

# WCFS



# Research and Industry in

*Wageningen Centre for Food Sciences carries out strategic, fundamental research to contribute to the long-term commercial advantage of the Dutch food industry.*

# Interactive Dialogue

Mr Laurens Jan Brinkhorst

Prof. Jo Hautvast

Dr Ger Willems, Friesland Coberco Dairy Foods; Prof. Frans Kok, Wageningen University

Prof. Willem de Vos; Prof. Rob Hamer

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Drs Hannie van Oosten

*This year's Annual Report shows WCFS from the perspective of the different actors and their contribution to this public-private partnership for strategic fundamental research for the Dutch food industry.*

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# Research, Innovation and Society

*Netherlands Minister for Economic Affairs, Mr Laurens Jan Brinkhorst*

## OECD Peer Review

'One of the purest forms of public-private partnerships in both rationale and organisation', states the report of the 2003 OECD peer review on the Netherlands Leading Technological Institutes (LTIs). These institutes have clearly demonstrated 'good practice in mobilising public and private research towards common objectives of high importance for the economy and society'. According to the report: 'The four Leading Technological Institutes perform well, are based on a sound rationale, and are implemented efficiently'.

## New Initiatives

The Netherlands Minister for Economic Affairs, Mr Laurens Jan Brinkhorst is very pleased with this positive assessment of the Dutch Leading Technological Institutes (LTIs).

Minister Brinkhorst: 'We will draw on the success elements of these public-private partnerships in developing new policy instruments for further co-operation between science and industry. I envisage that these new initiatives will be less institutionalised and more programme-based actions to promote innovation in specific areas.'

'The challenge is to create an environment in which top research can flourish that will ultimately contribute to future applications in industry as well as for society as a whole. We must ensure that these cooperative research programmes allow sufficient flexibility to enable changes in direction to support more promising research areas. I am thinking particularly of the flexibility to carry out multidisciplinary research in areas of specific relevance to society.'

## WCFS' Role

*How should WCFS as a LTI play a role in the wider society, nationally and internationally?*

Minister Brinkhorst: 'As is the case for all four LTIs, WCFS has a mandate to carry out fundamental research that will promote innovation in industry. Naturally, this does not preclude research to enhance the welfare of people and society. In fact, I would actively encourage such research. In the area of food research, there are many challenges. At the end of last year, the Dutch Government granted euro 10 million jointly to WCFS and the Centre for Medical Systems Biology (Leiden), for research in the new promising area of nutrigenomics. It is hoped that work in this area will bring new insights in the development of metabolic syndrome and the health consequences such as obesity, diabetes and other diseases of the Western world.'

'It seems to me one of the greatest challenges is over-nutrition or obesity. I know that WCFS has brought together eminent scientists to explore potential research issues in obesity. WCFS is working on some of the challenges in food, nutrition and health such as reducing the risk of heart disease and cancer, and improving food safety. Rapid advances have been made in the comparatively new research area in food perception in responding to consumer demands for healthy, tasty and easy to prepare foods.'

## Dutch Food Valley

*What do you consider WCFS' role could be with respect to the Food Valley concept?*

Minister Brinkhorst: 'Personally, I am very much in favour of the Dutch Food Valley concept, where research and industry bring together the very best in expertise and innovation in nutrition, food, agriculture, life science and health to advance and to further strengthen the Dutch food industry.'

## LEADING TECHNOLOGICAL INSTITUTES

WCFS is one of the four leading technological institutes established in 1997 at the initiative of and with support from the Netherlands Government. These consortia of government, industry and research aim to stimulate the transfer of knowledge generated in fundamental research to the Dutch industry and thus to strengthen its innovative power and competitive strength.

'Because of its unique position at the crossroads of research and industry, WCFS is very well positioned to play an accelerating role in the Dutch Food Valley. I envisage WCFS becoming a focal point for Dutch food research and being a catalyst in bringing together outstanding research groups. The greatest challenge, however, will be to bridge the gap between innovative research and successful commercial applications. WCFS has already taken significant steps in that direction by establishing a sound platform where research and industry can meet to debate the issues. WCFS is to be congratulated on this achievement.'

## Growth and Development

*How do you foresee the further development of WCFS in contributing to innovation in the food industry?*

Minister Brinkhorst: 'The LTIs have now reached a mature phase, and are thus positioned to continue growing with a lower proportion of government funding in the future. For growth, therefore, the LTIs will need to attract more partners both in research and industry. I am very pleased that WCFS has already gained new partners and I hope WCFS will be able to continue this trend.'

'I am also very pleased that WCFS is involved in European Framework Programmes. Innovation comes through cooperation. A European dimension is essential in food, health and nutrition research which knows no international boundaries. Furthermore, WCFS is well positioned to play a leading role in future European Technology Platforms.'

# WCFS Partners

## RESEARCH PARTNERS

DLO

NIZO FOOD RESEARCH B.V.

TNO NUTRITION AND FOOD RESEARCH

UNIVERSITEIT MAASTRICHT

WAGENINGEN UNIVERSITY

## INDUSTRY PARTNERS

AVEBE

COSUN

CSM NV

DSM

UNILEVER N.V.

DUTCH DAIRY ASSOCIATION (NZO) representing:  
Coöperatieve Zuivelonderneming CONO b.a.  
Coöperatieve Zuivelfabriek 'Rouveen' u.a.  
Drents-Overijsselse Coöperatie Kaas B.A. (DOC Kaas)  
Friesland Coberco Dairy Foods BV  
Koninklijke Numico N.V.  
Leerdammer Company b.v.  
Zuivelcoöperatie Campina U.A.

## Motivating Force

**Prof. Jo Hautvast**

Prof. Jo Hautvast retired as WCFS Director at the end of 2003. Jo Hautvast has been closely involved in food, nutrition and health research for 28 years as Professor of Human Nutrition at Wageningen University. During that time, he put human nutrition on the research map in the Netherlands and was an energetic and motivating force in stimulating nutrition research in Europe. In July 2000, he became WCFS Director. 'I am very privileged to have had the opportunity to guide this innovative approach to food research and to work with such a highly motivated and multidisciplinary group of researchers', says Jo Hautvast in his farewell to WCFS.



### From Pioneering to Maturity

During his term of office as Director, Jo Hautvast has seen WCFS move through the pioneering phase to a mature institute, well established in the Netherlands and rapidly gaining a reputation internationally. 'An essential factor in our success is the ongoing dialogue that has become increasingly more open and frank with the years between scientists, and between scientists and our partners in industry', he says.

As WCFS Director, he saw his task was to motivate researchers to take on daring and challenging projects, 'Discovery comes when researchers venture into the unknown and this involves taking risks. My task has been to provide the environment, in every sense of the word, where creativity can flourish.'



### Platform for Dialogue

Jo Hautvast has been instrumental in strengthening WCFS as a science-industry platform, a meeting place for science and industry. 'This has happened more rapidly than we had dared to hope', says the retiring WCFS Director. WCFS is a bridge for industry partners to the world of science. One important bridge is the WCFS Food Summit. These annual meetings bring together world experts with industry partners to brainstorm beyond the boundaries of current research. The 2003 Food Summit, for example, considered bioinformatics in the context of mining microbes – from data to knowledge.

Jo Hautvast also sees WCFS as a platform to discuss emerging issues of relevance to the food industry. In November 2003, for example, WCFS invited experts from science and industry to discuss new research avenues in weight management.

### Food Valley

As a public-private partnership, WCFS is a catalyst in accelerating conceptual thinking and in developing the Netherlands as a high quality Food Valley. 'But positioning is not enough', stresses Jo Hautvast. 'We must not only maintain but also strengthen our position as high quality food producing country. This can only be achieved if the food industry and research work hand-in-hand as is happening in WCFS.'

At Jo Hautvast's initiative, WCFS participated in the first exchange of views as a source of inspiration for strengthening the Netherlands' position in the science-based food industry. This exchange took place at the 'Taste of Innovation' conference held in Ede, in September 2003. The conference formally established the Food Valley platform to stimulate and strengthen a research and industry network in the Dutch food sector.

*As one of the founding fathers and then as WCFS Director, Prof. Jo Hautvast has helped to shape the WCFS research-industry alliance to maturity. He has been a motivating force in making WCFS a viable platform for dialogue by government, science and industry as a basis for successful innovation in the food sector.*

## Partner Trust

**Dr Ger Willems, Friesland Coberco Dairy Foods**



### WCFS Programme

The Programme Council together with the Scientific Directors review the research strategy annually to ensure it is still in line with the WCFS watchwords of industrial relevance and scientific excellence. 'Of course, we can't please everyone all of the time. Here's where trust and respect come in again. As WCFS partners, we have to understand one another's points of view. While, for example, NZO may be the biggest contributor, we can't expect to have it our way all the time. In the Programme Council, we never compromise but instead strive for a good balance and consensus. Because over the whole research programme, all of the partners must achieve a fair return on investment.'

### Risks and Gains

'Inevitably, there is a certain amount of risk when it comes to industrial relevance', explains Ger Willems. 'That's because it's hard to predict what consumers will want in five to ten years, which is the time frame for precompetitive research. But some risk in the total research programme must be possible in a stimulating research environment. We don't have unlimited resources, however, so we have to make choices. That's why the WCFS research programme focuses on three main areas of relevance to the industry partners. Still within that scope, there's room for some risk.'

### Technology Road Map

'I want to stress the point that industrial relevance and transferring knowledge must start on day one of all research projects', says the Programme Council member. 'As partners, we must participate in setting research priorities. Each of the partners needs to ask what are we going to do with the knowledge generated. The relevance needs to be clear!'

R&D Director at Friesland Coberco Dairy Foods, Dr Ger Willems is a NZO Programme Council member and one of the WCFS founding fathers. The WCFS concept of collective research was not an entirely new idea for NZO (Dutch Dairy Association) because in the past, the dairy industry joined forces to have their R&D done by NIZO, now also one of the WCFS partners.

### Partners

'In the Programme Council, we sit around the table with our direct competitors,' Ger Willems explains. 'While we are talking, for example, about how structures can affect taste perception, we are on common ground. But, of course, we can't talk about how such structures can be achieved in cheeses or yoghurts.'

'The burning question is, what research is relevant to the industry partners. As Programme Council, we are responsible for the WCFS research strategy. This requires trust and understanding by all partners', stresses the Programme Council member. 'Such mutual trust and respect takes time to develop. Programme Council members are always outspoken but we do have a sound basis for reaching agreement. Partner trust is what makes WCFS work.'



'I know there are strong feelings that WCFS scientists should translate the research findings into potential for the industry partners', he continues. 'But in my opinion, the industry partners must take this responsibility themselves. I am aware, however, that the partners have different capabilities to absorb the knowledge generated by WCFS. At Friesland Coberco, our Corporate Research has most of the expertise needed to do this for our company. If companies don't have the expertise in house, the task could be contracted to WCFS research partners. That's a spin-off for the research partners and I believe this is already happening.'

#### Talking about Competition

According to Ger Willems, 'Competition is not only between the industrial companies but also between the research institutes. There is a danger that expertise could become fragmented in research groups in different institutes competing with one another. It seems to me there is much to be learned from the WCFS model as a vehicle for opening up communication, learning to respect one another's views, and thus for creating stronger research groupings that can have a significant impact on innovative strategic research in the Netherlands.'

#### PROGRAMME COUNCIL

All WCFS partners are represented on the Programme Council, which determines the overall research strategy by identifying the research competences to be developed and strengthened. A key task of the Programme Council is to review the project portfolio regularly, and to assess and review all projects and project proposals against the desired research competences. The guiding principle in establishing the research strategy is to maintain a balance between scientific excellence and industrial relevance in carrying out innovative research. The Programme Council also advises the WCFS Board on the research strategies and financial project plans.



## Scientific Excellence

*Prof. Frans Kok, Wageningen University*

As a member of the Programme Council, Prof. Frans Kok has a guiding hand in shaping the research programme. 'While the industry members are keen to ensure industrial relevance, as a representative of one of the research partners, I see my major task is to safeguard scientific excellence. You could say, I'm a heavy weight on that side of the balance in evaluating the strategic fit of projects in the WCFS research programme.'

#### No Crazy Ideas

'We can't go pursuing crazy ideas, chasing after shooting stars', he laughs. 'All research done by WCFS must be soundly based. As research scientists, we have to safeguard the scientific quality and by that I mean, we must ensure there is sufficient basis to get useful results or answers for our efforts. The major proportion of WCFS research must fall into that category', stresses Frans Kok. 'Otherwise, we are wasting the time and money of all of the partners. But soundly based research doesn't exclude daring research at the frontiers of science, as long as it is done in a responsible way. Let us be clear on this, there is no reason why we can't pursue a daring lead. In fact, that must be actively encouraged.'

#### No Quick Fix

According to Frans Kok, 'There's no quick fix when it comes to fundamental research. By its very nature, fundamental research takes time to achieve results.' He believes that while stressing the need for industrial relevance, it's very important to have vision. 'It's not realistic for industry to expect short-term results from WCFS but neither can we as scientists expect to work on long-term research without a sense of urgency. The Programme Council has to ensure that WCFS balances these two goals, which are not necessarily opposites.'

Frans Kok was a member of the WCFS working group to re-examine the research process. 'The ultimate decision on whether a project is a strategic fit rests with the Programme Council', he explains. 'However, our working group concluded that this process would benefit greatly from the closer involvement of the Focal Points in formulating and developing promising research ideas. Their involvement would also contribute substantially in balancing scientific excellence and industrial relevance at the project level. And what's more, this would help in creating greater ownership of projects by both research and industry partners.'

#### Multidisciplinary Research

'WCFS provides an environment for research at the crossroads of scientific disciplines', he continues. 'I'm a proponent of multidisciplinary research because I firmly believe this is where real breakthroughs in new knowledge and technology will come in the future'. In the Programme Council, I have actively supported this type of research. This is already happening in the WCFS portfolio, take, for example, research on the gastrointestinal tract, where research in nutrition and microbiology meet. Another area where scientific disciplines meet is in the very new multidisciplinary area of nutrigenomics. The stakes are high, but there is a real chance of a breakthrough, for example, in understanding more about metabolic disorders.'

'Multidisciplinary research takes time. WCFS offers great opportunities for the research partners and we must make the most of these. WCFS enables multi-year research projects without the constant concern about whether we have sufficient resources to keep going', stresses the Programme Council member.

# Industry Focus

*Prof. Rob Hamer, Structure and Functionality*



‘The research had to be on food structure, that’s all we knew for certain when we started in 1997’, explains Rob Hamer. ‘It was a bit like an architect starting from scratch to design a building, with so many options and possibilities. It was a leap into the unknown, but we soon realised that research on food structure had to be linked with food perception. So yes, we set out to do groundbreaking research because such research had never been done before.’

## Interdisciplinary Approach

‘After consultation with the industry partners, we decided the focus should be food texture’, continues the research director. The first research project on interfaces in emulsions and foams required an entirely new approach integrating expertise in food physics and biochemistry to go for more generic answers. This required us to study different types of proteins rather than to focus on one specific protein. While the trend in studying food structures has been to narrow down to micro disciplines, we needed to cut across the disciplines in a more interdisciplinary approach. This was something of an “intellectual hurdle” in the pioneering days of WCFS’, he explains.

## Texture and Perception

It has long been known that typical food texture related sensory attributes, such as creaminess or crispiness, are much enjoyed by consumers. WCFS research aims to understand the mechanisms responsible for such food attributes. This knowledge will enable WCFS partners to exploit these mechanisms in developing the attributes they want in their own food products.

But that’s only part of the story. What controls the sensory properties of different types of food textures? ‘In studying sensory perception, we opted initially for a more holistic approach to sensory perception, investigating the links between sensory attributes and

physical and chemical attributes of foods. We are continually fine-tuning our approach as we map our way in this new area of research’, says Rob Hamer.

## Mouth Feel

What is the secret of creaminess, for example? ‘The search becomes more complex because consumer preference for creaminess is also accompanied by a demand for low-fat food products. And at the same time, there is a demand for food products with an extended shelf life’, explains the Scientific Director. ‘Just to make it a little more complex, creaminess in one product, for example cheese, is not necessarily the same as creaminess in another product, say mayonnaise or yoghurt’.

What happens in the mouth when we are eating a product that we experience as being “creamy”. WCFS researchers are endeavouring to find out, for example, by measuring with infrared sensors the coating left behind on the tongue after a “creamy” eating experience. This work is done with experimental panels, who manipulate a bite or a spoonful of food in their mouth and spit it out. These samples are then examined under the microscope to establish how the food reacts with saliva and how, for example, the fat distribution in the sample changes.

‘We want to establish the physiological and chemical factors that lead consumers to value creaminess and other basic food attributes’, continues Rob Hamer, ‘and how these attributes can be built into food products. Because this knowledge is essential to the food industry in producing food products that are not only healthier and keep long, but just as important, taste better.’

## Tip of the Iceberg

This branch of food research is only just beginning, we’ve hardly scratched the surface’, stresses Rob Hamer. ‘Lots of exciting ideas and leads come up during the research. But we have to stay focused and identify the main opportunities based on what’s industrially relevant and of course, what’s scientifically feasible.’

One new area with exciting possibilities might be that our sensory research could help explain individual differences in the perception of food attributes. It is important to gain a better understanding of individual differences, for example, between old and young people. This knowledge will help to understand the “consumer” and could enable us in the future to design products for certain age groups, for example. The potential is boundless.’



## FOOD TEXTURE AND PERCEPTION

Research on food structure and functionality has entered a new phase to focus on the interrelationship between *food texture and food perception*. The research will build on knowledge base developed in previous projects on food microstructures, in challenging new research projects with the ultimate aim of enabling industry to control food texture and even further in controlling perceived attributes.

This is a very ambitious target, and the research is experimentally challenging because complex systems are being investigated including the complex environment of the oral cavity. Furthermore, this research is at the forefront of an entirely new area and thus WCFS researchers are working in uncharted territory. A number of exploratory studies have been carried out to select the most appropriate approaches to new work that started in 2003.

*Dynamics of biopolymer networks and textures* is investigating the mechanical properties of gels with the aim of designing and producing microstructures responsible for specific mouth-feel performance and stability of soft-solid composite food products based on biopolymer networks. The relationship with the physical and chemical origin of sensory attributes such as body/fullness, stickiness, and creaminess.

*Engineered textures of emulsions and foams* is investigating the intra-oral behaviour of emulsion droplets and foam bubbles in relation to hypothetical physico-chemical origins of sensory attributes such as velvety after-feel, fatty taste and lubricating ability. The current focus is on the role of saliva and shear in relation to droplet stability and sensory attributes.



## Scientific Entrepreneur

### *Prof. Willem de Vos, Microbial Functionality and Safety*

According to Prof. Willem de Vos: 'It is not sufficient to know what's happening, you need to be actively involved in dialogue with science, industry and government. This way, you are alert to new developments and trends, and so innovation is nurtured and flourishes. The consequence is that a professor, and certainly a WCFS scientific director, needs to be something of a scientific entrepreneur.'

#### **International Context**

'Science knows no national boundaries; it has to be international', stresses the Scientific Director. 'Of course, this does not preclude us from doing our own research and developing research programmes that are original and creative. But research programmes need to be developed within the context of what is happening on the scientific scene worldwide. There is no point in WCFS duplicating research work that's being done elsewhere. We can and must complement and expand but never duplicate', he emphasizes. 'This is my starting point in developing and continually refining the research strategy on microbial functionality and safety, and in working out this strategy into concrete research projects.'

#### **National Scene**

'As WCFS, we must be involved internationally and strive to be in the forefront in innovative, groundbreaking research', continues Willem de Vos. 'That's why we are participating in leading edge research programmes, both here in the Netherlands and in Europe. To give you an example, we are at the forefront of genomics research on industrial

microorganisms as an active partner in the Kluiver Centre for Genomics of Industrial Fermentation. Our research on the metabolic engineering of lactic acid bacteria using a genomics approach is closely integrated with work being done in the Kluiver Centre.'

#### **European Arena**

'WCFS' work on lactic acid bacteria is also linked to joint research projects funded by the European Union. We are involved in the NutraCells project directed to increasing the nutritional value of food raw materials with microbial nutraceuticals and in the LabDel project investigating the use of lactic acid bacteria in the oral delivery of compounds including nutritionals. Our involvement in these activities puts us at the cutting edge and gives us access to additional expertise to increase our critical mass. We will continue to respond to new EU calls for collaborative research in microbial functionality and safety.'

#### **Building a Research Strategy**

How do you define a research strategy that responds to the WCFS goals of scientific excellence and industrial relevance? 'First and foremost, we need to keep a keen eye on what's happening in the field', stresses the Scientific Director. 'In this way, we are best positioned to capitalise on progress elsewhere and select our own strategy. In formulating a strategy that gets results, regular consultations are essential with our research and industry partners, through the Focal Points and Programme Council. But equally important are informal discussions with our scientists and other experts.'



'We have agreed a strategy for microbial functionality and safety, and all research activities must fall within that strategy. This is by no means a straightjacket that stifles new ideas but rather a set of strong guidelines that allow a great deal of flexibility in achieving our research goals.'

#### **Strategic Goals**

For research on microbial functionality and safety, there are three strategically defined objectives. The first is to carry out research aimed at optimising fermentation processes and the microorganisms and enzymes used in these processes in preparing food and food components. This is of direct industrial relevance.

The second is also of clear industrial relevance and is to increase microbial safety throughout the food chain by gaining greater understanding of the mechanisms in microbial stress responses.

The third strategic objective is to optimise the functionality of microorganisms in the gastrointestinal tract by gaining better understanding of host-microbe interactions and the effect of diet on intestinal ecology. 'This last goal is particularly relevant', explains Willem de Vos, 'not only for our industrial partners but also for human well being.' The work has links with WCFS research on nutrition and health and with the new developments in nutrigenomics starting in 2004.

*'A WCFS scientific director needs to be something of a scientific entrepreneur.'*

#### **STATE-OF-THE-ART RESEARCH ON MICROORGANISMS**

Research on microbial functionality and safety is based on highly advanced and complementary technologies, which together enable better understanding and thus control of the activity of food-grade, food-spoilage or pathogenic microorganisms. Moreover, since these microorganisms are relatively simple biological systems they are timely model studies to extrapolate generic principles for use with other microorganisms and strains.

#### **Genomics**

One of these techniques arises from developments in genomics, which have enabled complete descriptions of the coding capacity of genomes and their expression products. As a result, global studies can now be carried out on just about any biological system using DNA arrays, proteomics and analysis of metabolic end products. These techniques facilitate the discovery of new genomes and pathways by means of functional and comparative genomics. Advances in genomics have opened the way for high throughput approaches, which can lead to the identification of novel strains and the construction of improved microbial strains with enhanced functionality. Another advanced approach is mathematical modelling that enables researchers to predict microbial activity compromising food safety and food preservation.

#### **Bioinformatics**

Rapid advances in bioinformatics have enabled the handling of the vast amounts of data generated in genomics research and systems biology on microorganisms. Bioinformatics was the topic of the 2003 WCFS Food Summit entitled 'Mining microbes: from data to knowledge'. Experts from science and industry participated in discussions on how developments in bioinformatics can contribute to the design, production and marketing of healthy, functional and safe foods.



FOCAL POINTS

# Gaining Consensus

**Prof. Kees de Kruif, NIZO food research**

From the very beginning, Prof. Kees de Kruif, Head of Product Technology at NIZO food research, has been closely involved in the WCFS research programme on food structure and functionality. Kees de Kruif is the Focal Point for this programme. As he points out, 'Our participation in WCFS research offers us a "scientific playground", with opportunities for scientific reflection as well as extending our knowledge and expertise in new areas at the forefront of food research.'

Participation in WCFS research has created many synergies for NIZO food research. One important spin-off is follow-up contract research for some of the industry partners. 'Certainly, the research on food structure and functionality has generated knowledge about generic systems and mechanisms that we have been able to use in fundamental and applied research', explains the Focal Point.

### Safeguarding Quality

How does Kees de Kruif see his role as a Focal Point? 'As the Focal Point for a research partner, I am a sounding board for WCFS and I have a role in ensuring research projects are firmly anchored in the strengths of the research partners, working either separately or collectively.'

Research projects in food structure and functionality carried out at NIZO food research fit into the institute's core research on taste, processes and health. 'I see one of my responsibilities as Focal Point is to safeguard the quality of research done at NIZO food research. Furthermore, my close involvement with the research also enables direct communication with our Programme Council member, NIZO Director Dr Ad Juriaanse, and that's important as well', Kees de Kruif explains.

### Personal Involvement

Prof. Kees de Kruif is closely involved in the WCFS research because several projects are being carried out in his department by scientists seconded from that

department. One such project is the research on food biopolymer dispersions and gels. 'At NIZO food research, we keep up-to-date on WCFS projects through regular meetings and presentations by WCFS Project Leaders and PhD fellows', says Kees de Kruif. 'But most exchanges, and perhaps the most meaningful, occur informally. This is inevitably when a group of scientists are working under one roof. We also meet with WCFS researchers to brainstorm about the research and the potential applications in both the short term and with a longer term perspective.'

### About Researchers

'Several scientists have completed their WCFS secondment and have returned to our department, clearly enriched by their experience', continues Kees de Kruif, 'I believe that our researchers are well positioned to carry out the type of research demanded by the WCFS mandate. Not only are they highly trained and experienced, they are motivated to do research that leads somewhere. This makes a bridge to industry because researchers need to have a good feeling for industry's needs. They also need to be good communicators. Our researchers have the know-how and perspective to make the scientific breakthroughs that WCFS wants, and to translate the results to potential industrial applications, and that's what NIZO food research wants', stresses Kees de Kruif.

### Evolving Task

As one of the founding Focal Points, Kees de Kruif has seen the task evolve since WCFS started. In the beginning, the Focal Points were profiled as advisors without well-defined responsibilities. 'The Focal Points for Structure and Functionality have now become a team with responsibility to help reach an effective consensus about the direction of research projects. Of course, not all projects are of equal interest to everyone, but at NIZO food research, we like to know what's going on. That's also part of my job as Focal Point.'

# From Specifics to General Principles

**Dr Tony Else, CSM**

FOCAL POINTS



Motivated by the company strategy on innovation, CSM joined WCFS in 2001. By then, the first round of research projects on Microbial Functionality and Safety was well underway. 'So in that respect, we were too late to influence the research direction', says Dr Tony Else. 'Nevertheless, CSM has made some valuable gains from the research in terms of genomics and new methodologies and tools in our work on lactic acid bacteria.'



### FOCAL POINTS

WCFS research and industry partners has designated a scientist as the Focal Point for each of the three WCFS research programmes: Nutrition and Health, Structure and Functionality, and Microbial Functionality and Safety. The Focal Points meet regularly with the Scientific Directors and Project Leaders about the overall research strategy, new project proposals and project progress. While the Focal Points have no formal authority, they are a vital channel of two-way communication within their organisation and between their organisation and WCFS.



### Industrial Relevance

CSM has high hopes for usable results from the new project on food safety and preservation, which started at the end of 2003. This project is directed to developing and using genomics-based approaches to identify the molecular nature of stress responses in microorganisms. As Focal Point, Dr Tony Else has been actively involved in the project development and has participated in the preparation of the Full Project Plan.

Not all projects are of direct relevance to the company. 'While the work on microbial gut metabolism is very interesting, it does not seem to be of immediate relevance to us', the Focal Point explains. 'But you never know in science. Like any company, we do not have the time and resources to explore all possible avenues. Still, those research areas of crucial importance to our company can't be left entirely to WCFS; we have to do the research ourselves. But WCFS does have a very important role to play. If we didn't think so, we wouldn't invest in WCFS!'

### Making it Work from Both Sides

Tony Else firmly believes the Focal Points can and must play a pivotal role in making WCFS research more industrially relevant. 'WCFS is a new concept and both research and industry partners have to take the time and effort to work out the best approach. How do I see things developing? We need more dialogue to ensure industrial relevance, especially in the initial phases when research projects are being defined.'

## FOCAL POINTS

‘To explain, the goals of the research will often take the form of generic principles that the research is directed to explain or verify, and these must be clearly defined right at the start’, he stresses. ‘This requires intensive dialogue with all partners through the Focal Points. However, scientists have to work with specifics, that is, with concrete subjects that may be several layers of detail removed from the generic principle. At this point, the research results may be groundbreaking from the scientific perspective. But to be industrially relevant, the results need to be translated back to the generic principles, which industry partners can use in their own research. In our case, for example, we need to translate the research on specific strains of microorganisms into results that we can apply to our commercial strains.’

‘At this point research, even of a fundamental nature, may well be commercially sensitive. If the companies can’t do the research themselves, it could be done as contract research by one of the research partners. They offer the added advantage of being up to speed on the new methods and techniques developed. WCFS is a learning experience for us all. But as I see it, this is what makes WCFS science different.’

### Spin-offs

According to Tony Else, ‘WCFS gives CSM access to frontline research, which in turn can motivate new directions in our own research. It’s stimulating to talk to people working at the cutting edge of science, and to build a network of contacts both in research and industry. It’s very handy to know someone who knows somebody.’

‘An important part of the role of Focal Point is to communicate with WCFS and within CSM about WCFS research’, concludes Tony Else. ‘At CSM, we have regular meetings with all three Focal Points, Experts and our Programme Council member, Dr Rop Zoetemeyer. We discuss all aspects, but the bottomline is always: are we getting our money’s worth on balance – and we are!’



## Meeting of Minds



‘Key decisions that shape the direction of the research project are made in consultation with the Focal Points and particularly with Experts from our partners’, explains Project Leader Dr Eddy Smid. We have decided to use *Lactobacillus plantarum* as the model organisms because WCFS has an annotated genome sequence of this microorganism. ‘Furthermore, we have chosen the vitamin folate and the cofactor thioredoxin because we’ve already developed suitable mutants. Folate is a vital metabolite produced by lactic acid bacteria during the fermentation. We are particularly interested to know whether the level of folate can be increased in fermented foods.’

‘This project is an experiment in another way’, says Eddy Smid, ‘We found that the twice-yearly meetings with experts from our industry partners do not always give sufficient opportunity to discuss the scientific details. So we have decided to exchange expertise, experience and results by involving subject matter experts in the regular progress meetings of the project team. Of course, not all partners are equally interested but those who do come to the meetings can make a substantial contribution.’

### Dialogue

Unilever’s expert for this WCFS project is Dr Aat Ledebøer, a specialist in fermented foods and lactic acid bacteria. He considers this interaction is well worthwhile. ‘The discussions in which the experimental work is presented are highly scientific. It’s an opportunity to ask questions and have an input in the project. Of course, we can’t influence the overall

*Experts Dr Aat Ledebøer, Unilever Research and Dr Paul Bruinenberg, Campina; Project Leader Dr Eddy Smid*



research direction. But even small adjustments can add up to a considerable impact over a five-year period.’

There’s another important point on which both Aat Ledebøer and his colleague from Campina, Dr Paul Bruinenberg can agree. ‘We really appreciate this opportunity to discuss the approach and results with WCFS scientists, sometimes on a one-to-one basis’, says Paul Bruinenberg. ‘These contacts also help us in our search for new opportunities for our companies. That’s my job as Expert for this project as well as Campina’s Focal Point for this research programme.’

### Greater Access

The research on engineering microbial functionality is closely linked with the EU funded NutraCells project and the integration of the research in the activities of the Kluyver Centre for Nutrigenomics of Industrial Fermentation. ‘These links open up access to a much wider range of research’, says Aat Ledebøer. ‘Even a large company like Unilever can’t pursue all new developments. We appreciate the opportunity through WCFS to keep abreast with the latest developments in this challenging new approach to research on lactic acid bacteria.’

Paul Bruinenberg adds, ‘WCFS gives Campina access to integrated research efforts in the Netherlands and in Europe. I certainly enjoy meeting as colleagues with scientists from research institutes and from other companies. I know most of the industry partners really appreciate this.’

### ENGINEERING MICROBIAL FUNCTIONALITY

The vast amount of genetic data from genome sequencing has opened up new opportunities to study the effect of engineered metabolic pathways on the metabolism of microorganisms. The research project aims to optimise biosynthesis of key metabolites such as the vitamin folic acid and the cofactor thioredoxin, and thus to evaluate the effect of these on microbial functionality. A functional genomic approach will be followed in constructing metabolic models from genomic data including annotated genome, high-throughput transcriptome profiling and targeted metabolome profiling. These metabolic models will be used to develop new metabolic engineering strategies leading to microbial strains with improved characteristics for industrial fermentations. The annotated genome sequence from *Lactobacillus plantarum* WCFS1 is being used to map all potential metabolic pathways. Transcriptome data obtained experimentally will be processed to predict those parts of the metabolic network present under specific growth conditions or in specific engineered strains. Finally, key metabolites will be analysed to verify the presence of the predicted pathways. Alternative modelling and experiment aims to provide insight into the effect of perturbation of specific metabolite pools on the metabolism of *Lactobacillus plantarum*.



## EXPERTS

# Teamwork Creates Added Value

## PROJECT TEAM

**Dr Harmen de Jongh, Project Leader**  
**Ir Peter Wierenga, PhD Fellow**



## PROJECT TEAM

‘Our research is highly fundamental, investigating the chemical mechanisms in microstructure formation and stability of foams, emulsions and gels, and especially the role of protein’, explains Project Leader Dr Harmen de Jongh. ‘For example, we want to understand why  $\beta$ -lactoglobulin makes a good foam while ovalbumin does not? Why are networks of S-ovalbumin more brittle than those of the native protein? Why are some ingredients more sensitive to matrix composition than others? Why does aging of microstructures depend on the ingredients used? Answers to these and many other such questions provide essential fundamental knowledge.’

### Added Value

The industrial relevance of the research on biopolymer stability and functionality must be seen in terms of its contribution to the whole research programme on food structure and functionality. According to Harmen de Jongh, ‘WCFS research in this area should be seen as one large integrated project investigating the interrelationship between physical and sensory aspects of food structures. Understanding the chemical mechanisms within these microstructures is an essential part of the jigsaw puzzle.’

### Patentable Knowledge

‘In terms of industrial relevance’, continues the project leader, ‘fundamental knowledge about chemical mechanisms may not in itself be patentable. What is patentable, however, is how this knowledge can be applied. It’s up to each of the partners to determine for themselves what can be done with the knowledge, and therefore, whether or not to patent.’

### Teamwork

Because of the nature of the work, a range of disciplines is required and that means teamwork, with each member of the team contributing specific expertise. ‘Teamwork means working closely together as “parts of a whole”. Because we have joint objectives, we depend heavily on one another to get results and to work with the data generated’, stresses Harmen de Jongh. ‘This means you have to have trust in one another, and as I see it, that’s the real essence of multidisciplinary research.’

‘You could say we take teamwork very seriously, even to agreeing to use our team bonus to do something together.’ In June last year, the ten members of the team made a four-day visit to the Department of Chemistry at Moscow State University. As well as a symposium on engineering and understanding protein functionality, with colleagues in Russia, they had time to enjoy the sights of Moscow and the warm hospitality.

### PhD Fellows

One of the three PhD fellows in the research project is Ir Peter Wierenga. He is investigating the molecular properties of proteins in relation to their structure. According to Peter, ‘Being a PhD fellow in a multidisciplinary team is a big plus, not only because you are exposed to different ideas and perspectives but also because you participate in the debate and you can make a worthwhile contribution. Another advantage of WCFS is the sense of urgency about your research because others are relying on your data. That’s the other side of being part of a multidisciplinary team.’

Project Leader, Dr Harmen de Jongh sees that the PhD Fellows make a valuable contribution to the research; their in-depth studies are essential ‘parts of the whole!’ ‘We need to create an environment in which PhD fellows are able to do their research without distraction. At WCFS, we endeavour to provide a good balance between intellectual interaction and a rich environment for in-depth research.’

*‘Teamwork means working closely together as “parts of a whole”...it means trusting one another... that’s the real essence of multidisciplinary work.’*



### BIOPOLYMER STABILITY AND FUNCTIONALITY

The project on biopolymer stability and functionality is investigating the functionality of proteins in relation to their molecular properties. Functionality here refers to the capacity of a protein to form a specific structure, such as a foam, and also to the resulting behaviour of that structure, for example, its strength. Differences in functionality of proteins from different sources result from differences in their molecular properties.

Within this framework, PhD Fellow Peter Wierenga is studying the role of proteins at air-water interfaces in the formation and stability of foamed products. This study builds on previous research on foams and emulsions. Whipped whey protein  $\beta$ -lactoglobulin at concentrations as low as 0.1 g/l produces good foam but foam can only be produced with chicken egg-white protein ovalbumin at concentrations higher than 10 mg/ml. This difference seems to be related to ovalbumin’s lower adsorption to the interface and is believed to be due mainly to the lower exposed hydrophobicity of ovalbumin.

Peter Wierenga is investigating the chemical mechanisms involved in this process. When exposed hydrophobicity is increased while preserving most of the other molecular properties, ovalbumin foaming behaviour is similar to that of  $\beta$ -lactoglobulin. In the same way, other ingredients are being modified to identify critical properties for the formation and stabilisation of foams. Peter Wierenga is investigating the introduction of extra electrostatic charges to change the intra-molecular interactions between adsorbed proteins. In addition he is introducing sulfhydryl groups to increase the formation of a covalently bound network at the interface. Modification of chemical properties gives valuable insights into the role of different molecular properties of proteins in complex mechanisms.

## PROJECT LEADER



# WCFS Pioneer

One of the WCFS pioneers is project leader Peter Zock whose team is working on n-3 fatty acids and cardiac arrhythmias. As WCFS pioneer, he was responsible for exploring the feasibility of several research leads in the start up phase of the WCFS nutrition and health research programme. 'Like any new concept, you have to start somewhere,' explains Peter Zock. 'It was an exciting and challenging time. What type of good scientific research is industrially relevant? How do you interact with the industry partners? How would the Focal Points contribute to the project? And many more questions had to be answered.'

### New Opportunity, New Challenge

Peter Zock, who was seconded to WCFS from the Wageningen University in 1997, believes strongly in the WCFS concept. 'It is a unique partnership to push forward innovation and I'm very pleased to have been part of this process. From the point of view of a scientist, I have been able to do long-term research that would not have been possible, or certainly much more difficult to do, through the university system of grant funding.'

This exposure to industry and to WCFS industry partners has re-inforced Peter Zock's decision to accept an appointment at Unilever Research and Development. In November 2003, he started working at the Unilever Health Institute as senior lipid expert. 'The research work is more product oriented compared

### Dr Peter Zock

to the type of research we do at WCFS', explains Peter Zock. 'WCFS nutrition research is directed to establishing generic principles and unravelling mechanisms, or to investigating the effect of nutrients on specific health aspects.'

### Long-Term Vision

Nutrition research is by nature long-term because it's difficult to achieve significant results within a short time frame of two to three years. 'In the early days of WCFS, this sometimes led to conflicting messages from the partners. Companies have different interests, for example, specific food ingredient makers are not as interested in general nutrition research as are the manufacturers of food products, but more recently, ingredient makers have become increasingly interested in nutrition and health', explains the Project Leader.

In the early days, Scientific Director, Prof. Martijn Katan and researchers visited the companies to discuss what WCFS research could mean for them. 'You could say we needed to do something of a selling job! We needed to talk with our industry partners to find out what is or could be important in, say, five years time. That's why WCFS procedures have a system of lead investigations and feasibility studies to test concepts and research ideas. From both sides – industry and research – it's important to strike a balance because there's no point in committing to four or five years of research if you don't believe in it.'

models and methods for studying arrhythmia and heart disease risk. These tools can then be used in investigating the effects of various dietary components on heart health.

A multicentre, Europe-wide study has been set up to investigate the effects of n-3 fatty acids on the incidence of life-threatening arrhythmias in patients at risk. Patients with implanted cardioverter defibrillators have been recruited for this study from 26 cardiological centres throughout Europe.

### N-3 FATTY ACIDS AND CARDIAC ARRHYTHMIAS

There are strong indications that dietary n-3 fatty acids reduce the risk of heart disease, but it is unclear how they work. It is thought that n-3 fatty acids can reduce the risk of heart disease by preventing life-threatening cardiac arrhythmias. If so, what is the mechanism involved? WCFS researchers are studying the effects of n-3 fatty acids on the electrical activity of the heart at all stages of the pathway from diet to disease prevention. The overall objective is to develop reliable biomarkers and new



## PROJECT LEADER

# Pioneer New Style

### Prof. Ronald Mensink

The first WCFS project leader appointed from the WCFS research partner, Universiteit Maastricht, is Prof. Ronald Mensink to lead research on insulin resistance and chronic inflammation. This project was approved by the Programme Council in December 2003. It is based on a "promising lead", explored last year by Ronald Mensink in terms of its scientific potential and assessed in close consultation with the industry partners on its potential industrial relevance. 'This is a very challenging concept but it's risky, simply because it has never been done before', explains the Project Leader. 'We believe it's worth the risk because the research will generate much new information and implement new techniques. Scientifically, we're convinced the research is soundly based.'

### Industrial Relevance

'But knowledge for knowledge's sake is not sufficient', he continues. 'A lot of thought has gone into how knowledge generated can be used. We have done this in interactive debate with the Focal Points and Expert groups. We believe the investigation will provide new perspectives in designing foods with beneficial effects on insulin resistance and chronic inflammation for a large and still growing segment of the population.'



### Time Frame

'The industry partners want to see useful results within a reasonably short time frame, and rightly so', stresses Ronald Mensink. 'But very often, nutrition research is a long process before there are any conclusive results. To put it in a rather simplified way, you add molecules to cell systems to see whether a dietary component produces the desired effect. If that appears to be successful, you need to do extensive studies with animal models and then finally, to carry out human studies. All this takes time. When you think, four to five years is not much time compared with the time it takes to develop a new pharmaceutical, which can be ten or more years.'

### Nutrigenomics

Ronald Mensink is also closely involved in the innovative research on nutrigenomics, which will start in 2004. 'At Universiteit Maastricht, we will be carrying out some human studies, with the long-term objective of finding out whether it is possible to prescribe personalised diets. For example, is it possible to predict from my genes, whether I need extra vitamin B<sub>6</sub> in my diet? If so, can food products be specifically modified with the amounts of the vitamin I need?'

## PROJECT LEADER



‘This is really research at the frontiers of science. But expectation should not be too high at least in the early stages. The risks are high, but if we succeed, the potential for our industry partners will be enormous. Industry needs nutrigenomic information but the research is far too expensive for companies to carry out separately. This research is a good example of what they can do collectively through WCFS.’

*‘Knowledge knows no boundaries.’*

### DIET, INSULIN RESISTANCE, AND CHRONIC INFLAMMATION

The prevalence of insulin resistance and chronic inflammation is rising, not the least due to the growing numbers of overweight and elderly people. The health consequences of these metabolic aberrations may be prevented or delayed by dietary changes or modifications. WCFS researchers led by Prof. Ronald Mensink have started a multidisciplinary research project in the Universiteit Maastricht. Focusing on diacylglycerol metabolism in the muscle, which plays a central role in insulin-signalling and inflammatory pathways, the research team will endeavour to systemically unravel and identify diet-sensitive molecular targets for improving insulin resistance and chronic inflammation. The research also aims to validate cell and animal models for the effects of foods and nutrients on insulin resistance and chronic inflammation.



## PHD FELLOW

# Enthusiastic, Energetic, Ambitious

*Drs Wendy Rodenburg*

PhD fellow, Wendy Rodenburg is very enthusiastic about her research, nutrition research and the interactive research environment at WCFS. ‘As a PhD fellow, you have the chance to do highly focused research using sophisticated methods and techniques. You have to take the initiative yourself but you are certainly not working on your own’, says Wendy Rodenburg. ‘It’s very stimulating to do research within the framework of a much larger project, and to see how your research fits into the whole. And what’s more, the WCFS multidisciplinary approach lowers the barriers for a PhD fellow like myself to make contact with researchers across the disciplines. I really appreciate this aspect of WCFS.’

### PhD Research

Wendy Rodenburg joined WCFS in November 2002 as a PhD fellow within the project on dietary modulation of intestinal infections, investigating whether and how specific nutrients can improve host resistance to intestinal bacterial pathogens. Her research is part of the investigation of the underlying mechanisms and aims to identify genes that are expressed differentially in the rat gut wall during bacterial infections, and are modulated by dietary components. By studying barrier-related differential gene expression induced by dietary interventions, she aims to identify diet-sensitive biomarkers of gut health that can be used in human dietary intervention studies.

*‘The WCFS multidisciplinary approach lowers the barriers for a PhD fellow to make contact with researchers across the disciplines.’*

### Multidisciplinary

Wendy Rodenburg’s research is scientifically ambitious. It builds on the work done by a WCFS team led by Dr Roelof van der Meer at NIZO food research. Their studies with rats and humans have shown that diet can modulate gut infections. The PhD study also draws on the work conducted at RIKILT by Dr Jaap Keijer in identifying dietary sensitive molecular marker genes of mucosal damage associated with colon cancer risk. A specific rat intestinal cDNA microarray was developed which led to the identification of genes in the rat gut that are affected by diet. ‘If we are able to identify specific barrier- and infection-related genes, this can be potentially very interesting to the industry partners’, explains the PhD fellow.

### Interaction

There are many opportunities to interact with other scientists in the research team and with industry partners. ‘We have regular contact with the partners to discuss progress. This compels you to really think about your own research in terms of how it fits into the bigger picture, and to come to a better understanding of its potential relevance’, she explains.

‘I thoroughly enjoy the interaction with people across the different disciplines in WCFS, for example, in the regular colloquia for PhD fellows and post docs’, she continues. These colloquia are held every 6 to 8 weeks to enable PhD fellows to present their research and to open discussion. ‘It gives us the chance to learn what’s going on in WCFS and to make contacts. I guess you could call it networking; it’s important to get to know other scientists in a multidisciplinary environment. And there is the social aspect as well. This is the great thing about WCFS. There is so much going on; it’s a stimulating atmosphere in which to do a PhD.’



# Getting Research off the Ground

Ing. Wim Lichtendonk



Laboratory Manager at TNO Nutrition and Food Research, Wim Lichtendonk is under contract to WCFS and working at Agrotechnology & Food Innovations. He is a member of the multidisciplinary team brought together by WCFS to carry out new research on the crispy/crunchy crusts of bread and fried snacks. What makes a crust crunchy and crisp, and how can the crust be made to remain crispy-crunchy for a longer period?

## Multidisciplinary Research

Wim Lichtendonk joined WCFS in April 2001 to work with the team on the stability of foams and emulsions at Wageningen University. When the project was completed, he was contracted for the new crispy/crunchy project at Agrotechnology & Food Innovations. This type of research had never been done before; it's an exciting challenge requiring a combination of expertise from different disciplines including fracture physics, sound physics, physical chemistry, analytical chemistry, biochemistry, sensory sciences and more.

Part of Wim Lichtendonk's task has been to get sophisticated equipment installed and operating that meets some unusual and exacting requirements for measuring food texture and sound of crunchiness in the mouth. 'There were no standard solutions; we had to start from basic principles,' he explains. 'That's why it's so exiting to be part of this never-before project.'

He is also closely involved in training three PhD fellows to use this equipment. It will be used with trained expert panels to establish terms to describe the sensory characteristics of crispiness and crunchiness, and in the perception of these characteristics.

## Win-Win

'I don't have a problem with divided loyalty', explains Wim. 'I'm employed by TNO, one of the WCFS research partners and contracted to WCFS on a project basis. It's all in the family.'

'I spend four days a week at Agrotechnology & Food Innovations on the WCFS crispy/crunchy project and one day a week at TNO in Zeist, where I am the manager of the Rheology Lab. There is frequent contact and feedback between the WCFS project in Wageningen and TNO in Zeist through an informal network of colleagues. WCFS has also established formal lines of communication with the partners through regular WCFS Focal Point and Expert meetings.

'These formal and informal contacts ensure that the research partners are kept up to date with new techniques and skills developed in WCFS research. This knowledge as well as access to equipment, such as the food texture and sound analysers, could, for example, be of special interest to TNO', explains the Laboratory Manager. 'As well as providing expertise to



WCFS, I'm also learning new techniques of added value to TNO in applied research commissioned by TNO customers, some of which are WCFS partners.'

## New Horizons

'WCFS is more than a research project; WCFS has opened up new horizons and given a whole new dimension to my work', he explains. 'I'm a biochemist by training and later I switched to rheology. In your own organisation, you tend to get known for a certain area of expertise and for me at TNO, it's rheology. At WCFS in a multidisciplinary research environment, you have to think outside of the box. You're exposed to new expertise and ideas.'

Because WCFS project teams are drawn from different organisations and backgrounds, an extra effort is made to enable researchers to meet and interact within and across the projects. 'That's something special about WCFS, which everyone is very enthusiastic about. It's not only in the lab but also in scientific forums and discussions as well as socially and informally. That's something else to take back to TNO, a new network of contacts across disciplines and organisations in food research.'

## CRISPY/CRUNCHY BEHAVIOUR OF CELLULAR SOLID FOODS

The crispy/crunchy behaviour of cellular solid foods is being studied with the aim of extending the shelf life of products with a crispy/crunchy external crust such as bread and fried snacks. Dr Ton van Vliet from Wageningen University is leading the research project in uncovering the mechanisms responsible for these sensory properties and for their deterioration with time.

The study involves two model food systems – baked flat bread and fried products. The baked product has a crust of the same chemical composition as the food product itself and is made of flour, sugar and salt. The fried product has a coating of wheat flour batter that becomes crispy/crunchy when fried in oil.

Highly sensitive, state-of-the-art equipment has been purchased and adapted to carry out sound measurement and analysis. This equipment is being used with a trained expert panel in establishing terms to describe sensory characteristics of cellular solid food products with a crispy or crunchy crust. Another expert panel is being trained to perceive minimal changes in crispy/crunchy characteristics with time after baking or frying. The relationship between these sensory characteristics and objectively measurable chemical, physical and morphological properties has been established.

*'That's something special about WCFS ... not only in the lab but also in scientific forums and discussions as well as socially and informally ... a network of contacts across disciplines and organisations in food research.'*



# How Virtual is Virtual

*Drs Hannie van Oosten*



Visitors to WCFS ask where are the laboratories, where are the facilities. There are none. So yes, in that sense WCFS could be considered to be a virtual institute. But, in fact, this is far from the reality. WCFS is a tangible institute; it has a small central office in its own distinctive building. It has its own logo and identity and thus is a separate entity in Wageningen where it is physically located.

## Who Does the Research

As Human Resources Manager, Drs Hannie van Oosten explains, 'WCFS is a virtual institute in the sense that no one is employed directly. All members of staff are on secondment from one of the research partners. This was done initially because WCFS funding was guaranteed for eight years, in the first instance. Since then, the period has been extended. Nevertheless, it was never intended that scientists would be permanently employed by WCFS but rather contracted for a specific project or activity.'

WCFS projects have funding for periods of four to five years, enabling the seconded researchers to carry out long-term investigations without concern about continuity. 'Most people consider their time at WCFS to be an invaluable experience', says Hannie van Oosten. 'This is borne out by the results of a staff satisfaction survey we conducted earlier this year. The experience gained while working for WCFS is certainly added value when staff return to the research institutes in terms of exposure to new ideas, concepts and techniques. In this sense, WCFS creates a win-win situation for both participating scientists and research institutes.'

## Where is the Research Done

WCFS research is carried out in the participating research institutes, using their laboratory facilities and equipment. That is part of the deal with the research partners. The decision where to locate a project depends on which research partner has the state-of-the-art expertise and facilities required. Most projects, however, require the purchase of new equipment and sometimes even the redesign of laboratory space.

## Setting up Research Teams

'A project team is drawn from all participating research partners and sometimes special expertise has to be hired from outside. It is WCFS policy to concentrate the project team in one research institute. In practical terms, this means bringing together researchers from Wageningen University, NIZO, TNO, Agrotechnology & Food Innovations and Universiteit Maastricht in one institute. This has happened, for example, in the project on crispy, crunchy behaviour of cellular solid foods, which draws researchers from four research partners to work at Agrotechnology & Food Innovations in Wageningen for four years. 'While inevitably there are some personal



disadvantages, such as longer travel distances, the members of the research team see this is a great chance to broaden their horizons', explains the HR Manager.

## Central Office and Meeting Point

In the WCFS organisational set up with research projects spread over the different institutes, a central office and a meeting point is vital. This is the rationale behind locating the WCFS office in Wageningen. 'Our central office is very important in giving WCFS a tangible identity', says Hannie van Oosten. In line with

keeping the overhead low, WCFS has a small central office to house the central functions of finance, human resources, public relations and ICT functions.

There are two rooms for meetings, seminars and training sessions within and across project teams and disciplines. 'It is very important for PhD fellows to interact and be exposed to the views and ideas of other disciplines. It's part of the WCFS mandate to train young scientists', explains Hannie van Oosten. 'And for WCFS as a fledgling organisation, it's vital that "WCFSers" meet on a regular basis.'

## Keeping in Touch

From the start, it was recognised that effective communications would be the key to maintaining and strengthening the WCFS identity. As well as physical facilities, WCFS has invested in an extensive intranet connecting all WCFS researchers and designated persons in the industry partners. 'We need to constantly update and extend the intranet and this year it was completely overhauled adding new information and more access. This was necessary to fully integrate our new research partner, Universiteit Maastricht,' explains Hannie van Oosten.

## HUMAN RESOURCES FACTS AND FIGURES

Because almost all WCFS staff are on secondment from the research partners, human resources management plays a particularly important role in WCFS. The number of senior scientists seconded varies from year to year. In 2003, there were 160 on secondment from the five research partners.

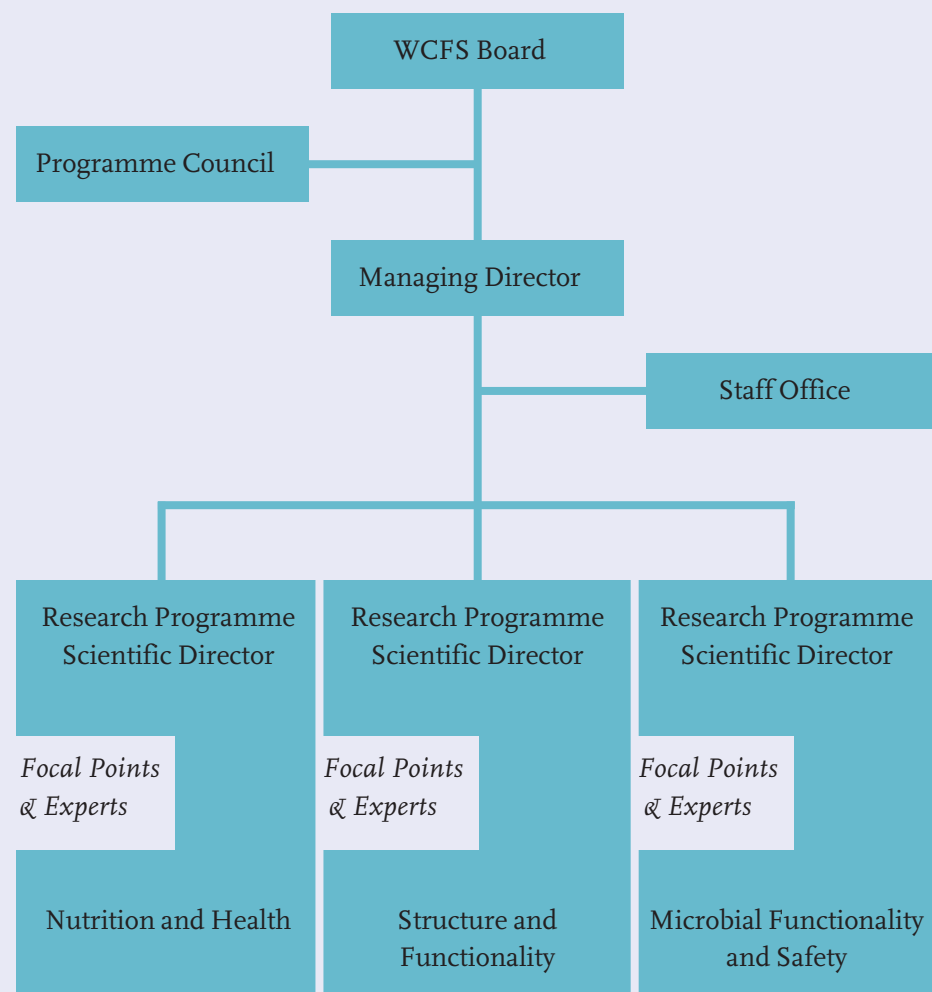
As part of the WCFS mandate to strengthen innovative developments in the Dutch food sector, WCFS has a responsibility for training and development of young researchers. There are 36 PhD fellows, currently working in WCFS research. In 2003, six PhD fellows graduated and most are now working in the food industry.

All PhD fellows participate in the postgraduate training programme of the VLAG Graduate School, which is accredited by the Royal Netherlands Academy of Arts and Sciences. Scientists working at WCFS contribute to the training on subjects as far ranging as protein engineering to nutrigenomics. As well as the scientific training attention is given to personal development of young scientists.

*'WCFS can only exist if people can identify with the organisation. This goes beyond having a building to a sense of belonging to an organisation with a stimulating work environment and congenial colleagues.'*

# WCFS Organisation

## WCFS ORGANISATION



# Management Report

## WCFS Director Prof. Jo Hautvast

## MANAGEMENT REPORT

The OECD peer review conducted in 2003 reported very favourably on the performance, rationale and efficiency of the Netherlands Leading Technological Institutes. At WCFS, this is borne out by the increasing interaction between the research and industry partners.



The transfer of the first two WCFS patents to industry partners took place during the year. One of these patents concerns the production of bioavailable folic acid and was transferred to Campina as legal owner on behalf of a consortium of WCFS partners including Campina, Friesland Coberco Dairy Foods, CSM and Unilever. The other patent on the preparation of a gelled aqueous composition by means of microbial acidification was transferred to Friesland Coberco Dairy Foods. During the year, WCFS filed four new patent applications, bringing the total number of patent applications filed to 15. During the year, WCFS published about 150 papers in peer-reviewed and other scientific journals.



The year ended on a high note with the announcement by the Netherlands Government of euro 10 million for research in the groundbreaking area of nutrigenomics. This project results from the proposal submitted by WCFS on behalf of the industry partners.

### Research Portfolio

During the year, the Programme Council examined the research portfolio in relation to the long-term strategy objectives and within that framework, a number of new project proposals were considered.



Two large projects in food structure and functionality were completed in 2003. One project concerns biopolymer dispersions and gels, and the other on sensory research on the underlying mechanisms of the attribute "creaminess". Research on Structure and Functionality has taken a new course with the incorporation of oral physiology and psychology. In addition to the two new projects on specific food structures and perception that started in 2003, the Programme Council gave final approval for the project entitled "Integration of sensory perception". This project is directed to texture-related attributes such as taste and smell.

In the research programme on Microbial Functionality and Safety, the Programme Council approved a new project on food preservation and safety as a continuation to the research on minimal processing completed in 2003. A new project proposal was also approved on microbe-mediated gut metabolism. This research is related to work being carried out in nutrition and health and in nutrigenomics, a new joint initiative of WCFS and the Centre for Medical Systems Biology.





The new research partner, Universiteit Maastricht, has been integrated into all three WCFS research programmes, particularly in the research in Nutrition and Health. Researchers at Universiteit Maastricht are working on insulin-related metabolic disorders and are pursuing promising leads in homocysteine metabolism.

**Strategic Review**

As a result of the strategic review conducted by the Programme Council in January, two working groups were set up to examine the WCFS research process, to define research competencies to be strengthened, and to improve knowledge transfer to the industry partners. In a pilot scheme, WCFS research partners were invited to formulate “exemplification” projects as a means of making research findings more accessible to the industry partners. The results will be evaluated in 2004.

**New Appointments**

The appointment of Drs Driek Vergouwen as WCFS Managing Director was announced in October 2003. He succeeds Prof. Jo Hautvast who retired at the end of the year. In December, Prof Martijn Katan stepped down as Science Director Nutrition and Health to take up an appointment as WCFS Distinguished Scientist.



**Activities in 2003**

**January**

- Researchers from the new partner, Universiteit Maastricht, are introduced to WCFS and scientists from the other research partners in a special day of discussions and social events.

- Strategic Review conducted by the Programme Council recommends improving the practical relevance of research results and knowledge transfer between WCFS, and the research and industry partners. The strategic review also recommends increasing the speed and flexibility of the WCFS research process.

**February**

- Complete genome sequence lactic acid bacterium *Lactobacillus plantarum* is presented in the Proceedings of the National Academy of Science of the USA.



- Seminar: “Fracture of Crispy Foods; why do you like it?”, is conducted by Prof. Julian Vincent, University of Bath, United Kingdom.

**March**

- Programme Council meeting decides to set up two working groups to review the issues presented in the strategic review and to formulate actions. One group reviews the WCFS research process and the other working group, the WCFS research competences and knowledge transfer.

- Staff satisfaction survey shows that scientists from all four research partners are well satisfied with WCFS as their employer, with high scores on aspects such as work quality and sense of belonging. However, there are areas requiring more attention, largely arising from the nature of the WCFS virtual organisation.

**April**

- At the Board meeting, Drs Gerard van der Lely, first chairman of the WCFS Board and Mr Andre Olijslager, founder member of the WCFS Board, are formally farewelled; and Dr Theo Ockhuizen is welcomed as Chairman of the Board.

- Workshop: “Diet and Gut Health” is organised by WCFS.

**May**

- Programme Council Chairman, Ir. Joop Roels presents the annual WCFS patent and publication prizes of scientific excellence and industrial relevance (see separate report).

- Programme Council allocates funds for short exemplification studies to be carried out by the research partners, with the aim of increasing the applicability of knowledge and techniques generated in WCFS research for the industry partners.

- Seminar: “Measurement of Carotid Arteriosclerosis: application in patient care, genetics and evaluation of new therapies”, is conducted by Prof. David Spence, Robarts Research Institute, London, United Kingdom.





**June**

- Programme Council meeting concludes that their task is to manage the research programme rather than individual projects. Their task is to indicate the competencies to be developed and strengthened and to consider project proposals and project in the light of these competences.
- Project leaders brainstorm on a vision for the future development of WCFS beyond 2007 and attend training session on team building.

**July**

- A delegation of representatives of the Institut National de la Recherche Agronomique and French companies visit WCFS to learn more about the WCFS public-private partnership and for discussions with WCFS research partners.
- Seminar: "Towards Controlled Structure Formation in Polymeric Systems", is conducted by Prof. Gerard Barkema, University of Utrecht.

**August**

- Seminar: "Assessment of Human Chemosensory Functions", conducted by Dr Thomas Hummel, Smell and Taste Clinic, University of Dresden Medical School, Germany.

**September**

- Programme Council provisionally approves new Outline Project Proposals on diet insulin resistance and chronic inflammation, dietary modulation of mucosal cell integrity, dietary modulation of resistance to gut infection and associated mucosal inflammation; integration of sensory perception; and microbe-mediated gut metabolism.
- The opening of the WCFS Genomics Facility Centre is marked by a lunch and tour of the new centre for invited guests.
- WCFS participates in the organisation of the first Food Valley conference – "Taste of Innovation" – to exchange views with companies, research institutes and policy makers on the role of innovation in the agro-food industry. The Food Valley conference is to become an annual event as a source of inspiration to strengthen the Netherlands' position in a science-based food industry.



- International seminar: "Folate Metabolism: new approaches and insights".
- Seminar: "The Metabolic Tune up: delayed aging and optimising health with supplements and diet", Prof Bruce Ames, University of California Berkeley, USA.

**October**

- WCFS Board announces the appointment of Drs Driek Vergouwen as new WCFS Managing Director to succeed Prof. Jo Hautvast who retires in December 2003.
- Research directors of European research institutes make a two-day visit to Wageningen to brainstorm about the WCFS research programme.
- WCFS intranet for researchers and industrial partners is completely renewed with extended structure, access for more users and more information.

**November**

- A Round Table discussion with international scientists in research and industry on "New research avenues in the management of obesity" results in a number of potential research leads for WCFS.
- Scientists in biotechnology in China visit WCFS to learn about the WCFS concept and new developments in solid state fermentation.
- Delegation from leading research institutes in Japan visits WCFS to learn about the WCFS public-private partnership.

**December**

- WCFS farewells Prof. Jo Hautvast on his retirement as WCFS Director.
- Programme Council decides to pursue research on weight management and obesity and agrees to the preparation of an Outline Project Proposal for consideration in 2004.



## MANAGEMENT REPORT



### NUTRIGENOMICS

Dutch Government approves a five-year research programme for the Netherlands Genomics Initiative, which comprises six innovative clusters. One of these innovative clusters is on Nutrigenomics, which will receive euro 10 million for research to be carried out jointly by WCFS and Centre for Medical Systems Biology (Leiden). The Nutrigenomics programme, initiated by Prof. Michael Müller, aims to provide tools for molecular phenotyping by measuring gene and protein expression and by determining metabolite patterns in response to diet (dietary intervention). New biomarkers will enable very early detection of instability in homeostatic control due to sustained metabolic and pro-inflammatory stress and will enable dietary interventions aimed at preventing metabolic syndrome to be developed.



### WCFS FOOD SUMMIT

The Food Summit is entitled "Mining Food Microbes: From Data To Knowledge" was held in Wageningen from 10 to 12 December 2003. The three-day meeting of invited specialists in computational biology and bioinformatics together with representatives of WCFS research and industry partners discussed how to organise and manage the vast amount of data generated in genomics studies on industrial microorganisms. Research in food sciences is being profoundly influenced by the exponential growth in information on microbial genome sequences and high-throughput analysis of expression products and metabolites. The vast amount of data being generated in genomics experiments on industrial microorganisms raises the issues of how to organise and integrate this data flow, what computational tools are needed to analyse these data, and how the data can be translated into knowledge. During the Food Summit, the 75 participants attended hands-on demonstrations of specific software and databases in bioinformatics.



### PROF. MARTIJN KATAN APPOINTED WCFS DISTINGUISHED SCIENTIST

In December, the Programme Council approved the appointment of Prof. Martijn Katan as WCFS Distinguished Scientist as from 1 January 2004. He will do in-depth research on a specific topic within the framework of the WCFS long-term research strategy. In taking up the position of WCFS Distinguished Scientist, Prof. Katan has stepped down as Scientific Director, Nutrition and Health. On 28 April 2003, Prof. Martijn Katan was appointed member of the Royal Dutch Academy of Arts and Sciences and is the first nutrition scientist to receive this honour.



# Financial Highlights

## FINANCIAL HIGHLIGHTS

Income (in millions of euros)	2003*	2002	2001	2000
<i>Government</i>				
Ministry of Economic Affairs	7.91	6.31	6.04	5.22
Contribution to internationalisation	0.08	0.00	0.00	0.00
<i>Research organisations</i>				
Wageningen University	1.10	1.05	1.01	0.96
DLO	1.10	1.05	1.01	0.96
TNO Nutrition and Food Research	1.10	1.05	1.01	0.96
Universiteit Maastricht	0.66	0.00	0.00	0.00
<i>Industry partners</i>				
NZO	3.00	2.67	2.22	2.45
Unilever N.V.	1.20	1.07	0.89	0.98
DSM	0.60	0.53	0.45	0.49
CSM nv	0.53	0.47	0.39	0.00
AVEBE	0.30	0.27	0.22	0.25
Cebeco Group	0.29	0.27	0.22	0.25
Cosun	0.30	0.27	0.22	0.25
<b>Total</b>	<b>18.17</b>	<b>15.01</b>	<b>13.68</b>	<b>12.77</b>
<b>Research expenditure (in millions of euros)</b>				
Research contracted to:				
Wageningen University	4.81	5.01	4.42	3.72
NIZO food research B.V.	3.63	3.85	2.86	2.50
TNO Nutrition and Food Research	1.91	1.96	1.77	1.50
DLO	1.62	1.50	1.27	1.18
Universiteit Maastricht	0.80	0.00	0.00	0.00
Other research costs	3.04	2.04	1.36	2.72
<b>Total</b>	<b>15.81</b>	<b>14.37</b>	<b>11.68</b>	<b>11.62</b>
<b>Expenditure per research programme (in millions of euros)</b>				
Nutrition and Health	5.39	4.34	3.87	3.13
Structure and Functionality	4.87	5.68	3.91	3.72
Microbial Functionality and Safety	4.53	4.02	3.72	4.08
Other programme expenditure (leads, patents, Food Summit)	1.02	0.33	0.18	0.69
<b>Total</b>	<b>15.81</b>	<b>14.37</b>	<b>11.68</b>	<b>11.62</b>
<b>Overhead and provisions (in millions of euros)</b>				
Overhead costs	1.29	1.20	0.86	1.15
Provisions for VAT, etc.	-0.91	-0.56	1.14	0.00
<b>Total</b>	<b>0.38</b>	<b>0.64</b>	<b>2.00</b>	<b>1.15</b>

\*Preliminary financial results for 2003 without an Accountant's Statement. Financial results with the Accountant's Statement will be presented to the WCFS Board on 14 April 2004.

# Patent and Publication Prizes

## MANAGEMENT REPORT



The WCFS Patent and Publication Prizes were presented in a special ceremony on 21 May 2003. In presenting the prizes, Jury Chairman and Chairman of WCFS Programme Council, Ir. Joop Roels stated: 'As WCFS we strive for excellent publications, and preferably also of industrial relevance. This was one of the criteria used by the jury in evaluating the publications in addition to their scientific quality, originality and clarity. Our search for industrial relevance is clearly recognisable in our patents applications. Patents are a means of protecting research results and one of the few legitimate ways of protecting the profitability of products and processes.'

The members of the Jury were Ir. Joop Roels, DSM Research; Prof. W. Norde, Laboratory of Physical Chemistry and Colloid Science, Wageningen University; Dr Onno Korver, former Chief of Nutrition Research, Unilever Research; and Prof. Jan Wouters, former Director Research, NIZO food research and Emeritus Professor Dairy Science.

### Prize Winning Patent Application

R. Van der Meer, J. Keijer S.M.B.J. Van der Meer-van Kraaij, E.H.M. Kramer. Gene expression in the gut.

### Prize Winning Publications

M. Klerk, P. Verhoef, R. Clarke, H.J. Blom, F.J. Kok, E.G. Schouten and MTHFR Studies Collaboration Group. MTHFR 677C→T Polymorphism and Risk of Coronary Heart Disease. *Journal of the American Medical Association* 288, 2023-2031 (2002).

A.C. Alting; H.H.J. De Jongh; R.W. Visschers; and J.W.F.A. Simons. Physical and chemical interactions in cold gelation of food proteins. *Journal of Agricultural and Food Chemistry* 50, 4681-4689 (2002).

J.W.F.A. Simons, H.A. Kusters, R.W. Visschers, and H.H.J. De Jongh. Role of calcium as trigger in thermal  $\beta$ -lactoglobulin aggregation. *Archives of Biochemistry and Biophysics* 406, 143-152 (2002).

M.A.I. Schutyser, F.J. Weber, W.J. Briels, R.M. Boom, and A. Rinzema. Three-dimensional simulation of grain mixing in three different rotating drum designs for solid-state fermentation. *Biotechnology and Bioengineering* 79, 284-294 (2002).

E.G. Zoetendal, A. von Wright, T. Vilpponen-Salmela, K. Ben-Amor, A.D.L. Akkermans, and W.M. De Vos. Mucosa-associated bacteria in the human gastrointestinal tract are uniformly distributed along the colon and differ from the community recovered from feces. *Applied and Environmental Microbiology* 68, 3401-3407 (2002).



# WCFS Projects

A complete list of WCFS publications and research activities in 2003 is published separately.

## PROJECTS

### Nutrition and Health

Scientific Director  
Prof. Martijn Katan

Research on Nutrition and Health integrates laboratory and clinical studies to identify food components that affect the risk of cardiovascular disease, cancer and infectious diseases. We need to understand the mode of action of such food components in relation to the risk of these common diseases, which offer good prospects for nutrition intervention. Research projects may start from either the laboratory or the clinical side but should involve both approaches as well as studies with animal models. A crucial aspect of the research is establishing biomarkers. In 2003, a considerable number of papers were published in peer-reviewed journals and one patent application was filed.

### Dietary Modulation of Colon Cancer Risk

Epidemiological studies indicate that diet can modulate the incidence of colon cancer, which is the second leading cause of cancer deaths in Western societies. WCFS researchers at NIZO food research and RIKILT are investigating how non-absorbed nutrients, such as calcium, chlorophyll and haem (in red meat) modulate colonic cytotoxicity and epithelial cell turnover, which affects endogenous mutations and thus the risk of colon cancer.

Project Leader: Dr Roelof van der Meer

### Dietary Modulation of Intestinal Infections

With the growing resistance of food-borne bacterial pathogens to antibiotics, the focus is changing from treatment to prevention of gastrointestinal infections. Studies are being carried out to identify nutrients that can prevent or inhibit intestinal bacterial infections, and to develop mechanistic concepts that can be used in designing food ingredients to improve host resistance to gastrointestinal infections. Animal models are developed and validated in studies in human volunteers.

Project Leader: Dr Roelof van der Meer

### Homocysteine: a Risk Factor for Cardiovascular Disease

WCFS researchers at Wageningen University and TNO Nutrition and Food Research in Zeist, are investigating food components that can lower homocysteine concentrations in plasma, and the relationship between homocysteine and cardiovascular disease. High homocysteine levels are associated with cardiovascular disease and dementia, but it is still unknown whether there is a causal link.

Project Leader: Dr Petra Verhoef

### N-3 Fatty Acids and Cardiac Arrhythmias

WCFS researchers are investigating whether and how dietary n-3 fatty acids can prevent cardiac arrhythmias and related risks of heart disease. The work involves studying the effects of n-3 fatty acids on the electrical activity of the heart at all stages of the pathway from diet to disease prevention. The overall objective is to develop reliable biomarkers and new models and methods for studying arrhythmia and

heart disease risk. These tools can then be used in investigating the effects of various dietary components on heart health.

Project Leader: Dr Peter Zock

### Diet, Insulin Resistance, and Chronic Inflammation

The prevalence of the metabolic syndrome is and will continue to increase, not least because of the growing numbers of overweight and elderly people. WCFS is studying the effect of diet on two major reversible metabolic risk factors: insulin resistance and chronic inflammation with the aim of identifying molecular targets responsive to dietary components. The research will involve studies at the molecular level and *in vivo* studies in humans.

Project Leader: Prof. Ronald Mensink

### Structure and Functionality

Scientific Director  
Prof. Rob Hamer

In 2003, two projects were completed - Biopolymer Dispersions and Gels and Physical and Chemical Aspects of Sensory Attributes. Two new projects started - Engineered Textures of Emulsions and Foams and Dynamics of Biopolymer Networks and Textures. The Outline Project Proposal for a third project - Integration of Sensory Perception - was approved by the Programme Council. These new projects open a new phase in the research which directly links sensory properties of foods and

# WCFS Projects

## PROJECTS

physical/chemical studies on foods and foods during mastication, for example, the crispy/crunchy behaviour of cellular solid foods. 2003 was a productive year with over 40 papers published in peer-reviewed journals. At the end of the year, 20 patent opportunities were identified, and new applications will be filed in 2004.

### Food Biopolymer Dispersions and Gels

The research project on the formation of food microstructures in relation to their physicochemical properties was completed at the end of 2003. Significant progress was made especially in understanding protein functions in relation to gel formation and properties of and in controlling protein-carbohydrate mixtures in relation to stability and phase separation.

*Project Leader: Dr Ronald Visschers*

### Physical and Chemical Aspects of Sensory Attributes

This project focused on the relationship between the textures of semi-solid foods (desserts, sauces, mayonnaise) and the perception of specific attributes such as creamy and fatty. Data from sensory studies and physical and physiological studies using the same model foods were integrated to develop comprehensive models. At the end of the project, two predictive models for creamy mouth feel and models for the prediction of creamy mouth feel based on instrumental measurements had been developed. Findings related to the mechanism of creaminess will be used in a patent application.

*Project Leader: Dr Hugo Weenen*

### Biopolymer Stability and Functionality

The key mechanisms controlling the formation and stabilisation of microstructures in foams, emulsions and gels are being investigated by assessing the intrinsic functionality of the most dominant ingredient in the process. Functional properties of proteins have been identified that control the appearance and behaviour of proteins at interfaces. During the year, the work was extended from air-water systems to oil-water systems as in emulsions. The behaviour of proteins at the initial stages of gel formation is also being investigated. Here the focus is on the thermo-dynamics of various reaction intermediates and products with the aim of improving the participation of proteins in heat-induced networks and gaining better control of their properties.

*Project Leader: Dr Harmen de Jongh*

### Crispy/Crunchy Behaviour of Cellular Solid Foods

In 2003, panel tests resulted in a detailed sensory description of crispiness/crunchiness and changes in these properties during food storage. Panel tests with recorded cracking events confirmed the importance of sound in the perception of crispiness. A novel acoustical/physical test was developed and considerable progress was made in linking sensory perception to sound perception to fracture mechanical events. In a parallel study, model products were used to study the effects of moisture on crispiness. This research has led to a patent application in 2004.

*Project Leader: Dr Ton van Vliet*

### Engineered Textures of Emulsions and Foams

Building on the earlier work on emulsions and foams, and using insights from the sensory research, the intra oral behaviour of emulsions is being studied in a new project.

In 2003, exploratory studies were conducted on the role of saliva and shear in relation to droplet stability and sensory attributes.

*Project Leader: Dr George van Aken*

### Dynamics of Biopolymer Networks and Textures

In parallel with the studies on emulsions and foams, a new project is underway on gels and builds on the recently completed project on biopolymer dispersions and gels.

In line with the programme strategy, research focuses on changes in gels during oral processes in relation to sensory attributes such as sticky or slippery.

*Project Leader: Dr Ronald Visschers*

### Advanced Knowledge Management

Tools and systems are being developed to manage and analyse the vast amounts of data generated especially in the studies with model products, which combine sensory panel data with data from physical and physiological studies. The knowledge management system is now in use. With this project we are also collaborating with the VL-E (Virtual Laboratory E-sciences, Bsik), a euro 20 million consortium dedicated to advancing data management and *in silico* experimentation.

*Project Leader: Dr Jan Top*

# WCFS Projects

## PROJECTS

### Microbial Functionality and Safety

#### Scientific Director

**Prof. Willem de Vos**

WCFS is studying the metabolic and enzymatic activities of micro-organisms with the ultimate aim of improving organoleptic and health-promoting properties of foods, maintaining food safety by destroying food pathogens and increasing shelf life by inhibiting spoilage bacteria.

During the year, two major projects were completed, one on solid-state food fermentations and the other on microbial stress response in minimal processing. In 2003, preparations were well underway for two new projects starting in 2004. The Full Project Plan was approved for the project entitled Food Preservation and Safety and the Programme Council approved the Outline Project Proposal on Microbe-Mediated Gut Metabolism. 2003 was productive, with a considerable number of papers published, including three PhD theses. Three patent applications were filed.

#### Solid-State Food Fermentations

WCFS researchers at the Wageningen University and TNO Nutrition and Food Research studied the process of solid-state fermentation from genome and transcriptome level to modelling of large-scale fermenters. Significant progress was made with *Aspergillus oryzae* as the model organism, wheat and soybean as model substrates, and amylases and proteases as model products. This resulted in the

development of non-empirical, model-based methods for designing and operating solid-state fermentation processes. In addition, molecular genetic aspects of protein production and fungal growth in solid-state fermentation were studied in relation to temporal and spatial gradients under environmental conditions, such as nutrients, oxygen, water activity, pH and temperature.

*Project Leader: Dr Peter J. Punt*

#### Microbial Stress Response in Minimal Processing

WCFS researchers at Wageningen University, Agrotechnology & Food Innovations and TNO Nutrition and Food Research studied the short-term physiological adaptation and the long-term genetic adaptation stress response of food-borne microorganisms. This is particularly relevant since it is not known how mild physical and biological preservation methods affect food-borne microorganisms. The mode of action and the underlying mechanisms in food-borne microorganisms subjected to stress were analysed. Cellular targets of selected stress factors have been identified in the food-borne human pathogen *Listeria monocytogenes* and spore-forming *Bacillus cereus*. In addition, the cellular mechanisms that can provoke tolerance to stresses in minimal processing were investigated.

*Project Leader: Dr Tjakko Abee*

#### Gastrointestinal Tract Host-Microbe Interactions and Functional Microbiomics

Initiated mid-2002, this research

project aims to identify the molecular response of host and microbe to one another. This project aims to provide insight into host-microbe communication mechanisms using global and genomics-based approaches and will aid the development of fermented and other functional foods that affect the host physiology. The model microbe to be used is *Lactobacillus plantarum* WCFS1, an isolate of human origin that survives passage in the gastrointestinal tract in an active form. The complete genome sequence of this microbe has been determined and DNA microarrays are available.

*Project Leader:*

*Dr Michiel Kleerebezem*

#### Engineering of Microbial Functionality

WCFS researchers are studying new genomics-based approaches to evaluate the effect of engineered metabolic pathways on overall metabolism. The aim is to rationally optimise the biosynthesis of key metabolites, such as vitamins and other cofactors, in simple food-grade (lactic acid) bacteria. This will be achieved by taking the functional genomics approach in which various genomics data (annotated genome, high-throughput transcriptome profiling and targeted metabolome profiling) will be used to construct metabolic models. Subsequently, the metabolic models will guide the development of new metabolic engineering strategies leading to microbial strains with improved characteristics relevant for industrial fermentations.

*Project Leader: Dr Eddy Smid*

# WCFS Organisation

2003 ANNUAL REPORT

## WCFS ORGANISATION

### WCFS Board 2003

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NIZO food research B.V.

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TNO

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TNO Nutrition and Food Research  
(from 01-12-2003)

Prof. Dr A.G.J. Voragen  
DLO

Dr K.E.D. Wapenaar  
TNO Nutrition and Food Research  
(until 01-12-2003)

Dr Ir G.H.W. Willems  
NZO (Friesland Coberco Dairy Foods)

Dr Ir R.J. Zoetemeijer  
CSM nv

Prof. Dr J.G.A.J. Hautvast (secretary)  
WCFS

\* Member of the Executive Board

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