consumption increasing from €2.134 trillion in 2025 to €2.550 trillion in 2029. Non-alcoholic beverages are expected to be the most dynamic segment (+6.1%), outperforming alcoholic beverages (+3.0%).

ipackima.com

FAO warns about potential risks linked to recycled plastic food packaging

The growing use of recycled plastics in food packaging may present critical issues that have not yet been fully assessed from a chemical safety perspective. This is highlighted in a recent report by the Food and Agriculture Organization (**FAO**), which draws attention to regulatory gaps and the limitations of current assessment systems for recycled plastic materials intended for food contact.

Risks linked to contaminants

According to FAO, recycling processes may introduce or concentrate undesirable substances capable of migrating into food. These include residues from previous plastic uses, impurities, degradation products, and chemical compounds generated during collection, sorting, and reprocessing stages.

Particular attention is given to the so-called NIAS (Non-Intentionally Added Substances), compounds that are often difficult to identify and characterize. According to the report, the complexity of recycled material streams still makes a complete verification of chemical safety challenging, especially when material origins are heterogeneous or poorly documented.



Circular economy and food safety

The issue is becoming increasingly important at a time when recycled packaging and the circular economy are key pillars of global sustainability strategies. Materials such as rPET and other recycled polymers are being used more and more frequently for beverage bottles, trays, and flexible packaging formats.

However, FAO stresses that the expansion of recycling systems must be accompanied by more effective control measures to ensure that environmental objectives do not conflict with food safety and consumer protection.

More harmonized regulations are needed

One of the main issues highlighted by the report is the fragmentation of international regulations. Although some regions, such as the European Union, have already introduced specific authorization systems for recycling processes intended for food-contact applications, harmonized methodologies for assessing the risks associated with substances present in recycled materials are still lacking.

For this reason, FAO calls for the development of more robust risk assessment approaches covering the entire lifecycle of recycled plastics, from collection to final use in food packaging. Priorities include improving analytical techniques to detect unknown substances and achieving greater convergence among international regulatory systems.

Sustainable but safe packaging

According to FAO, the evolution of recycling technologies must go hand in hand with stronger food safety systems. Only through stricter controls and shared criteria will it be possible to ensure that the growth of sustainable packaging does not compromise the chemical safety of materials intended for food contact.

TECNOPACK GROUP

ENGINEERING EXCELLENCE

HIGH-SPEED PACKAGING LINE



GSP 55 S BB
electronic inverted flow pack wrapper



general system pack

Via Lago di Albano, 82 - 36015 Schio (VI) Italy
info@gsp.it - www.gsp.it
+39 0445 576 285

Food Safety: Global Market for Pathogen Testing Continues to Grow

Microbiological food safety is becoming increasingly central to the strategies of the global food industry. According to a recent market analysis by **Markets and Markets**, the global food pathogen testing market is expected to reach US$23.9 billion by 2031, up from an estimated US$16.49 billion in 2026, with a compound annual growth rate (CAGR) of 7.7%.

Market growth is being driven primarily by the rising incidence of foodborne illnesses, increasingly stringent international regulations, and growing attention from consumers and retailers toward quality, traceability, and food safety.

Microbiological testing now involves a wide range of products, from meat and dairy products to seafood, ready meals, cereals, fruits and vegetables, and processed foods. In particular, the meat segment is expected to continue holding the largest market share, accounting for more than 32% of the total market in 2026.

Among the main microorganisms monitored are Salmonella, Listeria, and E. coli. Salmonella, in particular, remains the most significant pathogen globally, with an estimated market share exceeding 31%.

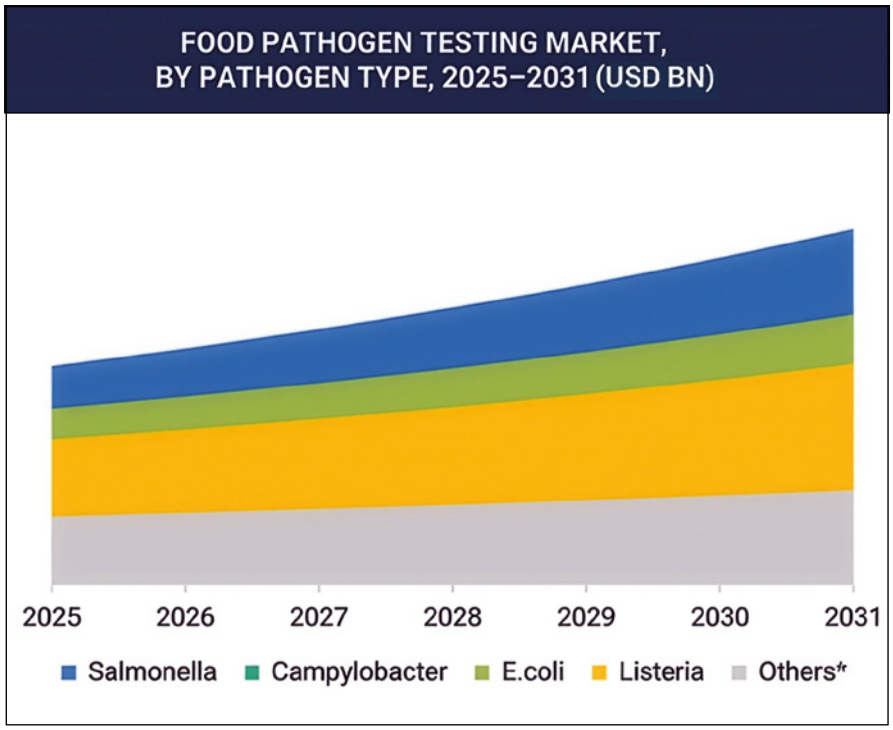


Rapid diagnostics and molecular technologies

The sector is currently experiencing strong technological acceleration. Food companies are increasingly adopting rapid detection systems based on PCR, immunoassays, biosensors, and advanced molecular platforms capable of drastically reducing response times compared to traditional microbiological methods.

The objective is to identify potential contamination at the earliest stages of the supply chain, thereby limiting product recalls, reputational damage, and operational costs.

Interest is also growing in automated laboratories, digital workflows, and integrated monitoring systems, in line with the evolution of Industry 4.0 applied to the food sector.





These new technologies not only improve analytical speed, but also enhance traceability and regulatory compliance across increasingly complex and globalized supply chains.

Asia-Pacific sees strong expansion

From a geographical perspective, Asia-Pacific represents the fastest-growing region, with a projected CAGR of 8.9% through 2031. The expansion of the food industry, aquaculture, and seafood consumption is significantly increasing the need for advanced microbiological testing.

Europe, however, continues to maintain a dominant position thanks to particularly strict regulations and a high level of consumer awareness regarding food safety.

AI, biosensors, and smart laboratories

Among the most interesting development trends are AI-integrated diagnostic platforms, portable on-site testing systems, and "lab-on-chip" technologies designed to perform rapid analyses directly within production facilities.

According to the report, the future of the sector will increasingly focus on real-time monitoring, laboratory automation, and predictive systems capable of anticipating microbiological risks before they evolve into public health emergencies.

marketsandmarkets.com

Resistance of multispecies biofilms to sanitization

Microbial communities that permanently persist in food processing facilities challenge food safety and food quality. Sanitization resistance is enhanced by the formation of biofilms, but sanitization resistance in multispecies biofilms remains poorly documented. It was therefore the objective of a Canadian study to determine the resistance of biofilms formed by 12 microbial communities to 200 ppm chlorine, 40 ppm peracetic acid, and nano-bubbles with 7 ppm ozone.



The composition of the microbial communities was analyzed by culture and by 16S rRNA gene amplicon sequencing. The microbial communities, previously isolated from a pork processing facility, consisted of 6-19 bacterial strains each and together comprised 130 strains representing 19 genera. All 12 communities formed dense biofilms at 4°C and, to a lesser extent (P<0.05), during growth at 25°C. The resistance of the microbial communities to chlorine, peracetic acid, and ozone nano-bubbles was specific for the microbial community and the incubation temperature (P<0.05). One or more of the microbial communities resisted chlorine, peracetic acid, or ozone nano-bubbles, but none of the microbial communities was resistant to all three sanitizers. Sanitization altered the composition of microbial communities in a strain-specific manner.

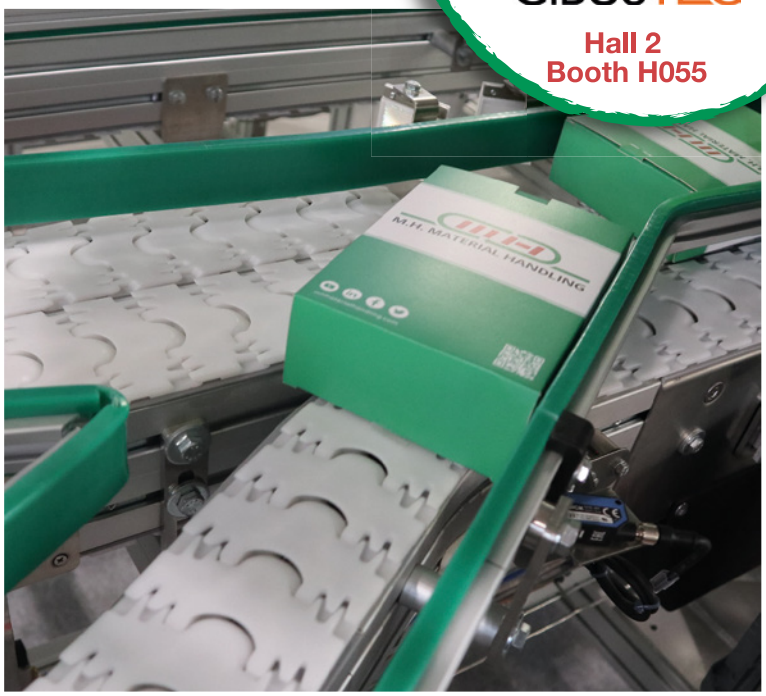
Results published in **Journal of Food Protection** imply that incorporating a rotation of several different sanitizers as part of routine sanitization protocols may be a practical and effective strategy to improve sanitization outcomes and reduce the persistence of biofilms in meat processing facilities.



MEET US
27-30.10.2026 Parma
CIBUSTEC
Hall 2
Booth H055

The BAT Buffer you know.
A chain designed to take it further.

For more than thirty years, the BAT system has supported food and pharmaceutical production lines with reliable, flexible solutions. Among them, the BAT Buffer has become a benchmark: a compact, pressureless accumulation system designed to keep production moving during short downstream stops.



Today, the BAT Buffer can also be equipped with **USC – Ultimate Safety Chain**, developed together with **Ammeraal Beltech** as the evolution of the well-established 879 chain.

USC maintains full backward compatibility while introducing several improvements: higher pulling capacity, quieter operation even at high speeds, more stable sprocket engagement and, above all, the integrated **Safety Finger**, designed to improve operator protection in the most critical areas of the line.



The result is a chain that combines performance, reliability and safety without changing the proven BAT concept.

Upgrading an existing system is straightforward: by replacing chain and sprockets, older installations can benefit from the advantages of USC without redesigning the complete conveyor.

A familiar accumulation system, updated with a chain designed for today's production requirements.

M.H. Material Handling SpA
Via G. Di Vittorio, 3 - 20826 Misinto MB - ITALIA
Tel. (+39) 0296720176
Fax (+39) 0296720215

info@mhconveyors.com
www.mhmaterialhandling.com
YouTube Channel: MaterialHandlingITA

INFORMAZIONE PUBBLICITARIA

Development and characterization of pistachio yogurt analog

Plant-based yogurts are increasingly recognized as sustainable and health-conscious alternatives to dairy-based products, driven by environmental, ethical, and nutritional motivations. Pistachio milk, derived from an efficient and resilient crop, emerges as a promising raw material for yogurt production, offering unique sensory qualities and a dense nutritional profile. Rich in unsaturated fatty acids, bioactive compounds, and essential nutrients, pistachios are ideal for fermentation with lactic acid bacteria (LAB).



In a Spanish study, a novel pistachio-based yogurt analog (PBYA) was developed using lactic acid fermentation, with a yogurt commercial starter, of pistachio milk. The production process was optimized to create an additive-free, clean-label formulation without the use of stabilizers or thickeners. The physicochemical, microbiological, and sensory properties of the PBYA were evaluated over refrigerated storage. The final product exhibited high levels of protein (5.6%), fat (5.4-6.8%), and total solids (20.5-21.4%), along with desirable texture and flavor characteristics. Notably, PBYA presented significantly higher concentrations of total free amino acids (754 mg/L) compared to commercial soy (557 mg/L) and cow's milk yogurts (390 mg/L), particularly in essential amino acids such as lysine, methionine, and tryptophan. This enhanced free amino acid profile contributes to the product's functional and nutritional value. Sensory analysis revealed good acceptance of the product, with improvements in viscosity and firmness over time, likely due to microbial exopolysaccharide production.

Overall, the findings published in **Fermentation** journal highlight the feasibility and commercial potential of PBYA as a clean-label, plant-based fermented product that meets current consumer demands for sustainability, nutrition, and sensory quality.

A novel fermented milk with anti-aging and anti-oxidative properties

Lactobacillus kefiranofaciens HL1, isolated from kefir, exhibits antioxidant and anti-aging activities, defined here as improved cognitive function and reductions in oxidative stress and inflammatory markers. However, its poor milk viability limits application. A Taiwan study published in **Nutrients** journal developed a novel fermented milk by co-culturing HL1 with *Lactococcus lactis* subsp. *cremoris* APL015 (APL15) to enhance fermentation and health benefits.

HL1 and APL15 were co-cultured to produce fermented milk (FM), and fermentation perfor-

mance, microbial viability, texture, and syneresis were evaluated. A D-galactose-induced aging BALB/c mouse model was used to assess cognitive function, oxidative stress, inflammation, antioxidant enzyme activity, and gut microbiota after 8 weeks of oral administration.

FM reached pH 4.6 within 16 h, with high viable counts (~10^9 CFU/mL) for both strains. HL1 viability and texture were maintained, with smooth consistency and low syneresis. In vivo, FM improved cognitive behavior



(Y-maze, Morris water maze), reduced oxidative damage (MDA), lowered IL-1beta and TNF-alpha, and enhanced brain SOD levels. FM-fed mice exhibited increased short-chain fatty acid producers, higher cecal butyrate, and reduced *Clostridium perfringens*.

In conclusions, the co-cultured fermented milk effectively delivers HL1 and provides antioxidant, anti-inflammatory, and anti-aging effects in vivo, likely via gut-brain axis modulation. It shows promise as a functional food for healthy aging.

Valorizing press cakes as ingredients in textured vegetable proteins

In a German study, press cakes (PCs)-the by-products from almond, coconut, flaxseed, pumpkin seed, rapeseed, and sunflower oil production-were used to create textured vegetable proteins (TVPs) that offer both nutritional and sustainability benefits. Several technological and textural properties were measured to evaluate the potential of the PCs for use as ingredients in meat alternatives.

After raw material characterization, 15 PC flours were mixed with pea protein isolate at three levels (25%, 45%, and 50-100% PC, depending on composition) and low-moisture extruded in a pilot-scale co-rotating twin-screw extruder (11% feed water content, 150°C barrel temperature, 10.18 kg/h throughput). Extrusion response parameters were recorded. The structure and texture of the resulting extrudates were analyzed by light microscopy, fracture test, and texture profile analysis. Finally, the PC-TVPs were compared to reference products and meat. Oil and protein content are the most important factors influencing processing and TVP properties because they reduce shear forces and cross-linking. The decrease in protein network stability seen as PC content increases results in denser TVPs with smaller pores and thicker lamellae. These TVPs-especially those made with sunflower seed, flaxseed, and pumpkin seed PCs-are more chewy and less spongy than higher protein TVPs, making the texture more meat-like. Press cakes possess the techno-functional properties to (partially) replace protein isolates or concentrates in TVP production, thereby improving the nutritional profile, texture, and sustainability of meat alternatives.

Technological insights gained from this study, published in **Journal of Food Science**, will facilitate the production of TVPs from press cakes in new plant-based products. Drawing on the results of this study, producers will be able to choose press cake ingredients and concentrations to achieve the desired textural properties while diversifying their raw materials. Starting from the specified extrusion and formulation conditions indicated here, future research can further optimize processes and TVP properties.



Animal- and plant-derived coagulant in Caciotta cheesemaking

Consumer interest in vegetarian, ethical, and clean-label foods is reviving the use of plant-derived milk coagulants. Cardosins from *Cynara cardunculus* ("thistle") are aspartic proteases with strong clotting activity, yet their technological impact in cheese remains under-explored.

An Italian study compared a commercial thistle extract (PC) with traditional bovine rennet rich in chymosin (AC) during manufacture and 60-day ripening of Caciotta cheese. Classical compositional assays (ripening index, texture profile, color, solubility) were integrated with scanning electron microscopy, three-dimensional surface reconstruction, and descriptive sensory analysis. AC cheeses displayed slower but sustained proteolysis, yielding a higher and more linear ripening index, softer body, greater solubility, and brighter, more yellow appearance. Imaging revealed a continuous protein matrix with uniformly distributed, larger pores, consistent with a dairy-like sensory profile dominated by milky and umami notes. Conversely, PC cheeses underwent rapid early proteolysis that plateaued, producing firmer, chewier curds with lower solubility and darker color. Micrographs showed a fragmented matrix with smaller, heterogeneous pores; sensory evaluation highlighted



vegetal, bitter, and astringent attributes.

The data, published in **Dairy** journal, demonstrate that thistle coagulant can successfully replace animal rennet but generates cheeses with distinct structural and sensory fingerprints. The optimization of process parameters is therefore required when targeting specific product styles.

Potential of brewer's spent grain as a nutritional ingredient in bakery products

Barley (*Hordeum vulgare*) is widely used in the production of beer and distilled beverages, generating a nutrient-rich by-product known as brewer's spent grain (BSG). A Brazilian study investigates the potential of brewer's spent grain flour (BSGF) as a functional ingredient to enhance the nutritional profile of bakery products, specifically chocolate cakes, while contributing to waste reduction in the food industry.



The effects of partially substituting wheat flour with BSGF at 40% and 60% levels were assessed. BSGF was found to be rich in protein (15.5 ±0.14 g/100 g), zinc (7.92 ±0.44 mg/100 g), and dietary fiber (52.12 g/100 g). Cakes with 60% BSGF substitution showed increased fiber content (69.8 g/100 g) and zinc content (27.04 g/100 g). Organoleptic evaluation indicated that the tenderness of all three cakes did not show statistical differences. However, among the cakes with BSGF, the 40% substitution level was better accepted by consumers, particularly in terms of flavor.

These findings published in **Plant Foods for Human Nutrition** journal suggest that incorporating BSGF into bakery products can improve nutritional value while offering a sustainable approach to food production by valorizing industry by-products.

Acid whey retentate as fat replacer in cream cheese

The production of whey protein-based fat replacers often requires significant energy (75°-90°C) and/or extended duration (25-50 min), limiting their production efficiency and application in food systems. An US study developed a whey protein aggregates-based fat replacer using acid whey (AW), with reduced heat input and processing time.



AW was concentrated under alkaline conditions (pH 8) by ultrafiltration to recover proteins and calcium as retentate (AWR), followed by heating (85°C for 15 min) at pH 6, 7, and 8 to induce aggregation. Although aggregation occurred across all pH levels, the samples at pH 8 demonstrated the lowest storage modulus (G'). Surface charge and hydrophobicity were the highest for AWR aggregates formed at pH 8 compared to pH 6 and pH 7, probably due to a more complete denaturation of whey proteins under alkaline condition. Compositional and energy-dispersive X-ray analysis revealed that calcium and whey proteins in AWR participated in aggregation. These AWR aggregates were incorporated into skim milk to develop cream cheese, which exhibited significantly lower G', fully relaxable stress amplitude, and characteristic relaxation times comparable to those of low-fat cream cheese. Cryo-SEM showed that AWR aggregates reduced the compactness and continuity of casein network in cream cheese.

This laboratory-scale study published in **Food Hydrocolloids** journal presents a promising strategy for valorizing acid whey as an effective fat replacer in dairy products and contributes toward more sustainable dairy processing.

Enhancing meat aroma in thermally treated chicken carcass hydrolysate

Chicken carcass is a side stream of poultry processing and can be transformed into chicken sauce via hydrolysis and heat treatment. However, the sauce has weaker meaty aroma intensity due to deficiency of sulfur-containing (S-containing) amino acids.

In a study from Singapore, three different S-containing precursors (cysteine, onion, and djenkol bean) were selected for supplementation into chicken carcass hydrolysate to boost the generation of meaty aroma compounds. Cysteine was found to promote the formation of key meaty volatiles like 2-methyl-3-furanthiol and 2-furfurylthiol. Supplementation of onion or djenkol beans increased the formation of furfuryl methyl sulfide with fresh garlic or onion character aroma. The stable djenkolic acid in djenkol beans likely hindered their effectiveness as a precursor to volatile sulfur compounds. Headspace-solid-phase microextraction-gas chromatography-mass spectrometry (HS-SPME-GC-MS) and HS-GC-ion mobility spectrometry (IMS) detected a total of 60 and 49 volatiles, respectively, notably heat-generated aroma-active compounds 1-octen-3-ol, hexanal, and benzaldehyde.

This study published in **Journal of Food Science** presents a promising approach to transforming low-value poultry side streams into flavorful condiments.



Detection of saffron adulteration

Crocus sativus L. (saffron) is the most valuable spice worldwide, yet its limited production and high market value make it highly susceptible to adulteration with plant substitutes and synthetic dyes. In an Indian study, ^{1}H Nuclear Magnetic Resonance (NMR) spectroscopy was applied as a rapid, non-destructive technique for saffron authentication



and detection of eight plant adulterants and one synthetic dye in a single experiment.

Methanolic and hexane extracts were prepared to capture a broad polarity range of metabolites from authentic saffron, known adulterants, and commercial brands. Spectral comparison targeted key saffron markers, including picrocrocin, crocin, and crocetin. Most brand samples closely matched the authentic reference, with minor variations that can attributed to seasonal and geographical factors, whereas the ZK sample lacked diagnostic saffron peaks and instead displayed resonances consistent with Sudan IV and *Arnica montana*, confirming adulteration. Quantitative NMR (qNMR) was further employed for picrocrocin determination, and the method was validated in terms of selectivity, specificity, linearity (R2 > 0.998), precision (intra- and inter-day RSD < 5.5%), robustness (consistent results across varied scan numbers and relaxation delays). The method demonstrated a limit of detection (LOD) of 0.443 µg/mL and a limit of quantification (LOQ) of 1.342 µg/mL for picrocrocin, indicating high sensitivity and suitability for reliable quantification.

Overall, these findings published in **Journal of Applied Research on Medicinal and Aromatic Plants** establish ^{1}H NMR spectroscopy as a robust qualitative analytical platform for both authentication and detection of adulteration of saffron. Its integration into routine quality control and regulatory frameworks could strengthen consumer protection and ensure the integrity of high-value herbal and food products.

Cranberry pomace in functional biscuits

Large-fruited cranberry (*Vaccinium macrocarpon* Ait.) is a rich source of polyphenolic compounds, including anthocyanins, flavonols, and unique A-type proanthocyanidins, which exhibit strong antioxidant and health-promoting properties. Cranberry pomace, a by-product generated during juice and concentrate production, remains underutilized despite being abundant in dietary fiber and non-extractable polyphenols (NEPPs).

In a Polish study, cranberry pomace was characterized phytochemically and applied as a functional ingredient in biscuits at levels of 5%, 10%, and 15% substitution of wheat flour. Total polyphenol content (TPC) and antioxidant activity (ABTS^{+}, DPPH$^{\cdot}$) were significantly higher in pomace compared to whole fruit values reported in the literature, which can be attributed to the concentration of polymeric proanthocyanidins and flavonols in skins and seeds. Biscuits enriched with pomace exhibited a dose-dependent increase in TPC and antioxidant capacity, with the 15% variant showing up to 6-fold higher polyphenol content and over 30-fold higher ABTS^{+} activity after in vitro digestion compared to control. Digestion also released NEPP bound to the fiber matrix, improving bioacces-



sibility. Moreover, extracts from digested biscuits reduced oxidative stress in *Saccharomyces cerevisiae* and inhibited COX-1, COX-2, and AChE activities, suggesting potential anti-inflammatory and neuroprotective effects.

These findings published in **International Journal of Molecular Sciences** highlight cranberry pomace as a sustainable, high-value ingredient for functional foods, aligning with circular economy strategies.

High protein yogurt alternative using pea protein hydrolysate

Non-dairy yogurt alternatives have become increasingly popular in the market but the impact of enzymatic hydrolysis on the textural and structural properties of pea protein based yogurt alternative (PBYA) with high protein content is not well understood.

In a US study, commercial pea protein isolate was hydrolyzed with trypsin using the pH -stat method to obtain a degree of hydrolysis of approximately 1%. The hydrolysis led to a significant degradation of the major pea proteins including convicilin (~95-97%), vicilin (~88-93%) and legumin alpha (~93-97%). The PBYA made from pea protein hydrolysate, namely, PPH-PBYA, was produced at both bench and pilot scale with a protein content at 10% (w/w) and was compared with the control PBYA made from pea protein isolate (PPI-PBYA). The PPH-PBYA contained a smaller gel particle size (~20-40 µm) than PPI-PBYA (~50-70 µm), and possessed softer and smoother texture. For instance, the PPH-PBYA manufactured at pilot scale, when compared with the PPI counterpart, had lower yield stress (~32 Pa vs. ~454 Pa), a lower flow consistency coefficient (~135 $Pa.s^n$ vs. ~1016 $Pa.s^n$), and lower firmness (~3 N vs. ~9 N). Moreover, the hydrolysis treatment did not negatively impact syneresis stability; the characterized syneresis rates for both PPI- and PPH-PBYA were < 1%. Furthermore, PPH-PBYA exhibited lower frication coefficients at the elastohydrodynamic lubrication regime, suggesting a better lubrication behavior compared with PPI-PBYA. The improvement in the texture and structure was consistent with visual and microscopical observations, where the PPH-PBYA featured smoother surface characteristics and more homogenous microstructure. The impacts of enzymatic hydrolysis of pea protein on particle size, texture, and microstructure of the PBYA produced from pilot scale trials showed a similar trend to those produced from the bench scale, validating the feasibility for scale-up production.



The study published in **Food Structure** journal provides a feasible route to manufacture commercial PBYA products with high protein content and optimized textural properties using enzymatic treatment.

Yellow pea ingredients for pan bread applications

Yellow peas (YPs) are a promising source of sustainable plant proteins however, characteristic off-flavors limit consumer acceptance and hinder their use as value-added food ingredients. A Canadian study evaluated the compositional and sensory characteristics of fourteen processed YP ingredients to determine their suitability in pan breads.

Nine protein isolates (YPIs), three protein concentrates (YPCs), and two heat-treated flours (YP-IR and YP-RF) were analyzed for fatty acid composition, lipoxygenase (LOX) activity, volatile organic compounds (VOCs), and electronic nose (eNose) responses. LOX activity and linoleic acid, a key LOX substrate, differed significantly between YP ingredients. Fifteen



VOCs previously linked to off-flavors were identified, with YPIs exhibiting the highest concentrations. eNose analysis correctly predicted YP ingredient identities with 69.5% accuracy and distinguished treated flours from other YP ingredients. Pan breads using two YPI ingredients (YPI-1 and YPI-2) predicted to produce strong off-flavors, the two heat-treated flours and a wheat flour (WF) control were prepared. Breads were evaluated for proximate composition, consumer acceptance, descriptive sensory attributes, and instrumental color. YPI-1 bread was significantly less acceptable overall than WF ($p < 0.001$) and showed higher pea aroma and flavor ($p < 0.001$). YPI-2 bread had a denser texture ($p < 0.05$) and significantly higher wheaty aroma ($p < 0.01$). Breads made with YP-IR and YP-RF performed closest to the WF control. The heat-treated YP flours demonstrated the greatest potential as pan bread additives. YPI samples were associated with undesirable sensory characteristics. Analyses of the raw YP ingredients effectively predicted sensory differences, highlighting the usefulness of these methods as screening tools during product development.

This research published in **Journal of Food Science** shows that different value-added yellow pea ingredients can introduce a range of flavors into food matrices, and that flavoromics tools can assist with product development. The two heat-treated yellow pea flours were identified as the best options for bread making because they were less related to pea aroma and flavor in the final product. These findings can help bakers and food manufacturers choose pea ingredients that make high-protein breads taste better.

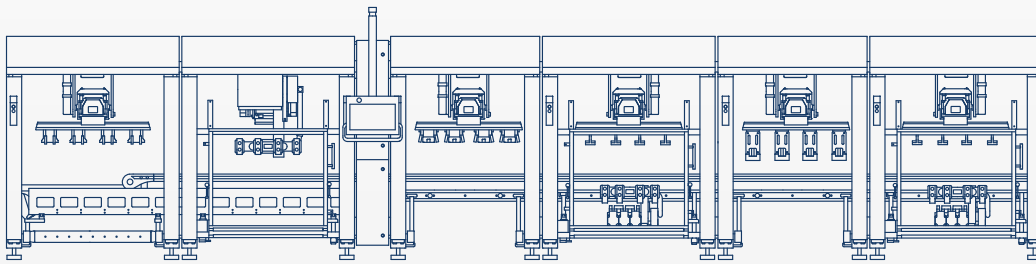
Debittered pomelo seed powder as a functional ingredient in low-fat ice cream

By-product valorisation is a hallmark of sustainable processing and resource efficiency. Repurposing wastes into functional entities fosters environmentally responsible and viable industrial practices. In an Indian study published in **Sustainable Food Technology** journal, pomelo (*Citrus maxima*) seed powder was explored as a functional ingredient in low-fat ice cream.

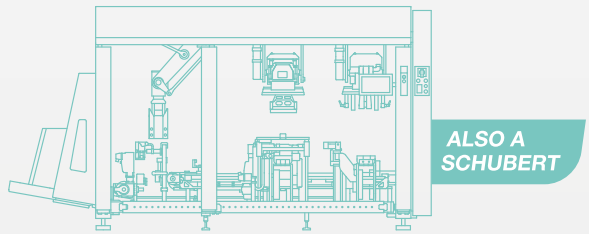
Both raw (OSP) and de-oiled seed powders (DSPs) were first debittered using appropriate methods, achieving over 90% reduction in limonin and naringin. The processes also remarkably eliminated tannins, phytic acid and trypsin inhibitors. DSP exhibited >200% enhancement in functional properties over OSP. Improved melting resistance (0.32 g min^{-1} to 0.64 g min^{-1}) and reduced overrun (51.49% to 29.74%), indicating enhanced ice cream matrix stability, were attained. Hardness, adhesiveness, and gumminess increased with rising concentrations (1-5%) of the powder, indicating the roles of seed polysaccharides and proteins in inducing structural integrity in the pseudoplastic emulsions. This was supported by steady and dynamic rheometry, revealing significant enhancements in apparent viscosity (1.52 Pa s to 9.33 Pa s), consistency index (7.36 Pa s to 47.92 Pa s), yield stress (23.83 Pa to 398.74 Pa) and viscoelastic moduli (G' and G''), with decreases in the flow behaviour index (0.66 to 0.17) and loss tangent (0.251 to 0.137). However, prominent color differences, as affirmed by spectrophotometric analysis of lightness (L^*), whiteness (WI) and yellowness (b^*) occurred. Fuzzy logic-based sensory evaluation identified the formulation with 4% DSP as the most acceptable in terms of taste, creaminess, mouthfeel and appearance. Nutritional analysis re-confirmed the low-caloric nature of the final product. Hence, the processed seed powder served a dual-function as a fat mimetic and stabilizer in the low-fat dairy system.



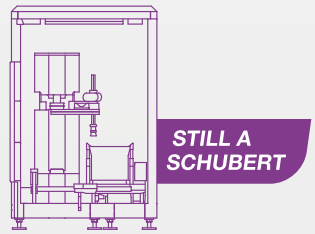
SAME SCHUBERT TECHNOLOGY DIFFERENT SIZE



TLM | engineered for performance



LIGHTLINE | standardized for simplicity



TOG | built for versatility

Discover the three Schubert product lines for packaging tasks of any size and complexity.

SCHUBERT

Valorization of acid whey to produce sourdough bread starter



Acid whey, a by-product of Greek yogurt and acid-coagulated cheese, poses environmental challenges due to high biochemical and chemical oxygen demand. It also contains lactic acid bacteria (LAB) with the potential to enhance fermentation. Using acid whey in breadmaking addresses waste management while creating value-added products.

To evaluate acid whey as a starter in bread production and compare its performance with commercial sourdough and white bread, acid whey from skim milk yogurt was used to replace 50% of the water in the dough. Three breads were prepared: white bread (WB), acid whey bread (AWB), and commercial sourdough bread (CSB). Physical, chemical, microbial, and textural properties were measured. Consumer acceptability was assessed using a nine-point hedonic scale with 81 participants. Data were analyzed using ANOVA and paired *t*-tests ($p<0.05$). AWB showed greater loaf volume (1550±20.4 cm^3) than WB (1375±20.4 cm^3, $p<0.05$) and similar aeration to CSB ($p=0.97$). Its pH (5.17±0.03) was lower than WB (6.07±0.12, $p<0.05$), indicating stronger fermentation. AWB displayed lighter crust color and delayed mold growth compared to WB. Sensory tests showed higher scores for AWB in flavor, aroma, color, texture, and overall acceptability ($p<0.001$). Notably, 76.5% of participants preferred AWB over CSB for purchase.

Accordind to a Canadian study published in **Journal of Food Process Engineering**, acid whey is a viable alternative to commercial sourdough starters, producing bread with favorable qualities while reducing dairy industry waste, offering benefits for sustainable food production.

Enhancing the bioactive profile of dark chocolates with berry peel extracts

The food industry is focusing on incorporating functional ingredients to enhance the nutritional and bioactive value of food products. Therefore, a Peruvian study published in **Frontiers in Food Science and Technology** journal aimed to evaluate the effect of incorporating encapsulated peel extracts from four berry species at concentrations.

To this end, dark chocolates were formulated with the addition of berries at 0.5, 1.0, 1.5, and 2.5%, where was evaluated functional properties of dark chocolates, like as antioxidant activity by three assays; total phenolic content (TPC); and individual phenolic compounds (catechin, epicatechin, theobromine, caffeine, and gallic acid) were quantified by UHPLC. The results showed that the incorporation of berry peel extracts at concentrations between 1.5% and 2.5% in dark chocolates was the most effective, producing significant enhancements in antioxidant activity, TPC, and phenolic compounds. Within the antioxidant assays, FRAP showed the greatest sensitivity for detecting differences among formulations. The DC/Rf sample exhibited the highest levels of TPC, FRAP, gallic acid, and catechin. Similarly, the DC/Vc formulation showed elevated values of TPC, FRAP, and gallic acid.

In conclusion, microencapsulation of native berry peel extracts enhanced the bioactive composition of dark chocolates, resulting in higher antioxidant capacity and phenolic compound content, thereby indicating their potential application in the development of functional foods.



Green coffee powder as a clean-label functional ingredient in meat systems

In a Turkish study published in **Food Biophysics** journal, green coffee powder (GCP) was used as a source of dietary fiber and antioxidants in beef burgers stored under refrigeration for 7 days. The effects of GCP on the color, dietary fiber content, oxidative stability, sensory and textural properties of the burgers were evaluated. Additionally, the polyphenolic composition, total phenolic and flavonoid contents, antioxidant activities, and molecular docking analyses of GCP were performed.

Green coffee powder contained high levels of bioactive compounds, particularly caffeic acid (724 mg/100 g), caffeine



(754 mg/100 g), and chlorogenic acid (321.1 mg/100 g). Results such as DPPH radical scavenging activity (82.98%), total phenolic content (662.99 mg GAE/100 mL), total flavonoid content (144.63 mg CE/100 mL) and FRAP value (133.03 nmol Fe(II)/g) supported the strong antioxidant potential of GCP. The addition of GCP significantly increased the dietary fiber content of beef burgers. On day 7, the lowest TBARS values were observed in the GCP1 (3% green coffee powder added beef burger), GCP2 (6% green coffee powder added beef burger) and GCP3 (10% green coffee powder added beef burger) groups (0.65, 0.68, and 0.81 mg MA/kg sample, respectively), while the control group showed the highest value (1.96 mg MA/kg sample), indicating improved oxidative stability. Ferulic acid showed superior pharmacokinetics with high absorption and bioavailability, while chlorogenic acid had limited absorption and low bioavailability. Molecular docking studies with the 5IKQ protein target revealed that chlorogenic acid had the strongest binding affinity (-9.4 kcal/mol) and formed multiple stabilizing hydrogen bonds.

In conclusion, the use of green coffee powder as a natural source of antioxidants and dietary fiber offers a promising, clean-label, and cost-effective strategy to enhance the functional and technological quality of meat products.

Tomato pomace powder as a bioactive ingredient in semi-hard cheese

Tomatoes (*Solanum lycopersicum* L.) are among the most widely consumed and nutritious vegetables globally, being abundant in lycopene, carotenoids, phenolics, organic acids, vitamins, and several other bioactive and health-enhancing compounds. Tomato processing yields a substantial residue known as tomato pomace (TP), primarily composed of peels and seeds, along with a small quantity of pulp.

A Romanian study investigates the potential of TP powder, rich in dietary fiber, lycopene, polyphenols, and other bioactive compounds, as a natural ingredient in semi-hard cheese. The cheese was enhanced with varying concentrations of TP (5%, 7%), and each variant was assessed for physico-chemicals, sensory properties, minerals, color, phytochemicals, and texture. Cheeses supplemented with TP showed elevated levels of phytochemicals (45.44-82.83 mg GAE/100 g), greater antioxidant capacity (470.25-977.41 micromol TE/g), and higher fiber content (3.62-5.44%), while sensory acceptability remained acceptable at lower inclusion levels but decreased at 7% TP due to slightly bitter aftertaste. Textural analysis showed minimal changes in TP-enriched cheeses, suggest-



ing that TP can be integrated into semi-hard cheese matrices without compromising quality.

This study published in **Foods** journal illustrates the feasibility of utilizing TP as an important ingredient in cheese manufacturing, aiding in waste minimization and fostering a circular economy within the food sector. The findings underscore TP's capacity to enhance dairy products, facilitating innovative and sustainable food solutions that advance health and environmental objectives.



Artichoke and broccoli by-products for gluten-free bread

Commercial gluten-free (GF) breads often exhibit low nutritional quality due to limited fiber and bioactive compounds. The enzymatic treatment of vegetable by-products, such as broccoli and artichoke, represents a sustainable strategy to release soluble dietary fiber and phenolic compounds, enhancing the functional value of GF products.

Five GF bread formulations were developed by Spanish Researchers: a control bread, breads containing broccoli or artichoke extracts (BB and BA), and breads with enzymatically treated extracts using Viscozyme L and Celluclast 1.5 L (BBE and BAE). A commercial GF bread (BC) served as a reference. Nutritional composition, dietary fiber fractions, phenolic content, antioxidant capacity, starch digestibility, physicochemical parameters, and sensory properties were evaluated.

Enzymatic treatments significantly improved the nutritional and functional properties of GF breads. Viscozyme L produced the highest increases in antioxidant capacity and phenolic content (up to 30% higher in FRAP), while Celluclast 1.5 L generated the highest rise in soluble dietary fiber (up to 2.75 g/100 g) and the best sensory acceptance. Moreover, Celluclast 1.5 L significantly modified starch digestibility, reducing rapidly digestible starch by 14% and increasing slowly digestible starch by over 150%, suggesting a lower predicted glycemic response.

In conclusions, incorporating the enzyme-treated artichoke and broccoli by-products into GF breads effectively enhances soluble fiber, antioxidant potential, and sensory quality. Among treatments, Celluclast 1.5 L applied to artichoke proved most effective overall, providing a balanced improvement in nutritional and functional attributes.

These findings published in **Molecules** journal revealed the potential of Celluclast 1.5 L-treated artichoke by-products as a source of natural bioactive compounds for developing clean-label, nutritionally enhanced GF breads.

Sunflower phospholipid fractions in ice cream

A Turkish study provides a quantitative evaluation of structure-function relationships in ice cream emulsions stabilized with phospholipid fractions derived from crude lecithin, a valuable byproduct after the degumming process in sunflower oil refining.

Four purified fractions with varying phosphatidylcholine (PC) contents, crude lecithins and a commercial product, were incorporated into an optimized base formulation (1.04% salep, 0.48% phospholipids). Microstructural analysis revealed that Fraction 4 (highest PC content) produced the smallest and most uniform oil particles. These results correlated strongly with zeta potential and particle size (0.391 microm), confirming the role of PC enrich-

ment in enhancing interfacial stability. While salep concentration primarily governed rheological properties (K ranged from 3.0 to 52.3 Pa.s^n and n from 0.43 to 0.72), phospholipid composition significantly affected zeta potential (-24.2 to -28.8 mV), particle size (0.427-0.547 microm), and overrun (22.7-46.2%).

The findings published in **Food Science and Biotechnology** journal highlight sunflower-derived phospholipids as sustainable, clean-label emulsifiers for ice cream.



Preservation of antioxidant phytochemicals in fruit ice cream with ultrasound

Ultrasonic-assisted pasteurization has gained increasing attention as a promising method for preserving heat-sensitive bioactive compounds in food products. In a Vietnamese study, the Box-Behnken experimental design method was employed to optimize key parameters for the processing of a mango-passion fruit ice cream formulation.

Through optimizing for viscosity and total solid content, the optimal contents of various additives were determined, which includes carrageenan (0.06 g/100 g), whipping cream (9.0 g/100 g), and lecithin (0.4 g/100 g). More importantly, ultrasonic-assisted pasteurization was proven to be better at preserving the nutrient contents of mango-passion fruit ice cream compared to conventional thermal methods. Particularly, at the optimal ultrasonic temperature (65°C), power intensity (46%), duration (15 min), and homogenization speed (6500 rpm), the mango-passion fruit ice cream managed to retain 90.41% (58.21 ±0.57 mgAA/100 g) and 92.67% (179.51 ±3.11 mgGAE/100 g) of its original vitamin C and polyphenol contents, while also meeting the local standards for microbial safety (QCVN 8-3:2012/BYT). In contrast, with conventional thermal pasteurization (95°C for 5 min), the final product exhibited 46.89% and 52.63% losses in its vitamin C and polyphenol contents, respectively.

These findings published in **Journal of Food Processing and Preservation** highlight the potential of ultrasonic processing as a superior alternative to traditional thermal methods, minimizing nutrient degradation while maintaining microbiological integrity, especially in the dairy industry to develop functional, nutrient-rich frozen desserts.



Development of high-fibre biscuits using brewers' spent grain

Hungarian Researchers investigated the possibility of reusing spent brewer's grains, known as BSGs (Brewers' Spent Grain), as a fibre-rich raw material for the



bakery industry. Research has focused mainly on new product development, color analysis, sensory characteristics and improvement of nutritional value.

Brewer's grains are a by-product of the brewing industry that is in a very humid state, which is why they always require prior treatment before they can be used. In the case of the study published in **Acta Universitatis Sapientiae, Alimentaria**, the BSG used came from material that would otherwise have been discarded, with the aim of understanding whether it could be reused effectively in the production of biscuits.

To create the different formulations, BSG was used with four different particle sizes, combined with enrichment levels of 25%, 50%, 75% and 100%. The biscuits obtained were analyzed from a chromatic and sensory point of view, i.e. evaluating aspects such as taste, texture and overall satisfaction. In addition, the nutritional values, with particular attention to the fiber content, were compared with those of a traditional biscuit used as a control sample, so as to verify its possible application on an industrial scale.

Sensory tests showed that biscuits enriched with 25% BSG were the most popular in all respects. In general, the addition of grains increased the fiber content in all variants compared to the traditional cookie. However, the color analysis showed that the presence of BSG makes the biscuits progressively darker, decreasing their brightness compared to the control sample.

Clean-label stabilization of plant-based emulsions

Plant-based emulsions, such as soy-based emulsions, can be unstable if not supported by effective stabilization systems. To achieve clean-label stability, i.e. without chemical additives, it is often necessary to combine interface-active proteins and polysaccharide networks.

In a South Korean study published in the **Journal of the Science of Food and Agriculture**, Researchers focused on emulsions based on cellulose nanofibers (CNF) and soy protein isolate (SPI), exploring different ratios between the two components and different percentages of oil. After an initial screening, the emulsions with 40% oil were examined in depth to study their characteristics in a systematic way. Several parameters were analyzed to understand how CNF and SPI work together: droplet surface charge (zeta-potential), emulsifying activity and stability, droplet size, droplet microstructure, and flow and elasticity properties. The results showed that all emulsions were electrically stabilized, with a negative surface charge that became more intense as the CNF fraction increased. Emulsions containing only SPI formed small but highly variable droplets and showed weak viscoelasticity, while those with only CNF generated large, bimodal droplets, despite a high surface charge.

Mixed formulations, on the other hand, demonstrated optimal behavior. In particular, the C8S2 and C6S4 ratios produced uniform droplets, a wide linear elasticity



range, and clear viscosity-reducing behavior under stress. Among these, the C6S4 emulsion achieved the highest values of emulsifying activity and stability, together with the highest critical deformation, indicating the best synergy between the formation of protein film on the droplet surfaces and the reinforcement of the continuous phase by the nanofibers.

The results confirm that a balance between CNF and SPI is essential to obtain stable and high-performance plant emulsions: proteins form elastic films around the droplets, while nanofibers strengthen the network in the continuous phase. Balanced ratios of CNF:SPI not only improve droplet uniformity and electrostatic stability, but also overall viscoelastic properties, providing concrete indications for designing effective, clean-label plant emulsions.

Food functional properties of chickpea protein sources as egg replacers in bakery

A Danish study aimed to evaluate the potential of chickpea protein powders as ingredients providing functionality of foaming and gelling. The chickpea protein was further studied as egg replacer in bakery applications with sponge cake as model system.

Six commercial chickpea sources representing different processing levels, including one flour, two protein concentrates, two protein isolates, and one aquafaba were included with whole hen egg (WHE) powder as reference. The composition, protein content, solubility, foaming, gelation, and microstructure were analysed for 100%, 75%, 50% and 0% egg replacements. Aquafaba was the most soluble and displayed excellent foaming capacity and stability, but performed poorly in gelation by no microstructural network. The solubility and foaming capabilities of the least processed chickpea flour were moderate, but it producee very hard and brittle gels, aligned with their microstructure, hence, was not found suitable for cake application. Although chickpea isolates formed strong gels when combined with eggs, as verified by microstructure analysis, their foaming capabilities were very limited. The concentrates showed a good balance of foaming and gelling, with moderate microstructural network formation during heat-set gelation, despite their low solubility. One chickpea concentrate had functionality most comparable to WHE, and was applied in a sponge cake formulation, with egg replacements of 100%, 75%, 50% and 0%, respectively. The cakes with 50% egg replacement performed high in texture and structure parameters.



The results published in **Food Hydrocolloids** journal highlight the potential of chickpea proteins to partially replace egg functionally in a sustainable food production, however, a 100% replacement was not viable.

Development of a functional olive oil-based spread

The growing production of olive oil generates large amounts of olive pomace, a phytotoxic by-product that requires sustainable strategies for valorization.

A Portuguese study developed an olive oil-based spread functionalized with a functional ingredient obtained from fresh olive pomace from Portugal through mechanical pressing. Two formulations (A and B), composed mainly of 70% olive oil, were prepared with or without coconut oil. Their fatty acid profiles, phenolic content, hydroxytyrosol content, and antioxidant activity were compared with three commercial vegetable spreads. Formulations A and B showed a predominance of oleic acid (62% and 61%) and significantly higher total phenolics, hydroxytyrosol, and antioxidant capacity ($p < 0.05$) than commercial samples.

These results published in **Journal of Agroalimentary Processes and Technologies** demonstrate that olive pomace extract is an effective natural ingredient to improve the nutritional and antioxidant quality of vegetable spreads while supporting sustainable valorization of olive industry by-products and reducing the environmental impact of olive oil production.



Aquafaba and plant extracts for a better structure of the whipped cream

A Chinese study investigates a novel formulation strategy combining aquafaba (AQ, from cooked chickpeas) with six herbal aqueous extracts (HAEs), including *astragali radix*, *ophiopogonis japonicus*, licorice (LI), *ziziphi spinosae* semen, *codonopsis pilosula*, and cinnamon (CI), to develop whipped cream that aligns with clean-label trends while delivering improved quality and health promotion.



The incorporation of AQ increased the foaming capacity (FC) and foam stability (FS) of the solution without coconut oil by 8.3% and 41.8%, respectively. The combination of AQ with HAEs resulted in much greater improvements in FC (up to 39.2%) and FS (up to 50.2%). During aeration, the whipping time of emulsion was significantly shortened from 295.3 seconds to 213.3 seconds ($P < 0.05$) upon AQ addition. The AQ-HAEs aerated creams exhibited a strengthened three-dimensional network structure, as evidenced by higher storage modulus (G›) and water retention compared with control, which contributed to AQ, AQ-LI, and AQ-CI creams with sharp edges, stiff peaks, and smooth cross-sections, even after 30 minutes of storage. Sensory evaluation confirmed that AQ and AQ-LI creams achieved the highest overall acceptability scores (8.1 and 7.6, respectively).

The results published in **Food Hydrocolloids** journal offer insights into expanding the application of AQ and HAEs in cream systems.

CHIRIOTTI EDITORI

Welcome to FoodTechVillage.com and foodexecutive.com



INDUSTRIE ALIMENTARI · INDUSTRIE DELLE BEVANDE · ITALIAN FOOD & PACKAGING TECHNOLOGY · TECNICA MOLITORIA · TECNICA MOLITORIA · INGREDIENTI ALIMENTARI · Alimenti Funzionali

Influence of ultrasonic parameters on osmotic dehydration of pork loin

The intensification of food processing using ultrasound (HIUS) has gained relevance at the industrial level due to its ability to improve process efficiency without compromising product quality. A Mexican study published in **Meat Science** journal investigated the influence of certain HIUS parameters on the osmotic dehydration (OD) of pork loin, evaluating its impact on mass transfer, physicochemical properties, structure, and thermal behavior.

Conventional OD (immersion) and with HIUS assistance were performed, varying the amplitude and duty cycle (*UA1*: 50% - 0.5; *UA2*: 50% - 0.8; *UA3*: 90% - 0.5; and *UA4*: 90% - 0.8). The results revealed that the *UA3*conditions significantly improved water loss, solute incorporation, and the diffusion coefficients of water (0.33 ±0.06 x 10^{-10} m^2/s) and solids (2.36 ±0.01 x 10^{-10} m^2/s), thus optimizing process efficiency. At the compositional level, *UA3* achieved greater dehydration (73.4 ±1.0%) without compromising protein content or water holding capacity. A substantial reduction in a_w was observed, going from 0.98 ±0.03 to 0.91 ±0.00, a key factor for OD. Scanning electron microscopy revealed a more porous microstructure with defined channels, which is associated with improved mass transfer. Thermal analysis confirmed the decrease in free water and the increase in incorporated solutes, reflected in lower enthalpies and melting temperatures. Regarding certain quality aspects, color remained stable in most treatments, and the reduction in shear force in *UA2* and *UA4* suggests an improvement in product tenderness.



Taken together, these findings position HIUS as a promising technology for enhancing meat preservation, enabling faster and more efficient processes.

Effects of high-voltage electrospray on orange juice

A Chinese study published on Innovative Food Science and Emerging Technologies. 104, 104148, 2025 examined high-voltage electrospray (HVES, 20-100 kV) as a chemical-free and non-thermal method for processing orange juice.

Remarkably, the 100 kV HVES treatment reduced the microbial load of orange juice by 2.92 log CFU/mL, equivalent to that obtained through thermal processing (TP) at 75 degreeC for 10 min. Compared with fresh juices, the orange juice treated with 100 kV HVES exhibited an 11.8% reduction in particle size, an 11.2% increase in zeta potential, and a 30.68% increase in electrical conductivity. The treatment inactivated polyphenol oxidase (50.8% inactivated) and peroxidase (46.4% inactivated) while maintaining superoxide dismutase activity (4.8% inactivated) and preserving more of the orange juice flavour. Meanwhile, HVES processing boosted the antioxidant capacity (>36.7% DPPH and > 20.5% ABTS scavenging ability) of orange juice. During 7-day storage, HVES-treated juice showed slower particle sedimentation and viscosity loss than TP-treated juice, although its shelf life remained shorter than that of commercial brands, such as Huiyuan 100% and Haoen.

These findings highlight HVES's potential for the preservation of orange juice quality. However, aseptic environment and operations are required for commercial applications.



Low-frequency magnetic field for improving marination

A Chinese study aimed to evaluate the effects of alternating magnetic field treatment on the mass transfer rate, microstructure, water retention, and texture of beef during the marination process. Results demonstrated that both Sodium chloride (NaCl) content and moisture content in beef were significantly increased after alternating magnetic field-assisted marination compared to conventional static marination.

Mass transfer was modeled using Fick's second law, which provided a good fit to the experimental data in the marination process. The diffusion coefficients (D-values) of NaCl and moisture were found to increase significantly with increasing magnetic field intensity, respectively. Specifically, alternating magnetic field-assisted marination with an intensity of 5 mT for 90 min resulted in a maximum increase of 21.77% in NaCl content and a 1.98% improvement in moisture content. In addition, microstructural analysis suggested that the accelerated marination induced by the alternating magnetic field might be due to the fact that the alternating magnetic field promoted the expansion of myofibrillar gaps in muscles, thereby enhancing the permeation rate of NaCl and moisture. The cooking loss reduced by marination assisted with a 5 mT magnetic field in beef tenderloin, although no significant negative impact in tenderness was observed compared to static marination.

This study published in **Journal of Food Engineering** demonstrates that a low-frequency alternating magnetic field can simultaneously enhance marination efficiency and maintain myofibrillar structural integrity, providing a potential alternative to conventional physical methods.



Thawing frozen pork with vacuum steam and microwave



To solve the problems of uneven temperature and localized overheating in microwave thawing method of frozen pork, a novel thawing method based on the principle of vacuum steam-microwave thawing (VSMT) was proposed by Chinese researchers.

To assess the initiation and completion of thawing, the center temperature of a 500 g frozen pork sample was raised from -18 to 2 degreeC. The effect of initial vacuum time on the thawing performance of VSMT was experimentally investigated. The thawing performance and the quality of the thawed pork were then compared under the optimal initial vacuum time of the VSMT with those thawed by microwave continuous thawing (MCT), microwave intermittent thawing (MIT), and vacuum steam thawing (VST). The results indicated that the lowest coefficient of variation of the surface temperature of the thawed sample, shortest thawing time, lowest system-specific energy consumption (system-SEC), and lowest thawing and cooking loss were achieved with an initial vacuum time of 10 min. Compared with the MCT and MIT, the VSMT significantly improved thawing uniformity and reduced thawing loss. A 31 % reduction in thawing time and a 38 % reduction in system-SEC were achieved by the VSMT compared to the VST. The pork samples thawed by the VSMT had the smallest total color difference. Their color, texture parameters, total volatile basic nitrogen, and thiobarbituric acid reaction substances were closest to those of fresh pork.

This study published in **Journal of Food Engineering** provides a novel and effective solution to the problems of uneven thawing and localized overheating associated with microwave thawing methods.

Sous-vide technique for the technological quality of marinated chicken

A Brazilian study published in **Journal of Food Science** evaluated the effects of the water immersion sous-vide technique, applied at industrial scale, on the technological and microbiological quality of marinated chicken breast fillets.



Two vacuum-packaged thermal treatments were applied: T1 (65°C for 150 min) and T2 (65°C/75°C for 200 min), along with respective non-vacuum controls (C1 and C2). Initially, the thermal process was validated through the determination of the coldest point and the calculation of accumulated lethality (F_{cal}), which exceeded the minimum required value (17.7 min), ensuring microbiological safety. Samples were evaluated for physicochemical composition, texture profile, and stability during 45 days of refrigerated storage (≤ 3°C). Treatment T1 demonstrated superior moisture retention (70.84%), reduced syneresis, and a softer texture (hardness: 20.76 N/cm^2; chewiness: 11.30 N.mm), whereas T2 was characterized by distinct instrumental color parameters and a more homogeneous texture profile. All treatments exhibited low water activity (aw; 0.9825-0.9855), stable pH, and peroxide index below 0.5 mEq O_2/kg.

Microbiological analyses confirmed the absence of *Salmonella* spp. and undetectable levels of *Escherichia coli*, *Clostridium perfringens*, *Staphylococcus aureus*, and *Listeria monocytogenes* throughout 45 days of storage, in accordance with legal limits. Multivariate analysis revealed significant correlations between texture and composition, highlighting the positive influence of vacuum packaging and thermal regime on final product quality.

It is concluded that water immersion sous-vide is an effective technique for producing marinated chicken meat with enhanced technological quality, extended stability, and microbiological safety, representing a promising alternative for the ready-to-eat food industry.

The industrial-scale sous-vide cooking enhances the technological quality of marinated chicken, resulting in a uniform texture and extended shelf life while ensuring microbiological safety. Compared to traditional cooking methods, this approach minimizes moisture loss and color deterioration, increases product consistency, and reduces the need for additives, resulting in cleaner labels. In addition, sous-vide offers relevant economic and energetic advantages for industry: precise temperature control can lower energy consumption, higher moisture retention improves yield, and extended stability reduces product waste and enhances distribution efficiency. These factors make sous-vide a competitive and cost-effective alternative for ready-to-eat poultry products.

Concentration of skim milk using a multistage filtration cascade

The goal of a German study published in the **International Dairy Journal** is to develop a multistage membrane filtration cascade using reverse osmosis (RO), nanofiltration (NF), and ultrafiltration (UF) to produce skim milk concentrate. Using the cascade or evaporation, skim milk concentrates with a dry matter of 40 %, 45 %, and 50 % were produced before being spray dried to produce skim milk powder.

Ceramic rotating disc membranes were used to process the highly viscous skim milk concentrate in the UF stage of the cascade. By recycling the permeates of the NF and UF stages of the cascade, the composition of the final UF retentate was close to that of regular skim milk concentrate. The flux of the membrane cascade ranged from 0.9 to 13 kg m^{-2} h^{-1}. The concentrates showed some differences in composition and viscosity, resulting in only minor variations in the functional properties of the skim milk powders. Membrane cascades are an emerging technology for concentrating skim milk.

Compared to evaporators, membrane cascades mostly require electrical energy. This means that their use could reduce the environmental impact of the dairy sector.



Improving functionality of the milk protein concentrates with improved functionality

Hydrodynamic cavitation (HC) and ultrasonic (US) treatments were applied by Indian Researchers to modify milk protein concentrates (MPCs) and enhance their techno-functional properties.

Treatments were conducted at 6 MPa for 0-30 min (HC) and 20 kHz at 200-600 W (US). Both cavitation techniques significantly improved emulsifying, foaming, and solubility characteristics of MPCs. The emulsifying activity increased by up to 110% at 600 W, while foaming capacity improved by over 200% at 6 MPa, following 20 min treatments. A marked increase in protein solubility (up to 99.6%) and reduction in particle size (from 4.82 μm in control to 0.94 μm for US-treated and 1.35 μm for HC-treated samples) indicated disaggregation and unfolding of protein aggregates. Spectroscopic analysis further confirmed alterations in the secondary structure, with reduced amide I intensity and slight band broadening, signifying partial unfolding and exposure of hydrophobic residues. These structural modifications directly correlated with improved surface activity, resulting in enhanced emulsifying and foaming behavior. SDS-PAGE analysis confirmed the absence of protein degradation, indicating that cavitation induced conformational rather than chemical changes. Overall, the findings substantiate that cavitation treatments effectively unfolded protein structures and exposed hydrophobic groups, leading to improved functional performance.

This study published in **Sustainable Food Technology** journal highlights the potential of scalable cavitation processes for producing high-performance, clean-label dairy ingredients suitable for industrial food applications.



Improvement of physicochemical and flavor properties of brined beef

To improve the physicochemical and flavor quality of brined beef, Chinese Researchers introduced microwave-assisted brining technology.

The process parameters were optimized through single-factor experiments and response surface methodology, determining the optimal brining conditions as a brine temperature of 90°C, brine time of 105 min, and microwave time of 85 s. Results showed that, compared with the traditional water bath method, the microwave-assisted technology significantly enhanced the chewiness and textural lightness of the beef, and increased the free amino acid content by approximately 37%. Microstructural analysis revealed an expansion in meat fiber gaps, which facilitated the penetration of flavor compounds. A total of 59 volatile compounds were identified, primarily aldehydes and alkanes, with several unique flavor components generated by microwave treatment.



This study, published in **Food Research International** journal proposed a novel microwave-assisted technique for developing high-quality brined beef, potentially offering a new approach for the precise control of flavor and texture in the meat industry.

Enhancing soak resistance of ready-to-eat cooked noodles



A Chinese study published in **Food Chemistry: X** has developed ready-to-eat noodles obtained from wheat flours from grains subjected to accelerated post-ripening, with the aim of delaying structural deterioration during immersion in water.

Changes in the textural properties, water status and migration, and protein network were determined. After wheat grains tempered with glucose oxidase (GOD) solution, firmness and elasticity of immersed noodles were improved by 40.82% and 73.50%, respectively. Meanwhile, various treatments significantly (p<0.05) decreased the sodium dodecyl sulfate extractable proteins content by promoting protein cross-linking. Furthermore, more compact gluten network and slower water intrusion were observed in GOD, transglutaminase, and O_3 groups. And GOD group exhibited the tightest protein network and lowest water absorption during immersion. This indicated that the enhanced protein polymerization restricted water migration and textural deterioration.

Therefore, GOD tempering-induced accelerated post-ripening of wheat grains represents an innovative approach to improving the cooked noodles' soak resistance by strengthening the initial protein network.

Improved rehydration characteristic of micellar casein powder

Micellar casein (MC), a key protein derived from milk, is extensively utilized in the food sector. Nevertheless, the practical application of MC powder is constrained by its inadequate rehydration performance. A Chinese study investigated the effect of electrostatic spray drying (ESD) on the rehydration properties of MC powder, as well as compared its performance with those of freeze drying (FD) and spray drying (SD). ESD powder showed a quick dissolution and dissolved nearly 96% within 16 h, showing a higher stability of MC solution without sediment. In contrast, FD and SD powders showed lower solubility (85% and 75%). ESD-produced MC powder exhibited higher kappa-casein and faster water erosion, leading to rapid size reduction (<200 nm) upon rehydration minimal hydrophobic exposure, and improved hydration efficiency.

This study published in **Food Chemistry: X** journal demonstrates that ESD can effectively improve the hydration properties of MC, establishing a theoretical foundation for industrial manufacturing processes of high quality MC powder.



Effect of freezing and cooking on sodium nitrite content in processed meat

Sodium nitrite ($NaNO_2$) is a bacteriostatic preservative widely used in the meat industry. However, as a food additive it can have a harmful effect on human health, for example by contributing to methemoglobinemia and anemia, and may also be a precursor of mutagenic, teratogenic and carcinogenic *N*-nitrosamines.

The aim of a Polish study was to evaluate the effect of freezing and cooking on $NaNO_2$ content in selected processed meats. The analysis was performed by molecular absorption spectroscopy using a UV-Vis spectrophotometer. The sodium nitrite content in the control meat products ranged from 1.54 to 26.20mgkg^{-1}. For most of the analyzed processed meats, freezing significantly reduced the content of sodium nitrite from 3.33% to 47.51% (p<=0.05 or p<=0.01). A very significant decrease in $NaNO_2$ was found for all cooked meat samples, i.e., from 26.46% to 80.98% (p<=0.01).



These findings, published in **Journal of Food Composition and Analysis**, suggest that cooking and freezing/thawing processes effectively reduce residual sodium nitrite in meat products, subsequently lowering consumer exposure through the diet. In all analyzed products the content of this preservative was within acceptable limits.

24-month shelf-life achievement in frozen whole milk concentrate

Optimizing the freezing process is crucial for extending the shelf-life of whole milk concentrate (WMC) by controlling ice crystal formation. However, a systematic approach to precisely control the freezing plateau period-the critical phase for ice crystal growth-during industrial-scale freezing of WMC is lacking.

A Chinese study investigated the effects of freezing rates (measured as 0°C to -6°C time) and storage temperature on WMC quality. The novelty of our approach lies in the coordinated control of the initial WMC temperature and the ambient freezing temperature to actively manage the plateau period. Lowering cryogenic chamber temperatures from -30°C to -50°C reduced the plateau period by 45% and the time to -6°C by 23%. Initiating freezing at -2.5°C, bypassing initial nucleation, further shortened the time to -6°C by 27%. Extreme



freezing at -80degreeCnearly eliminated the plateau. Cryo-SEM analysis confirmed that faster freezing minimized ice crystal size. Critically, WMC stored at -1°C remained microbiologically and physiochemically stable for 24 months, whereas samples at 4°C spoiled within 1.5 months. In conclusion, the proposed strategy of targeting the freezing plateau period through coordinated temperature control enables a 24-month shelf-life for WMC at -18°C.

This work, published in **LWT - Food Science and Technology** journal, provides a novel and practical framework for quality preservation in the dairy industry, offering a viable alternative to traditional thermal processing for long-term storage. Furthermore, it advances the current understanding of ice crystal management in concentrated dairy systems by establishing a direct link between controllable freezing parameters, ice morphology, and ultimate storage stability.

Relationships between gluten proteins and texture in low-hydration dough

Rheological properties of wheat dough are closely related to flour compositional and physical characteristics and are essential for dough handling and end-product quality. While gluten development has been extensively studied in high-hydration doughs, limited research exists on low-hydration doughs, such as those used for crackers and noodles.

AN US study investigates the molecular mechanisms underlying dough rheology under low-hydration conditions, focusing on the role of gluten proteins in dough extensional behavior. Nineteen soft wheat flours with different protein characteristics were analyzed for protein content and composition. Corresponding doughs were evaluated using integrated measurements linking protein composition and secondary structure, molecular mobility, and dough extensional rheology. Among the textural parameters assessed, distance to bioyield emerged as the most repeatable and effective indicator, differentiating flours based on high-molecular-weight glutenin subunit (HMW-GS) content and profile. HMW-GS content exhibited positive correlations with molecular mobility, intermolecular beta-sheet abundance, and dough extensibility to both the bioyield and rupture points, as well as enhanced intermolecular beta-sheets and increased molecular mobility. This mechanistic insight provides a valuable framework for wheat breeders to consider HMW-GS profiles when developing varieties tailored



area under the force-extension curve.

These findings published in **Food Research International** journal suggest that under low-hydration conditions, dough texture is strongly dependent on HMW-GS content through for low-hydration applications. Moreover, it offers manufacturers a scientific basis for innovating quality control and processing strategies, enabling the design of soft wheat flours optimized for specific product categories such as crackers and noodles.

Upcycled ingredients: from waste reduction to a new frontier of food value

The recovery of food waste is no longer just a virtuous practice – it is becoming a true industrial model. Upcycled ingredients, derived from the valorization of by-products and agri-food surplus, are emerging as one of the most dynamic trends in the global food landscape, aligned with the goals of circular economy and sustainability.

According to the **HTF Market** report, the global upcycled ingredient market is expected to grow from USD 3.4 billion in 2025 to USD 12.8 billion by 2033, with a compound annual growth rate of 18.1%. This significant acceleration is driven by food waste reduction policies, increasing environmental awareness among consumers, and the search for new sources of nutritional value.

From waste to resource

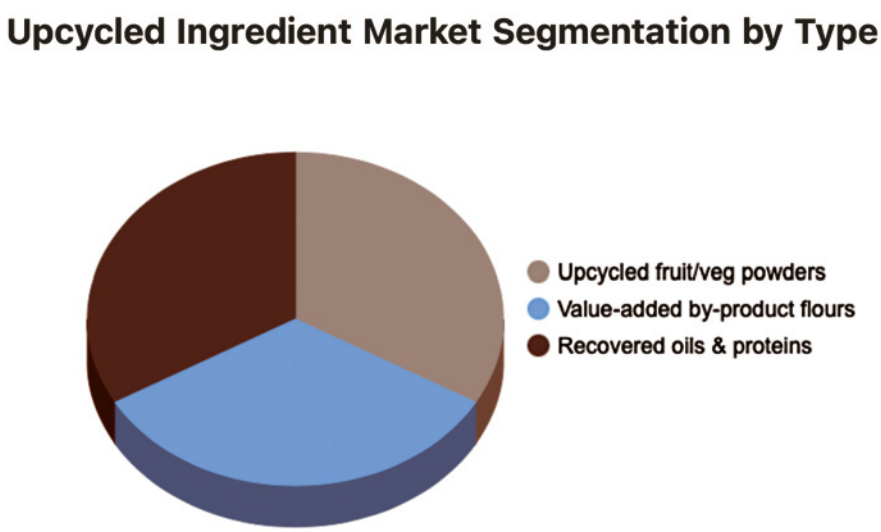
At the core of upcycling lies the transformation of raw materials that would otherwise be discarded: fruit pulp from juice production, spent grains from brewing, and imperfect fruits and vegetables that do not meet aesthetic standards, now recovered and converted into flours, powders, or functional extracts. As highlighted in the market chart on page 2 of the report, these solutions not only contribute to waste reduction but also introduce new ingredients with high nutritional and technological value.

Industry interest spans a wide range of applications, including snacks and bakery products, functional foods, fortified beverages, and even animal feed, as shown in the segmentations on pages 6 and 7 . At the same time, the sector is expanding into cosmetics and nutraceuticals, further broadening market opportunities.



Innovation and sustainability as competitive drivers

The growth of the sector is closely linked to companies' ability to integrate sustainability with innovation. Upcycled ingredients enable brands to communicate a more efficient and responsible supply chain – an increasingly important element in branding



strategies. Storytelling around waste reduction and resource valorization has become a powerful tool for differentiation.

From a technological standpoint, key challenges include raw material stabilization, quality standardization, and process scalability. Innovation is focused on extraction and transformation techniques that preserve nutrients and ensure food safety, while maintaining cost competitiveness compared to conventional ingredients.

Challenges and growth prospects

Despite strong momentum, the sector faces several challenges. The variability of raw materials, inherent to by-products, can affect consistency and quality. In addition, limited consumer awareness still represents a barrier to mainstream adoption, as does the lack of harmonized regulatory definitions at the international level.

At the same time, opportunities are substantial. Partnerships between food manufacturers and processing operators help secure consistent raw material streams, while innovation in shelf-stable products – such as powders and flours – supports industrial scalability. E-commerce is also playing a key role in giving visibility to niche brands and accelerating the adoption of upcycled ingredients.

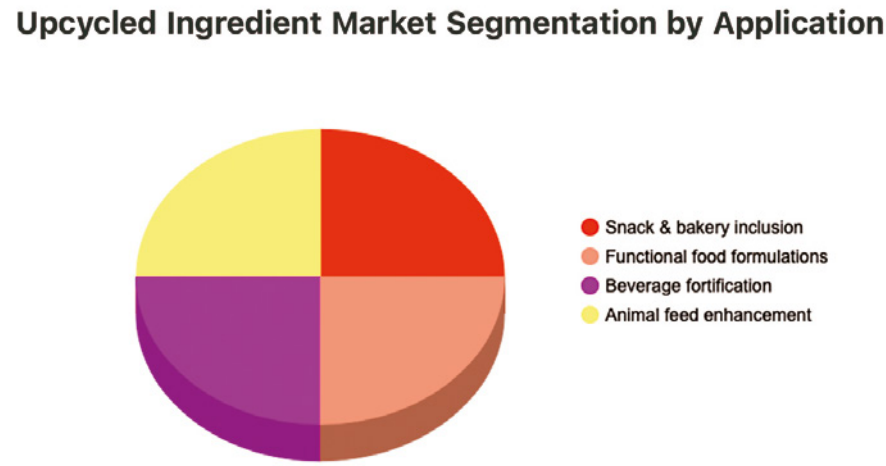
Geographies of growth

From a geographical perspective, North America currently leads the market, supported by a dynamic ecosystem of start-ups and major food companies engaged in waste valorization. Europe, identified as the fastest-growing region, benefits from EU policies promoting circular economy and food waste reduction, as highlighted in the regional analysis on page 10 . Asia-Pacific shows growth potential driven by the availability of agricultural by-products, while Latin America offers significant opportunities, albeit constrained by infrastructural limitations.

Toward a new industrial paradigm

Food upcycling is part of a broader transformation of production systems, where resource efficiency and sustainability are becoming key drivers of competitiveness. It is not only about reducing waste, but about redefining the value of raw materials, turning what was once considered a cost into a new economic opportunity.

In this perspective, upcycled ingredients are no longer a niche, but a rapidly expanding segment, contributing to the development of a more resilient, circular, and future-oriented production model.
htfmarketreport.com



FoodTech Village: The Digital Ecosystem Connecting Innovation, Technology and the Food Industry

A Platform for the Future of Food & Beverage

Digital transformation and the accelerating pace of innovation are profoundly reshaping the food industry. In this context, **FoodTech Village** was created as an international platform developed by Chiriotti Editori with the aim of establishing a permanent meeting point for companies, startups, researchers, technology providers, and professionals operating across the food and beverage sectors. The project serves as a digital ecosystem dedicated to knowledge sharing, professional networking, and the promotion of innovations that are redefining the future of the Food & Beverage industry.

Unlike traditional trade fairs, which are limited by time and location, FoodTech Village operates as a year-round platform, enabling companies to showcase products, technologies, services, and expertise to an international community of specialized professionals. Its primary objective is to facilitate the connection between innovation supply and demand, creating tangible opportunities for collaboration and business development.

The scientific direction of the project is entrusted to Professor Sebastiano Porretta, President of the Italian Association of Food Technology (AITA), whose expertise helps ensure the technical rigor and scientific quality of the content provided.

Specialized Content and Continuous Knowledge Sharing

One of the distinguishing features of FoodTech Village is the breadth and diversity of its content. The platform covers a wide range of food industry sectors, including bakery and confectionery, beverages, cereals and pasta, ingredients, dairy products, meat and seafood, as well as fruit and vegetable processing and food manufacturing technologies.

Particular attention is given to the key drivers shaping the future of the industry, such as industrial automation, robotics, artificial intelligence, sustainable packaging, food safety, quality control, process digitalization, nutrition, and health. Through technical articles, in-depth analyses, application case studies, and presentations of emerging technologies, FoodTech Village provides food professionals with a valuable source of continuous professional development and industry insights.

The platform also hosts an extensive program of webinars and specialized workshops. These events explore highly relevant topics, including the gluten-free market, new generations of non-alcoholic beers, advanced packaging solutions, innovative ingredients, and emerging food industry trends. Content is developed with contributions from experts representing industry, academia, and applied research institutions, offering participants a multidisciplinary perspective on current challenges and future opportunities.

Workshops are designed around an interactive approach, featuring discussion sessions, case studies, and practical insights that facilitate the transfer of knowledge directly applicable to industrial production environments.

Networking, Visibility and Innovation Growth

Beyond its informational role, FoodTech Village functions as a strategic networking platform. The initiative was conceived to foster connections among innovators, startups, technology suppliers, and established companies, creating a digital environment capable of accelerating innovation adoption and encouraging the development of new industrial partnerships.

Companies can leverage the platform to enhance their international visibility and present machinery, raw materials, ingredients, specialized services, and technological solutions to a highly qualified audience. At the same time, industry professionals gain access to a network of expertise and knowledge that facilitates the identification of technology partners and business opportunities.

An additional source of value lies in the networking activities organized through webinars, virtual roundtables, thematic events, and online meetings.

FOODTECH
VILLAGE



Welcome to FoodTech Village

New Project: discover the Future!
FoodTech Village is the latest groundbreaking initiative by Chiriotti Editori, designed to revolutionize the food & beverage industry by creating a virtual space for innovation, networking, and growth.

Innovation and excellence converge – FoodTech Village is your virtual destination where the future of food & beverage unfolds.
Imagine a global mall, open 365 days a year, without boundaries or limits. FoodTech Village connects you to pioneering companies worldwide.


Analysis and Control


Automation and Logistic


Bottling and Packaging


Hygiene and Safety


Processing


Services and other

CHIRIOTTI EDITORI

Are you ready to revolutionise your approach to the world of food & beverage?

www.foodtechvillage.com

These initiatives enable participants to build professional relationships that extend beyond geographical boundaries and contribute to the development of an international community focused on innovation.

In an environment increasingly shaped by complex challenges – from environmental sustainability and digital transformation to food safety and evolving consumer expectations – FoodTech Village stands out as a digital hub that effectively integrates information, education, and networking. Its mission is to support the growth of a more innovative, sustainable, and competitive food ecosystem by connecting the expertise, technologies, and ideas that will shape the future of the global Food & Beverage industry.
foodtechvillage.com

Ipack-Ima 2028, a Global Ecosystem for Packaging and Processing

Ipack-Ima 2028 is preparing to strengthen its role as an international platform for packaging, processing and innovative materials technologies. The next edition, scheduled to take place at Fiera Milano from 29 May to 1 June 2028, was presented on 8 May at Messe Düsseldorf, with a focus on market data, new projects and strategic partnerships.

"Ipack-Ima 2028 is a constantly evolving system, built on the idea that innovation is an art, expressed through the ability to listen to markets, anticipate transformations and provide excellent technical solutions," stated President **Valerio Soli**. "The platform we have created reflects the aptitude of our sectors to combine creativity, technology and vision, as well as the exhibition's ability to intercept market demands and provide the answers required, always looking towards the future: global company, local roots."

The exhibition project is developing as an integrated ecosystem capable of connecting Milan with the main global markets through vertical events, industrial collaborations and specialised communities. Alongside Ipack-Ima, Pharmintech by Ipack Ima, dedicated to the Pharma and Life Science sectors, has been confirmed, while Bevertech – created through the partnership with UIV, Unione Italiana Vini, and Simei — will debut in 2026 as an event dedicated to the Liquid Food & Beverage sector.

At an international level, the ProPak network, developed with Informa Markets, strengthens the exhibition's presence in Southeast Asia, India, Africa and South America. This structure is complemented by the Ipack-Ima Business Communities, organised around high-potential sectors including Grain Based Food, Liquid Food & Beverage, Food Fresh & Convenience, and Pharma & Life Science.

Among the main innovations planned for the 2028 edition is the introduction of a Technical Scientific Committee designed to guide the exhibition's content and technological development paths. Smart Factory will also expand, featuring complete operating lines and daily live shows, together with Ipack-Mat, the area dedicated to innovative materials. Smart Talks will be distributed directly throughout the exhibition halls, bringing techni-



cal knowledge and professional updates closer to where business takes place.

The partnership architecture represents one of the central elements of the strategy. UCIMA and Fiera Milano form the institutional and operational foundations, while BolognaFiere, UIV, Simei, Informa Markets and Deutsche Messe contribute to creating a broad and complementary exhibition offering. The simultaneous presence of Intralogistica Italia will further strengthen the connection between packaging technologies, internal handling and industrial logistics.

Ipack-Ima 2028 therefore positions itself as a highly technical and strategic event, focused not only on showcasing machinery and solutions, but also on building relationships, expertise and visions for the future of packaging, processing and advanced materials. *ipackima.com*

Cibus Tec 2026 Accelerates Growth and Strengthens Its International Dimension

Cibus Tec is set to return to **Parma from 27 to 30 October 2026** with growing figures and an increasingly international profile. The 54th edition of the exhibition dedicated to food and beverage processing technologies is approaching a sold-out status for exhibition space, confirming the strong market interest in one of the world's leading food technology events.

Forecasts indicate that the event will exceed 1,300 exhibitors and brands, more than 40,000 square metres of exhibition space, and over 40,000 professional visitors, with international exhibitors accounting for more than 30% of the total and over 3,000 international buyers participating through the Top Buyers Program. Special attention will also be given to African markets through the Cibus Tec for Africa initiative, which will bring more than 100 new buyers from high-potential countries to Parma.

One of the key highlights of the 2026 edition will be the hosting of **World Pasta Day**, which will take place in Parma for the first time in its history. Organized by Unione Italiana Food and the International Pasta Organisation, the event will bring together manufacturers, technology suppliers, retailers, and institutions to celebrate pasta as an icon of Italian food excellence.

Special attention will also be devoted to the beverage and bakery sectors through the "Beverage? Yes, We Tec" and "Bakery? Yes, We Tec" initiatives, designed to showcase the latest technologies and innovations for these industries. The exhibition will further feature workshops, startup areas, a Demo Factory with fully operational production lines, and dedicated programs focusing on artificial intelligence, automation, and digitalization in the food industry.

"The contribution of Koelnmesse represents a strategic accelerator for Cibus Tec's growth and its positioning in global markets," said Thomas Rosolia, President of Koeln Parma Exhibitions and CEO of



From left: Cristiano Laurenza, Director of the Legal, Economic and Internationalization Area of Unione Italiana Food and General Secretary of International Pasta Organization, Antonio Cellie, CEO of Koeln Parma Exhibitions and Fiere di Parma, Thomas Rosolia, President of Koeln Parma Exhibitions and CEO of Koelnmesse Italia, and Fabio Bettio, Director of Labotec

Koelnmesse Italia, highlighting the value of the international network built around the group's leading trade fairs.

Antonio Cellie, CEO of Koeln Parma Exhibitions and Fiere di Parma, also emphasized the unique role of the event: "Cibus Tec is the only exhibition capable of bringing together, in one place, all the technology and innovation supply chains serving the food and beverage industry." According to Cellie, this makes the show a privileged observatory of the solutions that will drive the industry's competitiveness in the years ahead.

Innovation will play a central role throughout the exhibition, with dedicated initiatives such as the Demo Factory, Startup Area, and Talent Academy, alongside the Food 5.0 conference focusing on automation, artificial intelligence, and process digitalization.

Commenting on the new partnership with Federvini, Director Gabriele Castelli stated that "Cibus Tec is increasingly becoming a showcase for new technologies applied to the food industry, including wine," announcing a workshop entirely dedicated to the wine sector that will bring together producers, technology suppliers, and institutions to discuss sustainability and international competitiveness.

Running alongside Cibus Tec, **Labotec 2026** will provide a dedicated platform for laboratory technologies, hosting more than 200 exhibitors and 5,000 specialized professionals. Together, the two events will reinforce Parma's role as a leading international hub for innovation in food production, laboratory sciences, and industrial technologies.

cibustec.it

INTERNATIONAL EVENTS IN ITALY

21-23 October 2026 - Trieste: Triestespresso, coffee show – www.triestespresso.it

27-28 October 2026 - Parma: Labotec, laboratory and analysis show- www.labotec.one

27-30 October 2026 - Parma: CibusTec, food processing show - www.cibustec.it

17-20 November 2026 - Milano: Simei, beverage and wine industry show - www.simei.it

13-14 January 2027 - Bologna: Marca, private label food show - www.marca.bolognafiere.it

23-27 January 2027 - Rimini: Sigep, confectionery, pastry and ice cream show - www.sigep.it

21-23 February 2027 - Rimini: BBTech, beer technology show - www.bbtechexpo.com

21-23 February 2027 - Bologna: Sana Food, organic food show – www.sana.it

28 February - 2 March 2027 - Verona: Sol2Expo, olive oil show - www.solverona.com

11-14 April 2027 - Verona: Vinitaly, Italian wine show - www.vinitaly.com

15-17 April 2027 - Bologna: Cosmofarma, functional and nutraceutical show - www.cosmofarma.com

20 - 22 April 2027 - Rimini: Macfrut, fruit and vegetable processing show – www.macfrut.com

4-7 May 2027 - Parma: Cibus, food show - www.cibus.it

18 - 20 May 2027 - Milano: Packaging Première - luxury packaging show - www.packagingpremiere.it

25-27 May 2027 - Parma: SPS Italia – automation and digital show - www.spsitalia.it

23-26 October 2027 - Milano: Host, foodservice show - host.fieramilano.it/

10-12 November 2027 - Bologna: Refrigera, freezing and refrigeration show - www.refrigera.show

2-5 February 2028 - Verona: Fieragricola, agricultural technologies show - www.fieragricola.it

16-17 February 2028 - Parma: Solids, powder and bulk processing show - www.solids-parma.de

8-11 May 2028 - Milano: Tuttofood, food show - www.tuttofood.it

29 May - 1 June 2028 - Milano: Ipack-Ima, packaging, food processing and pasta show - www.ipackima.com

THE REFERENCE PORTAL FOR FOOD INDUSTRY PROFESSIONALS

VISIT OUR WEBSITE

foodexecutive.com

INFORMATION. CONNECTIONS. OPPORTUNITIES. ALL IN ONE PLACE.



NEWS & INSIGHTS

Daily updates on trends, markets and innovations in the food industry.

COMPANIES & LEADERS

Discover the leading companies in the food industry and their key players.

PRODUCTS & SOLUTIONS

New products and technologies for a more competitive industry.

EVENTS & TRADE SHOWS

The complete calendar of events in Italy and around the world.

FOOD EXECUTIVE CLUB

The exclusive network to connect, build relationships and create new business opportunities.

YOUR BUSINESS DESERVES THE RIGHT VISIBILITY.
FOOD EXECUTIVE IS YOUR STRATEGIC PARTNER.

DISCOVER, CONNECT, GROW.

VISIT FOODEXECUTIVE.COM

Advertiser index

Ammega Italia/Megadyne - Mathi - www.megadynegroup.com **25**
Foodexecutive.com **71**
Foodtechvillage.com **55-67**
General System Pack - Schio - www.gsp.it **35**
Gerhard Schubert - Crailsheim (D) - www.schubert.group **47**
IFP Packaging - Schio - www.ifppackaging.it **19**
M.H. Material Handling - www.mhmaterialhandling.com ..... **cover 1-39**
P.E. Labellers - www.pelabellers.com ..... **cover 2**
Pinco - Stabio (CH) - www.pinco-sa.com **7**
Tecno 3 - Corneliano d'Alba - www.tecno-3.it ..... **cover 4**
Tecno Pack - Schio - www.tecnopackspa.it ..... **cover 3**
Wolhfarth - Sordio - www.wolhfarth.it **13**

Company directory

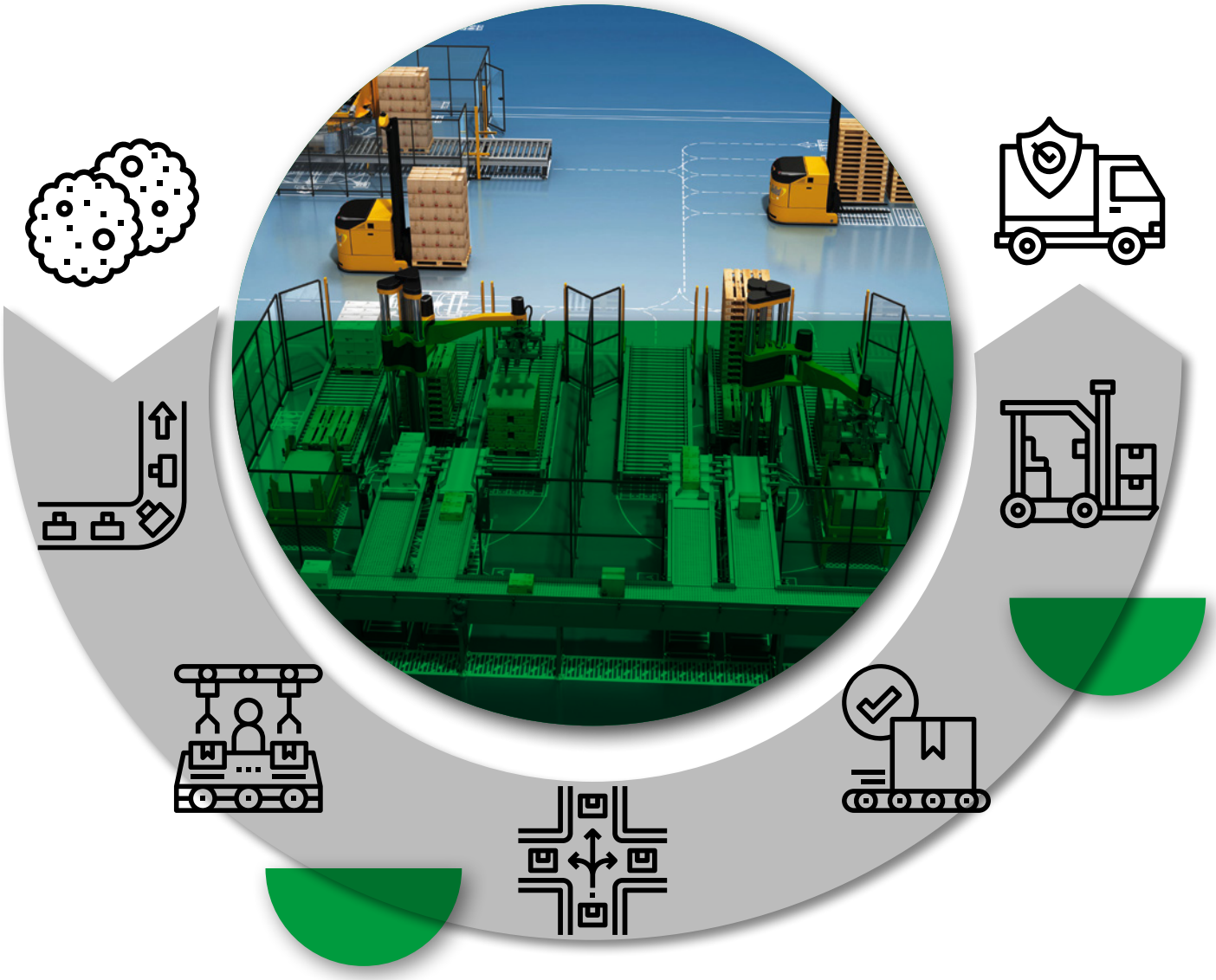
Ammega Italia/Megadyne **22**
Fristam Pumpen **21**
Gerhard Schubert **23**
M.H. Material Handling **20**
Tecno 3 ..... **18**



TECNOPACK GROUP

POWERING PACKAGING EXCELLENCE.

Through superior engineering, tangible sustainability,
and boundless performance.



+39 0445 575 661
Via Lago di Albano, 76 - 36015 - Schio (VI) - Italy
comm@tecnopackspa.it - www.tecnopackspa.it

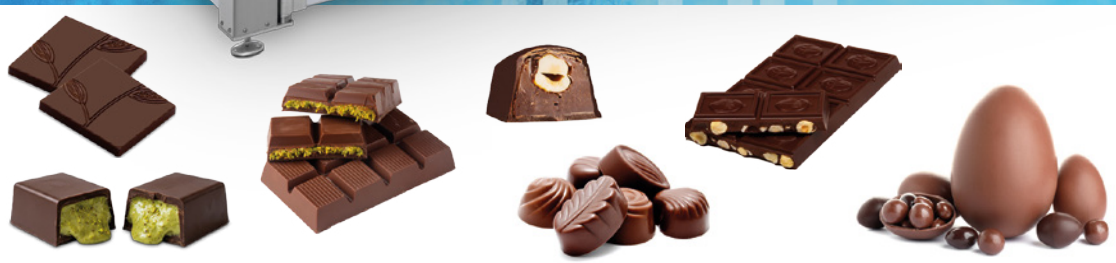
FROM LOOSE TO LOADED.

Tecno Pack designs and integrates complete lines
that transform your unpackaged product
into a truck-ready load.
Seamlessly. Efficiently. Ready for the world.

LMR | ROBOTIZED MOULDING LINE

Stop to complex mechanics,







INNOVATIVE
FLEXIBLE
COMPACT
CONSISTENT
PRECISE

– 90% **of mechanical parts** compared to conventional systems **of electronic timing synchronisms**

- **Reduced energy consumption**
- **Hygienic design**: maximum hygienic-sanitary standard
- **Reduced footprint**
- **Interchangeable depositors with quick-release couplings**
- **Extremely low maintenance requirements**
- **MOCA-certified materials** (materials suitable for food contact)
- **Modularity and versatility**: custom configurations for every production need



let's meet at PACK EXPO Stand **S-2391**

TECNO 3
Chocolate and Confectionery Technology

Headquarters: Tecno 3 S.r.l. - Corneliano d'Alba - ITALY
Tecno 3 Switzerland Tecno 3 USA INC
+39 0173 61.05.64 • www.tecno-3.com