

## Processing

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When I started working in the food industry, some twenty years ago, starting up production lines often took a lot of time. Also bringing new products into production was a lengthy process. Now, the innovation speed has increased tremendously, start-up times of production lines have reduced, as have the number of people involved in the actual production. This has many economical advantages, but also confronts management with new questions, especially when new products need to be implemented, and it raises the question of the continuity of expertise within the company.

Already in the very early 1990s, NIZO realised the potential of the combination of strong knowledge of product and process with computational skills. NIZO has a strong base in product and process knowledge, both on laboratory and pilot-plant scale. Over the years NIZO has built a range of validated process models that enable both rapid process development for new products, and process design and cost reduction applications. Rather than controlling processes on pressure, temperature and throughput, it is gradually becoming possible to control processes on real product properties, like texture and taste! Thanks to its long and historic liaison with the Dutch dairy industry, NIZO has always been able to develop a profound scientific understanding, but always with a focus on direct practical application! One of the best-established ways to reduce costs is to benchmark ones own operation to similar processes in the industry at other locations: "the best proven practice". This approach has given enormous benefits to many companies. By putting all available knowledge into process models, it is now possible to make the next step: to upgrade from best-proven practice to the best-possible practice! This approach is relevant to many supply-chain issues, and has a major impact on innovation processes as well. Use of integrated knowledge allows much faster process-aided product development as the number of trial runs can be reduced and a wider variety of raw materials can be easily tested. Although this science is rapidly maturing in the petrochemical industry, it is still in its early years in the food industry. We are about to see major developments in food processing that will revolutionise both supply-chain thinking and the speed of implementation of new innovative product concepts.

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In today's world where consumer demands and marketers push product development, processing is often considered a necessary evil. However processing plays a vital role in the development of foods with, e.g., 'fresher' taste, functionality of health promoting ingredients, special texture attributes, or extended shelf life. "It goes without saying that not all problems can be solved with existing technology", says Caroline van der Horst, Head of Processing, Quality and Safety, at NIZO food research. "Innovative technologies are constantly being developed and marketed. Examples of our latest successful innovations include the ISI heater, a new CO-detection system, the NIZO RheoLight, and the process control system, PREMIC", which are discussed in greater detail elsewhere in this magazine.

## Competitive advantage by Innovative Processing

The life cycle of consumer products is decreasing all the time. This means that when a new-product concept is born, innovation and supply chain need to work together concurrently. This is exactly where NIZO food research successfully assists its clients in gaining a competitive advantage. "Customers come to us for our expertise and facilities in processing liquids", says Caroline. Developing food-grade, environmentally 'green' processes (e.g., no use of antibiotics, or organic solvents) is central to NIZO's work.

### CAROLINE VAN DER HORST

"In addition, our expertise in efficient experimentation and smart processing is applied to accelerate product development and to optimise food production processes." Process and product experts of NIZO food research have proven to be able to work together with clients in project teams precisely in this area.

### THE NIZO APPROACH

Implementation of innovative laboratory concepts into processes on an industrial scale and ready for overnight implementation needs a specific approach. With its unique understanding of the interactions between products and processing, combined with specific tools, NIZO food research is able to bridge the gap between lab and production. "When a product is developed in the laboratory, the recipes to make the product are ready. However, achieving the required product properties on an industrial scale is still a major step. This is where the actual process development starts", says Caroline.

To achieve this, the product and process experts of NIZO use a set of complementary tools and facilities:

- Technology expertise
- A range of industrially validated models for product and process development and optimisation
- Flexible, food-grade pilot plant facilities with highly skilled operators

- Advanced analytical services to determine product properties and chemical and microbial contaminants

"Our customers experience that this approach saves a lot of time and money in the development trajectory, if only by limiting the number of experiments. In addition, they realise that in this way the effects of process or product alterations on taste, texture, shelf-life, food safety and processing costs are constantly taken into account and solutions are proposed in direct co-operation with them", says Caroline.

### PROCESS OPTIMISATION: BOTH UP- AND DOWNSTREAM

Scaling-up laboratory concepts to innovative products is an important issue. However, optimisation of existing processes and products in terms of, e.g., increased yield or decreased energy consumption, is equally important. ▶

CONTINUE ON PAGE 3



Over the years, NIZO food research has built-up a solid expertise in powder technology and has developed predictive models, safety systems and control systems. With current consumer demands, however, powder composition and associated properties become increasingly complex. The instant properties of powders, i.e., the ability to dissolve easily, quickly and completely, are determined by agglomerates of dry particles formed during spray drying. Agglomeration is a difficult process to control, and is often poorly understood and therefore operated by trial and error.

## Targeting powder functionality

To make the final step towards controlling agglomeration of complex powders, a European project (EDECAD) has been launched, co-ordinated by NIZO. This project aims at developing full control of powder properties. To achieve that, an industrially validated

predictive model, using computational fluid dynamics technology, will be developed. This model will establish relations between process parameters and the degree of agglomeration, resulting in constant and desired powder properties. EDECAD will provide a

powerful tool for designing and optimising spray drying and agglomeration equipment, meeting current consumer demands.

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DSM, the huge conglomerate that is active worldwide in life science, performance materials, chemical and other products, ranks among the world leaders in many of its fields. DSM Food Specialties is a major player in food and feed ingredients, with a product portfolio ranging from enzymes, yeast extracts, starter cultures and media, to natural beta-carotene and arachidonic acid. Having worked together with NIZO food research on many occasions in the past, it was natural that DSM should call on NIZO to help develop to process an essential enzyme required for poultry feed. The specific enzyme they wanted to bring to market is one that assists animals to digest Non-Starch-Polysaccharide (NSP) nutrients properly.



FRANK CORNELISSE,  
INTERNATIONAL PRODUCTIONMANAGER  
AGRI INGREDIENTS DSM

## Successful upscaling key in enzyme development

### DOWNSTREAM PROCESS

Frank Cornelisse, DSM's International Production Manager for the business unit Agri Ingredients, is responsible for processing at several sites, including the Capua plant near Naples, Italy. "We had already started working on the project when we called in NIZO, as the downstream part had not been installed in Capua", he says. "The enzyme had been fermented in Capua, but we needed to do some development work and optimise the downstream process of purification and concentration using NIZO's experienced resources and facilities. They helped us with centrifugal biomass separation

and another important process-step, ultra filtration, to concentrate the enzyme liquid."

The biomass was transferred from Capua to NIZO in bulk tankers and trials were started with a number of batches to develop the process. Finally, 30 batches of 25 tonnes of broth were produced for commercial use. Of course, there were challenges, but DSM always felt confident that everything was under control.

"When one is trying to optimise a process without knowing the production parameters in advance, it can be quite challenging", says Frank Cornelisse. "In particular, the biomass centrifugation was a focal point of activities at

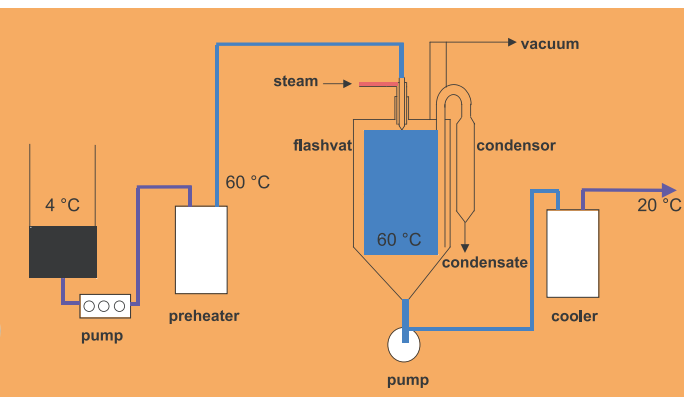
one stage because there always is a residual amount biomass in the fermentation liquid that acts as a limiting concentration factor in the filtration process. But working together with a knowledgeable and experienced team, highly skilled labour, and in the right pilot facilities, meant that NIZO was always in control of the situation. They liaised with our R&D people and were completely open and honest about the work and problems they were facing."

### FLEXIBILITY APPRECIATED

Another reason why DSM was very satisfied with the co-operation can be summed up in one

word: 'flexibility'. Frank Cornelisse: "When one operates in a highly competitive market, as we do, one has to get a new process on stream in the shortest possible time, otherwise the market opportunity diminishes and any advantage one may have had in fast development of a new product is wasted. In this respect, NIZO showed the utmost flexibility in helping us to achieve our goal."

As well as helping to develop a production-scale downstream process for this specific enzyme, NIZO has also helped to optimise DSM's vitamin B12 process. And these successful projects will lead to further co-operation in the future. "We aim to continue extending our business and NIZO food research is a logical partner in process development and contract manufacturing", says a contented Frank Cornelisse.



We all appreciate foods with a natural taste and a fresh appearance. This means less severely processed and preserved products. At the same time, however, the food quality and safety have to be guaranteed. Food and food ingredients manufacturers increasingly struggle with this paradoxical combination.

## Fresh and safe foods? The answer is ISI!

To prevent spoilage of food products, pasteurisation and sterilisation are still most commonly used. However, at high temperatures, product properties are affected, e.g., vitamins are lost and/or off-flavours are formed. In addition, some heat-resistant bacterial spores survive the applied processing treatments. Spore-formers determine the shelf life of especially heat-treated foods with a long shelf life, such as milk products, beverages, soups and sauces. Over the last few years, extremely resistant spores are of increasing concern. Alicyclobacillus species, for example, are very resistant to heat and acid, and cause off-flavours in fruit concentrates or fruit juices.

The possibilities of alternative technologies, such as pulsed electric fields and high pressure, are being studied extensively, but the inactivation of bacterial spores is insufficient.

### NEW TECHNOLOGY

Therefore, NIZO food research recently developed and patented a new UHT-technology: Innovative Steam Injection (ISI). ISI combines ultra high temperature (> 155 °C) with ultra short time (< 0,5 sec). This allows a reduction of extreme heat resistant spores by a factor 1000, compared to traditional UHT, while preserving the functionality of important ingredients.

Additional advantages include reduction of fouling of the heating equipment. This results in lower energy consumption (estimated at 70%) and environmental load (60% reduction), and increased processing run times (about 50% longer).

The ISI-technology offers unique applications for the preservation of a variety of liquid foods, such as dairy products, beverages and sauces. In the fermentation industry, the technology can be used for inactivation of microbial contaminants or specific enzymes, while fermentation products remain largely active. The ISI-technology allows the development of high-quality ingredients and food products, which are safe and taste natural!

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## LOOKING FOR CONTRACT MANUFACTURING FACILITIES?

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- Product applications: beverages, soups, sauces, instant powders, enzymes, cheese, emulsions, soy products
- Analytical services support

Ask and compare:  
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+31 (0)318 659 597



CONTINUATION OF COVER STORY 'COMPETITIVE ADVANTAGE BY INNOVATIVE PROCESSING'



"We do not just develop processes, we consider all the angles and suggest ways of developing an economical and ecological process", says Caroline. Usually ecology and economy go hand in hand.

"We may propose another composition of the fermentation broth, or the use of another

production organism, or come up with a simpler process ensuring higher yield."

The food industry increasingly realises the enormous possibilities of automation in combination with predictive models for process and quality control, such as in heating processes or drying systems. Industrially validated software in combination with advanced analytical methods has enabled NIZO's customers to realise double-digit savings.

THE FUTURE

"We realise that demands for time-to-market and product safety will continue to increase", says Caroline. Predictive models, as well as interaction between processing and innovation, are key in providing answers to these challenging demands. "We invest in these areas in order to stay the chosen partner for the food industries."

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Drying of powders entails a serious fire risk. By far the most fires in drying installations start by self-ignition of the product (smouldering). In many situations, experience and alertness of operators proved to be inadequate for early detection. NIZO food research, therefore, has developed an online system (NICOSYS) that detects smouldering powder before it starts burning. NICOSYS has proven its value and is now installed worldwide for drying applications. A new generation detection system is currently being developed, which is also suitable for extremely large drying installations.

## Early warning system for fire in drying installations



NICOSYS PRINCIPLE

Smouldering starts as a result of exothermic reactions occurring in the product due to exposure to hot or warm air. One of the reaction products in these reactions is carbon monoxide (CO) gas. An industrially robust CO-analyser measures the difference in CO-concentration between the inlet and outlet air. The air that is supplied to the CO-analyser is cleaned and conditioned in an air-sample treatment unit. A PLC is used for controlling and signalling in case of a system or fire alarm. NICOSYS is being marketed by Hobr  Instruments and has found its way to many applications, e.g., milk, coffee and cocoa based powders.

DOES IT WORK FOR MY PRODUCT?

Every product is unique. In order to decide whether a smouldering detection system is suitable for a specific product in a specific drying process, one should know the smouldering properties of the powders.

These smouldering properties are: the minimum self-ignition temperature, the minimum size of a lump of powder to self-ignite, and the CO-production of smouldering product. NIZO food research can determine all these smouldering properties. Based on these data, advice can be given for the application of a smouldering detection system.

THE NEW GENERATION

For extremely large drying installations (i.e., a capacity of over 10 tons per hour) the measurement of minute increases of CO becomes difficult due to the diluting effect of the enormous quantities of air. NIZO, therefore, is currently testing a new generation detection system. Its long-standing experience in relating powder properties (taste and agglomeration size, etc.) to processing conditions, has led NIZO to develop a novel approach based on new instrumental analysis. This allows detection based on other parameters. Phone for the latest developments!

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Let's be honest, using lactic acid bacteria to fight hospital-associated infections is not the first thing that springs to mind when talking about NIZO food research. But this is exactly what our scientists make possible.

## Pure bio-active components

With the purchase of a food-grade, industrial-scale, chromatography unit from Amersham Biosciences, NIZO food research can now provide in-house isolation and purification at kg level of high-value biological components like proteins, peptides, amino acids, (oligo)saccharides, (iso)flavonoids, and a range of other bio-active ingredients. The development of purification protocols can be a part of the assignment.

Purified bio-active components obtained are often used for animal studies and (pre) clinical trials. NIZO has specialised testing facilities in its nutrition department for testing protection against salmonella, influenza, traveller's diarrhoea, etc. A variety of in vitro and in vivo biomarkers are available to scientifically prove the effects of the component of interest.

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## Food meets pharma

NIZO food research is frequently asked to propose and develop processes for new ingredients and to deliver batches for test markets. In this particular case, Biosynexus, a biotech firm from the US, approached us to isolate lysostaphin. This is an enzyme that rapidly degrades the cell wall of *Staphylococcus aureus*, a rather nasty pathogen, and kills the organism in seconds to minutes. It has been shown in a number of animal models to be significantly more effective than available antibiotics in eliminating staphylococcal disease. This pathogenic micro-organism, which causes the majority of hospital associated infections, is becoming increasingly resistant even to the most recently developed antibiotics. It is critically important to develop novel approaches to eliminate this potentially lethal infection. Biosynexus has the licence for the patent for the use of lysostaphin to prevent

and cure staphylococcal disease. Initial attempts were made to produce lysostaphin through fermentation using *Bacillus sphaericus* and *E. coli*. Biosynexus then approached NIZO to perform the downstream processing for the isolation of lysostaphin from *B. sphaericus*.

NICE

On the basis of our experience and expertise, we proposed an alternative for the production and isolation of lysostaphin. Our patented NICE (NIsin Controlled gene Expression) system, using *Lactococcus lactis* bacteria, provided an excellent and safe production of lysostaphin. Through the close co-operation between NIZO experts on genetics, fermentation and downstream processing a process was being developed and scaled-up to pilot plant operation within three months after the start of the project. The downstream

processing included membrane filtration, homogenisation, chromatography and freeze-drying, all readily available in our pilot plant.

CLINICAL TRIALS

The 1-gram batches of 97% pure lysostaphin produced are currently being used by Biosynexus in pre-clinical trials. On the basis of this successful development, NIZO produced another 100-gram batch of lysostaphin in a 2000 l batch fermentation. Within nine months, Biosynexus was provided with sufficient product to speed up the steps leading to clinical trials.

This process was also accepted as a valid process in preliminary discussions with the American Food and Drug Administration (FDA). NIZO food research's 50-years experience with food grade micro-organisms provided unique synergy between food and pharma, resulting in accelerated entry into phase I clinical trials. Using the *L. lactis* system

provided an attractive alternative for the *E. coli* based fermentation with the following advantages:

- Use of food-grade instead of pathogenic micro-organisms
- No toxins or LPS (toxic cell wall fragments) are produced
- No antibiotics are required during processing
- Simple scale-up from 1 to 2000 l and more

Formal FDA approval for this system is now underway.

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imirau@nizo.nl (NICE)





Ir. J.L. OOSTERVELD, CEO DOC KAAS



## New Dairy Park supports 'growth strategy'

Since a few years, the 'DOC' in DOC Kaas also stands for 'Dutch Original Cheese'. DOC has a modern and flexible cheese plant where the rectangular-shaped cheese is produced. The demand for DOC cheese has increased over the past few years, such that a new factory will be constructed. Aiming at an even higher efficiency, DOC will be able to produce and deliver sufficient cheese well into the future.

Hoogeveen will miss its old cheese factory. The characteristic building stands near the centre of the city, adding a remarkable chimney to its skyline. Looking at this industrial monument, it would be easy to forget that it holds one of the most advanced cheese-making production facilities in the world. DOC produces cheese for a number of renowned Dutch cheese brands, as Edam and Gouda. Although it doesn't carry a brand of its own, the company does add the DOC-quality mark to its products.

Ultramodern production techniques give DOC Kaas a sharp, competitive edge. "It not only

enables us to produce large quantities at a modest cost, we also managed to make our organisation very flexible", says CEO Oosterveld. "Our production methods always leave room for last-minute changes, which is highly appreciated by our customers."

### SCRUPULOUSLY ANALYSED

The primary target for building the new 'Dairy Park' just outside Hoogeveen is to increase the output from 55.000 tons to 70.000 tons per year. Mr Oosterveld: "If we want to continue our strategy, it is of vital importance that the production process and the ripening facilities are concentrated at the same location."

As the factory is being transferred, the whole production process is also being scrupulously

analysed in order to see where improvements can be made. For that, DOC Kaas has selected several partners, among whom is NIZO food research. NIZO has developed and applied process models for pre-testing and optimising production processes. In addition, DOC Hoogeveen will be one of first cheese production plants in the world to employ the NIZO RheoLight, a non-destructive, inline texture monitoring system that automatically determines the optimal cutting time during gelation.

### € 115 MILLIONS

The Dairy Park will cost about € 115 millions once it's finished, which will probably be around the year 2007. "The construction takes place in several different stages", explains Mr Oosterveld.

"First we build everything we need to produce cheese, like the milk receiving station, the pre-factory, the cheese factory, and the evaporation installation. After that we'll build the warehouses and the office, which will be finished a few years later. But we don't mind. We rather do things properly than in a rush. Like making cheese."



## New aseptic bag-in-box

The Pilot Plant of NIZO food research knows many processing possibilities for the preparation of liquid (-like) products. An important expansion is the completely new filling machine for aseptic or sterile filling into 'bag-in-box' packaging (0.25-10 l). It allows handling of a broader range of products. This type of packaging is often employed for food-service products like soups, sauces, cream, fruit fillings or concentrates, and can be used for non-branded consumer tests.

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## NIZO FOOD RESEARCH'S LEADING AREAS OF EXPERTISE:

### BIO-MOLECULES

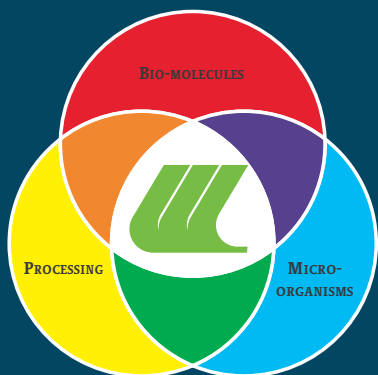
- Texture and stability
- Emulsions
- Enzymatic modification
- Analysis

### PROCESSING

- Predictive modelling
- Separation and drying
- Fermentation and inactivation
- Pilot plant

### MICRO-ORGANISMS

- Flavour
- Food Safety
- Metabolic engineering
- Health
- Culture collection



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Website: [www.nizo.com](http://www.nizo.com)

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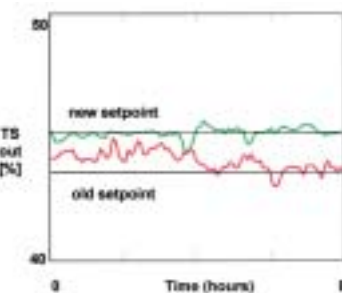
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Realisation: Advertising Agency Ruijs Draaisma

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## Drying processes use lots of energy

Reduction of energy, and capacity increases of more than 10% can be realised for evaporators and spray dryers, using the NIZO Feed Forward Control. This is a process control algorithm, based on variations in input parameters, rather than output. The shorter reaction time results in a more stable feed and a higher total solids content in this feed to the dryer. Consequently the dryer operation is more stable and can be run at higher capacity and closer to the moisture specification in the product.



The Feed Forward Control has been industrially validated and implemented in several processing installations.

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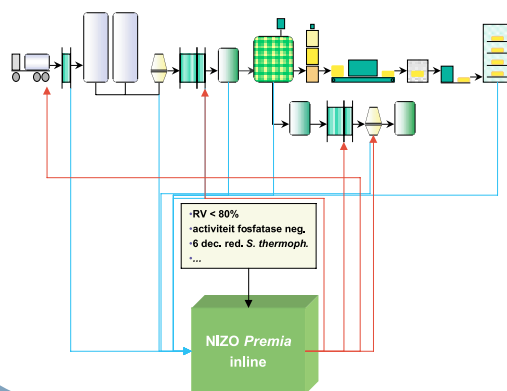
## Upgrade data to knowledge with NIZO Premia

All companies face the challenge of having to optimise and consolidate their know-how. Knowledge management is crucial to making data accessible, resulting in verifiable benefits for process and product optimisation. This has been

the aim for developing the computer software NIZO Premia: a platform technology in which your various databases can be linked to process control and predictive models, either developed by NIZO, or company specific. NIZO Premia is much more than a database: It upgrades data to become knowledge!

Variations in raw materials, for example, can be easily translated into process set points to ensure products within specification, while optimising the process. The most efficient process can, thus, be calculated for every different product.

In addition, the software is perfectly suited for speeding up of process and product development. Various large companies already enjoy the benefits of the NIZO Premia.



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## Calendar of events

- APRIL 14-17 | Food Colloids 2002 conference, 'Food Colloids, Biopolymers & Materials' organised by WCFS, RSC and VLAG, sponsored, a.o., by NIZO food research. (FoodColloids2002@phys.fdsi.wau.nl) at Wageningen International Conference Centre, Wageningen
- APRIL 17-18 | NIZO/Leatherhead Spring course 'Novel preservation techniques' at NIZO food research, Ede
- MAY 16 | WCFS patent & publication award at WCFS, Wageningen
- MAY 17 | Open NIZO Lecture entitled 'Sensors: Future tools for monitoring Cleaning in Place (CIP)' by Ir. Arjan van Asselt at NIZO food research, Ede
- MAY 28 | Dairy Conference on fundamental aspects of cheese preparation and ripening. Organised by Mesdag-Fund in collaboration with NIZO food research at Hotel Hiddingerberg, Steenwijk
- JUNE 28 | Open NIZO Lecture entitled 'Application of bacterial genomics for the development of novel industrial micro-organisms' by Dr. Johan van Hylckama-Vlieg at NIZO food research, Ede
- SEPTEMBER 20 | Open NIZO Lecture entitled 'Visualising ingredients in action' by Dr. Hans Tromp at NIZO food research, Ede
- NOVEMBER 22 | Open NIZO Lecture entitled 'NIZO Premia: Model-based software to streamline R&D and time to market' by Dr. Peter de Jong at NIZO food research, Ede

FOR MORE INFORMATION ABOUT ANY OF THE ABOVE EVENTS: CONTACT US AT [INFO@NIZO.NL](mailto:info@nizo.nl)