



Market Innovations, Part 2: Tech advances at the service of sustainability

Introduction

A brave new world of creative solutions harnessing the power of AI and data-driven technology promises to solve everything from world hunger to climate change. From precision fermentation to plant cell cultivation, the burgeoning techniques offer the potential for more efficient processes and novel solutions to old problems. But can innovative tech and sustainability always walk hand-in-hand? And who should bear the costs of making this shift towards a cleaner, greener future?

The Market Innovations Report is written in two parts that will be published throughout 2023. This is part two.



Brewing up solutions: Precision fermentation

Precision fermentation is one technology that has been lauded for its sustainability credentials.

George Monbiot, a British journalist known for his environmental activism, has gone so far as to describe it as possibly being “the most important environmental technology ever developed”,¹ while a 2023 review in *Critical Reviews in Food Science and Nutrition* concluded: “Successful innovation in fermentation-derived ingredients will help feed the world more sustainably.”²

The technique, a means of producing gene-edited microbes, yeast, or algae in lab-controlled environments to create specific functional ingredients, allows companies

to replace protein- and fat-rich foods – many of which are obtained from animal sources – with more sustainable alternatives.³ It can be used to produce alternative proteins, lipids, and carbohydrates, as

well as bioactive compounds of interest to the nutraceutical industry, such as resveratrol and astaxanthin.

It has the potential to reduce the footprint of food production

dramatically, with one study⁴ estimating that precision fermentation using methanol needs 1,700 times less land than the most efficient agricultural means of producing protein: US-grown soy. As Monbiot explains, this suggests it might use “138,000 and 157,000 times less land than the least efficient means: beef and lamb production”.⁵

Moreover, it could reduce the dependence of many nations worldwide on convoluted supply chains, in themselves a major contributor to environmental degradation.⁶

Using biotech to reproduce breast milk proteins

Laura Katz is the founder and CEO of Helaina, a New York City-based biotech company that is using precision fermentation



to reproduce the proteins found in human breast milk.

The company, which is one of the first to commercialise such glycoproteins or develop them at scale in a factory, says it hopes to bring the immunity properties of breast milk to food “for all stages of life, from enhanced infant formula to elderly care nutrition”.

Katz said the technology not only allowed the company to be very precise but was scalable, making the path to market more viable. She said Helaina believes that “there’s a really big opportunity to remove the cow from this situation”.

Speaking at the Future of Nutrition Summit at this year’s Vitafoods Europe event, she said: “Even the big dairy

companies are saying to us, ‘We use so much cow’s milk to produce such a small volume of protein, and the impact on the environment and just the amount of milk that we need to do that is unsustainable.’ So sustainability is one of our core tenets.

“We’re really focused right now on efficacy and making sure that the protein is having the functionality that it needs to have – but we also really care about how we can be bringing more sustainable practices to nutrition because at the end of the day, when we’re thinking



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When we’re thinking about the future of nutrition and what that means, sustainability has to be part of the conversation.”

Laura Katz, founder and CEO, Helaina

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Fermentation figures add up to success

In a Good Food Institute report published earlier this year, “Fermentation: Meat, seafood, eggs, and dairy”, David Verbitsky, managing director at the global financial services group Nomura, highlighted the “attractive economics” associated with fermentation technologies as being exciting for investors.

“The specialty proteins produced through these novel fermentation methods are high-value, premium, functional ingredients,” he said. “This, combined with lower relative input costs, excites investors



and companies about the near-term potential for positive unit economics.”⁷

Precision fermentation is “five times cheaper than any bovine bioactive protein at scale” as well as being much more efficacious, said Katz, allowing for the possibility of targeting

markets outside of infant nutrition that would not previously have been able to afford ingredients such as lactoferrin, for example.

“We’re making these proteins accessible to markets that have not been able to afford to use them... We’re kind of creating a

new market at the same time and that allows us to get into so many types of products where we can actually have a meaningful impact on someone’s health,” she added.

However, Verbitsky sounded a note of caution. “Funding scale-up will be the main challenge for many players,” he said.

“Access to capital will be driven by operational and technical milestones, procuring feedstock agreements, and long-term off-take contracts.

“Strategic partnerships will take increased importance in helping to drive funding needs down and unit economics up. Companies with increasingly capital-efficient business models will be well-positioned for success.”⁸

Inspired by nature: Plant cell cultivation



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hile precision fermentation can be used to unlock the benefits of a single ingredient, such as lactoferrin, it cannot replicate the complexity of the matrix of ingredients found in plant sources.

Enter plant cell cultivation. The technique – whereby cells are grown under controlled lab conditions to produce exact copies of those found in plants with desirable traits, such as in-demand bioactives – is already used in pharmaceuticals and cosmetics.

Companies operating in this space feed the cells with sugars and nutrients to replicate the conditions for photosynthesis.

Within nutraceuticals, the technology offers the opportunity to create a consistent supply of high-value ingredients like botanicals without dependence on unreliable and increasingly disjointed supply chains. Plant cells cultured in this way can be propagated at scale, to

produce mature, disease-free plants much more quickly than traditional agriculture can.

In April, US startup Ayana Bio launched its first ingredients made using plant cell cultivation. It says the bioactives



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We don’t need the land, irrigation, herbicides, or pesticides required by agriculture.”

Frank Jaksch, CEO, Ayana Bio

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produced by the cells have the same composition as those found in conventionally grown lemon balm and echinacea, two established ingredients in nutraceuticals for supporting immunity, sleep, and mood.

It chose them because both are facing supply chain issues, “including adulteration, pesticides, contamination, inconsistent quality, seasonal weather variation, quality and consistency of bioactive metabolites”.

CEO Frank Jaksch said: “Plant cell cultivation is the ability to grow plant cells in a stainless-steel cultivation system akin to beer fermentation and is a safer and more efficient way to produce the desired high-quality bioactives.

“Ayana Bio’s technology starts by identifying and selecting superior plant cell lines, similar to traditional plant breeding. These plant cells are created from real plants and assessed throughout the cell

cultivation process for important characteristics like high bioactive content, stability, and purity.

“Ayana Bio further identifies the ideal plant cell line for standardised quality in the end-product – for example, echinacea cell lines with high amounts of beneficial bioactives replicating the full spectrum found in nature.”

Making nutrition more accessible and affordable

Asked about what makes the technique so innovative, Jaksch said: “Plant cells are the only way to recreate the entire array of bioactives from plants without agriculture.

“With Ayana Bio’s plant cell technology, consumers can enjoy the health benefits from ingredients such as blueberries, chocolate, saffron, and echinacea at a price that makes nutrition accessible and affordable.”

Its sustainability credentials are impressive:

while some of the most health-beneficial bioactives from plants can only be produced via agriculture or foraging, it is “too expensive, too inefficient, or simply environmentally unsustainable to use agriculture-derived bioactives for nutritional solutions at scale”, he said.

“By creating bioactive ingredients with plant cell cultivation, we don’t need the land, irrigation, herbicides, or pesticides required by agriculture, or create wasted biomass to extract bioactives,” he added. “It also solves the bioactive potency, quality, and standardisation problem, as it is very challenging to reliably obtain plant-based ingredients with consistent levels of plant bioactives sourced from agriculture-based supply chains.

“This technology produces ingredients that can be used to formulate food, beverage, dietary supplement[s], and sports nutrition products that are more consistent and affordable, while using fewer natural resources.”



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Harnessing a cocktail of molecules

How does plant cell cultivation compare to other emerging techniques?

Jaksch admitted that precision fermentation can be valuable “for delivering specific single compounds found in nature” but said it was limited in the sense that it can deliver “only one bioactive at a time”.

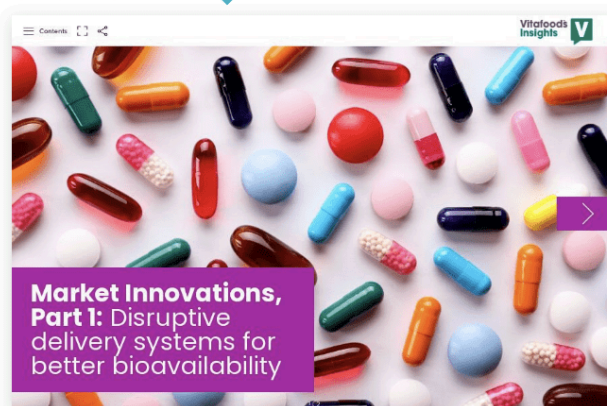
He added: “It has been established that more than 5,000 to 25,000 different phytochemical compounds with bioactive properties are present in grains, vegetables, and fruits.

“In most cases, the health-beneficial effects from these plants cannot be derived from a single compound.

“It is known that there is a synergistic benefit in the complete and unique cocktail of molecules present in plants that cannot be replicated with a single phytochemical or bioactive alone.”

He gave the example of rose extract, saying that “thousands” of molecules come together to create “the depth, nuance, and complexity of each specific varietal of rose. A single molecule alone will be flat and one-note in comparison”.

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He added: “This is why plant bioactives are most effective when they are delivered as a full-spectrum phytocomplex.

“At Ayana Bio, we call this our Plant Cell Advantage – a collection of bioactive compounds found in nature that work

together in harmony to deliver the most powerful benefits possible, without heavy metals, solvents, microbes, or pesticides.”

In January, the company pledged to “accelerate the production of cacao bioactives and support genetic research to identify cacao plant varieties that may be more resilient to climate change”.

Its product pipeline also includes ginseng, saffron, and ginger.

David Foreman, a pharmacist and natural health expert, said plant cell cultivation “appears to be a great solution to sustainability of rare or environmentally sensitive plants”, adding: “So far, it appears to be much more cost-effective and scalable [than precision fermentation].”

Asked which nutraceutical ingredients held the most promise in this area, he suggested those which are “scarce in nature”, such as “rhodiola and those with a high price tag to purchase”.



Encapsulation for a
new era

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apsules remain the most popular delivery system for

supplement users: according to FMCG Gurus research, 67% of consumers show a preference for capsules.⁹

It means that encapsulation – a set of technologies in which a barrier is created around an active ingredient to ensure that it cannot directly interact with outside substances, protecting properties such as bioavailability and stability¹⁰ – isn't going anywhere fast.

However, not all capsules are created equal – and plastic is often the material of choice.

Martina Vakarelova is co-CEO of Sphera Encapsulation, an Italian company that specialises in micro- and



nanoencapsulation. It uses biocompatible and biodegradable materials to make its encapsulating carrier shells, which are often plant-based.

She says the startup is proud to take its inspiration from nature:

its capsules are “100% biodegradable” and made in a “100% natural way”, while the polymers it uses “you can find [in] your own kitchen”. The company is now trying to implement its learnings from nutraceuticals to cosmetics and agriculture, where there

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What we're trying to do is take these natural ingredients – that we actually eat, because they are food – and try to encapsulate with them.”

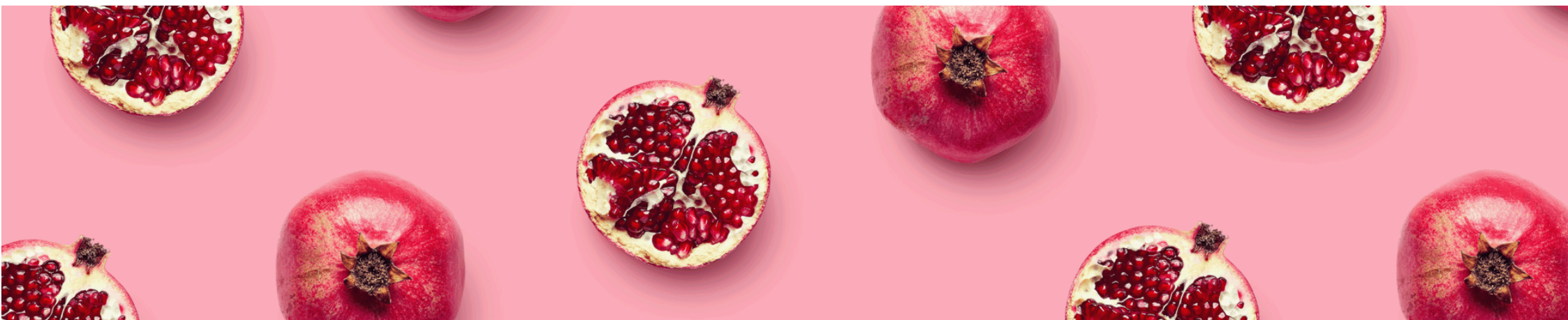
Martina Vakarelova, co-CEO,
Sphera Encapsulation

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is “a huge problem” with microplastics.

Vakarelova said: “This is a huge problem in the industry: you have shampoos full of microplastics, you have toothpaste, you have detergents ... home care is full of microplastics.

“What we're trying to do is take these natural ingredients – that we actually eat, because they



are food – and try to encapsulate with them when it comes to other markets as well.”

She added: “We try to use our knowledge in the food and implement it also in other fields where it's really needed.”

Finding value from waste materials

Sphera is working to make the materials with which it works even more sustainable.

This year, it dedicated a lot of its internal R&D to search for new

materials – in particular, waste materials suitable for upcycling, said Vakarelova.

She gave by-products of the wine process, such as leaves and grape skins, as one example; Sphera uses the latter as colourants “because they are also full of antioxidants”.

Asked which ingredients showed the most upcycling potential, she said: “The most promising things are exactly these waste materials that are full of active ingredients.”

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One of the most exciting examples, she said, was the water used to process olive oil, which is “full of antioxidants”. This is particularly promising because the water does not require any additional

processing, and ultimately, upcycling needs to be easy if uptake is to be scalable.

She also discussed pomegranate, during the processing of which “there is the part which goes to waste – but it's full of pectin. And we have this very interesting regional project to understand how much pectin is inside”.

Pectin can be extracted for use in encapsulation; earlier this year, a group of researchers from Brazil identified a novel

nanoencapsulation technology using pectin from upcycled citrus peel, a method they claimed was both cost-efficient and environmentally friendly.¹¹

The cost point is important: embedding sustainable practices into business requires careful management of economics.

Vakarelova pointed to the pomegranate project as a good illustration of this problem, as “it did have a lot of pectin, but to extract it was not cost-effective”.

She added: “When you're doing these kind[s] of projects, you also need to understand: what are the benefits? Because if you're going to use as much energy... it is just not good any more, and it's not

sustainable because you're using a lot of energy...

“It needs to be evaluated also from an economical point of view, because the idea of sustainability is to do easy things that do not cost too much... [otherwise], it's just not worth it.”

But while pomegranate did not prove to be a cost-effective source, that does not mean the project's findings were not of value, she explained.

“I think what is most important is to evaluate [these waste materials] and to understand which can be used and which cannot be used, because at the end of the day, we need to be objective and we need to understand that not everything can be reused,” she said.



Read more: Novel technology using upcycled citrus peel offers new possibilities for nanoencapsulation

Investing in green futures



More than half (58%) of respondents to a Vitafoods Insights survey conducted earlier this year agreed that nutraceutical companies should both do business in a more environmentally sustainable way, and be prepared to accept a reduction in profits to achieve this.¹²

However, bearing these increased costs, particularly at the outset of their sustainability journey, was an obvious roadblock for companies, Sphera's Vakarelova said.

"First of all, you need to put a lot of R&D to understand what you can use from the waste materials," she said. "Obviously, the cost is going to be a little bit higher, and some companies just don't have this mindset..."

"You really need to believe in it, because otherwise it's just not going to happen – because if I can buy things from China that I don't care how they [are] made, and just make them and sell

them, and [make] a lot of money – a lot of people would do that."

But she highlighted what despite the challenge of making

that initial investment, there was a need to think about the bigger picture and the potential benefits of practices such as upcycling that will only be felt in the future.

"If we look on a global scale, the economy now is very bad because we're not using all of these [waste] materials," she said. "So I think that there is going to be an equilibrium somewhere because yes, [the cost] is going to be higher – but then maybe other costs are going to go down."

Sustainable change comes at a price

Another survey,¹³ carried out by Ipsos on behalf of the International Alliance of Dietary/Food Supplement Associations (IADSA), asked participants what, if anything, was holding



Read more: Who should carry the costs of going green? Our readers' thoughts revealed

their company back from doing more on environmental sustainability. Almost half mentioned the cost to the consumer (48%), while a slightly smaller proportion cited the cost to the company itself (44%).

But in a time where inflationary pressures are being felt around the globe, is it fair – or realistic – to pass those costs on to the consumer?

Asked about barriers to adopting a more sustainable lifestyle, 52% of respondents said it was too expensive, according to market research conducted by Deloitte UK.¹⁴

Meanwhile, a 2023 report by The Food Foundation think tank found that the most deprived fifth of the British population



would need to spend 50% of their disposable income on food to meet the cost of a healthy diet.¹⁵

Ultimately, big businesses need to get on board if meaningful change is to be made, said Vakarelova, particularly as the onus is falling on smaller

operations – typically, those with less capital.

“It’s this vicious circle, because the companies that would like to do sustainability normally are the small ones, the new ones, the startups that don’t have the money to do that – and the ones that have the money [are]

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It’s this vicious circle, because the companies that would like to do sustainability normally are the small ones, the new ones, the startups that don’t have the money.”

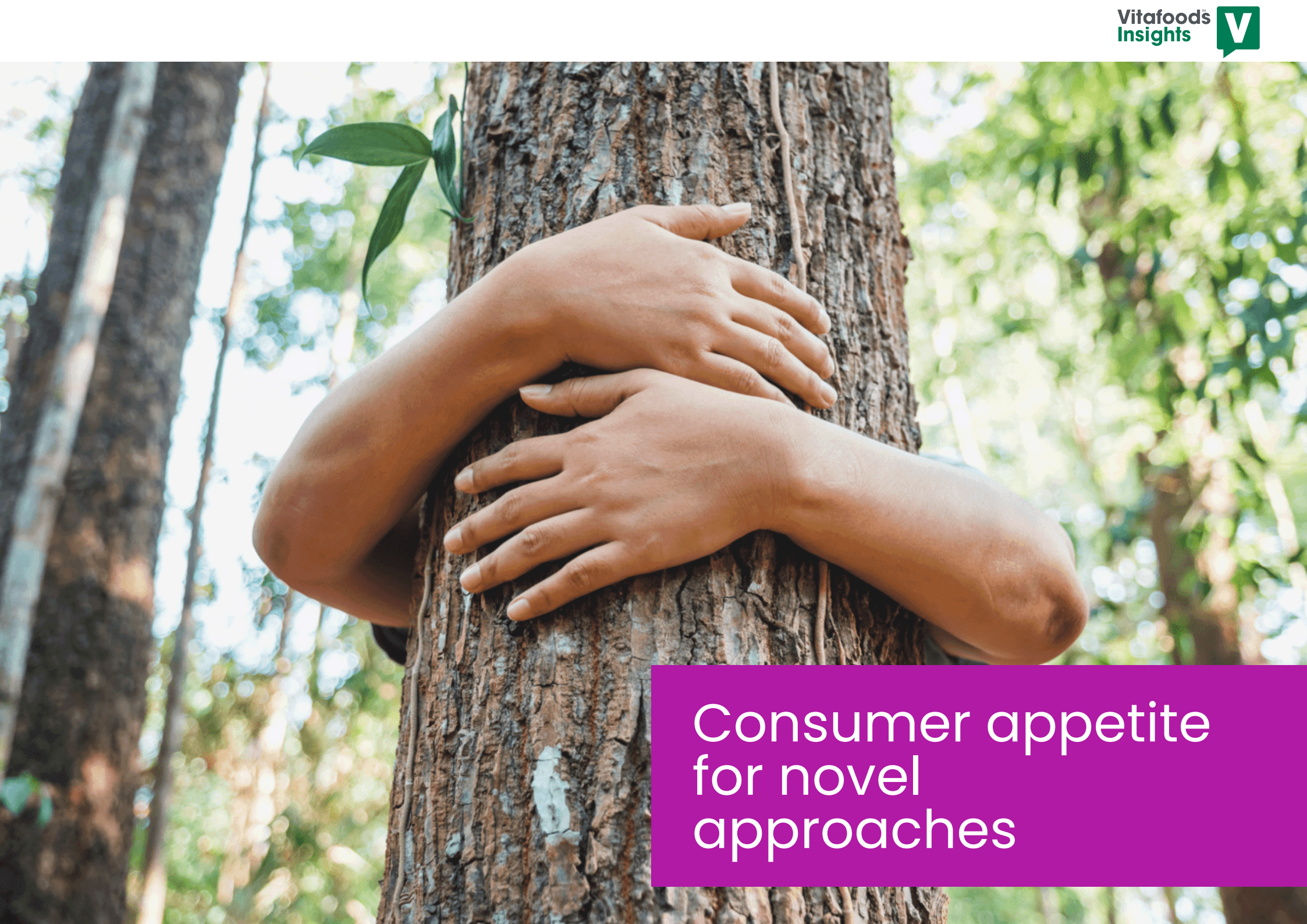
Martina Vakarelova, co-CEO,
Sphera Encapsulation

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just not doing anything,” she said.

But she sounded a positive note, saying “things are going to change. I see the mindset is changing”.

She added: “I see also the European Union is really going that way, so even if [companies don’t] want to, they will have to put their money into R&D.”

A photograph of a person's arms hugging a tree trunk in a forest. The person's hands are resting on the rough bark of the tree, and their forearms are wrapped around it. The background is a soft-focus view of a forest with green foliage and sunlight filtering through the trees. The image conveys a sense of connection with nature and tranquility.

Consumer appetite
for novel
approaches

The consumer appetite for sustainable lifestyles is clear:

according to Deloitte, there was a sharp increase in the number of people who adopted a more sustainable lifestyle last year, compared with 2021.¹⁶ But what is the public perception of

emerging technologies such as precision fermentation?

Helaina CEO Katz said that despite industry fears, people were generally quite accepting, observing that most consumers “care about the impact of their food on their

health first, and how it's made second”.

She gave the example of Impossible Foods, which uses the technology to make soy leghemoglobin, the ingredient that makes the plant-based burger “bleed”.

“
[Consumers] know the burger bleeds but they don't really know how the components of the burger are manufactured.”

Laura Katz, CEO, Helaina

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“If you go to a regular consumer, no one knows that – they know the burger bleeds but they don't really know how the components of the burger are manufactured,” she said.

However, she admitted the regulatory landscape and consumer response were very different in the US compared with Europe.

“In Europe, genetically engineered and GMO is maybe a little bit of a scarier term than in the US – but in the US, if you make something like a protein, and there's no more genetic material left in the final ingredient, then you don't need to label it as GMO,” she explained.

“And so without that labelling, and without even mentioning precision fermentation, I don't know that a consumer is really going to care how their ingredient is manufactured, if they believe that it's going to do something better for their health.”



Sustainability as a mindset

What about the role of policymakers? Around a third of respondents to the IADSA survey said a lack of government support or incentives (34%) was hindering their efforts to become more sustainable.¹⁷

Meanwhile, government policy has been demonstrated to have a “significant direct promoting effect” on green technology innovation.¹⁸

Pharmacist and natural health expert Foreman, who is based in the US, expressed scepticism. “I believe the governments should stick to governing and let the industries involved lead the way through this process,” he said. “Too much government is never a good thing.”

However, from the European



side, Sphera’s Vakarelova remained cautiously optimistic about the direction of industry, saying that she did not believe businesses would make this level of effort without a push from authorities.

“I don’t think that industry will change if the European Union [does not care] about it,”

she said. “And now I see that the European projects are very dedicated to sustainability, so [companies] will have to. They will just have to. And I think that this is the only way right now.”

Moreover, sustainability needs to be embedded into company culture, she added.

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It’s little things, little steps – but for us, it’s very important.”

Martina Vakarelova, co-CEO,
Sphera Encapsulation

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“For us, it’s kind of a mindset because also the people working here have a mindset of sustainability,” she said. “It’s little things, little steps – but for us, it’s very important.”

And she said it was a 24/7 endeavour, adding: “It’s a mindset that [sustainability] should be something that is a way of life; it’s not [that] you do it here, and then you go home and you stop doing it. It’s just something that, in my opinion, all people need to be living in this manner.”



Key takeaways

- **Precision fermentation and plant cell cultivation are examples of innovative technologies that offer the potential to produce animal-derived ingredients with a dramatically reduced footprint and less dependence on supply chains.**
- **Such emerging techniques are cheaper, more efficient, and easier to scale than traditional agriculture.**
- **Using materials that are biocompatible, biodegradable, plant-based, or upcycled is another means by which brands can enhance their products' green credentials.**
- **Embedding environmentally sensitive practices into business can be expensive and requires careful management; projects cannot be sustainable if they incur insurmountable costs.**
- **Despite industry concerns, innovative technologies appear to have good buy-in from consumers: most people care more about how their food impacts on their health than how it is made.**



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