High culture: how dsm-firmenich is harnessing AI to

take fermented dairy to the next level

dsm-firmenich

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Insights of the global yogurt market

Selecting and testing cultures for fermented dairy products typically involves lengthy, complicated, and often siloed processes. Underpinned by a pioneering, artificial intelligence (AI)-powered collaborative platform, dsm-firmenich's Delvo®ONE family of cultures overcomes such pain-points, alongside other challenges, to deliver on multiple targets via one elegant solution.

With consumer awareness today widespread with regards to the importance of good digestive health, and shoppers increasingly shifting to gut-friendly foods, the global yogurt market in 2023 reached an estimated value of US$168 billion, and is set to expand to over $237 bn by 2028, according to Statista.[1]

While these are certainly encouraging figures for the world's fermented dairy producers, there nonetheless remain key issues, both external and internal, that manufacturers must face – from food affordability and food waste concerns at the consumer level, to all manner of inefficiencies and inaccuracies throughout the various stages of product development and production that serve to further compound the food waste problem.

In response, dsm-firmenich has sought to combine the power of AI machine learning (ML) with the insights that come from close collaboration with the customer, as it looks to reimagine the culture selection and blending process – and conserve significant resources in so doing.

By fully understanding the manufacturer's painpoints and product prerequisites, dsm-firmenich can today swiftly and accurately test hundreds of billions of potential culture combinations to meet multiple targets without compromise – and, crucially, without the considerable waste (in time, energy, valuable ingredients, and final product alike) that has long typified new product development (NPD) in the fermented milk product space.

With its resultant Delvo®ONE family of cultures, dsmfirmenich is now leading the way with a smarter, more holistic solution for fermented dairy products – one that hits the spot first time with both its customers and the end-consumer.

[1] Global yogurt market revenue 2028 | Statista

AI-powered Culture Co-Creation Platform

Underpinning the new Delvo®ONE portfolio is dsm-firmenich's first-of-its-kind, AI-powered Culture Co-Creation Platform. By reducing trial complexity during the culture selection process, this novel machine-learning-led platform significantly improves the accuracy and speed of NPD, thus dramatically enhancing efficiencies, as well as driving down waste at both the manufacturer and end-consumer level. The process starts with the yogurt producer and dsmfirmenich together clarifying the specific performance needs for an application.

"This could include longer shelf-life, creamier taste, better texture, and improved nutritional profile," exemplifies Claire Price, global innovation manager for taste, texture and health at leading nutrition business dsm-firmenich. "Such needs are then translated into a clear objective for the machine learning framework."

Through several ML iteration cycles, the blends are incrementally improved until performance targets are met. The most promising culture solutions are thereafter tested in application at pilot scale to verify their performance. dsm-firmenich's experts then work with the yogurt manufacturer to select the best performing blends to suit their requirements. The final stage involves validating the taste, texture, health benefits, and shelf-life of the product in real-world conditions, to ensure it meets both producer and consumer expectations.

Machine learning's crucial advantage, notes Price, is in allowing for an efficient exploration of blend designs, and in proposing the best new culture combinations to be tested.

"In developing this platform, our aim was to increase the precision of our solutions. This means the culture needs to work not only in our lab, but also within the confines of our customer's manufacturing processes," notes Price. "By designing holistic solutions, we eliminate unintended effects when the different culture strains are combined. So, it's all about increasing precision – and that's where the data comes in."

A key reason for going down the AI route was dsmfirmenich's desire to meet multiple targets at once, and without any trade-off.

"Doing so requires a huge design space," notes Price. "To make full use of your culture portfolio, while the combinations may not be mathematically infinite, you're still talking about hundreds of billions of possible combinations. There's no robotic screening system out there that can screen that quantity," she advises.

"Yet introducing AI machine learning enables us to make use of the full design space available for every possible combination. The advantage with machine learning is that it does the calculations for you upfront, meaning only the most likely candidates are tested in your lab. "So, while it's not a completely people-free or wetlab-free system, the AI machine learning component dramatically reduces the number of options we have to test; there's also a better chance that the ones we do test will actually meet all the targets," she summarises.

Claire Price,
Global Innovation Manager for Taste, Texture and Health, dsm-firmenich

"The culture needs to work not only in our lab, but also within the confines of our customer's manufacturing processes."

Responding to consumer-led concerns

Certainly, dsm-firmenich's ambition for its Delvo®ONE solution in meeting all the targets includes effectively responding to the numerous concerns and challenges that exist for the fermented milk product manufacturer – from both an external and internal standpoint.

With regards to external pressures, amidst the continuing cost of living crisis, food affordability concerns inevitably remain top of mind for consumers: "Accordingly, we observe a major drive amongst manufacturers to increase efficiency and improve processes, in order to save costs and ensure consumer products remain affordable," advises Price. "For the same reason, there's a drive to reduce the cost of ingredients like fats and proteins, whilst maintaining those allimportant properties like texture that keep consumers eating dairy."

Heightened pressure for dairy to become more sustainable is another key external challenge. "For dsmfirmenich, this means developing solutions that extend the product's shelf-life, in order to reduce food waste, protect the brand, and help optimise logistics," advises Price.

She notes that comparisons with the expanding plantbased segment only serve to underline the vital task for dairy producers in reducing waste and advancing their sustainability credentials, in a bid to maintain consumer appeal and retain market share.

"There's a drive to reduce the cost of ingredients like fats and proteins"

Addressing internal pain-points for producers

Meanwhile, from a fermented dairy manufacturer's perspective, major internal points of contention include the lengthy process of culture selection that has long posed a bottleneck in NPD.

"Generally, dairy producers assess each culture independently from others that might be used in the final formulation. Starter cultures are typically evaluated for taste and texture, bioprotective cultures for their shelf-life properties, and probiotic cultures for their ability to support specific health benefits. This atomised testing process is clearly time-consuming," Price elaborates.

Another internal challenge for producers is the distinct risk of unintended interactions when different strains – living organisms – are combined in an application.

"Bioprotective cultures, for example, are a great way to protect a yogurt product against yeast and moulds, which is vitally important in protecting a brand's reputation. However, when these bioprotective cultures are added on top of starter cultures, they can produce too much post-acidification, which can negatively affect the taste of the yogurt," points out Price. "So, there's always that potential to see something unexpected or unintended."

A further issue is the oft-error-prone nature of operations in the factory setting wherever different bags of cultures require blending, leading to inefficiency and inoculation errors. Adding probiotic and bioprotective cultures to a recipe also represents extra cost on top of the basic starter culture cost, notes Price.

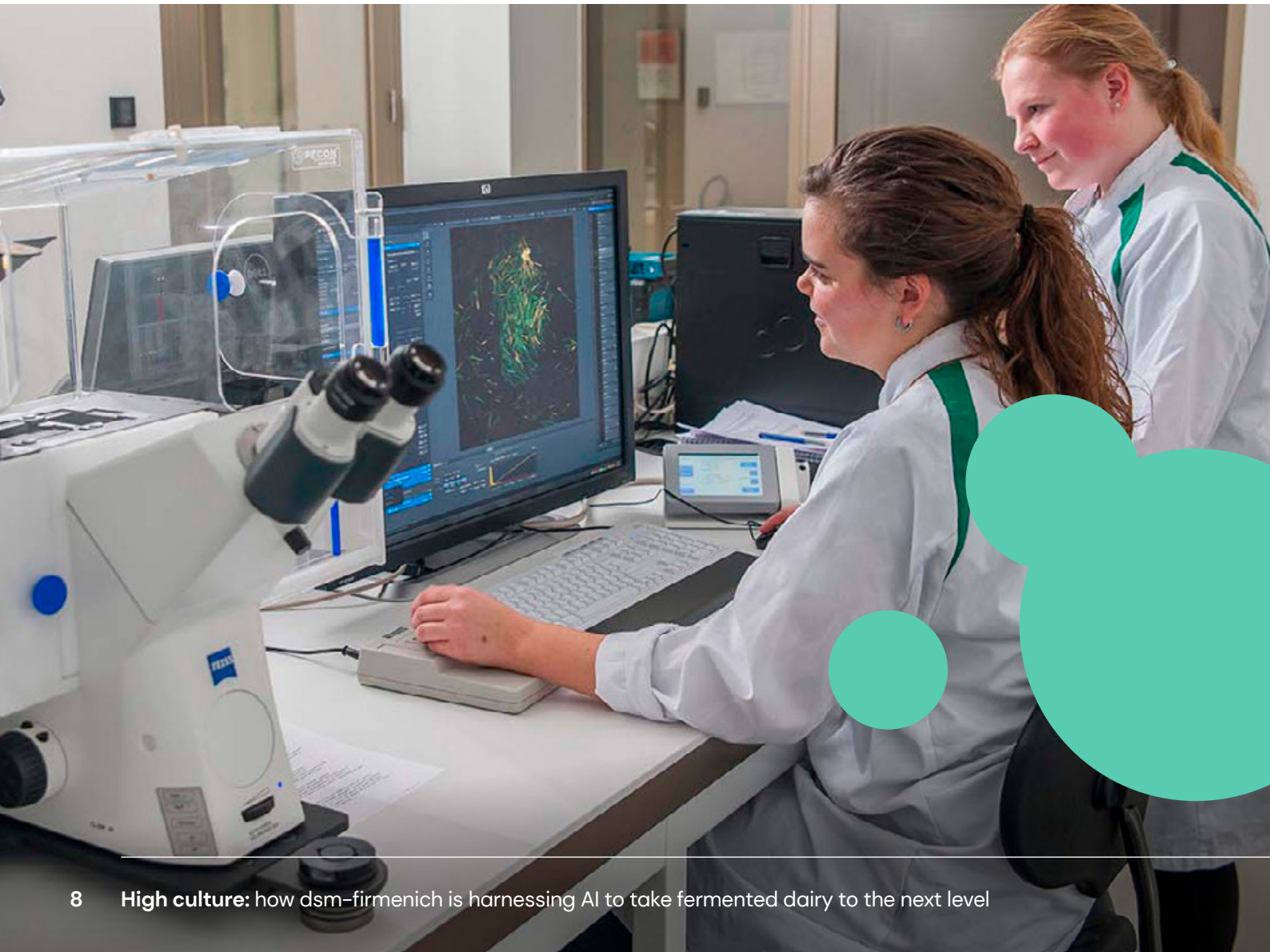
"With our Delvo®ONE family, we address not only the functional aspect of the product, but also its cost in use – and by developing cultures that have more than one function, we're able to offer customers something that's also cost effective."

Meet the Delvo®ONE family

Informed by over a century of scientific knowhow and biotechnology expertise, the most convincing response to all aforementioned pain-points in fermented dairy production is dsm-firmenich's Delvo®ONE family of cultures.

Encompassing five culture blends – each containing a starter culture, built-in bioprotective culture, and optional probiotic culture – this all-in-one solution meets the requirement for bioprotection in yogurt products, simultaneously delivering on key targets for taste, texture, fermentation time, and post-acidification, while in tandem promoting impressive efficiencies in the manufacturing process.

"The key feature driving Delvo®ONE's efficiency in the factory is that although it hits multiple targets, it does so – and very effectively – as 'one solution' in one bag," advises Price. "This means ease-of-use, fewer stockkeeping units, and less prep work in terms of the day-today operations."



Key characteristics of the Delvo®ONE culture blends:

- Delvo®ONE Alpha – Extra mild and creamy taste, high texture, a good level of bioprotection, and limited post-acidification. This blend features the least post-acidification.
- Delvo®ONE Gamma – Mild and creamy taste, high texture, a good level of bioprotection, and limited post-acidification. The key feature of the blend is its slightly thicker consistency.
- Delvo®ONE Zeta-C – Mild and creamy taste, high texture, a good level of bioprotection, and limited post-acidification. With probiotic *L. paracasei* L26, the culture blend retains a high cell-count until end of shelf-life.
- Delvo®ONE Alpha and Gamma are also available with probiotic *B. animalis lactis* Bif-6. The culture blend retains a high cell-count until end of shelf-life.

All Delvo®ONE culture blends boast comparably fast fermentation times – each coming in at less than six hours (tested in a milk base of 4.2% protein, 1.5% fat, at a fermentation temperature of 42°C). Aimed at driving down food spoilage and waste, Delvo®ONE cultures exhibit excellent bioprotective activity against both mould and yeast. For example, during an intentional challenge test, the cultures demonstrated a good level of protection against *P. roqueforti, P. brevicompactum,* and *D. hansenii,* when tested at 4-7°C and 21°C.

Significantly, while adding a bioprotective culture typically impacts upon post-acidification in fermented dairy products, the low-level post-acidification demonstrated with Delvo®ONE blends is comparable to that of the starter culture alone (even during extended shelf-life, and at an elevated temperature), thus demonstrating another advantage of dsm-firmenich's simplified yet superior solution.

Furthermore, the cultures can optionally include probiotics (ie, Delvo®ONE Alpha-B, Gamma-B, and Zeta-C), retaining a high cell-count at the end of shelf-life to ensure the gut health benefits of the yoghurt product are maintained throughout.

A sustainability-minded solution

Through Delvo®ONE, dsm-firmenich is laser-focused on ensuring the customer's finished product remains as high quality as possible, with an emphasis on shelf-life extension, and on consistently meeting shelf-life targets.

"I passionately believe that if food is made for human consumption, then it should be consumed by humans – that's the goal," asserts Price. "And the issue is not only related to waste coming from manufacturers. Consumers are also increasingly aware that their own domestic food waste is contributing to the problem. So, that consideration was, likewise, fed into our vision when we developed Delvo®ONE, as part of dsm-firmenich's broader goal of creating sustainable food systems," she notes.

Underlining this sustainability-focused ambition, dsmfirmenich has developed its innovative culture portfolio in both frozen and freeze-dried formats, making it an effective choice for all regions, including emerging markets where cold-chain logistics are less reliable.

Aside from the important cost, affordability, and sustainability considerations, other market factors to which Delvo®ONE effectively responds include the rise of clean label, with cultures viewed as recognisable, natural, and appreciated ingredients on the list, from a health and nutrition perspective.

"A further key trend is convenience, which becomes more challenging when you want to develop a fresh dairy product as a snack, as it won't be staying in the fridge all day," remarks Price. "Our Delvo®ONE family of cultures can really support customers in the development of such snacks, in terms of extending shelf-life."

Co-creation is the key

Certainly, supporting customers is what lies at the heart of dsm-firmenich's new platform, with the focus being as much on the 'co-creation' aspect as it is on the AI, stresses Price.

"Our aim is to use the machine learning, and this digital approach more generally, to bring us closer to customers. It's not just about us working in a faster, more precise way. It's about collaborating with the customer to deeply understand their pain-points and the environment in which the solution needs to perform – co-creating, so that whatever we develop really hits the spot with them," Price tells us. "As excited as we are about the AI, we want our customers to be excited about working with us."

> "A computer only learns what you feed it"

This approach naturally serves to create a virtuous circle, as close collaboration with the client generates yet more interesting data that can then further enhance the ML algorithm.

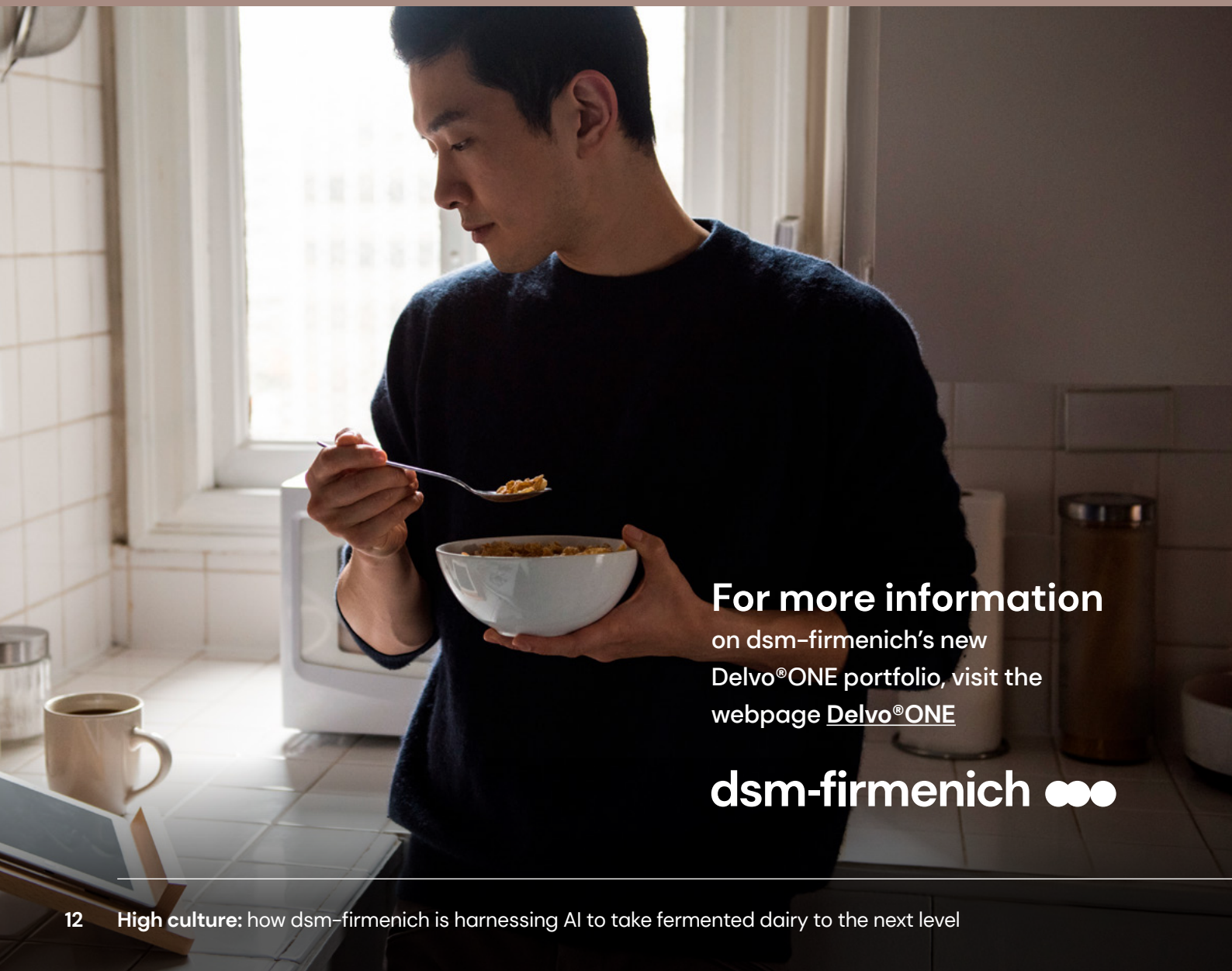
"A computer only learns what you feed it," remarks Price. "That's why co-creation is also about datasharing between the customer and supplier in a very open way – because the more data available to us to train the machine learning part, the better it becomes at predicting culture performance."

Choosing the right yogurt culture for a specific application has never been an easy task. Yet with its AI-driven Culture Co-Creation Platform and new Delvo®ONE portfolio, dsm-firmenich is helping fermented dairy manufacturers gain improved control over the sensory, technical, and shelf-life properties of yogurts all at once, saving valuable time and resources. Fast, accurate, and streamlined, the company's Culture Co-Creation Platform effectively transforms a lengthy and complex process into a valuable opportunity for collaborative innovation.

Key takeaways:

Delvo®ONE – An all-in-one culture solution, delivering on multiple targets:

- Co-created with AI and customers, a unique blend of starter culture with built-in-bioprotective culture, and optional probiotic culture.
- Improved performance compared to separate culture solutions, delivering excellent texture and flavour, plus very low post-acidification.
- High-level bioprotection offers: the potential for shelf-life extension (supporting product in the supply chain, reducing food waste); good quality at the end of shelf-life; brand protection by reducing risk of spoilage; the option for a probiotic health benefit.
- A convenient, one-bag solution for easy implementation during production.
- Improved cost-in-use compared to using separate cultures.
- An efficient, cost-effective solution removing the complexity and significant resources associated with testing separate cultures.
- Major sustainability benefits at both manufacturer and consumer level, resulting from reduced waste and extended shelf-life.



For more information
on dsm-firmenich's new Delvo®ONE portfolio, visit the webpage Delvo®ONE

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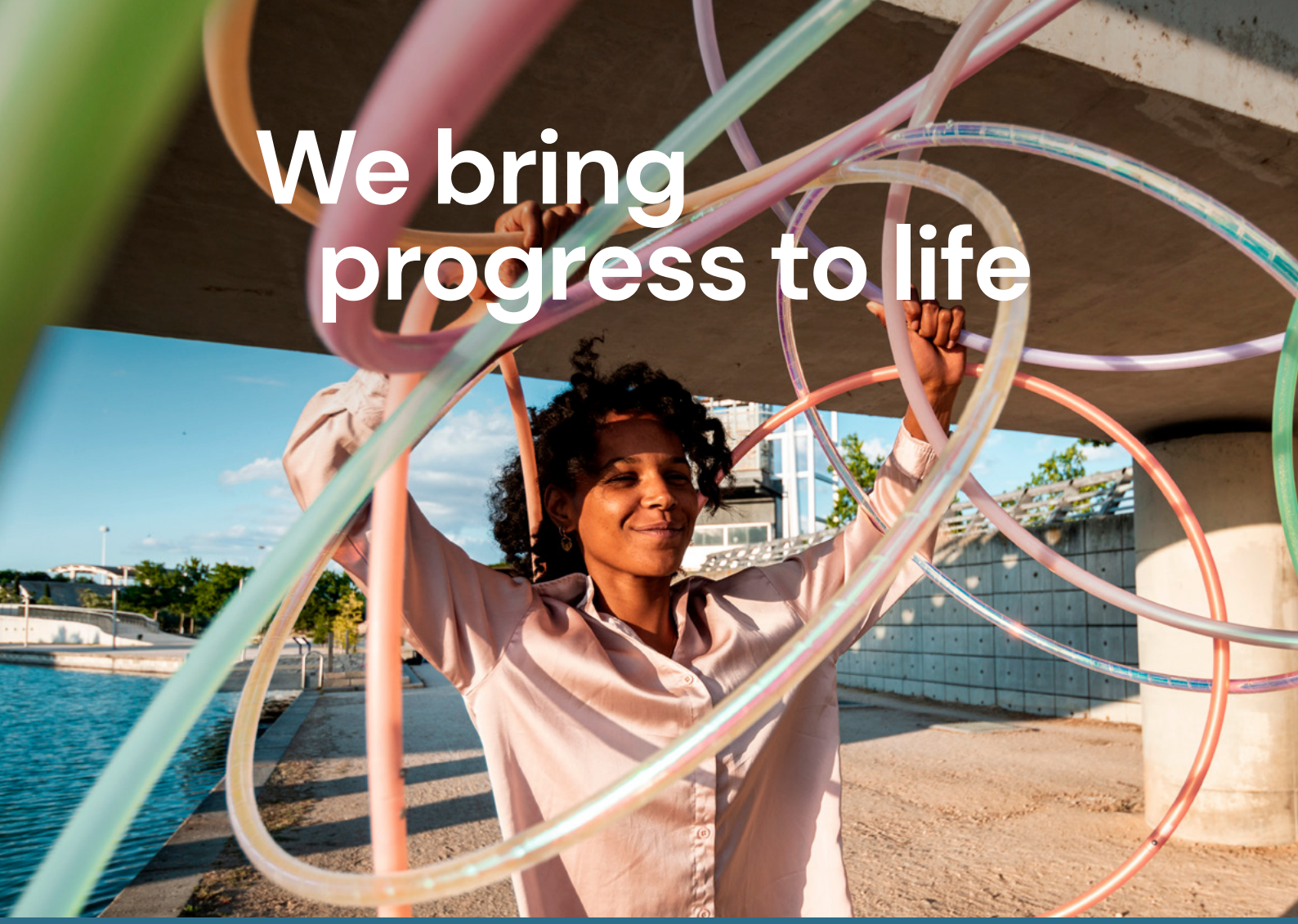

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Our nearly 30,000 loyal, passionate, talented and diverse employees across the globe strive every day to be a force for good and bring progress to life for people and the planet. And with over a century of scientific leadership under our belts, we intend to keep pushing the boundaries of what's possible – and improve billions of lives. We'd love you to join us on that journey.

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