Power to the plants:

Ingredient innovation in the plant-based category

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A flexible relationship with meat and dairy: Understanding the plant-based consumer

Progress in the alternative protein sector is being driven by a multi-faceted audience, according to the Good Food Institute Europe (GFI Europe), a nonprofit think tank, and plant-based and cultivated meat production advocacy firm.

Surprisingly, the primary group for non-meat and non-dairy options is not the loyal vegetarian or vegan consumer, even though these consumer sets play an important role in sustaining the category.[1] The flexitarian is the prized consumer segment pushing plant-based foods to the forefront.[2] This group of consumers typically eats meat and fish but will add in plant-based options in lieu of meat from time to time.

Case in point: Veganuary, which marked a 10-year anniversary in January 2024, is the one month the year where meat-eaters opt into a vegan diet for a full 31 days. It has been reported that in 2023, 700,000 people around the world either completely gave up or significantly reduced consumption of animal products.[3] Innova Market Insights' Plant-Based Consumer Trends in Europe trend report found that one-quarter of European consumers call themselves flexitarian.[4] Further, according to Innova's report, about one-quarter of consumers globally follow a flexitarian diet.[5]

Citing the EU's Smart Protein Project's Smart Protein Report, GFI Europe's research and resource manager, Helen Breewood, said more and more people are reducing their meat and dairy consumption.[6] The report found that flexitarians in Europe span the generational spectrum ranging from 26% of Gen Zers to 29% of Baby Boomers. Those who observe a strict vegetarian or vegan diet, however, are more common among younger generations, with 7% of Gen Zers following a vegan diet.

“Despite a shared interest in meat reduction across age groups, companies should consider tailoring their products and marketing strategies towards different target audiences,” Breewood stated.

In any case, the numbers look positive. In its market report, SPER market research, predicts the European plant-based food market will reach $24.62 billion by 2033 with a compound annual growth rate (CAGR) of more than 10%.[7]

Looking to beyond Europe, Innova’s Plant Based Consumer Trends in Europe[8] report found that 10% of the world’s population follows a vegetarian lifestyle, with only 2% of the world identifying as vegan, and those consumers are found mostly in Germany and India. An even higher proportion of consumers, one-third, follow a flexitarian diet in China, according to the trend report.

Plant-based purchase drivers: Personal and planetary health

In addition to simply switching meal choices, consumers are gravitating to alternative protein sources because their personal values align heavily with supporting sustainable food cultivation, concern for animal welfare, and a belief that eating plant-based foods contributes to a healthier lifestyle.

"Consumers claim that naturalness, digestive health, and protein intake are the top health-related reasons for consuming dairy alternatives and meat alternatives," according to Innova.[9]

Finally, there is a growing segment of consumers with food sensitivities or intolerances to common ingredients like lactose leading consumers to try plant-based alternatives to avoid triggers from cow's milk.

Market intelligence firm, SkyQuest Technology found that 15% of all European retail milk sales in terms of dollars are made up of plant-based milk while in Finland and Sweden, over 14% of customers follow a lactose-free diet." [10]


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Replicating the real thing: The formulation challenge

Sales of meat and dairy alternatives dominate the plant-based space, with GFI Europe finding that plant-based meat and dairy captured 70% of the European market.[11] However, consumers have come to expect more than bland and colorless food choices. In response, non-meat and non-dairy drink formulators are working overtime to crack the proverbial code to create products that are tasty, offer a welcoming smell, and that look and feel like their animal-based counterpart. The difficulty is that making meat and other products without the animal can leave out critical components of the product.

When consumers purchases a beef steak, they expect to see marbling and fat, which, when cooked, gives it taste. Open a container of plant-based cream cheese and it will look nearly identical to a traditional dairy-based spread. However, the non-dairy alternative doesn't quite spread like a milk-based cream cheese and its slight dull grey color is a contrast to the bright white synonymous with cream cheese. The taste is close, but, again, not exactly the real thing. Similarly, if a consumer pulls apart a grilled cheese sandwich there is an expectation of a stretchy, gooey substance.

Most plant-based foods — until recently — have missed those key consumer touchpoints. However, food science researchers, chefs and others are embracing new technologies to create plant-based foods that replicate, at minimum, the look, feel and behavior of traditional animal-based foods.

"[Consumers] want foods that taste, look and feel like animal-based products without actually harming animals," said Wendy Frohlich, an independent food trend and marketing consultant focused on traditional and vegan food products and the emerging alternative protein space. "Think about the flexitarian – taste will sway them toward alternative protein sources", Frohlich said. In other words, taste is king.

Beyond soy, alternative dairy drinks incorporate a range of different bases such as almond, cashew, coconut, rice, oat, all of which can be transformed into several non-dairy spoonable and drinkable yoghurts, cheeses, creamers, ice creams, and butters. For non-dairy milks, the focus is first on meeting the taste and texture requirements to make the item more palatable to consumers, with the nutritional content of a protein boost coming in as a value add-on, Innova Market Insights pointed out.[12]

Ingredient innovation: Advances in food processing technology

The plant-based market globally is experiencing one of its greatest periods in innovation. These advances are owed, in part, to technological developments that will allow non-meat and non-dairy products to mimic the desired attributes of animal-based products, such as marbling and fat content typically found in meat or the gooey attributes of cheese, without sacrificing an animal.

The science behind next-generation plant-based food products, is still in early stages, with more novel approaches being launched all the time, said Nadia Grasso, PhD, programme manager at the Food Industry Training Unit (FITU) at Ireland's University College Cork (UCC). Grasso's food science technology research is focused on the formulation, processing, and functionality of plant-based alternatives to traditional cheese.

"Recent years have witnessed significant advancements in the development of [plant-based] products, with notable improvements in their characteristics compared to those available just a few years ago," said Grasso. "Nowadays we have a deeper understanding of the complexity involved in the formulation, processing, nutrition and sensory properties of these products," said Grasso.

According to Grasso, some of today's applications for plant-based food production are based on long-tested approaches such as extrusion, emulsion technologies, or fermentation. The twist is combining new raw materials with old approaches or entirely novel, advanced science-based approaches.

US-based food processing scaleup, Motif Foodworks, has licensed two novel technologies to create better plant-based products. For cheese specifically, the company partnered with the University of Guelph (Ontario, Canada) which developed a prolamin technology that Motif Foodworks has licensed to create an alternative cheese that stretches and melts like a dairy-based equivalent.

Plant-based alternatives are also using artificial intelligence for new product development and ingredient discovery. Plant-based dairy startup, Climax Foods (US launched a plant-based blue cheese that was developed using processes that “harness the intelligence of both humans and machines” using “deep-plant intelligence” to replace cow’s milk. [13]


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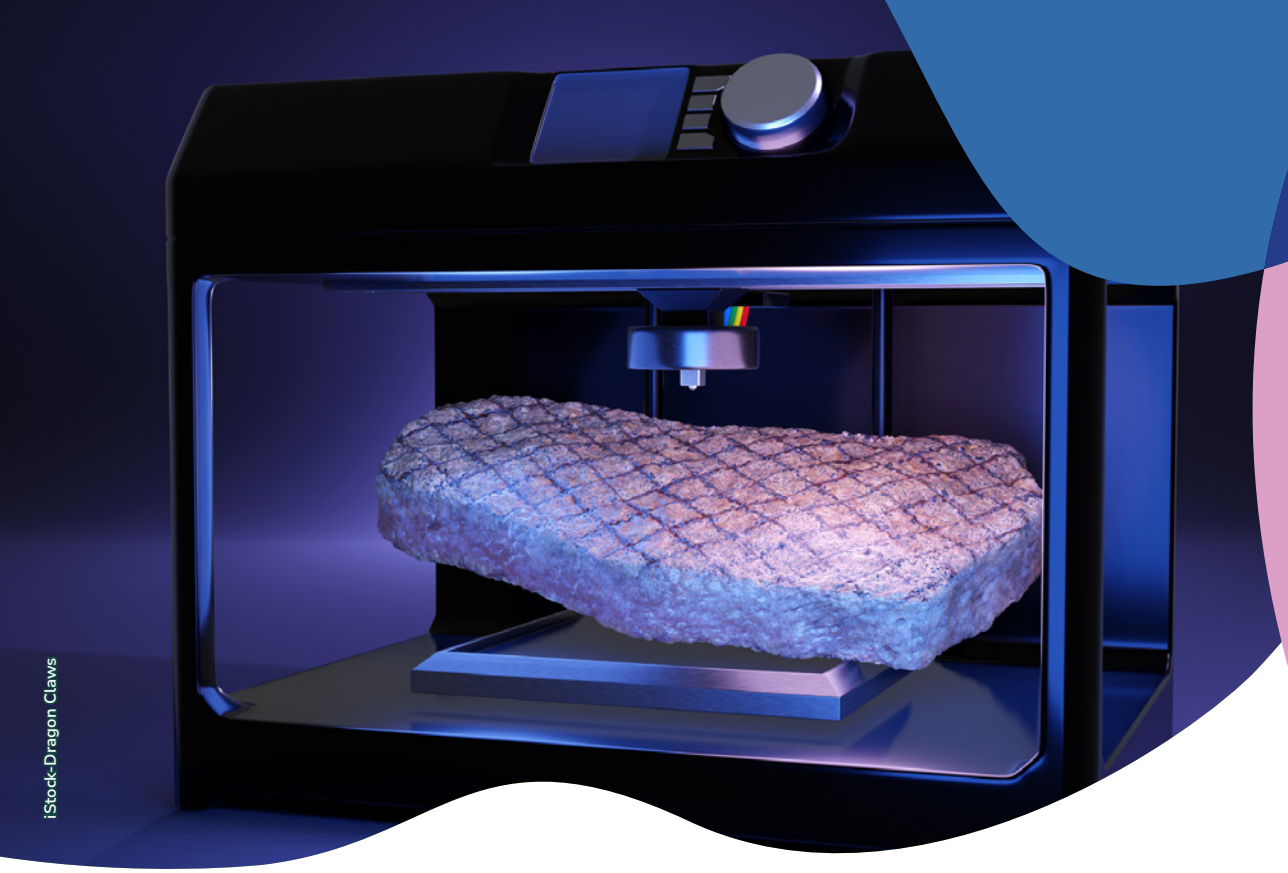

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Next-generation plant-based steak: From fibrous mycelium to extruded fats

The challenge for alternative meat formulators is creating a 'whole cut' approach, allowing brands to launch meat-substitutes that replicate the fibrous structure of a traditional steak or chop as opposed to the usual patty or sausage that consumers typically see.

Mycelium is one ingredient being used to replicate this. It can be grown in a solid-state process, whereby it is grown on a solid substrate, on liquid, and even in the air. UK startup Adamo Foods uses liquid state fermentation to produce its ingredient, forming it into slabs that can be cut into steak-like pieces. This allows it to make a highly realistic steak alternative thanks to the fungi's naturally fibrous structure, it says.

In order to replicate the marbling of a steak, Adamo Foods uses a blend of natural, flavoured plant-based fats.

"We have a blended fat throughout the product as well as a visual fat element that creates this succulence and tenderness – the mouthfeel [experience] that you get from biting into a whole-cut steak," said Nick Wood, COO of the startup. [14]

Motif Foodworks is using extrudable fat technology to recreate the marbled fat of animal meat in a plant-based, whole-cut alternative while its Appetex ingredient can be used to give plant-based meat the "springy" effect consumers want.

Researchers from the School of Food Science and Nutrition at the University of Leeds in the UK are transforming the taste of plant proteins from dry and dull to juicy and fat-like using water as the main activator. The process uses plant protein microgels – microgelation – to envelop the protein in water, giving it a moister mouthfeel. [15]

Grasso pointed to other emerging technologies, such as 3D printing and shear-cell as technologies coming into their own. These techniques, she said, “show promising results in mimicking the textural characteristics of animal products. These approaches have progressed significantly in the past few years and show great potential in possibly achieving large scale mass production”.

Making plant proteins more nutritious with high-power sonication

In the US, the University of Arkansas' agricultural experiment station, the research arm of its department of agriculture, is utilising new wave non-thermal protein extraction technologies to improve the nutritional value of plant-based meats and dairy products. Food scientist and grain processing engineer associated with the research, Mahfuzur Rahman, is experimenting with high-frequency sound waves, also known as high-power sonication. According to the university, sound waves break apart cell membranes to release proteins into a solution that can enrich plant-based foods.[16]

Atmospheric cold plasma is another emerging nonthermal technology that Rahman has used to improve the functionality of plant proteins. This type of plasma is less than (40 degrees Celsius) 104 degrees Fahrenheit and uses air to make plasma – an ionized gas and is one of the four natural states of matter following solid, liquid and gas – at atmospheric pressure.[17]

A recently published study by Rahman compared ultrasonication and atmospheric cold plasma technologies on improving the functional properties of mung bean protein.[18] In his study, the scientists found that both treatments improved gelling properties, an important attribute for processing plant-based meat alternatives and making plant-based desserts such as yoghurt and ice cream.

"Plant-based protein is healthier and more sustainable than animal-based protein, but because not all plant-based proteins are a 'complete' protein, one of my research areas is to find ways to make more plant-based protein complete by blending and [to] utilise that in a plant-based product," Rahman said.

Not so niche: Plant-based ice cream and butter

Ice cream is a small, but growing portion of the plant-based dairy category. Non-dairy ice cream alternatives offer indulgence and enticing flavours but are perceived to be healthier thanks to their use of plant-based ingredients.

According to Straights Research (US), plant-based ice cream is making a strong showing — and expected to continue to grow — in countries like Finland, Sweden, Denmark, Italy, and the UK. [19]

According to data released in 2023 from research firm, Custom Market Insights, the global market for plant-based ice cream is expected to see a 10.8% compound annual growth rate between 2023 and 2032, going from $685 million in 2023 and reaching $1.7 billion by 2032.

Germany-based startup, Planet A Foods, is using a proprietary technology that naturally ferments oats and sunflower seeds to recreate the flavours and fats in chocolate, creating a giant leap forward in the development of sustainable, cocoa-free alternatives, it says. [20]

Outside the cheese and ice cream category, plants are showing up as an alternative to dairy butter. Gavan, a startup based in Israel, has developed Fatrix, a plant-based fat-replacing ingredient using a proprietary platform and process that extracts proteins from plants in their natural state. The company says the proteins are then combined to form a cohesive structure that binds to vegetable oil and water, producing an effective and sustainable, synthetic-free fat replacer. The concept was created by a group of entrepreneurs including Israeli chef, Uri Jeremias. [21]

Savor, a US-based food technology company, has developed an animal-free butter alternative based on a combination of carbon, heat and hydrogen that forms chains, which are then blended with oxygen from air to make the fats and oils consumers have come to expect from traditional butters.

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Plant-based products and the ultra-processed backlash

Another trend expected to continue is where producers address the rising call for the exclusion of synthetic fillers used to bind the shape of products, often labelled as being ultra-processed foods (UPFs).

With rising consciousness and concerns, the UPF category is increasingly being challenged by a range of experts,[22] and research suggests that the ultra-processing designation may not have much to say about how healthy a product is, said Seren Kell, senior science and technology manager at GFI. WHO research has challenged the assumption that all UPFs are bad for health — finding products such as plant-based meat are not associated with problems linked to UPFs such as fizzy drinks.[23]

UPFs are foods that undergo multiple processes, such as extrusion, moulding or milling, contain many added ingredients, and experience high levels of manipulation.

"While people often label plant-based meat as a UPF, comparing these products against the typical definitions of UPF, it's clear they do not neatly fit," Kell told Ingredients Network recently.[24]

"Like the differences between plain white bread and seeded wholemeal bread, the nutritional makeup of different types of plant-based meat can vary a lot—but on the whole, they have a good nutritional profile, particularly compared to the red and processed conventional meat they often replace," Kell added.

Leveraging this nutritional element could therefore be crucial, with consumers seeing good-for-you claims of added nutrients like vitamin B12, iron, and more, as attractive.

Innova wrote in its trend report: "Protein content has been one of the main focus areas for companies wishing to market their products as healthy, and it is appealing to meat reducers looking for a high protein substitute. Front-of-pack messaging increasingly promotes if a product is high in protein, along with the amount of protein content."[25]

The road to growth: Investment, academic collaboration, and culinary partnerships

There is no one road to growth for plant-based foods in Europe. The GFI predicts more investment in the sector.

Laine Clark, senior corporate engagement manager for innovation at GFI US said: “From a startup perspective, we can expect to see more consistently well-positioned founding teams who de-risk their technologies and end products through unprecedented rigorous testing and analysis. If the past is prologue, the lessons learned in the sector’s infancy will pave the path for even greater investable innovation.”

Experts believe there will be more brands partnering with professional chefs to test ingredients and, eventually, spur real-life use cases. Confidence is based on the growing number of early-stage companies already boasting relationships.

New School Foods, for instance, is a Canadian start-up making plant-based seafood, that announced in 2024 a strategic partnership with plant-based chef Matthew Kenney. Kenney will join the startup’s New School Culinary Council (NSCC), an invite-only collective of chefs and restaurateurs from around the world, to guide product development and make preparation suggestions ahead of a planned commercial launch.[26]

Finally, increased collaboration between industry and academia is also important, with partnerships speeding up time from concept to market.

“I do see a solid future for plant-based foods,” said the University of Cork’s Grasso. “I have witnessed increasing interest within the food industry in the science of plant-based foods. This interest prompted us to develop a specialised short course – Formulation, Processing and Functionality of Plant-Based Alternatives to Cheese – tailored to meet the industry’s evolving needs.”

She added: “This course marks a significant milestone in our efforts to bridge the gap between academia and industry, and support realisation of the full potential of this dynamic area.”

Key takeaways

- Flexitarians are driving the plant-based foods market, demanding products that are highly similar to meat and dairy equivalents.
- Values-based buying remains an important element in consumer purchasing decisions with people attracted to plant-based products' sustainable credentials – but taste will always be the number one purchasing criteria.
- Novel processing technologies and ingredients are crucial to improving the sensory qualities of plant-based alternatives, taste, texture, and appearance, and a growing number of brands are leveraging artificial intelligence to aid with this.
- New product innovations can arise from applying old technologies to new ingredients, such as extrudable plant-based fats or liquid-state fermentation of mycelia biomass.
- The backlash against ultra-processed foods could potentially tarnish the image of some plant-based products. Brands should be mindful of the additives they use and how they are perceived.
- Partnerships – be they with academic institutions, investors, or culinary chefs – are important to driving the category forward.

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