



Global  
Insights

# Spotlight on ingredient innovation



Europe



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# New frontiers in health and wellbeing

Scientific research into how gut health impacts overall health and emotional wellbeing is growing, and this is creating an opportunity for the food and beverage market to deliver new products embracing this trend by using ingredients that are known to promote microbiome diversity and gut health. But how can brands communicate these benefits to consumers?

Meanwhile, interest in protein for health is still strong: one third of snack bar launches in Europe feature a high/added protein claim, which was once solely the domain of fitness enthusiasts. We look at some of the emerging trends around health and wellness and how manufacturers can tap into them.



# New plants: Equinom enhances biodiversity and functionality with plant-based food ingredients



Biodiversity underpins the world's food systems, but this foundation of organisms supporting and sustaining human life is fast declining due to unsustainable practices. Gil Shalev, CEO of Equinom, discusses how it is countering biodiversity loss and improving the healthiness and functionality of plant-based ingredients by creating new varieties of crops specifically designed to feed humans.

## *Segi Adewusi*

The foundation of the global food system is under threat. Around the world, large swathes of uncultivated woodlands, pastures and wetlands, home to much biodiversity, are being replaced with areas of monoculture farmed using pesticides and fertilisers. Crop output is high yet there are major disruptions to delicate ecosystems and their services that [keep soils fertile, pollinate plants, purify water and air, keep fish and trees healthy, and fight crop and livestock pests and diseases.](#)

“What if we can improve our food system from the ground up?” asked Shalev speaking at Fi Europe in Paris in December. Israeli-American food-tech company, Equinom develops sustainable non-GMO plant-based ingredients.

“What if we could restore biodiversity to our food supply by farming new varieties of non-GMO crops, that don't just grow well but are tasty, nutritious, and designed to feed people, not livestock. We know that shifting to a plant-based diet is necessary for a healthier and humane future.”

Despite an increase in plant-based diets, plant-based foods will never hit critical mass if taste, texture, and affordability are not delivered first, explained Shalev. According to a 2019 report by the [Food and Agriculture Organization of the United Nations \(FAO\)](#) plant diversity is decreasing in farmers' fields, less than 200 plant species cultivated for food significantly contribute to global food output, and only nine account for 66% of total crop production.

Biodiversity is important for safeguarding global food security and maintaining varied, healthy diets. With less biodiversity, humans have fewer species for food and plants and animals are more susceptible to pests and diseases.

Current global challenges affecting the food system such as loss and degradation of forest and aquatic ecosystems, pollution, overharvesting, and Russia's invasion of Ukraine disrupting the flow of commodities highlight the need for crop diversity to feed ever-expanding global populations nutritious food.

"[Equinom] is doing three major things. We are integrating to an existing supply chain; [...] we do not process the ingredient ourselves, but we are using partners. We are using their existing supply chain by elevating the supply chain and changing the grains," said Shalev.

### AI assists biodiversity

The Israeli food tech company uses its ingredient platform, Manna, and artificial intelligence to develop non-GMO ingredients for partnering food companies. By analysing millions of seeds in its database, Manna can predict breeding combinations to develop ingredients that meet exact specifications in half the time of traditional crop development cycles.

Restoring plant diversity naturally is important to Equinom, said Shalev. "[...] we take plants - very old plants that were [bred] one or two hundred years ago that contain the qualities of the traits that we are working upon - and we basically match them. It is non-GMO and non-gene editing."

Shalev describes Equinom as a "fully integrated food company" with an understanding of four core pillars - ingredients, food application, genetics, and how to produce genetics within the farming system.

"What is the technology behind what we are creating? I have seeds and dairy or an alt-meat application, and I need to combine those two parts. I need to understand how to close the gap. I need to develop two major engines: one that will enable me to take functional traits and convert them into biochemical components," explained Shalev. "What does that mean? Let's take oil-binding capacity or efficiency in extrusion. When I want to understand how to improve those traits, I need to understand the profile of the proteins that can enable me to have those benefits and those traits."

### From pea and soy to mung bean and cow peas

Equinom has pea and soy proteins available on the market, which the company has bred for over ten years. Yellow peas are currently grown in north America and processed to contain more protein with Equinom's technologies.

"[...] we are using existing factories, using peas, and we just changed the peas so now the same facility can create 65% even 70% protein," noted Shalev. "The genetics are powerful [and can] really change the entire food system in the way we process ingredients."

The company is currently working on other crops including chickpea, fava, mung bean, and cow pea (black eyed peas). Value to the food system is not only created by producing better ingredients but also the ability to create those ingredients in various locations, noted Shalev.

"People ask us, 'why mung or cow peas?' as the industry is not using these grains today. When you look at climate change, [...] the entire Midwest in the US is not going to be able to grow any more soybeans. So how are we going to overcome climate change? By changing the crops, we are working on - it is basically [by] using more heat-tolerant crops, and that is mung and cow pea," said Shalev.



# Algae acceptance requires awareness and better branding



Algae has the potential to become a dietary staple but manufacturers must focus on messaging around taste, convenience, and health, say product development experts.

## ***Natasha Spencer-Jolliffe***

Algae's potential continues to resonate within the food industry. While algae is yet to make it as a dietary staple, new research reveals it has the potential to become a health-conscious favourite.

A new Future of Food Institute [report](#) explores how manufacturers can create consumer demand for algae products. "New, sustainable proteins are vital for the future of our food system," Eva Hoogstins, a researcher at Future of Food Institute, told Fi Global. The study by the Future of Food Institute was funded by EIT Food, supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.

Today, the food system requires "sources of protein that are at least as healthy but more sustainable than animal-based proteins, and satisfy consumer needs and expectations when it comes to taste, convenience, and price", Hoogstins adds.

## **Algae appeal as an alternative**

The European Commission's Farm to Fork Strategy has identified algae, including seaweed as a key alternative protein for transitioning to a sustainable food system. Algae are high in protein, omega-3s, and a range of vitamins and minerals. They are fast-growing organisms that do not take up space on land and do a successful job of absorbing carbon dioxide (CO2).

"Despite all this potential, algae haven't really made it yet as a dietary staple in Europe," says Hoogstins. Subsequently, the researchers sought to discover the

potential of algae on the European consumer's plate and how to increase acceptance.

US non-profit Food for Climate League has also developed evidence-based health and wellness messaging and narratives to drive demand for sustainable and nutritious aquatic foods, namely bivalves and sea vegetables.

"Combined with their culinary opportunities in terms of flavour and texture, diverse cultural relevance, and nutritional benefits, aquatic foods present a unique opportunity for higher adoption on menus and shelves," says Gesina Beckert, director of operations at Food for Climate League.

"We found that people are genuinely interested in these foods but currently lack knowledge about them," Beckert says. "Current perceptions of these foods prevent greater adoption into many Americans' diets."

The Food for Climate League team's research was focused on the US only, but Beckert believes these findings can apply to other regions like Europe too. "Sea veggies meet consumer interests in adaptable, easy-to-use ingredients that boost wellbeing and add a one-of-a-kind, umami flavour."

Sea vegetables also align with today's leading food trends: plant-based eating, immunity-boosting foods and climate-smart eating. "Incorporating sea vegetables into products is a great way to appeal to eaters, especially Millennials and Gen Z."

## Accepting seaweed as a dietary staple

The Future of Food Institute researchers confirm there is potential for algae to become a healthy dietary staple for more people. Their findings suggest consumers will likely be interested in incorporating specific types of seaweed and microalgae into their meals with the right messaging and products.

“The biggest predictor for acceptance is taste,” says Hoogstins. However, the researchers found that most consumers are not convinced by algae’s taste, particularly those who have not tried it before and are not sure they will like it.

Although consumers recognised some health benefits of algae, the positive environmental impact of farmed algae was not. Consumers were unaware of algae’s potential use and relationship to reducing atmospheric CO<sub>2</sub>. However, upon learning this information, the study’s participants found it appealing and a good reason to try algae as a dietary product.

## Going microscopic on messaging

Creating consumer demand for algae does involve food manufacturers. Manufacturers need to create healthy, tasty, and affordable products. Importantly, they must also tell the right message to position themselves well and appeal to consumers.

Food for Climate League’s research and narrative tests confirmed that while the taste is always king when trying new foods, many people are unfamiliar with sea vegetables and are sceptical of their flavours. “Therefore, we advise manufacturers to lead their communications with messages around health and sustainability, paired with versatility,” Beckert says.

Food for Climate League recommends manufacturers compare aquatic ingredients with terrestrial foods like other leafy greens, as it is an easy way to help people understand these aquatic foods’ nutritional value and uses.

Using the term ‘sea vegetables’ helps eaters unfamiliar with seaweeds to think more broadly about how consumers could enjoy seaweeds, Beckert says and provides an immediate, familiar frame of reference to land vegetables.

The non-profit organisation advises manufacturers to visually present sea vegetables as convenient everyday foods. “Showcase the fun and practicality of sea vegetables—be it the colours, textures, or easy-to-eat formats,” says Beckert. Use imagery that emphasises the appealing taste of sea vegetables rather than their underwater habitat.

By changing how consumers talk about these foods, the hope is that eaters can be inspired and empowered to integrate bivalves and sea vegetables into their diets in ways that are accessible and meet their personal preferences.

## Manufacturing with seaweed

The study also sets out learnings for manufacturers interested in adding seaweed to their products. Future of Food Institute’s researchers found four ways to turn algae as an ingredient into a benefit for consumers. Healthiness, sustainability, an engaging experience and detailing that algae are a product already present in many foods consumers eat are key.

Manufacturers are uniquely positioned to introduce people to new, delicious food experiences that include sea vegetables. One of the key reasons people consume less of these foods is the need for more awareness, with Food for Climate League findings, uncovering a third (33%) of US eaters not wanting to consume sea vegetables because they are unaware of them.

“Going forward, there is a tremendous opportunity to integrate sea vegetables as an ingredient into a wide array of culturally relevant, widely accessible, highly nutritious food products,” says Beckert. Sauces, salsas, seasonings, and snacks have been tipped as relevant product categories for seaweed, along with other fun concepts with mass-market appeal, like kelp burgers and smoothie cubes.





## Next-generation plant-based and vegan

There is a growing mainstream interest in plant-based foods with the percentage of people globally who identify as flexitarian increasing from 26% in 2020 to 31% in 2022, according to data from FMCG Gurus. It is precisely this broader interest that is driving the surge in new product development. We look at some of the innovative ingredients being used to create next-generation plant-based products that replicate the taste, texture, and appearance of meat and dairy.





# Pioneering precision fermentation for more sustainable and localised food production



Precision fermentation could ease climate change and food insecurity by reducing the amount of land required to produce food and allowing large importers to domesticise food production. Regulation is a barrier to adoption, but several companies are striving for change.

## Lucy Whittaker

To sustain an expected global population of 9.7 billion by 2050, food production will need to [increase by as much as 60%](#), a United Nations report shows. Ensuring that the nutritional needs of the growing population are met will depend largely on the food industry's ability to create and uphold sustainable and efficient supply chains.

Precision fermentation, a means of producing gene-edited microbes, yeast, or algae in lab-controlled environments to create specific functional ingredients, is one promising and fast-growing innovation that could help alleviate the issues of global food insecurity and environmental degradation. This technology allows companies to replace protein- and fat-rich foods

obtained from animals and crops such as cows, pigs, soy, and palm oil, with “nature-identical” yet more sustainable alternatives.

## **Switching out farm for factory**

Foods produced via precision fermentation require only a tiny fraction of the land as agricultural inputs and could, in future, form the basis for cheaper and healthier alternatives to food and animal feed, said author and journalist George Monbiot in his [recent Ted Talk](#) on securing the future of food and the planet.

“We currently face two major issues: the environmental harm caused by the food system and the fact that the system itself may collapse.”



Farming is the foremost cause of land use globally, with agricultural land accounting for around [37% of all land](#), according to data from the World Bank. Despite representing over a quarter (26%) of global land use, pasture-fed meat produces [just 1% of the world's protein](#) and is a major source of greenhouse gas emissions.

“If the biggest issue [the food system poses] is land use, then the best solution is shifting food production off of the land and into the factory.”

According to [one study](#), precision fermentation fuelled by methanol uses 1,700 times less land than US-grown soy, which is the [most efficient means of protein production](#). Looking at beef and lamb, which require by far the largest amount of land per 100 g of protein produced, this figure jumps to an estimated 138,000 and 157,000 times, respectively.

### **Making protein from carbon, not cows**

Helsinki-headquartered start-up [Solar Foods](#) makes a high-protein powder using renewable electricity and carbon captured from the air. The company reproduces microbial organisms sourced from soil in gas fermentation bioreactors. The organisms are fuelled with a mixture of hydrogen, produced by splitting water with electricity; carbon collected via carbon capture technology; vitamins; and minerals. The result is the end-product Solein; a protein-rich microbial biomass consisting of single-cell organisms.

“If we could replace the protein we currently obtain from animals with protein obtained from single cell organisms, we could release vast tracts of the planet from our impacts, restoring forests, seafloors, mangroves, etcetera [...] we could stop the sixth great extinction in its tracks,” said Monbiot.

Solar Foods uses only carbon neutral energy sources, switching between solar, wind, hydro, or a combination of the three, based on what is most economically viable for each location.

### **Home-grown, lab-grown food**

Precision fermentation could also boost global food security by lowering the dependence of many nations on food imports.

Despite the growth in the size of the global food industry in recent decades, the number of chronically malnourished people has been on an upward trajectory since 2015. This could be attributed to the growing interconnectedness of the food system and its decreasing resilience to withstand shocks such as the Covid-19 pandemic, surging energy prices, and extreme weather conditions.



“Over recent years, the crucial elements of systemic resilience, namely redundancy, modularity, circuit breakers, and backup systems have been stripped out by corporate strategies,” said Monbiot.

“Four companies control 90% of the global grain trade and only four crops - wheat, grain, corn, and soy - account for 60% of the calories farmers produce. Production for the export of those crops has become highly concentrated in the hands of a few nations, including Russia and the Ukraine.”

## Singapore bets on food tech for food security

Singapore, which imports over 90% of its food is highly vulnerable to supply chain disruptions and food shortages. To improve the resilience of its food supply chain, the Singaporean government has [set a goal](#) to produce 30% of its nutritional needs locally and sustainably by 2030, with less than 1% of land assigned to farming.

By producing traditionally resource-intensive foodstuffs such as meat and dairy sustainably and at scale, this technology could provide a solution to the country’s low levels of domestic food production and lower its reliance on volatile imports.

Several companies such as alternative dairy producer, Perfect Day, and precision fermentation solution provider, ScaleUp Bio, are already active in the Singapore market and are paving the way for the commercialisation of precision fermentation produced food products in Asia and beyond.

Singapore also became the [first country to approve cell-cultured meat](#) for human consumption in 2021 when it greenlighted Eat Just’s cell-cultured chicken.

## Joining forces to push for precision fermentation approval

While precision fermentation offers potential for the future of the food industry, regulation remains a barrier

for many brands. To gain approval for sale in most major markets including the US, Europe and the UK, novel foods produced via this technology must undergo an application process which can be complex and range anywhere from one to four years.

In response, in March this year key players in the precision fermentation space joined to form Food Fermentation Europe (FFE), an alliance seeking to improve the regulatory framework for fermentation enabled foods. According to the group, urgent changes to improve processes that are ‘far too lengthy and opaque’ are required to facilitate market access of precision fermentation produced products.

“[This challenge] can be tackled by improving the transparency and communication around the process and improving timeline efficiency, while maintaining existing European food safety standards - which we fully support,” Christian Poppe, FFE spokesperson and global public affairs director for Formo, precision fermentation dairy-alternative producer, told Fi Global Insights.

“Another challenge would relate to the need to fast track infrastructure for sustainable food solutions so we can improve and increase capacity and production (for example bioreactors for fermentation).”

Amongst its founding members are UK-based Better Dairy, German-based Formo, Finland-based Onego Bio, Belgium-based Those Vegan Cowboys, and Israel-based Imagindairy.

“Our aim is to help by advocating for a much more straightforward and efficient application and regulatory process. Our alliance will focus on working with policymakers to achieve this change and through this we aim to help our whole ecosystem with access to market. We would like to see clear standards and guidance that our nascent sector can use,” Poppe said.

This move follows the launch of the [Precision Fermentation Alliance \(PFA\)](#) just a few weeks prior in the US. According to its founders - Change Foods, The EVERY Co., Helaina, Imagindairy, Motif FoodWorks, New Culture, Onego Bio, Perfect Day, and Remilk.

# Making mycelium mainstream through patented technology



Mycelium technology company Ecovative is helping brands create better plant-based products by developing patented processes to improve mushroom and mycelium production and processing.

## Natasha Spencer-Jolliffe

Interest in the alternative protein source is increasing, with the Good Food Institute (GFI) tipping the interconnected network that makes up the mass of many fungi varieties to be a leading trend in 2023.

[Mycelium](#) is a structure comprising root-like fungus that contains a mass of branching and thread-like hyphae. It contains fibre, vitamin D, and protein. If mushrooms are the fruiting part, mycelium represents the root-like network of fungi, which typically grow underground or inside trees. Using a [fermentation](#) process, manufacturers can take these mycelium structures to create meat-mimicking textures and whole cuts.

Mycelium producer, [MyForest Foods](#), is one brand utilising mycelium by taking mushroom roots from the forest and growing them indoors to create whole pieces of plant-based meat.

In launching the US-based brand, it wanted to bring tasty meatless foods to market to feed the planet sustainably.

“Gourmet, wild mushrooms offer distinct, savoury, umami-rich flavours, while their mycelial “roots” naturally weave together, much like the network of muscle tissues in animals,” Sarah-Marie Cole, chief marketing officer at MyForest Foods, told Fi Global.

## **Patented tech to recreate meat**

MyForest Foods forged a relationship with [Ecovative](#), a mycelium technology company, and utilised its patented AirMycelium technology. Ecovative holds over 40 patents in 30 countries worldwide for solid-state fermentation and mycelium technology.

Through its platform technology, AirMycelium works by guiding geometrical mycelia patterns and utilising biological processes to produce various materials. MyForest Foods uses vertical farms to grow mycelium products at an industrial scale.

The technology provides MyForest Foods with a way to make natural foods that seek to replicate traditional meat’s organoleptic properties. Growing AirMycelium uses less water and land than conventional animal agriculture practices, Cole says.

## Landing on mycelium manufacturing

Ecovative's research and development (R&D) lab, the Mycelium Foundry, has created a network of mycelium divisions: Mushroom Packaging in 2008, MyForest Foods in 2020 and Forager Hides & Foams in 2022.

"Through the Foundry's vast mycelium library, each division is equipped with a deep, biological understanding of fungi," says Cole. Through this knowledge base, each team can amplify specific mushroom strains' most useful natural properties to create food.

However, mycelium production to create plant-based foods cannot sacrifice flavour. Taste is paramount to satisfying consumers' needs. "Many plant-based products have long ingredient lists; they rely on fillers and binders to create meat-like textures," says Cole. MyForest Foods' star ingredient, mycelium, provides the brand with a farm-grown, whole-cut advantage, while minimal, familiar ingredients accentuate its flavour.

## Utilising pivotal and pioneering technologies

The vertical farming technology allows the brand to adjust several environmental factors to control the shape and density of mycelium as it grows. Introducing mycelium enables the brand to develop large structures that resemble — and can be sliced like—whole cuts of meat with a similar mouthfeel to chicken, fish, and bacon. After harvest, the brand slices its mycelium into strips and uses minimal ingredients to create its product's flavour.

"Mycelium is grown on a special blend of wood chips and other plant materials," says Adam Heinze, director of operations at MyForest Foods.

Replicating the environmental factors of the forest, the brand entices the mycelium to grow up and out of the substrate—towards the sky (hence the name AirMycelium). "We have fine-tuned and dialled in on just the right growth medium, air quality and water content to help our mycelium grow into dense, whole cuts that can be sliced just like meat," says Heinze.

Growing the mycelium of coveted gourmet mushroom strains in vertical farms, the brand can produce the same desirable textures and flavours in natural gourmet mushrooms in faster time frames of 12 to 16 days versus 12 to 16 weeks.

## Upcycling key ingredients

"A major element we upcycle is our substrate, mycelium's growing medium," says Cole. MyForest Foods uses byproducts from the hemp and forestry industry to create the substrate. The spent substrate has multiple uses, from soil remediation to creating fertilisers and composts.

To date, MyForest Foods' farm-grown mycelium has applications in the pork alternative and soon-to-be beef alternative markets. Its flagship product is MyBacon, a plant-based bacon. MyJerky, a plant-based beef jerky derived from the same mycelium ingredient, will be rolled out in 2023. Cole describes the release of the brand's second product as "our gateway to the beef alternative market".

For MyBacon, the brand's inaugural product, MyForest Foods introduced oyster mushroom mycelium to an optimal growing environment, replicating the forest's conditions. MyBacon offers the taste and texture of traditional pork bacon using six ingredients: mycelium, salt, sugar, coconut oil, natural flavours, and beet juice for colour.

Since mycelium can be used to make a limitless variety of products, including beverages and meats, the brand continues to innovate and research. "We're incredibly excited to add to the mix as our production and harvest capabilities continue to scale," says MyForest Foods.





# Leveraging science for safety-centric innovation

Food safety is not an add-on; it's an essential part of food manufacturing and companies must adhere to strict regulations to ensure they remain compliant and that the products they make are safe to eat. In this section, we will look at some recent developments in food processing and ingredient development that are pushing the needle forward in this important field.



# Bean-to-bar innovations to reduce toxic elements in chocolate



From genome-edited plants to longer cocoa fermentation, we look at how farmers and chocolate brands can reduce toxic cadmium and lead in chocolate – and how consumers can reduce their exposure.

## *Niamh Michail*

Earlier this year, non-profit Consumer Reports tested 28 different dark chocolate bars in the US and detected [“concerning levels” of cadmium and lead in all of them.](#)

Frequent exposure to lead in adults can lead to nervous system problems, hypertension, immune system suppression, kidney damage, and reproductive issues while cadmium can cause developmental problems, which is particularly concerning for children and pregnant women.

These toxic elements are not introduced during chocolate manufacturing but during the cultivation and processing of cocoa.

Cadmium is a heavy metal naturally present in the Earth’s crust but it becomes soluble in acidic soil and is absorbed by the roots of plants. Lead is also present in the soil and dust, mainly due to the use of leaded fuels that create particulates that settle in the environment.

## Solutions require collaboration across the supply chain

“There are several ways to reduce lead and cadmium in the cocoa or chocolate supply chain,” said Kantha Shelke, PhD, principal at food science and research firm Corvus Blue and senior food safety lecturer at Johns Hopkins University.

“Commercial viability is imperative for adoption and usually requires participation and support from every node across the value chain to participate and support.”

Carefully controlling how cocoa beans are processed can also reduce levels. Cocoa beans are generally fermented to improve their flavour, for instance, and [one study](#) found that when they are fermented for longer, they become acidic. This acidity means that the cadmium migrates away from the cocoa nib – the part that is used to make chocolate – to the outer husk, which is discarded.

This can decrease cadmium concentrations in the nib by a factor of 1.3, making it a useful technique to reduce levels. However, processors must control the fermentation process carefully or the cocoa nibs – and final product – will have an acidic flavour.

“Ensuring that the levels of cadmium and lead are at their lowest requires staying close to the source and being knowledgeable of the processing methods and their implications,” said Shelke. “Manufacturers getting their cocoa supply on spec can be reasonably assured of consistent quality while those shopping for bargains will not.”

Another strategy is to blend cocoa sourced from different regions. Latin American producer countries tend to have greater cadmium levels than other countries due to the volcanic nature of their soil.

The Democratic Republic of Congo and Sierra Leone currently attract [greater interest from European buyers](#) as alternative sources of organic cocoa beans because of the lower cadmium content compared to Latin American sources, according to the Centre for the Promotion of Imports from developing countries (CBI), part of the Netherlands’ Ministry of Foreign Affairs.

## Harnessing the soil microbiome

Several reduction strategies can also be used at the farmer level. One effective method is to add limestone and zinc to the soil, which reduces cadmium uptake by increasing the soil’s pH level. However, these inputs are expensive for many smallholder farmers and they can only be added to the topsoil, which does not prevent the cocoa tree’s deep roots from [absorbing cadmium in the bottom soil layer](#).

Other agronomy methods include growing certain crops around the cocoa trees to selectively absorb cadmium as well as coppicing and heavy pruning.

An emerging approach is bioaugmentation, which involves adding cultured microorganisms to enhance the prevailing microbial community.

“Phytoremediation with degradative aerobic bacteria such as *Pseudomonas*, *Alcaligenes*, *Sphingomonas*, *Rhodococcus*, and *Mycobacterium* is promising for the treatment of contaminated biomass,” Shelke said.

[One 2022 study](#) isolated 12 native Colombian bacteria strains and identified two distinct ways they captured cadmium: biosorption and cadmium cytoplasm precipitation.

## Genome-edited cocoa seedlings absorb less cadmium

Finally, farmers can use seeds and germplasm that have been genetically engineered or bred to absorb fewer toxic elements and in smaller quantities.

As part of the US-funded [Cacao for Peace](#) project, scientists from the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) developed nine gene-edited cacao lines to absorb less cadmium from the soil.

In February 2023, the scientists transplanted the genome-edited cacao plants from greenhouses into cadmium-containing soils from Colombia, testing the plants’ ability to grow in field conditions while maintaining low- or no-levels of cadmium.

The Cacao for Peace results have not yet been communicated although, according to Shelke, gene-editing can be an effective and viable method. She noted one limitation, however, namely that farmers must wait for the seedlings to grow and reach maturity before being able to harvest the pods.





## What can consumers do to reduce lead and cadmium intake?

The bitter irony for consumers who choose to eat dark chocolate rather than milk or white chocolate for health reasons is that, while dark chocolate is lower in sugar, it contains greater levels of toxic elements because of the higher cocoa nib content.

“Choosing milk over dark may help those who indulge on chocolate,” said Shelke. “In the US, where people tend to favour milk over dark chocolate, they are getting chocolate with lower cocoa content, and therefore much lower cadmium content.”

Nevertheless, Shelke said that people should not hesitate about eating dark chocolate. “It takes a lot of chocolate to get to dangerous levels for adults,” she said.

Having a healthy and diverse diet with high amounts of fresh fruit and vegetables can also help mitigate the negative health effects of toxic elements such as trace heavy metals.

“It’s not what we eat; it’s what we absorb. Fibre and phytates in vegetables, whole grains, nuts, and especially legumes can significantly lower cadmium and lead bioavailability, ie what we absorb,” she said.

Shelke referred to [an in vitro study](#), which found that cadmium bioavailability from cacao-2 cells exposed to animal-based foods (pork and clams) was higher than that from cocoa cells exposed to vegetable-based foods (kale).

“Antioxidants in plants have been shown to help inhibit the harmful effects of higher free radical production caused by cadmium exposure,” she added.

# How safe and healthy are novel sweeteners?



Consumer demand for healthy yet indulgent products is the driving force behind sweetener innovation, from monkfruit glycosides produced using plant molecular farming to stevia via precision fermentation. But could these sweeteners have unintended consequences for health?

## Niamh Michail

“Consumers are making our jobs even harder,” said Todd Rands, president and CEO of Elo Life Systems.

“[It] is already a challenging thing to replace sugar and now they also want it [...] to be a source of nutrition and health, even though they are indulging. And, while you’re at it, let’s make it sustainable and better for the planet. The consumer wants it all and that’s the challenge we have to deliver on.”

Elo Life Systems is producing mogroside – the sweet-tasting glycoside found in monk fruit and some other plants – in watermelon, using a technique called plant molecular farming (PMF). PMF uses crops as biofactories to produce molecules of interest that are difficult to synthesise through other means.

## Using technology to scale up natural sweeteners

The startup’s calorie-free “monk-fruit inspired sweetener” is 300 times sweeter than sugar and does not have the undesirable aftertaste associated with other sweeteners, according to the company. Stevia, for instance, has a lingering aftertaste with bitter or metallic notes, which has slowed down its uptake to an extent.

Companies thinking of using stevia should be aware that some segments of the population are more sensitive to bitter-tasting molecules while others may not even perceive the bitterness, said Abigail Storms, global head of specialty sweeteners at Tate & Lyle, also speaking on the panel.

“This adds in an extra lens of complexity and difficulty when it comes to formulation,” she noted.

Nevertheless, industry is using technology to overcome these obstacles by developing novel sweeteners or novel methods to produce sweeteners found in nature.

“Nature has given us a line of sight to what’s there and we can use technology to find ways to make that much more mainstream [and] accessible, getting to those better-tasting options so that when consumers try again, they are not disappointed by the experience.”

## Scaling up to bring costs down

In addition to the challenge of replicating sugar’s functionality, it is challenging for brands to find cost-competitive like-for-like replacements. Sugar is a very cheap and widely available commodity, Rands noted. It can also be produced around the world, in both cold and hot climates, using sugar beets and sugar cane. Scaling up alternative solutions to bring the cost down is therefore crucial.

“There is so much in nature that provides the sweetness we all crave. If we can find ways of producing it, harvesting it, and making it more broadly available, that’s a new evolution,” he said.

“The ability of plant cells to produce some of these more complex ingredients is essential to be able to scale them and have them available for the food system.”

## The unintended consequences of sweeteners

Rates of overweight, obesity, and type 2 diabetes are growing globally, prompting governments to mandate reformulation or introduce taxes and restrictions on the sale of unhealthy foods that are high in salt, sugar, and fat. Non-nutritive sweeteners that have a similar taste profile as sugar are therefore a solution for manufacturers. However, the safety of these ingredients – even if they have been greenlighted by food safety authorities – may not be so clear cut.

“I’m all for sugar reduction but I’m also concerned about unintended consequences,” Dr Robert Lustig told the panellists. Lustig is professor emeritus of paediatric endocrinology at the University of California; public health campaigner; and author of *Fat Chance: Beating the Odds Against Sugar, Processed Food, Obesity, and Disease*. He is also the [co-founder of the startup Biolumen](#), which makes cellulose-based fibres that can be added to processed foods to increase satiety.

Giving an example of such unintended consequences, Lustig referred [to the 2022 Suez et al study](#), which evaluated the impacts of non-nutritive sweeteners on 120 individuals and their microbiomes. In the randomised-controlled trial, participants ate either saccharin, sucralose, aspartame, or stevia (or sugar or nothing as a control) for two weeks in doses lower than the acceptable daily intake.

The researchers found that each sweetener “distinctly altered” stool and oral microbiome and plasma metabolome while saccharin and sucralose “significantly” impaired glycaemic responses.

## How to avoid ‘another Olestra’

“So, what should the food industry build into evaluating these sweeteners to make sure we don’t end up with another Olestra?” Lustig asked the panellists.

Famous for being a food industry failure, Olestra is a synthetic fat developed by Procter & Gamble that the body does not absorb, meaning it has no calories. However, the synthetic fat can cause severe diarrhoea; loose stools, abdominal cramps, flatulence, and other adverse effects. It also reduces the body’s ability to absorb important fat-soluble nutrients such as the carotenoids, alpha and beta-carotene, lycopene, and lutein. The Center for Science in the Public Interest (CSPI) [advises consumers to avoid Olestra](#).

## Safety knowledge ‘continues to evolve’

Responding to Lustig, Storms said the food industry was conducting a lot of safety work to ensure novel ingredients were safe and without unintended consequences.

“It doesn’t get the same headlines as some of the negative stories, but we are working to make sure we continue to stay ahead and provide good science for consumers and customers alike who are just as concerned obviously when those types of studies come out,” she said.

Rands suggested that taking a data-driven approach and focusing on natural sources could be key to ensuring ingredient safety.

“Our knowledge continues to evolve over time, and we have to [...] continue to study everything in our food system. From our standpoint, we are focused on things that are natural; that are already in our diets; and we think many of the solutions we need will come from those sources where there have been hundreds of years of experience.”





# Innovative ingredients for reformulation

Reformulation is a delicate balancing act: consumer demand for healthier, clean label food and supply chain disruptions are forcing brands to reformulate. But changing the formulation will inevitably impact the product's taste, colour, texture, mouth-feel, and shelf-life. And often the known alternatives are not the desired option. For example, according to Mintel, as much as 57% of UK consumers are interested in sugar reduced sweets but without artificial sweeteners. We look at some of the ingredients that are allowing brands to reformulate without impacting the sensory characteristics of their products.



# What's trending in the food colour industry?



Bright, bold, and better-for-you lead the way in colour innovation in the food and beverage industry.

## Lucy Whittaker

Colour is a crucial element of food and beverage formulation, as it plays a significant role in shaping the consumer perception of products. Not only does it affect the visual appeal of a product, but it can also influence its taste, texture, and overall quality.

Tapping into a range of techniques and trends, such as precision fermentation and bright and bold colours, manufacturers can improve the aesthetic appeal of their products to satisfy changing consumer preferences. Social media is driving consumer demand in the food industry.

## **Social media is driving consumer demand in the food industry**

It was over 2,000 years ago that first-century Roman gourmand [Marcus Gavius Apicius](#) reputedly said, “we eat first with our eyes.” In today’s social media age, where

many consumers’ [purchasing and consumption habits](#) are strongly influenced by the social media they are exposed to, this statement could not be more relevant.

A [survey](#) conducted by the International Food Information Council (IFIC) found that 64% of consumers considered the appearance of food and drink products to be an important factor when making purchasing decisions. The same research found that 42% of consumers were willing to pay a premium for products that had an appealing appearance.

In the food industry, social media is both a source and accelerator of consumer trends. Over one in six (62%) industry professionals believe that social media has increased the speed at which trends emerge and evolve, according to a survey by Innova Market Insights.

## Improving appearance and health via precision fermentation

As consumers become more health-conscious, there is a growing demand for natural food colourants. Consumers want products that look great, without compromising their health.

In turn, consumers are moving away from products containing artificial colours that they associate with negative health impacts. A survey conducted by FMCG Gurus in 2020 found that over half (56%) of US and UK consumers were concerned by the use of artificial colours in the food industry.

Israeli startup Phytolon is using precision fermentation to produce betalain colours that could replace up to 70% of the natural and synthetic options on the market today, according to Halim Jubran, [the company's co-founder and CEO](#).

[Betalains](#) are the water-soluble, nitrogen-containing pigments that provide red-violet (betacyanins) and yellow (betaxanthins) colours to some fruits and vegetables.

Using a proprietary technology and baker's yeast that is more sustainable than synthetic colour production, the startup extracts natural pigments of beet and cactus fruits, providing a colour spectrum ranging from purple to yellow.

Last year, Phytolon announced plans to partner with US biotech company Ginkgo Bioworks to develop yeast strains with enhanced production yields, which will help to "pave the way to compete with synthetic colours in terms of cost and performance", Jubran told Ingredients Network.

## Chinese consumers seek bright, baked goods

Aligning with social media's focus on vibrant and bold colours, several brands are building demand for products via visual appeal.

Mintel data shows that over half (56%) of Chinese consumers in the bakery sector are interested in trendily packaged pastries that are popular on social media. Sweet bakery launches with an ingredient-derived red colour, including red adzuki bean and strawberry, grew by 4% and 3% respectively in China from 2021 to 2022.

Two examples of recent Chinese product launches in this category that feature in the Mintel Global New Product Database include FamilyMart's Strawberry Cream Filled Bread, which has a bright pink colour, and Shi Zi Yuan's Red Bean Flavoured Egg Yolk Puff featuring a sweet, bright red bean paste.

## Bold and experimental colours are in vogue in 2023

Globally, more consumers are opting for new and experimental colours such as blue, pink, and green, with one in seven in saying they find these colours to be fun and exciting and make products more appealing, according to FMCG Gurus. Bright and bold colours make products stand out for 43% of consumers, and challenge perceptions of how a product should look for 42%, the same data shows.

In December 2022, Pantone, a subsidiary of multi-national colour measure and management company X-Rite, named its colour of the year for 2023 as 'Viva Magenta' or 'PANTONE 18-1750'. The bright, crimson red colour balances boldness with a feeling of fun and bridges the natural and virtual world, according to Pantone.



# Blending fibres and flavours to match sugar's functionality



A blend of dietary fibres, natural flavours, and some sucrose can help brands reduce their products' sugar content by up to 80% while still retaining the functional properties of sugar, such as caramelisation.

## *Niamh Michail*

According to market research company Mintel, manufacturers should consider combining natural sweeteners with fibres to replace the sweetness and bulk of sugar. This two-in-one reformulation approach allows them to make two appealing on-pack product claims: [less sugar and more fibre](#), it suggested.

"Consumers are aware of the importance of fibres in maintaining gut health," said Neha Srivastava, food and drink patent analyst at Mintel. "Brands can leverage this awareness by repositioning them as a multifunctional health ingredient that helps reduce sugar content in food and drink whilst improving gut health."

However, blending fibre with a natural or artificial sweetener, such as stevia or sucralose, means that many of the functional attributes of sugar are lost.

## **A synergistic effect to replicate the sweetness of sugar**

Israeli startup, Resugar, has developed a blended sweetening ingredient that, thanks to a 20% sugar inclusion, can help brands reduce the sugar content of their products by around 70 to 80% while retaining some of the key functional characteristics of sugar: bulking, freezing point modification, shelf-life prolongation, fermentation, moisture retention, colour, texturisation, and caramelisation.

CTO Michael Zviely said: "I cannot explain exactly what is in it because it's a trade secret but in principle, our product contains sugar but 80% less, it contains inulin, and it contains flavour ingredients. And these flavours have a synergy with the small amount of sucrose, which gives the same [sweetness] as full sucrose."

Asked whether Resugar Synergy has the same functional properties as sugar, Zviely told us: “That’s the whole idea. As you know, sugar is not only sweetness. It also provides many functionalities – bulk volume, fermentation, caramelisation.

The idea is to put all together the ingredients that give us the same functionality - the same caramelisation, the same fermentation, the same bulk volume - as sugar, so you don’t need to add anything else. You take out sugar and add [our ingredient] in the same amount.”

From a flavour perspective, the startup says its ingredient passes the taste test; it commissioned a blind taste test from sensory research firm New Sense Research, which found that 58% of consumers preferred Resugar’s vanilla ice cream over a Ben & Jerry’s ice cream, without knowing the health benefits.

### Nestlé and Tnuva are already customers

The ingredient, which can be listed on ingredient lists as dietary fibres, sugar, and natural flavours, is already being sold in Israel by Nestlé under its Froneri brand for a new range of low-sugar ice creams. Resugar also works with Tnuva, the largest dairy manufacturer in Israel. However, the startup has its sights set on bigger markets.

CEO and co-founder Ron Livny said: “We are now in several [proof of concepts] POCs with several big companies in the US and are working on getting the product on the market. We already have a facility in the US.

“In Israel, [we are producing] small volumes but we are working on volumes for the big companies. With any big company, their projections are one thousand tons annually, so we are talking about big companies and big volumes.”

### New product in the pipeline: Resugar Molecule

Resugar, which is a finalist in the [Fi Global 2022 Startup Innovation Challenge](#), closed a \$3 million series A fundraising round in March 2022, led by Eitan Yochananof, CEO and director of Israeli grocery chain M. Yochananof and Sons, and private investors.

The startup also has a second product in the pipeline - Resugar Molecule – that is currently being developed in collaboration with the Technion Israel Institute of Technology lab by its R&D leader, Professor Yuval Shoham.

Resugar Molecule is a disaccharide molecule that the company says has “an uncanny resemblance” to disaccharide sucrose, or table sugar. To make this sweetener, the company starts with a low-cost, plant-based substrate that it converts to an intermediate product using an enzyme. It then uses a second enzyme to decompose this intermediate product, resulting in the disaccharide molecule that is Resugar Molecule.

“Because of the specific glycosidic bond between the two saccharides of the Resugar molecule, it can’t be hydrolysed by human enzymes and thus should exhibit practically zero caloric value and [a] very low glycaemic index,” the startup said.

For this novel ingredient, Resugar may require regulatory approval before commercialising it; when it closed its \$3 million fundraising round, it said it planned to use the investment to build up its global marketing and sales team, deepen its R&D partnership with the Technion, and speed up the regulatory approval and IP protection for its expanding product portfolio.

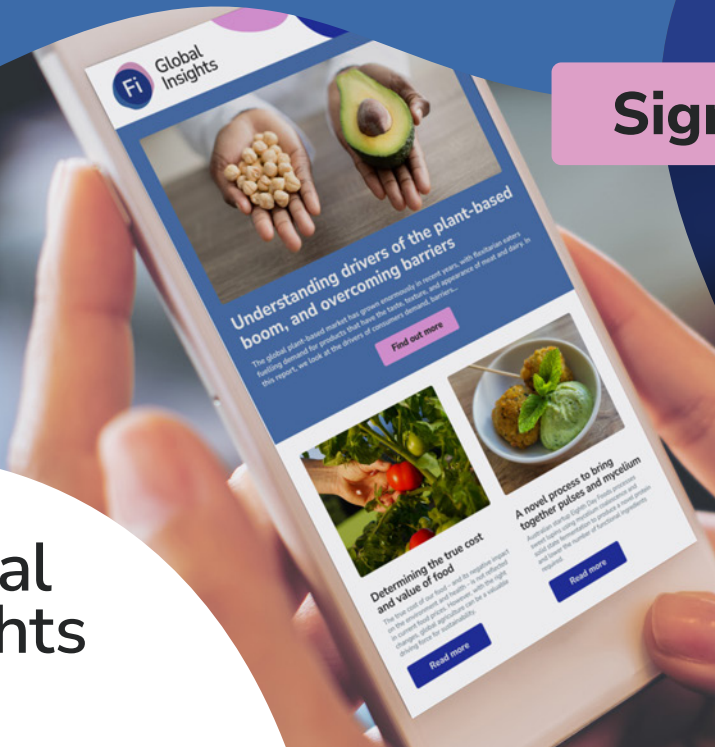




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