ROYAL DSM© JUNE 2021

DSM, a world leader in biotechnology

NUTRITION · HEALTH · SUSTAINABLE LIVING

DSM
BRIGHT SCIENCE. BRIGHTER LIVING.

Preface

At Royal DSM, we see biotechnology as an important building block to address climate change, resource scarcity, and circularity, and to optimize the global food system.

Building on 150 years of expertise, today DSM is a global purpose-led leader in biotechnology, developing a broad range of sustainable, bio-based products and solutions for better health through nutrition.

DSM's biotechnology competences offer world-class science and innovation, organized in a global network of R&D and manufacturing facilities in Europe, China, Brazil, and the USA. Here, collaborating with our partners from governments, business, and academia, we work to expand the possibilities of biotechnology and maximize its potential to provide solutions to help sustain and restore healthy populations, ecosystems, and societies – contributing to a world we all want to live in: healthy people, healthy animals, and a healthy planet.

This booklet provides an insight into the history and potential of biotechnology, the innovations driven by it, and the way DSM is advancing the responsible use of this promising technology.

Why.

Addressing global challenges through science & innovation.

The modern world is caught in the crossfire of a number of converging megatrends: population growth, increasing natural resource scarcity, and a growing demand for the sustainable production of healthy food, feed, nutritional ingredients, and medicines.

Tackling these challenges might seem like a tall order, but it's actually a very realistic and achievable goal when we make use of nature's toolbox, like microorganisms. Through biotechnology and biomanufacturing, we can use these microorganisms to develop products and solutions that allow us to feed a growing population more sustainably, while supporting with reducing food loss and waste, fighting climate change, avoiding natural resource depletion, and preserving biodiversity.

10bn

Population growth

The world's population is expected to reach 10 billion by 2050 – and with this comes increasing consumption of natural resources. Our demand for natural resources is expected to triple from 50 billion tons in 2014 to 130 billion tons by 2050 – an overuse of the earth's total capacity by more than 400%.

Source:
United Nations, 2019

821m

Hunger vs obesity

Over 821 million* people suffer from hunger, while over 2.3 billion people are overweight. Another 1 billion people are suffering from "hidden hunger," consuming food that is deficient in micronutrients such as the vitamins and minerals required for growth and development.**

Sources:
* Food & Agriculture Organization of the United States, 2019
** World Health Organization, 2018

40m

Non-communicable diseases

Non-communicable diseases like heart disease, stroke, and cancer are now the leading cause of death around the world, causing 40 million people to die every year – the equivalent of 70% of all deaths worldwide.

Source:
World Health Organization, 2021

$940bn

Food loss & waste

The world's annual food waste bill is US$940 billion – and food waste also accounts for about 8% of total global greenhouse gas emissions, ecosystem degradation, and biodiversity loss.

Source:
Food & Agriculture Organization of the United States, 2019

What.

Biotechnology is a key enabler as we work towards these challenges.

Biotechnology supports the development of sustainable and bio-based products, processes, and services that are safe, healthy, and scalable.

The production of bio-based products and solutions is often based on fermentation, which involves the use of microorganisms like yeast, fungi, or bacteria. These microorganisms, or microbes, are invisible to the naked eye but are considered the most versatile creatures on earth. They have populated our planet for over 3.5 billion years, performing essential functions to help sustain natural life cycles. They are highly adaptable, they can live under extreme conditions, and they are great chemists.

So it's not surprising that humans have been harnessing the power of microorganisms for thousands of years. Traditionally, we've used microbes to make and preserve foods like cheese, yogurt, bread, kimchi, beer, and wine.

Much of this traditional fermentation technology is still performed today, but in a more modern way. Nowadays, fermentation takes place at industrial scale in large stainless steel vessels, resulting in better and more consistent quality and safety. Also known as industrial biotechnology, these processes enable the development of products including baker's yeast, savory yeast extracts, and dairy cultures for the production of cheese and fermented milk products.

How old is the use of fermentation by humans?

The earliest archaeological evidence of fermentation is the 13,000-year-old residue of a beer with the consistency of gruel found at the Raqefet Cave in northern Israel. The beer would have been used by the semi-nomadic Natufians for ritual feasting. Other evidence of a fermented alcoholic beverage (made of fruit, honey, and rice) from Neolithic China dates back to 7,000–6,600 BC.

13,000

years of brewing using fermentation

With over 150 years of history, DSM has already developed an extensive portfolio of sustainable solutions that help address the challenges facing modern society.

During these 150 years, many acquisitions and partnerships supported DSM's transition into a global, purpose-led leader in biotechnology - specializing in solutions for health through nutrition.

1869 — Nederlandsche Gist- & Spiritusfabriek (Eng: Dutch Yeast and Ethanol Factory) founded by Jacques Van Marken, industrial biotechnology pioneer.

1896 — Hoffmann-La Roche founded by Fritz Hoffmann-La Roche. From early on, the company was known for producing various vitamin preparations and derivatives.

1902 — DSM was established by the Dutch government to mine coal reserves in the Southern Province of Limburg.

1968 — Nederlandsche Gist- & Spiritusfabriek becomes Gist-Brocades.

1998 — DSM acquires Gist-Brocades.

2003 — DSM acquires Roche's Vitamins and Fine Chemicals division in Switzerland, ultimately developing fermentation processes for vitamins including Vitamin B2 and Vitamin C.

2010 — DSM acquires Microbia (USA), a research facility developing high-quality, bio-based food and feed ingredients.

2011 — DSM acquires Martek (USA), broadening the spectrum of algae-derived specialty lipids.

2018 — Establishment of Veramaris®, a joint venture between DSM and Evonik, to produce omega-3 fatty acids for animal nutrition from microalgae.

2019 — Establishment of Avansya, a joint venture between Cargill and DSM, to produce calorie-free sweeteners through fermentation.

2020 — DSM becomes founding partner of Planet B.io, a scale-up ecosystem for biotechnology start-ups located at the Biotech Campus Delft.

2020 — Establishment of Olatein, a joint venture between DSM and Avril, to develop plant-based protein.

2020 — DSM acquires Glycom (Denmark), the world's leading supplier of human milk oligosaccharides (HMO) for early-life nutrition applications; CSK (the Netherlands), specialty dairy ingredients company; and Erber Group's Biomin and Romer Labs (Austria) to strengthen our specialty animal nutrition with mycotoxin and gut health solutions.

2021 — DSM invests in TU Delft's artificial intelligence (AI) for biosciences research lab, called AI4B.io, to develop a deeper understanding of how AI can improve efficiency and effectiveness in developing bio-based products and production technologies.

Biotechnology enables purpose-led innovations

DSM has created a strong platform for growth and is ideally positioned to capture the growth opportunities offered by the global megatrends and Sustainable Development Goals (SDGs).

During 150 years of industrial-scale biotechnology, DSM's experts have brought countless innovations to the world. Today, we are considered one of the top global innovators in the industry.

Going forward, DSM has identified four strategic growth themes based on global megatrends, linked to the United Nations Sustainable Development Goals (UN SDGs), that will give direction to the future of nutrition R&D and innovation at our company.

Pathways

We start with **Pathways** to produce macro- and micronutrients. This is our history and our base strength, where we combine our chemistry and biotechnology capabilities. Our process solutions produce ingredients and intermediates from renewable resources cost-effectively and with a low environmental footprint. One example is our bio-based vitamin and carotenoid platform, which delivers bio-based products with health benefits for humans and animals at competitive costs in a sustainable way.

Proteins

However, we are much more than an ingredient company. We also provide solutions. Our **Proteins** theme addresses the question of how to meet the protein demands of a growing global population sustainably, by enabling the lowest possible footprints for animal protein production, and providing alternative protein solutions for human nutrition.

Prevention

In our **Prevention** pillar, we have a rich portfolio of active ingredients that help to maintain and improve the health of people and animals. As we learn more about how our ingredients modulate the gut microbiome, for example, we see potential to develop solutions that build people's and animals' resilience to stress and disease. Meanwhile, our bio-preservation cultures, combined with DSM starter cultures, probiotics, and enzymes, offer solutions that can significantly reduce food loss and waste in fermented milk products like yogurt.

Precision

Finally comes **Precision**. With increasing insight into the microbiome function and the application of advanced analytical tools, we develop novel ingredients and digital solutions that allow precise nutritional interventions and thus create health benefits for humans and animals.

Developments in biotechnology and digital transformation

Developments in our understanding of biology, as well as major advances in adjacent research fields such as data science and modeling, are opening up exciting new possibilities for new bio-based products, applications, and manufacturing processes.

For instance, two key technologies behind many biotechnology developments of the past 30 years are the “reading” and “writing” of DNA. While early human full-genome sequencing would require more than 600 scientists from over 100 laboratories, a typical lab nowadays can read tens of human genomes per day. The development of the COVID-19 RNA vaccines in just a matter of months in 2020–21, for example, could not have been done without the technology behind the reading and writing of DNA.

Similarly, exponential improvements in the speed and cost of DNA synthesis are enabling scientists to adapt and modify microorganisms in a safe and efficient manner, allowing them to produce new bio-based products, applications, and manufacturing processes.

Meanwhile, other emerging technologies – such as robotization, advances in mathematical modeling, digital twins (a virtual mirror of a real-world product or process), and AI – allow us to further reduce the time and cost of bringing new solutions to our customers. Integrating these technologies reduces the time spent on R&D and innovation cycles, from prototyping to scaling and to commercialization.

These technologies will add great value to society in the years to come. Producers of food and feed will be able to deliver healthy, sustainable products – more efficiently, affordably, and quickly than ever before.

Disruptive biotechnology research recognized with Nobel Prizes

Technological progress in the field has been mind-boggling. A particularly interesting development is directed evolution. Based on the principles of mutation (which happens naturally, but can also be accelerated in the lab) and selection, this technology enables scientists to optimize enzymes – the proteins that catalyze biochemical reactions – for specific bioproducts.

In 1993, Professor Frances Arnold from the California Institute of Technology conducted the first directed evolution of enzymes. The applications of her results include more environmentally friendly manufacturing of chemical substances, the production of renewable fuels and the creation of superior enzyme products for food processing. Arnold was awarded the Nobel Prize in Chemistry in 2018.

More recently, CRISPR-based genome editing – invented in 2012 – has once more advanced the field of biotechnology. The CRISPR-enzyme acts as programmable “molecular scissors,” enabling very precise adaptations in the genome of a living cell, just like nature does it, without leaving traces of the genetic engineering behind. The pioneers of this technology, Emmanuelle Charpentier and Jennifer Doudna, were awarded the Nobel Prize in Chemistry in 2020.

How.

Biotechnology competences at DSM.

Through our world-class R&D and manufacturing facilities, DSM possesses the full range of biotechnology and biomanufacturing competences. These enable us to identify and develop new molecules, applications, and processes – and to commercialize them at scale.

1. Screening

Developments in biotechnology often rely on screening and selecting suitable high-performance microorganisms. These can be screened from microbial culture collections, classical mutagenesis, and evolution experiments or strain improvement programs. Automation and miniaturization are increasingly important to further optimize this process.

2. Strain development

Our scientists carry out strain development to make the selected organism fit for use, using classical (non-genetic modification) breeding tools as well as the latest genetic modification technologies.

3. Bioprocess development

Bioprocess development deals with bringing biotechnology innovations to factories. Upstream bioprocessing involves selecting feedstocks and cultivating microorganisms to manufacture bioproducts in large stainless steel vessels. Subsequent downstream processing is applied to secure good bioproduct yield and quality after purification and formulation within required specifications.

4. Biochemistry and microbiology

Biochemistry and microbiology provide insight into how enzymes and microbes function on a molecular level. Together with our food application science, they enable the application of bio-products such as enzymes and microbes. Moreover, insights in microbial populations, so called microbiomes, in gut and on skin are applied for developing novel applications for Precision Farming, Personal Care and Personalized Nutrition.

5. Bioinformatics and modeling

DSM's bioinformatics and modeling team supports the development of our strains, processes and applications. They draw on a wide range of scientific and technological specialisms, including DNA and genomics data interpretation, advanced computational models, and smart protein and pathway design methods.

6. Analysis

With our advanced analytical technologies, we generate insights to steer strain, process, application, and product development as an important facilitator of our biotechnology innovation cycles. DSM's biotechnology R&D teams leverage state-of-the-art analytical solutions, such as nuclear magnetic resonance (NMR) and mass spectroscopy, for screening and generating in-depth biological insights.

7. Data science

The principles of Findable, Accessible, Interoperable, and Reusable (FAIR) data and knowledge management are secured within the company as they are key to the success of our innovation programs. Extensive data and knowledge mining, including AI and machine learning, are applied to steer experimentation and generate insights.

DSM's global biotechnology R&D footprint

Currently, DSM has over 500 scientists working in biotechnology R&D across our facilities in Delft and Wageningen (the Netherlands), Kaiseraugst (Switzerland), Grenzach (Germany), Tulln (Austria), Hørsholm (Denmark), Tongxiang (China), and Lexington and Columbia (USA). Our biotechnology efforts – across our R&D locations and business areas – help us develop sustainable innovations, for and with our business partners.

Delft & Wageningen

Tulln

Grenzach

Columbia (MD)

Lexington (MA)

Hørsholm

Kaiseraugst

Tongxiang

DSM's collaborative approach

Continuous innovation is necessary to open up future pathways – and there is no innovation without collaboration. Only by working closely with our partners can we drive progress and develop innovative solutions that advance society. Around the world, DSM's biotechnology experts take part in academic partnerships, public–private partnerships, venturing projects, and joint ventures.

For instance, DSM develops new products through joint ventures like Veramaris®, Avansya, and Olatein, and through partnerships with Novozymes, Centrient, Amyris, and Syngenta. At the same time, we collaborate closely with start-ups, small and medium enterprises, and other early-stage biotechnology innovators. For example, as a founding partner of the Biotech Campus in Delft, an open innovation ecosystem, we support progress across the whole innovation cycle: from R&D at Planet B.io, to piloting at the Bio-process Pilot Facility, to full-scale production and commercialization.

Meanwhile, we take part in public–private partnerships and consortia such as the Bio-based Industries Consortium. Our scientific experts also liaise with their counterparts in the world of academia, fostering academic partnerships with more than 20 of the world's top universities and institutes, and take part in over 100 leading academic conferences each year. In this way, we continuously develop our competences in close collaboration with leading innovators, universities, and institutes. Together, we harness the long-term potential of biotechnology.

Some of the partners we collaborate with:

Avril · Evonik Industries · Syngenta · Cargill · Wageningen University & Research · TU Delft · Centrient Pharmaceuticals · biotech campus delft · planet b.io

Advocating for a sustainable future

At DSM, we don't just develop sustainable bio-based solutions for our customers and partners; we also advocate for the sustainable future we all want to live in. Our advocacy takes many shapes and forms. We work with academia, administrations, and industry at national, regional, and international levels including strong engagement with organizations such as EuropaBio, the Engineering Biology Research Consortium (EBRC), and HollandBio.

We also advocate for the adoption of new technologies as key enabler, like biotechnology, to drive the transition to a circular, bio-based economy. DSM's experts regularly take part in sustainability-focused public talks, conferences, and events, for example those hosted by the WEF Platform for Accelerating the Circular Economy (PACE), WBCSD Factor10, Circle Economy, Circular Economy 100 (CE100), the Ellen MacArthur Foundation, and other leading sustainability associations.

Alongside our advocacy, we provide transparency around our biotechnology activities through regular contributions to scientific publications. Through this wide range of activities, we aim to raise the profile of industrial biotechnology and connect with key stakeholders who will partner with us on our journey to a brighter world.

Now.

We are already making a difference, right now.

We are already reaching billions of people worldwide.

An overview of our biotechnology solutions

The following stories give an insight into how our biotechnology solutions already address many global societal challenges and reach billions of people worldwide. These innovative solutions span across our focus areas of Nutrition & Health, Climate & Energy, and Resources & Circularity.

While showcasing different innovations, one thing our case studies all show is that purpose and profitability can - and do - go hand in hand. By applying the very best science, by having a clear purpose, and by working closely with our partners, we persevere and achieve something incredible, together!

Opening up new horizons in lactose-free dairy

MAXILACT®

Today's dairy aisles are changing as they increasingly cater to consumer demand for affordable and premium products, as well as low-fat, low-sugar, clean-label, and lactose-free options. Lactose-free dairy is becoming particularly popular, and not just among those who are lactose intolerant: worldwide, three out of five people believe lactose-free dairy is healthier. This fast-expanding market is creating new opportunities for dairy manufacturers, but also drives the need for faster, more efficient production.

Putting the right capabilities to work

To address these market challenges and opportunities, DSM developed Maxilact®, a family of acidic and neutral lactase enzymes. We leveraged over five decades' experience producing healthy dairy ingredients. Our biotechnology expertise was essential to being able to develop the resulting lactose-free products.

A leading lactase with impact

Today, the Maxilact® portfolio of enzymes helps manufacturers deliver lactose-free dairy products without compromising on taste, mouthfeel, or texture. Not only does Maxilact® meet the needs of lactose-intolerant customers worldwide, the natural sweetness it unlocks also enables up to 20% sugar reduction in all dairy products.

Purpose led

DSM's Maxilact® product range enables consumers to enjoy lactose-free dairy that is delicious and clean-tasting. Maxilact® Smart, for instance, is a win-win solution for customers, end-consumers, and the environment, offering both a lower environmental impact and increased process efficiency. What's more, this unique story shows that bright solutions can always get even brighter! From production managers to brand owners and consumers, everyone in the value chain can benefit from this solution.

Performance driven

Driven by our winning combination of biotechnology innovation and commitment to enabling better food for everyone, Maxilact® helps dairy customers keep up with growing consumer demand for lactose-free products and maximize their sales without the need for significant capital investment.

Putting the life in yogurt.

DELVO®PRO

Today's consumers are more conscious than ever about the close relationship between food and health. And, with a growing body of scientific evidence underlining the importance of gut health for overall wellbeing, immunity-boosting probiotic products are an increasingly popular choice among health-savvy shoppers. So, whether in fermented milk products or either drinkable or stirred yogurts, probiotic strains must reliably uphold stability throughout their shelf life. In addition, these strains must offer good taste and maximize operational profitability.

Biotechnology in action

Leveraging more than 40 years' experience in the development of probiotic strains for consumer products, as well as the latest fermentation technology, DSM created Delvo®Pro, a family of probiotic strains for a range of dairy applications. Using our experience and state-of-the-art facilities, we applied biotechnology to ensure the strains' goodness reach the mouths and guts of consumers.

Driving gut health, one yogurt at a time

DSM's probiotic strains offer a real win-win by appealing to health- and taste-conscious dairy lovers and manufacturers alike. Not only does it help keep immune-boosting bacteria alive across long product lifetimes, but it does this without compromising on taste or mouthfeel. What's more, Delvo®Pro will be available in deep-frozen and freeze-dried versions, meeting the requirements of markets and manufacturers in diverse climates.

Purpose led

Today, Delvo®Pro helps boost the gut health and immunity of consumers around the world, creating healthier yogurt with an attractive taste and texture. This range of probiotic strains is produced with careful attention to water consumption and renewable energy, thanks to DSM's leading energy-efficient processes. In this way, it helps protect the planet even before the final product protects consumers.

Performance driven

DSM's combination of excellent quality standards and unique fermentation capabilities means we can deliver Delvo®Pro with an attractive cost-in-use, making it a strong competitor in the marketplace. In this way, Delvo®Pro helps make enhanced gut health accessible to more people than ever.

Enabling a range of superior meat alternatives

MAXAROME® SELECT

Whether because of concern for the environment or concern for one's health, plant-based diets – including vegan, vegetarian, and flexitarian diets – have grown in popularity in recent years. This has driven up the consumption of alternatives to meat and dairy by a broader set of consumers. This trend has brought both opportunities and challenges for food producers, who must deliver alternatives with the best taste and texture possible, while keeping salt, sugar, and fat low to promote the health benefits of their products.

MAXAROME® SELECT

Leveraging our unique R&D capabilities, including our fermentation technology, DSM developed Maxarome® Select – a unique yeast extract with a range of applications, including the delivery of an authentic meaty taste at reduced salt levels.

Helping people, helping the planet

Since its development, Maxarome® Select has been used in a variety of final products, enhancing quality perception in products including potato chips, dressings, low-fat cheeses, snacks, meaty products, and soups. Maxarome® Select also plays an important part in new applications. Increasingly, it enables producers of plant-based meat alternatives to mask undesirable off-notes that can be imparted by the protein base, for example beany flavors, and deliver an authentic meaty taste.

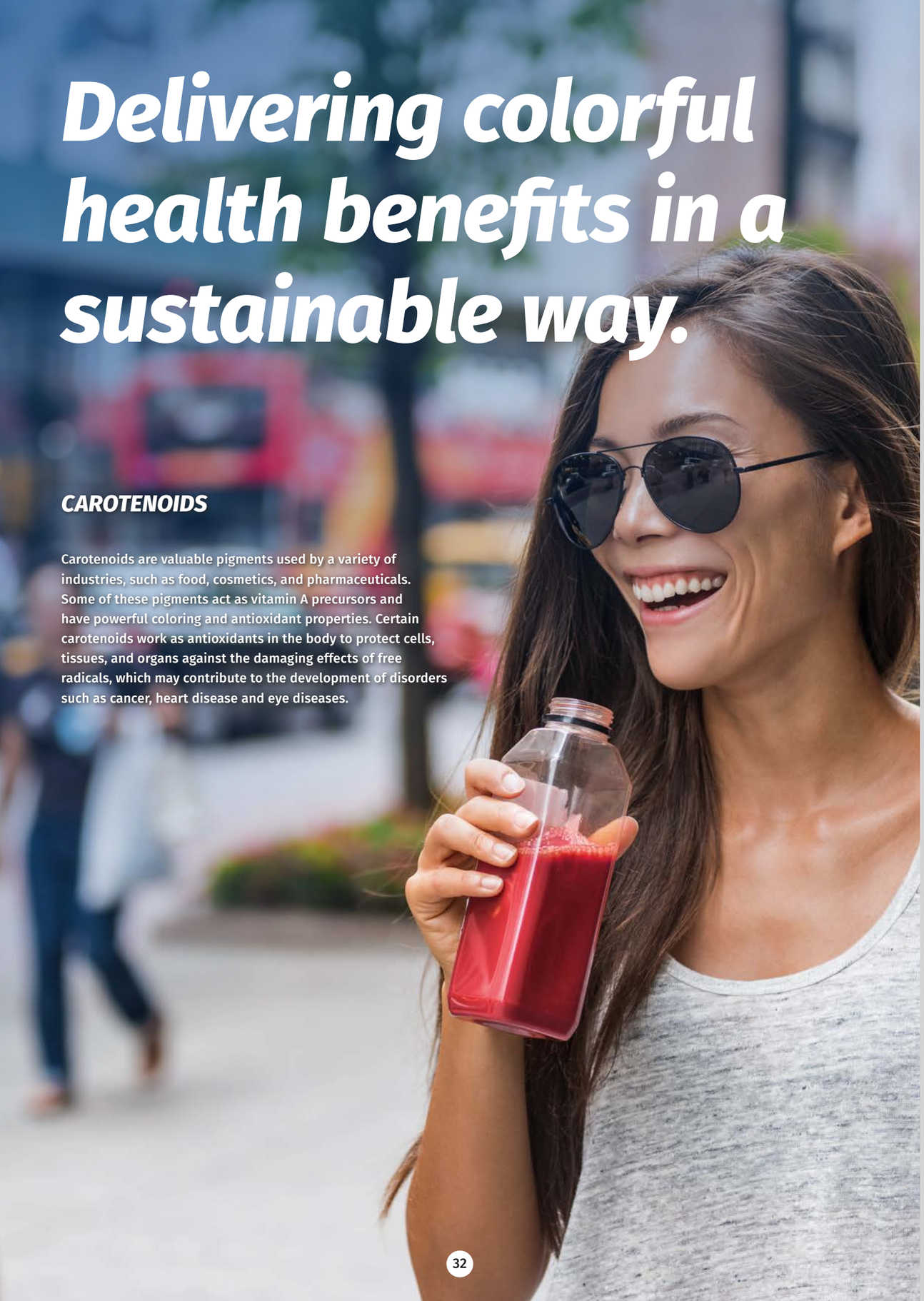
Purpose led

By helping keep salt, fat, and sugar low in final products without compromising on taste or texture, Maxarome® Select is enabling people everywhere to stay healthy. Moreover, since this yeast extract is produced sustainably and helps people shift away from high-carbon-footprint diets, it has a positive impact on our environment at large.

Performance driven

Maxarome® Select has continuously proven its great value in taste enhancement for many applications. Now it has also become a crucial part of DSM's taste toolbox for meat alternatives. As such, this solution continues to enable food producers everywhere to seize commercial opportunities and raise the bar for performance.

Delivering colorful health benefits in a sustainable way.



CAROTENOIDS

Carotenoids are valuable pigments used by a variety of industries, such as food, cosmetics, and pharmaceuticals. Some of these pigments act as vitamin A precursors and have powerful coloring and antioxidant properties. Certain carotenoids work as antioxidants in the body to protect cells, tissues, and organs against the damaging effects of free radicals, which may contribute to the development of disorders such as cancer, heart disease and eye diseases.

Meeting the demands of a changing world

Around the world, consumers increasingly demand foods and product ingredients that are free of artificially created additives, including colorants and preservatives, and have a low environmental impact. Traditional methods for manufacturing carotenoids are often limited by low yields and high amounts of waste, as well as significant environmental impact. To address changing consumer demand, new carotenoid production methods were required.

Biotech unlocks a better manufacturing pathway

Leveraging its long experience in both biotechnology and consumer ingredients, DSM began investigating the biotechnological production of carotenoids by fungi in the early 2010s. In particular, DSM has marketed and produced the production and sale of high-value natural beta carotene derived from fermentation of the *Blakeslea trispora*. Over the years, DSM has been able to develop a broad portfolio of natural-source and nature-based carotenoids – pigments with low environmental impact and high functional performance.

Purpose led

DSM's carotenoids are used in a wide range of dietary supplements, beverages and other food applications and offer important health benefits, such as protecting against degenerative eye diseases and other deficiency-related disorders. In addition, the biotech-enabled carotenoids are developed with a minimal environmental impact, enabling a better life for more people within planetary boundaries.

Performance driven

Biotechnology has not only facilitated an environmentally friendly carotenoid production – it's also enabling products that better fit growing consumer demand for products that are manufactured more naturally and with fewer artificial additives.

Improving edible oil processing

PURIFINE®

Feeding the world's growing population within planetary boundaries is a tough challenge. Edible vegetable oils are used in a wide range of foods and provide important nutrients to people around the world, but processing them can be carbon-intensive. Conventionally, producing high-quality oils required water degumming and/or caustic refining, steps that involved significant greenhouse gas emissions and the use of hazardous chemicals. Now, enzymatic degumming is opening up new horizons in sustainability, process efficiency, and product quality.

Biotechnology makes all the difference

By leveraging our strong track record in biotechnology and world-class life science expertise, DSM has been able to develop a family of enzymes that improve oil processing. These enzymes deliver consistent benefits in a range of industrial applications. In particular, Purifine® PLA1 – launched in June 2020 – is helping to shape the oilseed processing market, enabling a sustainable, high-quality manufacturing process.

A win-win for people and planet

In particular, Purifine® PLA1 enables oil refineries to improve cost-in-use, reduce their carbon footprint by 30–35% and consistently reach phosphorus specifications. In addition, it's a hassle-free, safe solution that helps prevent soap formation and centrifuge fouling. As such, this enzyme opens up new horizons for sustainable oil processing – a win for both people and planet.

Purpose led

By enabling oil refineries to significantly reduce their energy consumption and carbon footprints, Purifine® PLA1 delivers tangible environmental benefits without compromising in other areas. In this way, the enzyme helps enable healthy food production within planetary boundaries.

Performance driven

Purifine® PLA1 also helps oil refineries gain a competitive advantage in the marketplace by enabling a 2% extra oil yield, consistently achieving phosphorus specification, and delivering guaranteed product performance. Unlike standard enzyme solutions, Purifine® PLA1 requires no pH adjustments during processing because of its unique biological profile.

Creating happier, healthier lives with better early-life nutrition.

HUMAN MILK OLIGOSACCHARIDES

Human Milk Oligosaccharides (HMOs) are a collection of carbohydrates that naturally occur in our very first food, mother's milk. In fact, they are the third most abundant solid component of human milk after lipids and lactose. Research suggests that HMO supplements may help to develop a healthy microbiota by serving as a food source for the good bacteria in the intestine, as well as driving immunity. Correct levels of HMO supplementation can provide us with unique health benefits – during childhood and beyond. In particular, HMO supplements can support immunity and gut health, as well as cognitive development.

In search of cleaner, more efficient HMO production

HMOs have been heavily researched and documented in science for a long time. But until relatively recently, they were too complex to manufacture at scale as HMO production can lead to significant waste, use considerable amounts of water, and prove to be costly. To address these issues, and to help deliver healthy diets for all within planetary boundaries, DSM has leveraged state-of-the-art biotechnology solutions to develop oligosaccharides identical in structure to those in mother's milk.

The world's leading HMO supplier

Today, DSM is the only fully integrated HMO manufacturer in the world, with its own product development, preclinical and clinical development, regulatory and large-scale dedicated production site. By utilizing a unique combination of biotechnology and bioengineering excellence we develop cost-effective and environmentally friendly HMO production processes that deliver healthy products.

Purpose led

By leveraging the possibilities of biotechnology, DSM creates HMOs that support people's health and immunity and enable people to reach their genetic potential – with less than one-tenth of the environmental impact of HMOs manufactured with other commonly applied methods. In this way, we are helping to create brighter lives for all.

Performance driven

Biotechnology can enable efficient production processes – both in terms of speed and created waste. As such, DSM's HMO portfolio enables sustainable, cost-effective solutions that can be easily incorporated into different food formulations and solutions.

Driving more sustainable animal production.

MICROBIOTA

Animal-based proteins are highly nutritious and form a key part of a balanced, healthy diet. However, the rising demand for animal protein is driving greenhouse gas emissions, while animal health and welfare are increasingly important for consumers around the world. Biotechnology is opening up a range of opportunities to enable animal production that is better for farmers, animals, consumers and the planet – helping to make existing diets more sustainable, and giving increasing numbers of people access to affordable, nutritious food.

Bringing a new level of precision

DSM has been applying biotechnology to support its Animal Health & Nutrition business since around 2014. Above all, biotechnology capabilities have been leveraged to screen and select suitable high-performance microorganisms and molecules for a variety of animal nutrition applications, such as precision glycans. Through biotechnology, developing effective and precise animal health and nutrition solutions, with improved sustainability profiles, is easier and more efficient than ever.

Harnessing the potential of microbiomes

In particular, the use of advanced biotechnology-based tools together with digital tools like machine learning, has revealed important insights into, and between, the collection of genes and metabolites from the microbiota, called respectively ‘metagenome’ and ‘metabolome’. Such targeted approaches have opened up previously unthinkable possibilities: modulating pathways to utilize nitrogen or carbon more effectively, reducing emissions, improving welfare and enhancing immunity, beyond what is possible with conventional animal nutrition and health technologies.

Purpose led

By applying biotechnology-based solutions to animal nutrition and health, DSM is driving the transition toward more sustainable farming, with a lower environmental impact and higher levels of animal welfare. For farmers, biotechnology is enabling new opportunities to create value and achieve higher levels of income by improving diet efficiency and reducing animal mortality.

Performance driven

By deepening understanding of microbiota and making interventions more precise and accurate in the product development stage, biotechnology is enabling the development of novel molecules, applications, and processes for the animal farming industry – and commercialize them at scale.

A win-win for oceans and health

VERAMARIS®

With the world's population set to reach 10 billion by 2050, fish farming will play an important role in meeting the growing demand for sustainable protein. Fish, especially salmon, is a particularly rich source of omega-3 fatty acids and protein. But the consumption of fish has grown twice as fast as the world's population since 1961. Overfishing has placed extreme pressure on wild fish stocks – indeed, it's the main cause of biodiversity loss in our oceans.

Innovation driven by collaboration

In view of these environmental challenges, engineers and scientists from Veramaris® – a joint venture of DSM and Evonik – have pioneered a sustainable solution: making natural marine algae a high-quality source of omega-3 for aquafeed, replacing omega-3 fatty acids (namely eicosapentaenoic acid EPA and docosahexaenoic acid DHA) from wild-caught fish. Algal oil by Veramaris® is highly concentrated and helps resolve the global omega-3 shortage, enabling the continued production of healthy seafood. In fact, 1kg of Veramaris® oil yields the same amount of DHA and EPA omega-3 as 60kg of wild-caught fish!

Bright science in action

Biotechnology has played a key role in the development of this collaborative, sustainable solution. Specifically, DSM has expertise in cultivating marine organisms and biotechnology capabilities in development and operations, while Evonik's long-term focus has been on industrial amino acid biotechnology, executing large-volume fermentation processes. Through this collaboration, DSM's biotechnology team has been able to discover, develop, and deliver a unique, cost-effective, natural EPA and DHA omega-3 solution, thereby unlocking a more sustainable future.

Purpose led

Veramaris®' commitment encourages industry players to adopt sustainable feed production as a worldwide standard. By advancing an alternative to traditional seafood sources of EPA and DHA, Veramaris® is contributing to preserving oceans, seas, and marine resources for generations to come. Moreover, Veramaris® enables healthy animal diets within planetary boundaries and helps meet the omega-3 dietary needs of a growing world population.

Performance driven

The initial annual production capacity of the Veramaris® plant meets roughly 15% of the total current annual demand for EPA and DHA from the global salmon aquaculture industry. To drive positive change in feed production and food consumption, Veramaris® is working extensively with all stakeholders along the value chain, including feed producers, farmers, retailers, and non-governmental organizations. Pioneering collaborations have already enabled key players in aquaculture to raise Atlantic salmon on diets totally free from marine ingredients, using Veramaris®' algal oil as a complete replacement for fish oil.

More information
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