

Events at SIK

- *Research and business in 2005*





... is an industrial research institute owned by SP Swedish National Testing and Research Institute. The purpose of the Institute is to strengthen the competitiveness of its members.

... has an annual turnover of approximately SEK 100 million. One-third of its income comes from the Swedish state via the National Swedish Board for Industrial and Technical Development (NUTEK), the Nordic Fund for Technology and Industrial Development, the EU, IRECO AB and research councils. The other two-thirds come from assignments and membership fees from industry via the SIK Members' Association.

... conducts strategic and applied research for industry in accordance with a goal-oriented research programme and in the form of joint industrial projects. SIK also provides advice and service in R&D matters.

... offers comprehensive consultancy services in product and process development and problem-solving of both an acute and strategic nature.

... is the specialised resource for the co-ordination of R&D for the Swedish Food Federation (Li).

... is a member of United Competence, an industrial research and development consortium.

... maintains a strategic alliance with the British research institute Campden & Chorleywood FRA Group.

... is a member of an international network made up of other centres of knowledge and communicates know-how, ideas and information via regular customer contacts, reports and seminars.

... provides tailored training courses for individual companies and participates in graduate and undergraduate course programmes at universities and colleges in Gothenburg, Lund and Uppsala.

... has around 100 employees, most of whom are university graduates. The head office is in Gothenburg and there are regional offices in Lund, Uppsala, Umeå and Linköping.

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A company in the SP Group

SIK-Document no 175
ISSN 0280-9737

First year in a new institute group

At the turn of the year 2004/2005 SP, the Swedish National Testing and Research Institute, acquired all the shares in SIK to form the leading institute group in Sweden. During the year we have worked actively to utilise the synergies presented by the merger. In the same way YKI, the Institute for Surface Chemistry, another Sweden-based institute with an excellent international reputation in its field, also became part of the SP/SIK Group at the turn of the year 2005/2006. This even stronger institute group has a turnover of approximately SEK 730 million and over 810 qualified and experienced employees.

During the year, SIK's subsidiary SIK Valiguard also further reinforced its leading position in Sweden with regard to hygiene audits and certification. Through closer collaboration with the equivalent operations in quality and the environment built up at SP during the year we are well equipped to meet customer demands for complete certification services.

SIK's partly owned company Food Radar Systems is working with radar-based technology for the detection of foreign objects in sealed packagings. New capital has been secured through two directed new share issues, the most recent at a valuation level 100 times higher than when the company was formed two years ago.

During the year, SIK disposed of its shareholding in Saligus AB and at the same time it acquired all patent rights as well as the pilot facility for cold pasteurisation using pulsed electric fields, which Saligus had at its disposal.

Market and external conditions

The situation in the food industry nationally is becoming more and more competitive. The import of food from low-cost countries is increasing and at the same time new players in the retailing industry are becoming more established and are strengthening their brands. For the industry this means continued pressure to rationalise and make other structural changes. At the same time, the country's food exports are on the increase and SIK's services are in demand to improve efficiency and at the same time assist in the environmental adaptation of existing production and in the renewal and quality assurance of the product range.

SIK has increased the number of assignments from both foreign-based international food groups and major Sweden-based companies outside the food sector. SIK's work with the latter category has considerable development potential, particularly in the light of the new contact interface with other industry segments brought about by the merger in the SP Group.

The number of member companies that have linked up to SIK since the beginning of the 1990s has grown steadily. Significant investments were made during the year by member companies with the aim of further reinforcing SIK's expertise in health-related food. Likewise, there has been financial involvement in the development of know-how at SIK through international collaboration.

Research and international

During the year, SIK had major research success, including several new projects in the EU's Sixth Framework Programme. This makes the EU the largest individual source of funding for SIK's research. Unfortunately, this fact also reflects the difficulty SIK is encountering in Sweden regarding the potential for public funding of vital food research.

SIK has worked actively during the year to increase its collaboration with universities and colleges in Sweden. We have many examples of shared posts and projects and project collaboration. At the same time, we have developed our international contact interface even further. In addition to our long-term strategic alliance with our sister institute CCFRA in the UK, SIK is well established as a key player in international institute networks such as EFI, Food Force, Nordic Group, EARTO, Effost etc. as well as the EU's technology platform "Food for Life".

In spring 2005, the Swedish state presented a new research policy proposal. In this proposal the state emphasises - as did the Confederation of Swedish Enterprise previously - the importance of the institutes to Sweden's innovation system. The aim is to reinforce the institute system in the country and stimulate its interaction with universities and industry, particularly small and medium-sized companies. The significance of a strong EU commitment at the institutes is highlighted, as is their role with regard to greater movement of personnel between the academic world and industry and in the start-up of new growth companies. A certain increase in resources is also promised although not in the short term.

Looking to the future

During the coming year we will devote a great deal of energy to further developing the operational synergies at both SP and YKI. We will broaden our range of services to SIK's present customers at the same time that expertise at SIK will be demonstrated even more clearly to SP and YKI's customers. The improvement in cost efficiency which commenced within administration in the new group during 2005 will continue.

There is some uncertainty, however, with regard to state funding to secure the necessary development of know-how and expertise for the whole institute sector. In SIK's case the present level needs to be quadrupled if it is to match the level at associate institutes in other countries. The lack of Swedish co-funding in the EU's research programmes is a further problem.

SIK's close, successful collaboration with industry, particularly on the international level, is continuing. Several new customer offers are being developed and we estimate that during 2006 we can reinforce our commissioned assignments and training operations and increase the number of members in our industrial associations. SIK will also monitor the potential to create new growth companies based on the patents and business concepts that have emerged from its operations.

We will certainly do our utmost to meet the high expectations of SIK.



KAJ MÅRTENSSON
VD

A handwritten signature in black ink, which appears to read "Kaj Martensson". The signature is written in a cursive, flowing style.

HELENA – a gathering of European forces to counteract teenage obesity

Almost 400,000 teenagers in Europe are overweight or obese. This was the reason for the EU project HELENA, aimed at mapping the link between obesity, lifestyle, attitudes, genetics and environmental factors. SIK is involved in one of the four working groups.

"We will, among other things, work to develop healthy snack products that suit teenagers," says Gunnar Hall, project leader at SIK.

It is in childhood and adolescence that the foundation is laid for future food habits and a lifestyle that affects health. Diseases such as diabetes and heart problems are creeping further and further down the age range whilst the number of overweight and obese children and young people is increasing at the same rate. Such broad-based mapping of a range of scientific disciplines across several countries in order to identify the link between obesity, lifestyle, attitudes, genetics and environmental factors has never been conducted before.

SIK leading one of the groups

The project started at the beginning of the summer in Zaragoza in Spain, the base of project co-ordinator Professor Luis Moreno. Each of the participants is already working at the very highest level within his/her area to benefit from the knowledge that already exists. The guidelines for this multi-disciplinary project were drawn up and four sub-groups were set up with different specialisations.

SIK is leading BEFO – Behaviour and Food Choice – which is largely aimed at attitudes and lifestyle-affecting food habits. Also involved are corresponding institutes in the UK, Hungary, Spain and Belgium as well as four major companies in the food industry.

Mapping lifestyles

The Swedish-led group will begin with widespread mapping of young people's lifestyle and attitudes. With the aid of focus groups made up of young people from the different countries they will make use of discussions to pick up on their attitudes in matters such as lifestyle and food habits. This qualitative data will then form the basis



Good habits and the right attitude. It is in childhood and adolescence that the foundation is laid for a future lifestyle and health. The EU project HELENA has adopted a comprehensive approach in order to reverse the rise in the number of overweight young people. Photo: Chrissi Nerantzi

HELENA - Healthy Lifestyle in Europe by Nutrition in Adolescence

This three-year study will result in comparative data about young people throughout the EU. The aim is to understand and influence the lifestyle and food habits of young people.

The three main orientations are:

- Health status, knowledge, attitudes, preferences and lifestyle habits among 13-16 year olds within the EU will be mapped with the aid of multi-disciplinary surveys and studies.
- A programme for "Lifestyle Education", aimed at improving young people's food habits and lifestyle will be developed and tested.
- New products that appeal to young people will be produced in co-operation with the industrial companies involved, based on the information about preferences and so on that has emerged from the project.

for a major survey that will involve thousands of young people throughout the EU.

"Lifestyle among young people has changed a great deal in recent years. A far more sedentary existence in front of the computer, with fewer sports activities and new food habits are just some of the reasons," says Gunnar Hall.

Testing new food concepts

Part of the qualitative survey will offer the focus groups the opportunity to test different concepts and answer questions about the development of new products, such as snacks and different types of bars.

Two Swedish companies are involved in the product development phase, Cerealia, which has the brand names Axa and Start, and Cederroths, whose product range includes vitamins and nutritional supplements.

Reinforced networking

The foremost experts in Europe are involved in the project. Apart from SIK and the two food companies, Sweden is also represented by the Karolinska Institute, which will map young people's health status and will also be involved in the major mapping of the food habits and lifestyle of young Swedish people.

"It is also good for our networking on other fronts that co-operation with Karolinska is reinforced," says Gunnar Hall.

"By establishing this type of co-operation our potential to offer industry new services is increased."

The "red gold" of the food industry offers more effective processes and better economy

Interest in infrared heating is on the increase. This rapid and flexible heat treatment process can produce major savings in the food industry. A halving of the baking times, reduced weight losses and drastically reduced drying times are just some of the many advantages of this method. IR heating is also clearly beneficial to food quality.

SIK has long experience in the development of IR technology for the food industry. In the 1970s and 1980s SIK ran basic pioneering studies.

"We have produced a process technology base for frying and baking using IR," says Lilia Ahrné, project manager and researcher at SIK.

The application opportunities are many. These include:

- Surface pasteurisation of bread
- Surface pasteurisation of packaging material
- Baking of pizza, biscuits and bread
- Drying of vegetables, fish, pasta and rice
- Frying of meat and fish products
- Roasting of coffee, cocoa and cereals
- Blanching of vegetables
- Heat treatment of flour

Realising the benefits

"IR technology has been incredibly underestimated in the food industry but now it is making headway," says Lilia Ahrné. "Companies are beginning to realise the benefits of this technology. The frying time is shortened through double-sided heating and the use of fat is reduced, resulting in a lower fat content in the end product. In addition, there are low energy losses and it is possible to switch rapidly between different products."

"In baking, for example, the process times can be reduced dramatically - between 25 and 50%! The drying time for bread crumbs can be shortened from half an hour to four minutes!"

Surface pasteurisation of bread and pastries using IR can replace preservatives and increase the shelf life. IR heating, for example, kills off mould spores on the surface of the pastries effectively before it is packed.

The major potential for reducing the fat content in different foods is of course of considerable interest at the present time.



Advantages of IR technology

During infrared heating the energy is transferred in the form of electromagnetic waves from the IR heating source to the product surface. The temperature of the IR heater is 400-3,000°C.

The infrared area is between the visible light and the micro-waves in the electromagnetic spectra.

Compared with conventional heat transfer technologies, IR technology has the following main advantages:

- A higher heat transfer capacity, which results in a short processing time.
- The energy transfer takes place directly from the IR heater to the product.
- No unnecessary heating up of the surrounding air.
- Rapid control with good potential for process control.

The output and temperature of the IR heater and the IR optical features of the product are important factors in optimal heating in conjunction with an IR process.

In-depth knowledge of UHT processes vital for Tetra Pak

Being able to distribute and store milk without a refrigeration chain is a strategic question for many dairy companies around the world. SIK has been involved in a research project dealing with different methods for heat treatment at Tetra Pak Processing Systems in Lund.

"In order to distribute and store milk without a cold chain, effective killing of all microorganisms that could increase in number at room temperature is required."

These are the words of Bozena Malmgren, Senior Dairy Technologist at Tetra Pak Processing Systems in Lund. She is responsible for the company's technology know-how within aseptic dairy processes and she has made comparative studies of different heating processes involving ultra high temperatures (UHT).

"We are developing know-how about different heating processes in order to be able to develop our process modules further and support our customers in their choice of optimal heat treatment."

140 degrees

This time the study focused on so-called direct systems, where the milk is mixed with the direct heating medium - steam. First, however, the milk is preheated in a heat exchanger to 80°C to save energy. It is then heated by steam to the target temperature of 140°C in the space of just one-tenth of a second!

"In the study we have evaluated how the different parts of the heat treatment process affect the microstructure of the milk. We have also monitored the effect of storage at several different temperatures, from the coldest, + 5°C, to the warmest, +40°C, for up to six months," explains Bozena Malmgren.



Bozena Malmgren, Tetra Pak Processing System.

The microstructure in the samples changes with time and the differences are obvious. During storage, sediment could occur and at a later stage even form a gel.

"Temperature plays a very important role. At 5°C the changes are relatively slow but enhance with temperature increase."

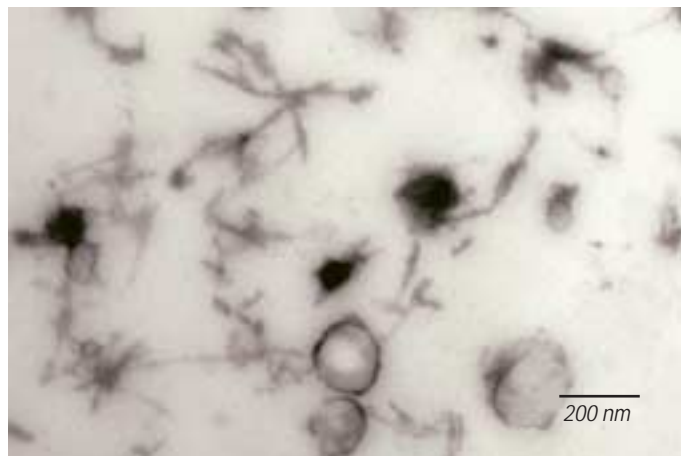
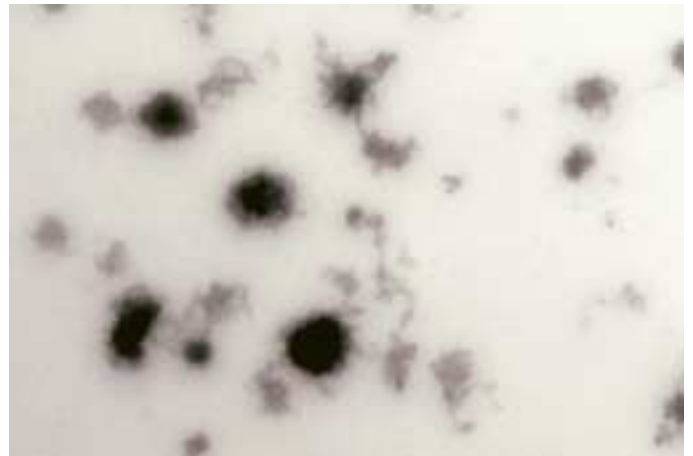
Unique expertise

SIK has been involved in trials by analysing how the structure and the sensory features are affected by process and storage conditions.

"At SIK there is in many respects unique expertise and experience with regard to interpreting the course of events in water-based systems in food products," says Maud Langton, project leader and researcher at SIK. "We also have access to the advanced technology required, including a transmission electron microscope (TEM), which gives



Maud Langton, SIK.



Both the size of the casein micelles and the protein tendrils between the micelles are affected by the process and the storage conditions. The result shows, for example, that the formation of straight, rigid protein tendrils between micelles leads to the formation of gel. To the right: newly produced milk; to the left: milk stored at 22°C.

the extremely high resolution required to study this type of subtle change."

DNA analysis - a tool for more in-depth knowledge and improved product safety

The type of bacteria we find in raw materials and during food processing is often the same as in the finished products. Yet there is still a great diversity of bacteria in nature. A high level of product safety requires more in-depth knowledge regarding the occurrence of microorganisms as well as their numbers and characteristics.

The environment that surrounds the bacteria affects their genetic activity. The environment can also be crucial to how dangerous a certain microorganism can be. Knowledge of the impact of environmental factors is required in order to optimise manufacturing, additives and packaging and to reduce contamination.

"A particularly interesting phenomenon is bacteria that attaches to surfaces," explains Maria Lövenklev, project manager. "They form biofilms on food products, raw materials and production surfaces and have totally different features than bacteria that are free-swimming in a liquid medium."

"At SIK, long-term work commenced in autumn 2005 to develop DNA-based methodology even further," explains Maria Lövenklev. "We are seeking to understand the occurrence of microorganisms, their specific features and their activity in different biological systems. A project was started to develop DNA-based methodology and to study the composition of microbial communities on surfaces."

"In the project we have chosen to study *Listeria*, which is a common problem in the food industry," says Maria. "It has the capacity of establish itself as a 'house flora' on production surfaces and form biofilms. The bacteria can in this way spread to food and is particularly hazardous to children, the elderly and pregnant women. Foods that are associated in particular with the *Listeria* bacteria include refrigerated, ready-to-eat food such as smoked and pickled fish, sliced sandwich fillings and dessert cheeses."

Genetic profile

The method is based on first demonstrating the occurrence of *Listeria* in biofilms by directing a molecular analysis - PCR analysis - to a gene that is specific to all species of *Listeria*. An analysis is then made where the copied gene fragment is separated and a genetic profile arises specifically for this biofilm. The genetic profile then tells us about the different species on the biofilm.

"The method that we have developed can separate four species of *Listeria*, including *Listeria monocytogenes*, which causes food poisoning.

In 2006, work will be done on real-time PCR, both to demonstrate the existence of bacteria on surfaces and in biofilm and to quantify them. An important factor here is to distinguish between living and dead bacteria in a sample. A study can also be made of why bacteria attach to surfaces and become established.

"Which genes are activated when bacteria attach and become established on a surface? How do different environmental factors, such as temperature, affect the activity of these genes? These are just some of the major questions that we are seeking to answer," concludes Maria Lövenklev.

Methods for analysing the DNA of microorganisms

Within genetic engineering there are many applications that can contribute to the development of more refined analysis methods by studying specifically the DNA of microorganisms. The DNA analysis that has made the biggest breakthrough in microorganism diagnostics is PCR – Polymerase Chain Reaction – technology. PCR is based on knowledge of the genetic mass of the microorganism that one is seeking to demonstrate, i.e. one must know the exact nucleotide sequence in a certain unique part of the DNA sequence - a gene.

The principle of PCR is to copy this unique gene piece through a temperature-dependent reaction based on an enzymatic synthesis of nuclein acid. When a sufficient number of copies have been formed, the DNA can be made visible using a special colouring technology. In doing so, the bacteria are detected.

After the second generation of PCR technology, the so-called real-time PCR, was introduced during the latter half of the 1990s both the amount of DNA and the activity of a gene could be quantified reliably. This technology is based on studying the actual DNA synthesis in real time, i.e. during the time the actual copying and synthesis of the DNA sequence is taking place.



"At SIK, long-term work commenced in autumn 2005 to develop DNA-based methodology even further," explains Maria Lövenklev, project manager.
Photo Bo Håkansson/Bilduppdraget

Cleaning using membrane technology saves on energy and reduces negative environmental impact

In the food industry it is vital to reduce energy and water consumption - without jeopardising microbiological and chemical safety.

Membrane processes are an energy-efficient technique for concentrating and separating substances in a liquid phase. It is an attractive form of technology for the food industry as no foreign chemicals need to be added, neither as process aids nor to eliminate bacteria in the filtrated process stream.

"Together with Professor Gun Trägårdh at the Centre for Membrane Technology at Lund University and five companies, we have attempted in this project to highlight the potential of membrane technology to save on energy in the food industry as well as ways in which this technology can contribute to reduced negative environmental impact. The focus is on processing of warm solutions and on the recirculation of process flows," explains project leader Karin Östergren, SIK.

Three applications evaluated

Three industrial applications of membrane technology have been evaluated with regard to energy use and environmental impact:

- nanofiltration of rinse milk, in co-operation with Skånemejerier
- concentration of process water into a protein concentrate, in co-operation with Ellco Food
- ultra-filtration of warm beet raw juice, in co-operation with Danisco

When nanofiltering rinse milk, the water and milk mixture that arises at the start and end of a milk production run is concentrated. By using the retentate, i.e. the concentrated product flow, in other dairy products, raw materials can be saved which results in major environmental and energy gains due to the fact that the milk "bears" a large environmental load from previous stages in the milk chain.

In the case where concentration of process water was studied the aim was to upgrade a residual production flow to a protein con-

centrate that could be used as an ingredient in other foods. By using the process flow in question a new product is added to the range.

A new process stage produces in this case a small net increase in the total energy consumption (<10%) and a small contribution to the greenhouse effect (<5%) as well as other effect categories. The proposed investment, however, leads to reduced energy consumption/gain compared with the original process. The same applies to over-fertilisation and the production of greenhouse gases.

In sugar production, the raw juice is precipitated by carbonation. In this case the potential was examined to replace this process with a membrane filtration process.

"Should this prove successful in a production facility for 230,000 tonnes of sugar per year a total of 16,000 MWh/year would be saved," says Karin Östergren. "The final evaluation of the pilot tests, however, showed that it was not possible to achieve the desired capacity. To achieve better capacity and financial profitability, major efforts are required with regard to pre-treatment of the raw juice before the membrane filtration and/or a more effective membrane.

PhD project on nanofiltration

To understand how temperature, mass transport and ion strength affect a polymer membrane and its separation capacity, a PhD project dealing with nanofiltration at high temperatures has taken place in parallel with the industrial projects. The project is being run at the Department of Food Technology, Engineering and Nutrition at Lund University, with Mattias Nilsson as the PhD student, Gun Trägårdh as the main supervisor and Karin Östergren as assistant supervisor.

"Once you understand the physics behind this the potential is opened up to optimise and design a membrane and membrane processes in a totally new way," says Karin Östergren. The research project is being followed with great interest by AlfaLaval, which is a supplier of membrane filtration systems

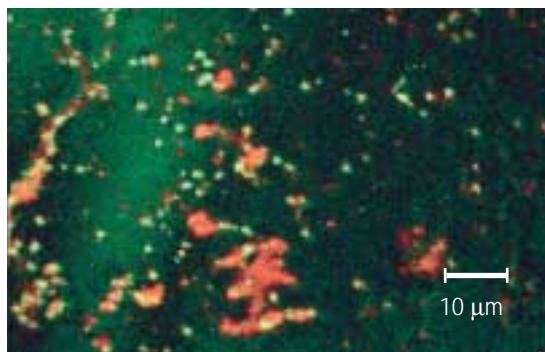
Assessment of environmental implications

In order to evaluate the environmental effects, potential risks and optimal process conditions, supplementary methods are required. SIK's environmental group has supported the project with an envi-



To the left: Original process water concentrated by evaporation at Ellco Food. To the right: Process water concentrated using membrane technology. Photos: Kerstin Christensson, Ellco Food

The microscopy image below shows protein (green) and fat (red) residues on a cleaned membrane used in one of the pilot tests.



ronmental analysis in the three industrial projects and has in parallel developed a method to assess the environmental consequences of different process alternatives in relation to the financial results.

The microbiological safety must always be guaranteed in a food process. In another sub-project, SIK's hygiene group has created a model for microbiological risk analysis for membrane filtration, which was then used in the project.

Important to optimise the cleaning of the membrane

The cleaning stage is an important part of a membrane process. Frequent cleaning cycles reduce the available processing time and the cleaning stage in itself uses water, energy and cleaning chemicals. It is therefore important to choose a membrane that produces as little fouling as possible and ensures that the membrane cleaning process is optimised in line with current process conditions. Using microscopy (CLSM) it is possible to determine the degree of fouling and the nature of the fouling of a membrane surface. In a sub-project run together with, among others, Johnson Diversey, this technique has been used to study the protein and fat residue following the different stages in a cleaning cycle.

In summary, the project has demonstrated the following:

- Membrane processes could be a beneficial process alternative compared with other traditional separation processes, such as precipitation and evaporation.
- By bringing back "lost raw material" to the process major environmental gains can be made. In conjunction with continuous production the membrane technology is a gentle process alternative for this purpose.
- A membrane's fouling tendency under certain conditions could in many cases be crucial to whether the technology is applicable or not.
- The cleaning requires water and energy, which can seldom be returned to the process and consequently the choice of membrane and process conditions are of key importance.
- Increased knowledge of the function of the membrane would in the future help reduce the problems of fouling and cleaning and be an important source when designing membrane processes.

NbiNet - Nordic industrial network for Biomanufacturing

The chemical and pharmaceutical industries of the future will produce more and more products using biotechnical production processes. The raw materials for the processes are often sugar and subsidiary flows from agriculture, resulting in fine chemicals and pharmaceuticals. Plants are also used as a source of processed products. Using modern biotechnology, antibodies and pharmaceuticals can be produced in green plants and then purified using biotechnical process technology.



Just over three years ago, SIK began building up an industrial network on biotechnical production issues (NbiNet). During the first phase the network received vital financial support from the Nordic Innovation Centre, which made possible some ten first-rate workshops and seminars on business development, marketing issues and technical matters related to the future.

The network is now independent, with 35 member companies. In 2006, the participants will go through the FDA's new rule system for process analytical technologies and discuss how it will affect existing production methods.

Biotechnical manufacturing is important to the development of new production methods in Europe. A European consortium has recently been given the go-ahead by the EU Commission to form a so-called ERA network for industrial biotechnology (ERA-IB). Sweden (VINNOVA) has an observer post in ERA-IB and Gunnar Hörnsten, SIK, has been invited to sit on its External Advisory Board.

"This invitation is a result of our work within NbiNet," says Gunnar Hörnsten, who adds:

"The biotechnical production industry has a strong foothold in Scandinavia. Sweden's centre for biotechnical production is in Strängnäs, where one of the first two facilities in the world for biotechnical manufacturing of protein pharmaceuticals (at the time Kabi AB) was built."



Production of industrial enzymes at the Novozymes A/S facility in Kalundborg in Denmark. Industrial enzymes are used, among other things, to manufacture dairy, brewing, meat and bakery products

Small-scale food producers receive help with product development

If we are to retain a living countryside it is important to create and develop companies that can assume responsibility for growth and employment.

SIK has elaborated a working model for product and process development at small companies based on a combination of a theoretical and practical implementation of knowledge.

"Many small companies have an inbuilt capacity for development. Their ideas can often be developed and the step from hatching an idea to commencing work on it practically is much shorter at a small company than at a large company. They can often work with less bureaucracy and have shorter lines of communication," says Yngve Andersson, SIK.

"When working with development, small companies often have limited time, expertise, financial resources and/or discussion partners."

However, small food-producing companies are now being faced to a greater extent with the demand to increase their production and to develop new products to achieve long-term profitability. The companies need help in their development for, among other things, the following reasons:

- Many are skilled, often based on practical experience. This needs to be complemented with theoretical knowledge.
- Many small companies lack the potential to develop their products in-house. SIK's project can give them the opportunity to test their ideas in a professional pilot plant.

The working model, which has been divided into three stages, has been applied in Östergötland, Västra Götaland, Norrland and Åland.

Step 1. Knowledge build-up: Theoretical and practical exercises with companies divided into groups depending on the production orientation (e.g. whole and processed meat, vegetables, dairy products etc.). The aim of this first stage is to create a platform of increased knowledge within the area of interest for the participants, which can be used for further product development.

Step 2. Product development: In this stage we explain the procedures involved in the product development process. This is exemplified by practical exercises where the participants have the opportunity to work with their own products. This involves upscaling from the experimental level to the production level as well as choice of equipment.

Step 3. The first two stages are followed by an individual follow-up at each company with advice on home territory. The aim is, together with the company, to establish the conditions for starting their product development work and production



PHoto: Rickard Manéus

From juice, jelly and marmalade to a successful ice cream product

Lena Gunnarsson wanted to develop her berry company further. She went on a product development course at SIK and received help to start ice cream production. Today she can hardly keep pace with demand.

Lena Gunnarsson at Stebbarps Gård outside Tranås has run a berry-growing farm for nine years. She has also manufactured juice, jelly and jam, which she has sold in her own farm shop and at markets.

Lena got tired of travelling around to markets during the summer and wanted the company to develop. She began thinking about ways of attracting more customers to the farm, which is beautifully located on Lake Sommen, but this would require a cafeteria. Then a new question arose. What would she serve? She needed a new product. Perhaps an ice cream using her own berries?

Lena enrolled on the SIK product development course with the aim of creating a new ice cream product. During the course she received help to solve the financing and to find the right ice-cream machine. She also acquired knowledge in nutrition, she tested recipes and she had the opportunity to test her way forward in a pilot plant.

"It is always good that someone else evaluates my work and gives me new ideas. SIK also has a network and considerable access to information that we small companies do not have," says Lena Gunnarsson.

Last summer she started manufacturing and it was certainly a success - despite the fact that the summer was rainy and the weather did not exactly encourage eating ice cream. Now there are so many people who want to buy her ice cream, both shops and cafeterias, that she does not have the time to supply them all. And she has had her appetite whetted to continue development.

"It is not simply a case of sitting back and thinking that everything is done. Now it is a matter of constantly producing new tastes and arrangements," she says.

Consistency optimisation and sensorily designed food can improve health among the elderly

Becoming older often means that one develops new physiological requirements at the same time that one still wishes to live an active life and follow trends in society with regard to lifestyle, consumer patterns and so on. Older people are often affected by reduced physiological functions, such as deterioration in their sense of smell and taste as well as poorer chewing and swallowing capability. It is estimated that 40% of persons aged 70 or older are affected by dysphagia, i.e. the inability to eat and drink normally.

"This represents a considerable challenge and is a great opportunity for the food industry," states Karin Wendin who works with sensory science at SIK.

"By developing good, new, innovative, healthy foods for this group their health and well-being can be improved. What is being sought is a positive food experience that involves attractive appearance, good taste and smell and attractive consistency and texture. The food should also offer a comfortable feeling of satisfaction and well-being as well as the correct nutrition. When developing such foods - apart from the basic raw materials - the choice of other ingredients is vital if the product is to have a chewing and swallowing consistency and if it is to satisfy sensory requirements and nutritional requirements."

VINNOVA (the Swedish Government Agency for Innovation Systems) has financed a three-year project, co-ordinated by Karin Wendin, since the middle of 2004. The project is a collaborative venture between Findus, Lyckeby Culinar and Källbergs Industrier, as well as researchers from Sahlgrenska University Hospital, Göteborg University, Lund University and SIK. The overall question behind the project is: In what way and with what ingredients can the food industry develop innovative, consistency-adapted, healthy, sensory-designed foods for older persons which offer increased food pleasure and promote health and well-being?

"The overall aim of the project is to create a knowledge platform that can be used for the development of innovative, attractive foods that offer food satisfaction and promote well-being and health among older persons with chewing and swallowing difficulties," explains Karin Wendin.

Based on five cornerstones

The project is based on five cornerstones, of which three focus on the gathering of information. In the first cornerstone, "*Products and manufacturing*", the different food ingredients are examined in detail.

"It is important to be able to make the products as energy-rich as possible as many older people with chewing and swallowing problems suffer from lack of energy, which could in turn lead to negative nutrition and a negative health spiral," explains Karin Wendin. In this part, a trial series of products are manufactured. We are working with a meat system and a carrot system. Within each trial series different key ingredients are varied to make it possible to analyse how they affect the product, and also each other, from different aspects. There are also nutritional value analyses. When each trial series has been completed, so-called focus groups are set up comprising persons who work professionally with elderly persons, including chefs, speech therapists, dieticians, care personnel etc. They then

evaluate the samples that have been produced. Certain qualities, such as the food should not crumble in the mouth and that it should stick together when swallowed, are important. Similarly, fatty tastes are not allowed to dominate."

In the second cornerstone, "*Functional additives and methods*", the different methods and additives that stimulate saliva production and swallowing are examined.

"Acid stimulates saliva production and a great deal of saliva in the mouth makes it easier to swallow. Carbonated products stimulate the swallowing reflex and likewise cold products that can cool down the oesophagus. In this part of the project an examination is made, using x-rays and other things, of new and promising additives that can then be used in or together with foods."

The third cornerstone is an "*Eating study*". In this part older persons, both persons who are living at home and those living in residential accommodation for the elderly, test the samples from the trial series, which the earlier focus groups consider to be most appropriate.

"The fourth cornerstone is about *compiling and analysing all the data* and the fifth is aimed at *disseminating the newly acquired know-how*, something which takes place continuously throughout the project," concludes Karin Wendin.



Malnutrition a common problem

Malnutrition is a common problem among elderly persons and can be attributed, among other things, to dysphagia in combination with loss of appetite. The biggest problem for people with chewing and swallowing difficulties is often an energy intake that is far too low. Malnutrition leads to muscle changes, which in turn lead to reduced functional capacity and an increased risk of chronic diseases.

Key components in the taste experience are how the food is served and what type of food is offered. It is vitally important that the food tastes good and is aesthetically pleasing. Even if one eats what is apparently satisfactory food it could be difficult to cover the need for certain nutrients as a result of the fact that the total food intake is too low. Surveys have shown that for people with reduced chewing and swallowing capability a healthy diet should involve a reduced meal volume and a higher energy and protein density and it should comprise several smaller meals and/or snacks compared with a normal diet.

HACCP work more important than ever

"ISO 22000 is a natural development in the work on systematic approaches to food safety. There is good potential for the standard to be applied quickly and simply if you already have other types of management systems in place and a well-developed HACCP system. Companies that are certified in relation to technical standards such as the BRC Global Food Standard or similar can then develop this towards ISO 22000," says Patrick Gustavsson, SIK.

In autumn 1995, SIK ran the very first two-day HACCP course. Many large, forward-thinking Swedish companies were focused on laying the foundation for a more systematic way of working with food safety. The EU Hygiene Directive from 1993 had come into effect in these member countries and in Sweden the introduction of Swedish legal requirements had commenced.

Over the years, around a thousand participants have attended the course and acquired basic knowledge of how to produce an HACCP plan. All possible sectors have been represented and the exercises, which have always been an important part of the course, are adapted to the participants.

For many small companies the course certificates were in a way a mark of quality and many of them are framed and displayed.

New hygiene directive increases demands

SIK's hygiene consultants also work at companies as experts to offer support during the setting up of an HACCP plan. An important tool is the in-house developed computer support, which facilitates the production of all the documentation that is required.

The new hygiene regulation that came into effect in January 2006

further increases the demand for complete documentation in an HACCP system. These demands now cover the whole food chain although with slightly different applications depending on the type of handling. It has always been vitally important to make a hazard analysis and risk assessment that is as well founded as possible in the HACCP work although access to useable data and tools for this is lacking. In a number of current research projects attempts are being made to remedy this problem.

During the four years the work of producing the international standard and now the Swedish standard, Food Safety Management System (SS-EN ISO 22000:2005) has been in progress, Patrick Gustavsson has been an appointed expert and active participant. Interest in ISO 22000 is considerable, in particular since the Swedish retailers have declared their recognition of certification under this standard for, among others, its EMV suppliers. This system, like other ISO management system standards, is based on in-house defined applications, which make it more attractive, for example, at small and medium-sized companies. In Europe, there is considerable interest and this is also being speeded up by the new hygiene regulation. Several different national HACCP standards have been withdrawn and replaced by ISO 22000 in a national version. ISO 22000 is a global standard and is acknowledged in a series of key food exporting and importing countries.

"ISO's central secretariat has hopes that a standard specially designed for 'the world's largest industry' could perhaps lead to ISO 22000 becoming the most widely used ISO standard ever," says Patrick Gustavsson.

Systematic assessment of food safety

The intensive development in this area means an increasing need for



SIK's hygiene consultant Richard Karlsson demonstrating the handling of "Computer Support for Hazard Analysis" to Monica Svensson (at the computer) and Anneli Dahl at GG Handel in Skara.

Photo: Cissi Jonson/Bilduppdraget

better assessment tools and assessment documentation.

"According to ISO 22000, for example, it is required that all vital control points (PRP and CCP) must be validated with regard to their effectiveness before the system is brought into operation. This can be done using existing data and from the literature but very often calculations, modelling and the use of data from others are required. The hazard analysis and its end-result, the selection of PRP and CCP, also require considerably more advanced assessment and thus a need for better input and assessment tools."



*Full speed ahead at GG Handel's warehouse in Skara.
Photo: Cissi Jonson/Bilduppdraget*

Nordic research projects develop computer tools

SIK is co-ordinating a Nordic research project (CRAN, Company Risk Assessment Network) where, among other things, the concept in ISO 22000 is used as a basis for achieving the best possible industrial application. Computer tools to calculate the risks in process lines and a database-adapted collection tool are being developed within the framework of this project. The aim is to improve the efficiency and the risk assessments, both qualitatively and quantitatively.

Logisafe, a project run in co-ordination with the Department of Packaging Logistics at Lund University of Technology and within the framework of the research programme 'Food Innovation at Interfaces', aims to develop better assessment tools. There are good hopes that small and/or less developed companies can use these advances

as user-friendliness and pedagogics are characteristic features in both existing software (Computer Support for Hazard Analysis) and in the software SIK is involved in developing.

European project dealing with the rapid drying of tropical fruits

Consumer wishes regarding high quality and longer shelf life for tropical fruits, combined with the developing countries' need to process their raw materials, gave rise to a three-year European project, co-ordinated by Lilia Ahrné at SIK and which was concluded in 2005.

"The aim of the CombiDry project was to improve the shelf life of tropical fruits by developing a combined drying process," explains Lilia Ahrné.

The potential of a combination of drying techniques in order to dry pieces of fruit first emerged in a PhD thesis at SIK in 2002. This indicated, among other things, that pieces of apple dried much more quickly if microwaves were combined with warm air compared with drying using warm air only. If the pieces of apple were also pre-treated in an osmotic sucrose solution (55 Brix) the dried product had better colour and taste properties. The CombiDry project gave SIK the possibility to continue research within microwave drying. In collaboration with two European countries (Spain and Ireland) and four African countries (South Africa, Zambia, Uganda and Mozambique) a combination of osmotic treatment and microwave/warm air drying followed by well-adapted packaging has been developed. The idea behind this work, which was applied to the commercially

most important tropical fruits (bananas, pineapples and mango), was to develop and transfer process know-how to African countries.

"The process is adapted to small-scale production and can help African countries make better use of their raw materials and produce high-quality dried fruits," explains Lilia Ahrné.

The project also offered the potential for institutional development in Zambia, Uganda and Mozambique. New equipment was purchased and young researchers had the opportunity to increase their knowledge through education and close collaboration with European researchers in Spain, Sweden and Ireland.

An important part of the project was the training of personnel at African universities. Three researchers from South Africa, Mozambique and Uganda started their graduate programmes within the CombiDry project and are expected to complete their PhDs shortly.

"Within the CombiDry project we examined how it is possible to dry quickly and effectively and preserve as much of the original quality of the fresh food as possible. The effect of the microwaves in combination with the effect of the air temperature and air speed has been studied closely in bananas although this knowledge can be applied to other fruit and vegetables. A prototype of a combined microwave/warm air oven has been designed and built at SIK. This prototype will form the basis for the design of an optimised tunnel oven, which will be built at SIK shortly.

User-friendly packagings designed with the aid of sensory science

The task of providing consumers with easily opened and manageable packagings has come a long way in recent years. Everyone, not only people with rheumatic diseases, is aware of the problem of packagings that are difficult to handle. SP and SIK, at the request of the Swedish Rheumatism Association, and together with a number of interested parties at organisations, companies and public authorities, have been involved in the project.

Companies that realise that availability of the packaging is an important competitive factor are already testing their products. They receive help from an industrial designer with expertise in "Design for all" to develop new products. "User panels", comprising persons with different forms of reduced hand function, can also be used to provide guidance on what works and what does not work. Even if the Swedish Rheumatism Association has worked on this for several years there are few packagings that are user-friendly and a great deal of work remains.

Good standard drives development forwards

"It was natural for us to contact SIK when working on a standard for easily opened packagings," says Lars Göran Nilsson, project leader at SP.

"Now we are applying for funding to continue working with standardisation. Initially, we are looking for interested parties in the Nordic region and in time we would like to reach the whole of Europe. We need norms for testing the availability of packagings. This helps companies to drive development forward," emphasises Lars Göran Nilsson.

Objective methods

"Within sensory science and consumer studies we use people as measuring instruments. We seek to describe and characterise the 'perceived sensory qualities' in an objective way and to evaluate subjective perception," says Annika Åström, project leader at SIK.

SIK has worked with models for testing and evaluation in 'focus groups', a '100 panel' and a sensory analysis panel. Some of the

focus groups were only made up of people with rheumatism, others were made up of people with different types of reduced hand functions. The '100 panel' comprised people with rheumatism. The results from the different groups concur well.

"The objective measurements are made with the aid of specially trained people on a sensory analysis panel. The panel functions as an analysis instrument that provides detailed statements about 'perceived characteristics' in the packagings."

The results are used to produce a standardised method to evaluate the availability of the packagings. The assessors have worked with different packagings - cans with lids, Tetrapak, blister packs and injectors. The trial leaders and assessors have produced a glossary of characteristics that are needed to describe the availability of the packaging.

"Now we have a good basis on which to stand but we need to develop the sensory analysis technology in order to build up a standard. Extensive work is required," explains Annika Åström.

Closing just as important as opening

The first packaging recommended by the Swedish Rheumatism Association has already been produced. Emballator Våxjöplast is the first company to produce a can with a lid. The packaging is mainly intended for pharmaceuticals but the basic idea of an easily opened lid and an easily graspable can is applicable to many other products, including food. This user-friendly can is now being tested at a pharmaceutical company but is not yet in the stores.



One and a half million of Sweden's consumers have reduced hand function. To address this, the Swedish Rheumatism Association has started the project 'Easily opened packagings' and is running it in collaboration with a number of companies and organisations. The aim is to induce the market to offer packagings that elderly and disabled persons can open, use and close again.

Last year, 18,000 of Sweden's consumers voted egg cartons as the best packaging while glass jars with lids came bottom of the list.

The first packaging recommended by the Swedish Rheumatism Association is already available. Emballator Våxjöplast is the first company to produce a can with a lid.

Requirements for user-friendly packaging:

- *Easy to open the first time*
- *Easy to take out the desired amount*
- *Easy to close*
- *Easy to open the second time*
- *Easy to empty completely*

Energy-related issues increasingly important for food producers

The use of energy in food processing plants is increasing. This is due, among other things, to the increase in consumption of industrially manufactured food alongside the demand for a wider range of products. These trends at the consumer stage - in combination with rising energy prices, policy instruments and greater pressure on prices - mean that the interest in energy issues is on the increase in the food industry.

In a PhD project at SIK Anna Fritzon has examined the potential for reducing energy-related costs and CO₂ emissions at two modern slaughter and meat processing plants, with the aid of systematic methods, so-called process integration methods. In the case studies, increased heat exchange and the use of heat pumps were examined. At both facilities the potential was found to reduce external heat and cooling demands by installing a heat pump. At one of the plants it was even possible to reduce the external heat requirements to such an extent that the use of fuels would only be needed to produce process steam for the plant. In one of the case studies the potential was also discovered for reducing the need for electricity for the cooling system in the plant by ten per cent.

Anna Fritzon has also studied the economic and technical potential for reducing CO₂ emissions and fuel-related costs in fictitious plants of different sizes and levels of heat recycling. Increased heat exchange, the purchase of a heat pump, switching fuels in

steam boilers, the integration with a heat and power plant or a joint energy system with a nearby plant or community were the alternatives studied. The studies show that the different measures are beneficial to a varying degree and that expanded heat exchange and heat pumping are robust solutions, which are profitable in all the cases studied. The installation of some form of district heating proved to be profitable for a slaughter and meat processing plant - particularly if integration with another plant is possible.

"The energy measures studied can reduce CO₂ emissions from the plants considerably. The cheapest investment per kg CO₂ is to change from fuel oil to natural gas in the steam boilers. Other cost-effective ways of reducing CO₂ emissions are to use wood chips instead of fuel oil, increased heat exchange and the purchase of a heat pump," explains Anna Fritzon.

Anna Fritzon's licentiate dissertation is entitled "Energy Efficiency in the Meat Processing Industry - Opportunities for Process Integration".

Considerable interest in edible films

There is considerable interest in edible materials, both in the research world and in industry. Edible materials can improve both the quality and shelf life of the food. They can also function as bearers of active components and doing so provide further protection. Maria Petersson, doctoral student at SIK, has examined edible films in more detail.

"Edible films and coatings can be made, for example, from starch, proteins and lipids. Starch and proteins produce good materials, but are unfortunately also sensitive to moisture. The first part of this work focused on attempting to reduce the moisture sensitivity in films, manufactured from starch by mixing in a lipid," explains Maria Petersson.

When making films that contain more than one component, it is of vital importance to know how these phases separate in the material. The microstructure of a material affects the features of the material, such as permeability and mechanical properties. In the second part of the licentiate work, the focus was therefore on studying how a mixture of starch and protein phase-separated during the film formation process.

The material can also be used as a coating containing active components. It could, for example, involve vitamins and substances that counteract microbial growth on a food and it is thus important

to know what affects the re-release of these substances. In the third part of the project, Maria studied the release of four types of sugar with different molecular weights from a protein film to a model food.

Maria Petersson's licentiate thesis is entitled "Enhanced edible films of mixed biopolymers for controlled release". Maria is continuing her PhD project on surface coatings and improving their properties. She is mainly interested in the mechanisms for water vapour permeability through surface coatings and how these can be controlled.



Maria Petersson is continuing her PhD project on surface coatings and improvements in their properties. Photo: Mats Stading

Jellyfish research could result in new, super-absorbent materials

In the North Sea there are millions and millions of aurelia jellyfish. These cnidarians might appear to be simple but they possess a unique capacity to retain water and control their moisture level based on the prevailing conditions, such as the salt level in the water.

"If we succeed in understanding the mechanisms that control this capacity, this exciting knowledge could generate considerable benefits in a whole range of areas," explains Susanne Ekstedt at SIK. She is one of the researchers in the VINNOVA-funded project Jellysorb, run by Paul Gatenholm, Chalmers University of Technology and Anne-Marie Hermansson, SIK.

Jellyfish live on animals that they capture using their stinging cells. Whilst large jellyfish can prey on fish and other jellyfish, the majority live off small organisms that hover in the water. The jellyfish group comprises 14 species in Sweden and approximately 200 species throughout the world.

In time, increased knowledge of cnidarians could contribute to the development of new, super-absorbent materials, such as diapers, which are considerably better at absorbing and retaining moisture compared with current products.

But there are more applications from the results that are expected to emerge during the course of the project.

"There are many applications for water-absorbing capacity, such as the food industry or as a medium for medicine," explains Anne-Marie Hermansson.

Unknown territory

At SIK's laboratory Susanne Ekstedt is studying jellyfish in an attempt to determine their composition and how they function.

"When we started the project we quickly realised that not a great deal of research has been done into the characteristics of jellyfish and that we are in territory that was quite unknown. But it is exciting; jellyfish are mysterious, fascinating creatures. If we can understand how they function perhaps in time we can imitate them and in doing so create new types of material," says Susanne Ekstedt.

The most common super-absorbents used today have two weaknesses. They are not degradable and the absorption capacity falls drastically when the liquid they are to absorb contains salt - body fluids for example.

Jellyfish, however, manage to retain large volumes of salt water - they are largely made up of salt water themselves. Depending on the species, they comprise approximately 96% water, 3% salt and 1% organic material.

Extracting substances from jellyfish?

To date, research has shown that a form of network of polysaccharides and proteins creates a structure that binds water. This structure appears to play an important role in the capacity of the jellyfish to retain liquid. Exactly how this takes place is too early to say.

While researchers at Chalmers are working on extracting, separating and identifying different components in the jellyfish to understand what the structure comprises researchers at SIK are using



How do jellyfish react in order to store water in their bodies? Susanne Ekstedt, a chemist at SIK, is one of the researchers in the Jellysorb project. Photo Tommy Hvitfeldt

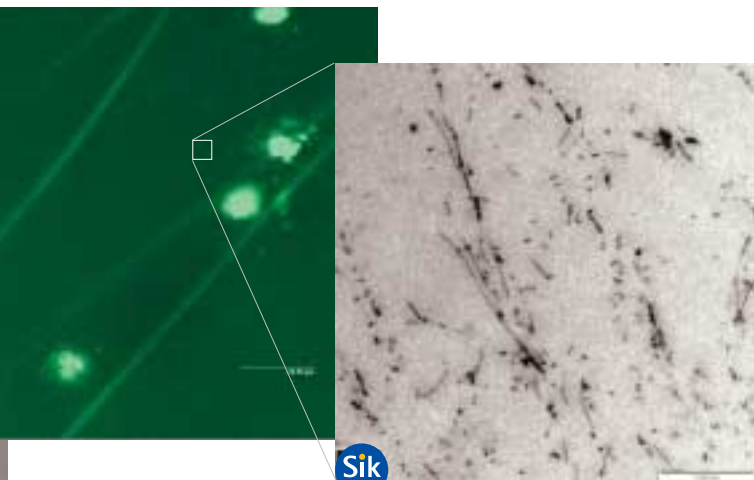
The images show how the structure of the jellyfish is built up, from a macroimage of a full jellyfish to the left, to the micrometer level in the middle, and then the nanolevel to the right. The images from the micro- and nanolevels show that the structure is built up of polysaccharides and proteins.



orbent materials



ist and researcher at SIK, is one of those looking for the answer to the question in the



From diapers to eye surgery

The research project Jellysorb is funded by Vinnova and is led by Paul Gatenholm at Chalmers University of Technology and Anne-Marie Hermansson at SIK. Researchers are also involved from SLU, the Swedish University of Agricultural Sciences. Several companies are also involved, including SCA, which, among other things, manufactures diapers and female hygiene products, as well as the biotechnology company Bohus Biotech, which is working on producing hyaluronic acid from rooster combs (used in conjunction with eye surgery for example). Bohus Biotech is interested in finding new sources of hyaluronic acid or a similar material. Jellysorb is expected to be concluded during the latter half of 2006.

microscopy and other means to examine the structure. They are also working with water with different salinity levels and pH values to study how the structure and other features change under different conditions.

The jellyfish can be quite difficult to work with, among other things as a result of their jellylike consistency. At the same time, it is the consistency that is exciting. Perhaps there is the potential to find substances such as hyaluron acid (which is used in eye surgery and plastic surgery) or cartilage-like substances that can be extracted from jellyfish. This offers considerable potential in surgery and the pharmaceutical industry.

Cultivated at Universeum

Access to naturally living aurelia jellyfish is uneven. It is also a time-consuming task to capture them as considerable care is required to avoid them being injured when handled. Consequently, researchers are also working with farmed jellyfish. At Universeum in Gothenburg there are large aquariums where personnel farm jellyfish from the polyp stage to jellyfish, which has proved to be quite complicated. The life cycle of the jellyfish means that they go through two different life stages – polyp and medusa. The polyp stage can in certain species last for several years. The polyps become detached from the medusas (the adult jellyfish), which seldom live for more than one season. It is the medusas that follow the water currents as they can only swim slowly.

Social responsibility - key factor for sustainable food production

SIK has for a long time studied how food production and consumption affect the environment and has a good level of know-how in this field. An obvious development has been to expand collaboration to include other areas that fall within the concept of sustainability - socio-economic and social responsibility aspects for example.

Within the project Improved sustainability of Agro-Food Chains in Central America various production techniques for agro-food products from Central America are being studied. The general objective is the identification of technological options that make agro-food systems more sustainable from an environmental, food safety and socio-economic perspective.

"SIK's part in the project is to integrate socio-economic aspects into the life cycle assessment tool. The project has been financed by the EU's International Scientific Co-operation Projects (INCO) and is now in its final phase," states Anna Flysjö.

"SIK has recent concluded a project where we have formulated



indicators for social responsibility that can be used by purchasers in the food sector. The project was financed by the Western Götaland region and has been in progress since the end of 2004. Within the project a study has been made of two common food products from Sweden (milk and strawberries) and two imported food products (coffee and bananas) and we have formulated criteria for social responsibility in conjunction with production for each food product."

The criteria can be categorised under different headings:

- Working environment (general work, physical and psychosocial)
- Labour contracts
- Workplace
- Social security
- Discrimination
- Under-age workers
- Trade union organisations

More about the projects can be found on SIK's website where, among other things, the criteria documents can be downloaded.

Artificial sensory intelligence opens up new potential

"Using sensors to make assessments of ready meals is something that is in demand from the food industry. A great deal of research is currently being done to carry out quality controls on individual products - apples for example. Our research, however, aims to go much further and sensors are used to make an assessment of whole meals. This has not been studied previously," says Per Munkevik.

The "Artificial Sensory Intelligence" project is a joint research project between SIK and the research group AASS (Applied Autonomous Sensor Systems), which is part of the Department of Technology at Örebro University.

The aim of the research is to develop a system that makes it possible to automatically assess the appearance of a ready meal. The background is the fact that industrial production of ready meals is increasing significantly. For industrial meal production, as with any other industrial manufacturing, it is important to be rational and the quality level must be high. One can therefore expect production in the future to take place using different types of "intelligent" robots. Among other things, they must take into account and assess the appearance of different meals in the same way that a person does.

The artificial assessment of ready meals has been done using a so-called vision system developed by Per Munkevik. The main components in this system are a camera and a computer with software that Per has "taught" to make assessments of meals in the same way as a human being. Using the camera as a sensor to assess meals offers considerable potential for ready meal manufacturers as they can acquire rapid, reliable results from the assessment of a meal at a relatively low cost.

Such a system can also be used when developing robots for the manufacturing of ready meals. By allowing the vision system to control the robot it can place the different food components on the plate in the same way as a human being when he or she puts the meal together.

The results from the research show that a camera and software together in a Computer Vision System can, in the same way as a sensory panel, check the quality of individual components in a meal and measure the attributes that describe the appearance of a meal made up of different components.

Research year 2005

At SIK 2005 was a strong research year, which is reflected in the unusually large number of students who graduated. Five students completed their PhDs and three students completed their licentiate degrees.

Graduate projects are an important part of our research and the effects of this are particularly obvious during the concluding year when the publication culminates, the results, main conclusions and application ideas are clarified and a new, highly educated person stands on the threshold of working life.

Focus on health

Interest in health matters is very tangible in modern society, in particular the health effects of food. This is, and will in the foreseeable future remain, a key area for the food industry and there are considerable challenges and development opportunities.

Food and health is also a key area for research and this is the case at SIK. Through specific funding, allocated by the SIK Members' Association, we have been able to make a special investment in this area in 2005.

This research investment has been adapted to process- and quality-oriented projects that provide a knowledge base for the development of products that are positive from a health point of view without sacrificing the quality and safety of the food. At SIK we have our areas of strength, which have been the starting point for investment, including the development of know-how in areas such as:

- control of the microstructure in cereals to improve nutrient intake
- factors affecting the perception of sweetness
- process development for frying with minimal fat content in the end product
- microbiological risk assessment of products with health-oriented recipe changes

Success in EU framework programmes

International collaboration is very important in research at SIK and in the development of knowledge generally. The EU framework programme has a particularly important role to play in this respect and SIK has been active for a long time in this area.

In 2005, the EU Sixth Framework Programme got under way fully and we can begin to summarise the project outcome. At the same time we are planning for the Seventh Framework Programme, which will be introduced at the end of 2006.

We can safely say that we have been very successful in our application endeavours in the Sixth Framework Programme. To date, SIK has had 14 projects granted. Ten of these fall within the FOOD Programme, where we have had 20 applications, giving us a 50 per cent allocation. This is an exceptionally good outcome, which we are very satisfied with, although it does place considerable demands on us to produce additional financing as the EU does not fund the project fully.

Competence centres

Nationally, major investments have been made in creating com-

petence centres, something which all public funding bodies have prioritised during the year. Efforts to create centres and formulate applications for this have kept a large part of the research community in Sweden busy during the year.

This also applies to SIK, which is involved in a number of such applications and where the decisions will be reached in 2006. Centre applications involve different areas and have their base at different universities and institutes.

There are two applications in which SIK has the most central role and where it has devoted most effort. Anne-Marie Hermansson is the principal applicant, working with the Applied Surface Chemistry Division at Chalmers University of Technology. These applications involve supramolecular biomaterials - an exciting field in which SIK is an important knowledge base.



SIK PhDs during 2005

In co-operation with:

Chalmers University of Technology

Lund University, Faculty of Engineering

Shaped drops control consistency and flavour

Who could imagine that small drops could differ in appearance and that this could be of major significance in a variety of contexts?

The microstructure of the drops could, for example, affect the consistency and flavour of food. By using microtechnology to shape drops it is possible to change a food without adding other ingredients. In the food industry this technique could be used to create the correct consistency - in dressings and low-fat margarine for example. This method could also be used to develop pharmaceuticals and cosmetics.

Bernhard Walther, a PhD student at SIK, has studied models for the shaping of drops to give them the desired positive properties. The equipment on which the work has been performed has been specially designed to create, study and measure how the shape of the drop evolves during dynamic processes. This involves extremely short process times - a few hundredths of a second - and a very small scale. Bernhard Walther has worked with model foods where the structure is built up using biopolymer gels, such as gelatine and carrageenan, which comes from an alga.

"A variety of gel drops were produced, such as triangles, ellipsoids, crosses, long threads and more complex shapes. By replacing spherical drops with shaped drops we showed how the viscosity of the emulsions can be increased," explains Bernhard Walther. "When the small gel drops are mixed with a dressing it can acquire a more viscous, creamier consistency without additives. Changing the consistency of the food through shaped drops is something quite new."

The properties of the gel drops do not end with their appearance. Using the same parameters that are important in controlling the shape it is also possible to create different structures in a gel. Carrageenan can then form a denser or more disperse thread network, which controls how quickly a flavour molecule or a drug can move in the gel.

Bernhard Walther demonstrates the link between network structures and diffusion behaviour in molecules. For these examinations he has made use of advanced microscopy technology and diffusion measurements (NMR). When the aim is to control the release of flavour or a drug from a gel this knowledge is vital.

The title of the thesis is "Flow processing and gel formation for producing biopolymer drops with functional shapes and diffusion properties".

What do soft drinks taste and smell like?

Water and soft drinks bottles made of polyethylene terephthalate, PET, can be reused or recycled. In both refillable bottles as well as bottles manufactured from recycled material there could be substances that have entered the plastic and which affect the smell and taste of the beverage that has been put into the bottle.

In her PhD project at SIK in Gothenburg and at Lund University,

Helene Widén examined more closely how consumer safety and the product quality of a beverage packed in both these types of PET bottle can be assured.

Among other things, empty, dirty PET bottles, which were rejected by the so-called sniffers for further refilling, were examined. A wide range of more than 50 misuse contaminants was identified, where the origin is assumed to be incorrect use.

In the case of refillable bottles it is important that the bottle material does not absorb aroma compounds from a product, which are then transferred to the next product stored in the bottle.

"We produced a sensory method where we set a threshold odour number in order to characterise how good a material is for refillable bottles so as not to transfer aromas. The method could differentiate between PET and PEN (polyethylene naphthalate) material. We also made a chemical analysis using headspace gas chromatography, linked to mass spectrometry, in order to compare aroma compound transfer from the different materials," explains Helene Widén.

"The results showed that PEN had a much lower level of off-odour transfer than PET, which indicates that PEN could be better suited as a material in refillable bottles."

In another study, PET bottles were manufactured with the deliberate addition of contaminated material in order to simulate the use of recycled material.

"The foreign substances, the contaminants, were found either in the whole bottle or just in the middle layer. The food was either in direct contact with the contaminated material or protected by a layer of uncontaminated plastic, a so-called functional barrier."

The migration of the contaminants from the bottle into the three different food simulants was studied during storage at two different temperatures for a period of one year.

"This showed that the functional barrier succeeded in preventing detectable amounts of the contaminants from migrating into the food even under what are for beverages, extreme storage conditions, such as +40°C for a period of one year," says Helene Widén.

The title of the thesis is "Reuse and recycling of food packaging - odour-related aspects of the use and misuse of PET beverage bottles"

Diversity of dairy products requires thought

The range of dairy products is growing at an incredible rate and at the same time dairies are growing in size. Trends such as these have been evaluated from an environmental point of view by Johanna Berlin in her PhD thesis at SIK in Gothenburg and at Chalmers University of Technology.

In conjunction with an evaluation of possible future development orientations for a dairy chain it was shown that the least preferable scenario from an environmental point of view was the one that had the greatest similarity to current trends in the milk chain.

"The concentration on larger and fewer facilities leads to a greater environmental load through the transport of milk and other dairy products over longer distances. On the other hand, small dairies are affected more by the increase in product diversification, which also

has a significant impact on the environment. It is in conjunction with the switch from one product to another that the majority of the wastage occurs. The increased environmental impact of product diversification at the dairy could be counteracted if the products are produced in an order where wastage is reduced in conjunction with each product change."

Johanna Berlin has developed a method that combines process optimisation with environmental system analysis in order to produce an optimal product sequence that means that as little of the milk product as possible becomes food for the pigs.

"We do not keep cows to rear pigs. This method has been used in two case studies presented in my thesis. During the case studies it emerged that apart from producing the products in the correct order significant environmental improvements could be achieved by reducing the number of product changes in the manufacturing process."

The dairies, the retail sector and the consumers have a choice of measures to reduce their environmental impact. It is not always easy, however, to know what has the greatest effect from a life cycle point of view. Johanna Berlin has developed a method to facilitate this choice.

"The method combines life cycle assessment and player analysis. Reducing wastage and not disposing of the product proved to be an effective measure for all three parties and in particular for the consumer," explains Johanna Berlin.

The title of the thesis is "Environmental Improvements of the Post-Farm Dairy Chain: Production Management by Systems Analysis Methods".

New light on pectin can produce fewer calories

In the food industry there is long experience of producing jam and marmalade although deeper knowledge has been lacking regarding the function of pectin. Fruit and vegetables contain pectin to a varying degree.

Caroline Löfgren, a PhD student at SIK in Gothenburg, devoted five years to studying the functionality of pectin and the mechanisms for forming gel. She also mapped what happens when pectin is used in different chemical compositions.

"Pectin can be used for more than just jam and marmalade. It can be used as a stabiliser in beverages and as a thickener in yoghurt. It is also used to achieve the correct consistency in sweets. In certain cases gelatine can be replaced by pectin. Pectin could even be used in the pharmaceutical industry," says Caroline Löfgren.

Pectin is a polysaccharide that is used to reinforce the cell walls and it also functions as an adhesive in the cell walls. Caroline Löfgren shows that in reality it involves a mixture of several types of polysaccharides which form gel in different ways. Collaboration with the university in Wageningen has given Caroline Löfgren access to well-characterised types of pectin. This offered the opportunity to study the function in pectin with different known chemical compositions. With the aid of advanced electronmicroscopy Caroline studied the appearance of different gels, how quickly they are formed and how they function.

"One of the most interesting results is that if one chooses the correct composition of pectin it is possible to reduce the volume of sugar in many products and at the same time acquire the desired consistency."

The title of the thesis is "Microstructure and Gelation Behaviour of High Methoxyl and Low Methoxyl Pectin Gels and their Mixtures".

More rapid food production with hot air jets and infrared heat

By using rapid heating methods in conjunction with food production it is possible to achieve a higher production speed and develop new foods and better product features. Eva Olsson has studied this in more detail in a PhD project at SIK.

"The heating techniques we have worked with are jet impingement and infrared heating, where impinge means to hit," explains Eva Olsson. "Impingement means that a jet of hot air hits the food at a high velocity. In the food industry impingement can be used for heating, drying, cooling and freezing."

The air velocity is much higher in conjunction with impingement than in a hot air oven although the principle is based on the same phenomenon. Heat is transported to the food using the hot air and is then led into the material, which is heated up. The greater the difference in the temperature between the air and the product and the greater the velocity in the air the more rapid the heat transport.

Infrared heat, IR, is the same type of heat that can be felt from the walls of a hot oven. The special type of IR (short wave IR) used by Eva is equivalent to a surface temperature of over 1,500°C. IR heats the product directly without heating up the surrounding air.

Eva Olsson has worked on mathematical modelling and simulation using advanced computer programs to describe the airflow and calculate the heat transport to the product.

"For the practical trials we have used mini-baguettes. We studied how the different heating techniques affect the crust of the baguettes by measuring the thickness and colour of the crust after different heating times."

"During the course of the work we acquired a greater understanding and knowledge of how to construct this type of equipment. It showed that when we used the correct combination of impingement and IR heating synergies could be achieved. Rapid heating produced increased colour and shortened the heating time. A thicker crust and better heating in the centre could only be obtained by combining the two techniques correctly."

Eva Olsson hopes that companies that manufacture equipment can use her results to build more effective equipment. Likewise, a company that produces food can make better use of the equipment with greater knowledge of flows and heat transport and they can also acquire ideas to develop new products.

The title of the thesis is "Jet Impingement and Infrared Heating of Cylindrical Foods - Flow and Heat Transfer Studies".

Research at SIK during 2005

Product design of tomorrow

- Water distribution and molecular mobility in heterogeneous structures of relevance to the food and pharmaceutical industry
Project Manager: Anne-Marie Hermansson

- Protein isolation from herring (*Clupea harengus*)
Project Manager: Gunnar Hall

- Active starch based coatings
Project Manager: Mats Stading

- Biodegradable films as an environmentally-friendly packaging solution for fruit
Project Manager: Mats Stading

- Ecopac

Project Manager: Anders Leufvén

- Öresund Starch Profiles

Project Manager: Mats Stading

- Sensory design and optimisation of consistency to promote health and comfort in elderly people

Project Manager: Karin Wendin

- Improving the quality of life of elderly people by co-ordinating research into malnutrition of the elderly (Nutri-Senex)

Project Manager: Gunnar Hall

- Healthy lifestyle in Europe by nutrition in adolescence

Project Manager: Gunnar Hall

- New products from foamed sorghum

Project Manager: Mats Stading

- Marine-inspired high performance super-absorbents based on renewable resources

Project Manager: Susanne Ekstedt

- Mixed pectins with new functional properties

Project Manager: Anne-Marie Hermansson

- Structural domains with specific properties

Project Manager: Maud Langton

- Factors influencing the perception of sweetness

Project Manager: Karin Wendin

PhD projects:

- Real time measurements of structure evolution during gel formation and fracture of biopolymer gels

*PhD student: Jenny Brink**Supervisors: Anne-Marie Hermansson*

- Structure and rheology of pectin

*PhD student: Caroline Löfgren**Supervisor: Anne-Marie Hermansson*

- Environmental assessment of seafood products with a life cycle perspective

*PhD student: Friederike Ziegler**Supervisor: Thomas Ohlsson*

- Flow-induced structure formation

*PhD student: Camilla Lundell**Supervisor: Anne-Marie Hermansson*

- Active product packaging interaction surfaces

*PhD student: Anna Nestorson**Supervisor: Anders Leufvén*

- Enhanced films for controlled release

*PhD student: Maria Pettersson**Supervisor: Mats Stading*

- Structure design for optimal sweetness intensity in food model systems

*PhD student: Karin Holm**Supervisor: Anne-Marie Hermansson*

Product safety and consumer trust

- Shelf-life extension of Swedish strawberries

Project Manager: Tim Nielsen

- Identification of off-odours in packaged ready-to-eat vegetables

Project Manager: Tim Nielsen

- Heat-generated food toxicants - identification, characterisation and risk minimisation (HEATOX)

Project Manager: Hans Lingnert

- Acrylamide-Precursors - limiting substrates and in vivo effects (NORDACRYL)

Project Manager: Hans Lingnert

- CRAN – Company Risk Assessment Network

Project Manager: Alexander Milanov

- EU-RAIN – European Union Risk Analysis Information Network

Contact: Alexander Milanov

- EU SMAS – Assurance System for Chilled Meat Products

Project Manager: Alexander Milanov

- LOGISAFE – Logistics and Product Safety

Project Manager: Alexander Milanov

- Plant allergenicity

Project manager: Bo Ekstrand

- Image analysis as a tool for site specific weed control

Project Manager: Niklas Lorén

- Microbiological risk assessment at reduced levels of fat, sugar, and salt

Project Manager: Elisabeth Borch

- A molecular safety approach for *Campylobacter*

Project Manager: Elisabeth Borch

PhD projects:

- Functional barriers, aroma barriers in packaging systems based on recycled materials

*PhD student: Heléne Widén**Supervisors: Anders Leufvén/Tim Nielsen*

- Control of *Clostridium spp.* in cheese – containing products – contamination sources as well as survival and growth characteristics

*PhD student: Lena Lycken**Supervisor: Elisabeth Borch*

- *Campylobacter* infections in poultry
PhD student: Anna-Clara Rönner
Supervisor: Elisabeth Borch

Technology development and production

- Microwave assisted drying
Project Manager: Lilia Ahrné
- Ohmic heating for food processing
Project Managers: Ingela Lindbom
- Reduction of energy and water consumption by application of membrane separation
Project Manager: Karin Östergren
- Software for Microwave thawing optimisation
Project Managers: Birgitta Raaholt
- Agro Food Chains in Central America
Project Manager: Thomas Ohlsson
- Sustainable plant protection
Project Manager: Ulf Sonesson
- Environmental systems analysis of grain legumes for food and fodder
Project Manager: Ulf Sonesson
- New combined drying technologies for the development of high-quality fruit products
Project Manager: Lilia Ahrné
- Modelling traceability, risk evaluation and risk handling in food process line design
Project Manager: Karin Östergren
- Biopowders
Project Manager: Lilia Ahrné
- Microprocessing for improved availability of nutrients in cereals
Project Manager: Maud Langton

- Dynamic measurement of water content in the development of healthy products
Project Manager: Per Floberg

- Frying method with reduced fat levels
Project Manager: Lilia Ahrné

- Life cycle assessment of salmon
Project Manager: Ulf Sonesson

- New technologies to reduce disposal of co-products (REPRO)
Project Manager: Ulf Sonesson

- Criteria for sustainability labelling
Project Manager: Ulf Sonesson

- Grain legumes in western Sweden
Project Manager: Jennifer Davis

PhD projects:

- Rapid cooling of solid foods – energy consumption and texture effects
PhD student: Eva Ohlsson
Supervisor: Lilia Ahrné

- Microstructure processing
PhD student: Bernhard Walther
Supervisors: Anne-Marie Hermansson

- In-line rheology for enhanced food quality
PhD student: Johan Wiklund
Supervisor: Mats Stading/Lilia Ahrné

- Energy effective microwave drying
PhD student: Emma Holtz
Supervisor: Lilia Ahrné

- Decontamination of heat sensitive powder food ingredients by infra-red heating
PhD student: Norman Staack
Supervisor: Lilia Ahrné

EU-projects in which SIK is involved:



FOOD QUALITY AND SAFETY

- Grain legumes – New strategies to improve grain legumes for food and feed
Ulf Sonesson
- Health risks from heat-treated foods and food products
Hans Lingnert
- Improving the quality of life of elderly people by co-ordinating research into malnutrition of the elderly
Gunnar Hall
- REPRO – Food processors to reduce disposal of co-product wastes
Ulf Sonesson
- HELENA – Healthy lifestyle in Europe through nutrition in adolescence
Gunnar Hall

MARIE CURIE

- Research training in food powders
Lilia Ahrné

LIFE SCIENCES

- Realisation of young innovative company status, YIC, for biotech companies
Per Vretblad

RESEARCH AND INNOVATION

- IRC Western & Southern Sweden and Iceland
Bruno Hedlund

CRAFT

- Ohmic heating for food processing
Ingela Lindbom

QUALITY OF LIFE

- Recycleable and biodegradable eco-efficient packaging solutions for the food industry
Anders Leufvén
- Development and application of a TTI-based safety and monitoring and assurance system for chilled meat products
Elisabeth Borch
- European Union - Risk assessment information network
Elisabeth Borch
- Communicating about food allergies
Bo Ekstrand

GROWTH

- Assimilation and standardisation of environmentally-friendly packaging technologies within the food industry
Mats Stading

INCO

- Environmentally-friendly packaging solutions for enhanced storage and quality of southern Africa's fruit and nut export
Mats Stading
- New combined drying technologies for the development of high quality shelf-stable fruit products
Lilia Ahrné
- Improved sustainability of agro-food chains in central America: A techno-managerial approach
Thomas Ohlsson

INNOVATION AND SME

- EuropaBio SME
Ulla Mortensen

Programmes ...

- BRC/EFSIS -orientering om nya krav
- HACCP och hälsofaror
- HACCP - riskanalysmetodik
- Hygien och kvalitet vid livsmedels-hantering
- Intern miljörevision för livsmedels-branschen
- Livsmedelsmikrobiologi med laboration, fördjupning
- Livsmedelsmikrobiologi med laborationer, grundläggande utbildning
- Livsmedelsmikrobiologi - teori
- Mikrobiologi för läkemedelsindustrin
- Mjölkebehandling, delkurs 1
- Revisionsteknik
- Sensorisk analys, grundkurs
- Simuleringsteknik som stöd för effektivare produktion
- Späckats emulsionsskola

Many training programmes have been run more than once during the year. A large number of in-house training programmes have also been run.



- Späckats grundkurs i charktillverkning
- Späckats hygienskola för förpackningspersonal
- Späckats saltsskola
- Temperaturmätning i livsmedel
- What makes your product unique?

... and seminars 2005

- Att förmedla känsliga budskap - strategier för kommunikation och mediehantering
- Closed Loop Food Factory
- Framtidens Mat
- In-line quality control - non-invasive measurement
- Lean Production för livsmedelsindustrin

Reports 2005

SIK Publications (SP) are off-prints of published articles.

SIK Reports (SR) and SIK Documents (SD) are research reports or reports of a more general nature.

- Ahlgren, Mia; Gustafsson, Inga-Britt; Hall, Gunnar

The impact of the meal situation on the consumption of ready meals

International Journal of Consumer Studies 29(2005) pp. 485-492
SP 977

- Aronsson, Kristina; Rönner, Ulf; Borch, Elisabeth

Inactivation of Escherichia coli, Listeria innocua and Saccharomyces cerevisiae in relation to membrane permeabilization and subsequent leakage of intracellular compounds due to pulsed electric field processing

International Journal of Food Microbiology 99(2005):1, pp. 19-32
SP 978

- Berlin, Johanna

Environmental improvements of the post-farm dairy chain: Production management by systems analysis methods.

Doctoral thesis, Department of Energy and Environment, Chalmers University of Technology, Göteborg, Sweden.

2005, 57 p. + 5 app.
SR 739

- Brink, Jenny

Structure-failure behaviour of biopolymer gels. A literature review.

2005, 75 p.
SR 729

- Ehn, Britt-Marie; Allmere, Toomas; Telemo, Esbjörn; Bengtsson, Ulf; Ekstrand, Bo
- Modification of IgE binding to β -lactoglobulin by fermentation and proteolysis of cow's milk*

Journal of Agricultural and Food Chemistry 53(2005) pp. 3743-3748
SP 981

- Eriksson, John; Borch, Elisabeth et al
- Comparison of genotyping methods by application to Salmonella livingstone strains associated with an outbreak of human salmonellosis*

International Journal of Food Microbiology 104(2005) pp. 93-103
SP 994

- Evenbratt, Hanne

QIM (Quality Index Method) assessment of cod and Norway lobster caught by various fishing methods. Project work.

2005, 37 p.
SR 732

- Florén, Britta; Davis, Jennifer; Cederberg, Christel

Kartläggning av produktion och konsumtion av livsmedel i Västra Götaland

2005, 95 s.
SR 733

- Fritzon, Anna

Energy efficiency in the meat processing industry. Opportunities for process integration. Licentiate thesis, Department of Energy and Environment, Heat and Power Technology, Chalmers University of Technology, Gothenburg, Sweden.

2005, 71 p. + 3 app.
SR 738

- Hermansson, Anne-Marie; Langton, Maud; Olsson, Camilla

Designing structure into food

In "Gums and stabilisers for the food industry 12", Eds P.A. Williams and G.O. Phillips.

(Royal Society of Chemistry). 2004, pp. 3-12.
SP 986

- Kaufmann, Svenja

Sensory design of easy-to-chew food for the elderly.

Ingredients and manufacturing conditions with a focus on meat and carrot. Literature review.

2005, 21 p.
SR 731

- Kent, Mike; Knöchel, Reinhard; Barr, Ulla-Karin; Tejada, Margarita; Munes, Leonor; Oehlschläger, Jörg (Eds.)

SEQUID. A new method for measurement of the quality of seafood.

Final Report EU-project QLK1-2001-01643. 2005, 216 p. + 8 app.
SD 173

- Lindstedt, M; Schiött, Åsa; et al
- Individuals with occupational allergy to detergent enzymes display a different transcriptional regulation and cellular immune response.*

Clinical and experimental allergy 35(200):2, pp. 199-206
SP 998

- Lindstedt, M; Schiött, Åsa; et al

Genomic and functional delineation of dendritic cells and memory T-cells derived from grass pollen-allergic patients and healthy individuals

International Immunology 17(2005):4, pp. 401-409
SP 999

- Lorén, Niklas; Hagglätt, H.; Nydén, M.; Hermansson, Anne-Marie
- Water mobility in heterogeneous emulsions determined by a new combination of confocal laser scanning microscopy, image analysis, nuclear magnetic resonance diffusometry, and finite element method simulation*

Journal of Chemical Physics 122(2005):2, 024716
SP 988

- Löfgren, Caroline; Guillotin, Stéphanie; Evenbratt, Hanne; Schols, Henk; Hermansson, Anne-Marie

Effects of calcium, pH and blockiness on kinetic rheological behavior and microstructure of HM pectin gels

Biomacromolecules 6(2005) pp. 646-652
SP 984

- Löfgren, Caroline; Hermansson, Anne-Marie
- Microstructure and kinetic behaviour of pure and mixed pectin gels*

In "Gums and stabilisers for the food industry 12", Eds P.A. Williams and G.O. Phillips. (Royal Society of Chemistry). 2004, pp. 153-159.
SP 987

- Löfgren, Caroline

Mixtures and gelation behaviour of high methoxyl and low methoxyl pectin gels and their mixtures.

Doctoral thesis, Department of Chemical and Biological Engineering/Food Science, Chalmers University of Technology, Gothenburg, Sweden. 2005, 66 p. + 5 app.
SR 740

- Munkevik, Per

Artificial sensory evaluation – appearance-based analysis of ready meals.

Licentiate thesis, Örebro University, Department of Technology, Sweden 2005, 42 p. + 3 app.
SR 734

- Olsson, Eva; Ahrné, Lilia; Trägårdh, A.C.
Flow and heat transfer from multiple slot air jets impinging on circular cylinders
Journal of Food Engineering 67(2005):3, pp. 273-280
SP 980
 - Olsson, Eva; Trägårdh, A.C.; Ahrné, Lilia
Effect of near-infrared radiation and jet impingement heat transfer on crust formation of bread
Journal of Food Science 70(2005):8, pp. E484-491
SP 997
 - Olsson, Eva
Jet impingement and infrared heating of cylindrical foods. Flow and heat transfer studies.
Doctoral thesis. Department of Food Technology, Engineering and Nutrition, Lund Institute of Technology, Lund University, Sweden. 2005, 70 p. + 5 app.
SP 742
 - Petersson, Maria; Lorén, Niklas; Stading, Mats
Characterization of phase separation in film forming biopolymer mixtures
Biomacromolecules 6(2005) pp. 932-941
SP 979
 - Petersson, Maria; Stading, Mats
Water vapour permeability and mechanical properties of mixed starch-monoglyceride films and effect of film forming conditions
Food Hydrocolloids 19(2005) pp. 123-132
SP 989
 - Petersson, Maria
Enhanced edible films of mixed biopolymers for controlled release.
Licentiate thesis, Department of Materials and Manufacturing Technology, Chalmers University of Technology, Gothenburg, Sweden. 2005, 38 p. +3 app.
SP 730
 - Rönner, Anna-Clara; Borch, Elisabeth; Kaijser, Bertil
Genetic profiling of Campylobacter jejuni strains from humans infected in Sweden or in Thailand, and from healthy Swedish chickens, studied by pulsed-field gel electrophoresis (PFGE)
Scandinavian Journal of Infectious Diseases 37(2005):8, pp. 579-584
SP 990
 - SIK. Det händer på SIK. Om forskning och affärer 2004. (Årsrapport). 2005, 26 s.
SD 169
 - SIK. Events at SIK. Research and business in 2004. (Annual report). 2005, 26 p.
SD 170
 - SIKs forskningsstrategier 2005-2007 2005, 8 s.
SD 171
 - SIK's research strategies 2005-2007 2005, 8 p.
SD 172
 - Schiött, Åsa; Lindstedt, M.; Johansson-Lindbom, B.; Roggen, E.; Borrebaeck, C.A.
CD2⁻CD4⁺ memory T cells define a differentiated memory population at both the functional and transcriptional levels
Immunology 113(2004):3, pp. 363-370
SP 982
 - Sonesson, Ulf; Anteson, Frida; Davis, Jennifer; Sjöden, Per-Olow
Home transport and wastage: Environmentally relevant household activities in the life cycle of food
Ambio 34(2005):4/5, pp. 371-375
SP 991
 - Sonesson, Ulf; Mattsson, Berit; Nybrant, Thomas; Ohlsson, Thomas
Industrial processing versus home cooking: An environmental comparison between three ways to prepare a meal
Ambio 34(2005):4/5, pp. 414-421
SP 993
 - Sonesson, Ulf; Davis, Jennifer
Environmental systems analysis of meals. Model description and data used for two different meals. (MAT 21)
2005, 155 p.
SR 735
 - Sonesson, Ulf
Environmental assessment of future dairy farming systems. Quantifications of two scenarios from the FOOD 21 synthesis work (MAT 21)
2005, 35 p. + 3 app.
SR 741
 - Stern, Susanne; Sonesson, Ulf et al
Sustainable development of food production: A case study on scenarios for pig production
Ambio 34(2005):4-5, pp. 402-407
SP 792
 - Thomas-Danguin, T.; Johansson, Anna; Bengtzon, Annika; Hall, Gunnar et al
Sensory analysis and olfactory perception: Some sources of variation.
In "Handbook of flavor characterization. Sensory analysis, chemistry and physiology." Eds. K.D. Deibler and J. Delwiche. (Marcel Dekker). 2004, pp. 56-81.
SP 995
 - Undeland, Ingrid; Hall, Gunnar; Wendin, Karin; Gangby, Ingela; Rutgersson, Annika
Preventing lipid oxidation during recovery of functional proteins from herring (Clupea harengus) fillets by an acid solubilization process
Journal of Agricultural and Food Chemistry 53(2005):14, pp. 5625-5634
SP 985
 - Walther, Bernhard; Hamberg, Lars; Hermansson, Anne-Marie et al
Drop deformation dynamics and gel kinetics in a co-flowing water-in-oil system
Journal of Colloid and Interface Science 286(2005):1, pp. 378-386
SP 996
 - Walther, Bernhard
Flow processing and gel formation for producing biopolymer drops with functional shapes and diffusion properties.
Doctoral thesis. Department of Chemical and Biological Engineering, Chalmers University of Technology, Gothenburg, Sweden. 2005, 68 p. + 4 app.
SR 737
 - Widén, Heléne; Leufvén, Anders; Nielsen, Tim
Identification of chemicals, possibly originating from misuse of refillable PET bottles, responsible for consumer complaints about off-odours in water and soft drinks
Food Additives and Contaminants 22(2005):7, pp. 681-692
SP 983
 - Widén, Heléne
Reuse and recycling of food packaging. Odour related aspects of the use and misuse of PET beverage bottles.
Doctoral thesis. Department of Food Technology, Engineering and Nutrition, Lund Institute of Technology, Lund University, Sweden. 2005, 78 p. + 4 app.
SR 736
- SIK Reports in summary or as PDF files are available at www.sik.se – Publications.

Imaging of foods

CCFRA has recently been involved in the internal and external imaging of foods in several different ways in order to provide objective information on the colour and structure of foods. Non-destructive methods using imaging scanners have been established as a useful aid for product development and fault diagnosis. They are readily applicable to a wide range of products and require no special sample preparation. Images can be viewed as time-lapse animations, providing a clear visualisation of dynamic effects, and are ideal for training and demonstration purposes.

X-ray computed tomography (CT) and magnetic resonance imaging (MRI) were used to take cross-sectional images of products in real-time during processing. The methods have initially been applied to baking. Special equipment was constructed, enabling products to be scanned during proving and baking, with simultaneous temperature measurements. Several types of bread and cake were studied, including lidded and unlidded loaves, frozen dough, high ratio cakes, sponge cake, fruit cakes and muffins. The processes observed included crust formation, convection, bubble coalescence, foam to sponge conversion, and collapse during cooling.

In a related development, the newly issued Version 2 of the C-Cell image analysis software will facilitate the measurement of the structure and appearance of bread and other baked products. C-Cell is a laboratory instrument, developed and marketed as a joint venture between CCFRA and Calibre Control International. The method provides an objective alternative to the visual assessment of products used previously for quality control, and provides more detailed quantitative measurements that enable the effects of ingredient and process changes to be assessed for research and product development applications. Version 2, developed at CCFRA, includes a re-designed user interface and a range of new tools and output options to improve ease of use and versatility.

Our service using the DigiEye instrument for producing high quality images of foods and raw materials is now well established. Accurate colour measurements using a calibrated digital camera are displayed on a calibrated monitor for visual assessment. Applications have included production of photographic training aids as part of product specifications, documentation of product appearance and assessment of colour changes in raw materials during storage.



SIK Board

The responsibility and authority of the board of SIK – the Swedish Institute for Food and Biotechnology are governed, among other things, by the Companies Act, the Articles of Association and the rules of procedure for the board. The owner of SIK, SP Swedish Testing and Research Institute appoints the SIK board following consultation with the SIK Members' Association. SIK Board is as follows:

Members elected at the annual general meeting

Jan Rosenström, Stockholm, *Chairman*
Claes Bankvall, SP, Borås
Agneta Dreber, Livsmedelsföretagen (*Li*), Stockholm
Bernt Gustafsson, Malmö
Gunilla Jönson, Lunds Tekniska Högskola, Lund
Lisbeth Kohls, ICA Handlarnas AB, Solna
Inger Larsson, Findus Sverige AB, Bjuv
Jan-Olof Lidfeldt, Karlshamns AB, Karlshamn

Employee representatives

Siw Kidman, SIF
Annika Åström, SACO

Auditors

Bo Strömberg, Authorised Public Accountant
Öhrlings PricewaterhouseCoopers
Bengt Kron, *Deputy Auditor*
Öhrlings PricewaterhouseCoopers

Industrial Advisory Group

The Industrial Advisory Group assists the Board in a consultative capacity and submits proposals concerning guidelines and programmes for the Institute's research activities, knowledge transfer and working procedures for contacts with industry.

The Group monitors SIK's activities and listens to feedback from members of the SIK Members' Association.

It also participates in the planning of the Institute's three-year research programme and the evaluation of SIK's activities.

The Industrial Advisory Group consists of some thirty representatives from member companies who have experience of and insight into research and development in the food industry. The Chairman and members of the Group are nominated by the President of SIK and appointed by the SIK Board.

Advisory Group

Kenneth Alness, Svenska Lantmännen AB
Jörgen Andersson, Nordmills AB
Rolf Andersson, SCA Hygiene Products AB
Bert-Ove Bergman, TetraPak Dairy & Beverage Systems AB
Lars Broberg, Findus Sverige AB
Sandra Flodström, Santa Maria AB
Pia Fäldt, Aromatic AB
Bert Holmqvist Swedish Meats AB
Håkan Hulander, Abba Seafood AB
Kjell Ivarsson, Lantbrukarnas Riksförbund
Lars Bo Jörgensen, Danisco Sugar AB
Mats Larsson, Cerealia R&D
Mats Lennersten, Göteborgs Kex AB
Marianne Lindblom, Kraft Foods Sverige
Christian Malmberg, Cloetta Fazer Production AB
Stefan Olsson, Ecolab A/S
Hans-Erik Pettersson, Svensk Mjölke
Sten Pålsson, Frigoscandia Equipment AB
Hasse Redestam, AB Sardus
Anna Ström Unilever R&D
Ulla Stöllman, Procordia Food AB
Svante Svensson, Orkla ASA

The SIK Members' Association

The SIK Members' Association is a non-profit-making association. The primary purpose of the Association is to promote technical and scientific research and higher education and to disseminate know-how and applications within food and biotechnology – and related areas – and in doing increase the competitiveness of industry. Members of the Association are companies and organisations that work within or have links to the food and biotechnology industries and collaborating companies. The members make an annual contribution to SIK, which is intended to finance in part the research, dissemination of know-how and service at SIK that will benefit the members.

The Members' Association puts forward proposals for the members of the SIK board and appoints the members of the SIK Industrial Committee. Through its board or through representatives from individual companies, the Association also has the opportunity to keep the Institute's management informed about areas that are considered particularly topical from the member companies' point of view.

Fourteen new member companies joined the Association during the year and a further nine have decided to join in January 1, 2006.

The Board of the SIK Members' Association

Lars Holmström, *Chairman*

Mikael Aru, Procordia Food

Bo Berg, Milko

Anne-Marie Dahlén, Svensk Mjök AB

Peter Elving, Kraft Foods i Sverige AB

Göran Harrysson, Tetra Pak International AB

Åsa Magnusson, Cloetta Fazer Sverige AB

Bertil Pettersson, Jakobsdals Charkuteri AB

Auditors

Bo Strömberg, Authorised Public Accountant

Öhrlings PricewaterhouseCoopers

Bengt Kron, *Deputy Auditor*

Öhrlings PricewaterhouseCoopers

The SIK Members' Association is a legal entity, independent of SIK.

The address is:

c/o SIK

Box 5401

SE-402 29 Gothenburg, Sweden

Phone: 031-335 56 00 (SIK switchboard)

SIK Industrial Research Award

The SIK Industrial Research Award was established in 2000. According to the statutes:

"The award is given to a person or persons in industry working for or who have links with food or biotechnology and collaborating companies, and who, through R&D co-operation with an industrial research institute or universities and colleges, have successfully contributed to industrial development in the food and/or biotechnology sectors".

The winner of the award is selected by an award committee, comprising Nils-Georg Asp, Lund University, Lennart Björk, Swedish University of Agricultural Sciences, Sven-Olof Enfors, Royal Institute of Technology, Lena Gustafsson, Chalmers University of Technology, and Kaj Mårtensson, SIK.

The winners of the SIK Industrial Research Award to date are:

- 2000 Hans Burling, Arla FoU
- 2001 P O Werling, Kraft Freia Marabou
- 2002 Harald Skogman, BioGaia Fermentation AB
- 2003 Rickard Öste, Ceba Foods AB
- 2004 Gun-Britt Fransson, Orkla Foods AS
- 2005 Svante Svensson, Orkla Foods AS



*Svante Svensson, the winner of the SIK Industrial Research Award 2005.
Photo: Åsa Leife*

The SIK Members' Association

- 3N Produkter AB, Helsingborg
- AarhusKarlshamns Sweden AB, Karlshamn
- Abba Seafood AB, Gothenburg
- Aerotech Telub Mainpartner AB, Linköping
- AGA AB, Lidingö
- ALcontrol AB, Linköping
- Alfa Laval Tumba AB, Tumba
- Almondy AB, Torslanda
- Alpharma AS, Oslo, Norge
- Arla Foods AB, Stockholm
- Aromatic AB, Stockholm
- ASM Foods AB, Mjölby
- AstaReal AB, Gustavsberg
- Astra Tech AB, Mölndal
- AstraZeneca Liquid Production Sweden AB, Södertälje
- Axfood Sverige AB, Solna
- Backens Skaleri AB, Falkenberg
- Barilla Alimentare SpA, Parma, Italy
- BE-Chark AB, Halmstad
- Berendsen Textil Service AB, Angered
- Bergströms Rökeri AB, Själevad
- Bimbo-group, Mexico
- Bioinvent International AB, Lund
- Biotage, Uppsala
- Biothema AB, Haninge
- Björnekulla Fruktindustrier AB, Åstorp
- Bohus BioTech AB, Strömstad
- Boxholm Ost AB, Boxholm
- Bröderna Magnusson Lantbruks AB, Falköping
- Bröderna Nilsson AB, Gothenburg
- Campbell Soup Sweden AB, Kristianstad
- Cederroth International AB, Upplands-Väsby
- Ceres Foods AB, Bjuv
- Chiquita International Services Group, Antwerpen, Belgium
- Cloetta Fazer Produktion AB, Ljungsbro
- ConTra AS, Tromsø, Norge
- CSM Bakery Supplies Division Europe, Warrill, United Kingdom
- Dahls Bageri AB, Gothenburg
- Daloon AB, Vadstena
- Dalsjöfors Slakteri, AB, Dalsjöfors
- Danica Foods AB, Lycksele
- Danisco AS, Braband, Denmark
- Danisco Sugar AB, Malmö
- Danisco Sweden AB, Norrköping
- Delicato Bakverk AB, Huddinge
- Diffchamb Sverige AB, Västra Frölunda
- Direkt Chark i Göteborg AB, Gothenburg
- DTI Sweden/XiniX AB, Märsta
- Ecolab AB, Hägersten
- Ellco Food AB, Kävlinge
- Fam Olsson Kött & Charkuterier AB, Askim
- Finax Bröd AB, Trelleborg
- Findus Sverige AB, Bjuv
- Finnerödja Bär AB, Hisings Backa
- Fiskberedning Paul Mattsson AB, Ellös
- Fjellfrys AB, Arvidsjaur
- FMC FoodTech Sweden, Helsingborg
- Foodmark Sweden AB/Rydbergs Sallader AB, Spånga
- Fram Foods AB, Lysekil
- Friesland Coberco Dairy Foods, Deventer, Netherlands
- Friggs AB, Stockholm
- Frödinge Mejeri AB, Vimmerby
- General Mills Technology Center East, Minneapolis, USA
- GG Handel i Skara AB, Skara
- Gisip AB, Skövde
- Go'Bullen i Motala AB, Motala
- Godbiten Konditori AB, Åstorp
- Göteborgs Kex AB, Kungälv
- Hot Cuisine, Varberg
- Hägges Finbageri AB, Örnköldsvik
- ICA Sverige AB, Solna
- Iggesunds Paperboard AB, Strömsbruk
- ITI, Technical Institute of Iceland, Reykjavik, Iceland
- Jakobsdals Charkuteri AB, Gothenburg
- Jojjen AB, Västervik
- Jästbolaget AB, Sollentuna
- Karamellpojkarne, AB, Alingsås
- Kavli AB, O, Älvsjö
- Kindagurka AB, Rimforsa
- KLS Livsmedel ek.för., Kalmar
- Konsum Värmland, Karlstad
- Kraft Foods Sverige AB, Angered
- Kraft Foods Sverige AB, Upplands Väsby
- Källbergs Industri AB, Töreboda
- Lantbrukarnas Riksförbund, Stockholm
- Leksandsbröd AB, Leksand
- Lindvalls Chark AB, Strömsnäsbruk
- LivsTek, Visby
- Lyckeby Stärkelsen Food & Fibre/Industrial, Kristianstad
- Marianne's Farm AB, Ängelholm
- Medipharm AB, Kågeröd
- MicVac AB, Gothenburg
- Milko ek.för., Östersund
- Mills DA, Oslo, Norway
- Munters Europe AB, Sollentuna
- Mälarchark AB, Eskilstuna
- Mäster Olof Kött AB, Gothenburg
- Novozymes Biopharma AB, Lund
- Nya August Larsson Charkuteri AB, Råda
- Opti Sverige AB, Motala
- Per i Viken Chark AB, Höganäs
- Pergo Elektronik AB, Solna
- Perstorp Compounds AB, Perstorp
- Pfizer AB, Consumer Healthcare, Helsingborg
- Polarbröd AB, Älvsbyn
- Procordia Food AB, Eslöv
- Pågen AB, Malmö
- Quest International Scandinavia AB, Lund
- Recip AB, Årsta
- Ridderheims Delikatesser AB, Västra Frölunda
- Roberts, AB, Örebro
- Rosén & Rydgren, AB, Norrköping
- Salico KB, Helsingborg
- Santa Maria AB, Mölndal
- Sardus, AB, Helsingborg
- SCA Hygiene Products AB, Mölndal
- Scan Foods AB, Johanneshov
- Semper AB, Stockholm
- Skal-Man i Halmstad Potatis AB, Harplinge
- SMAK, Svensk Matpotatiskontroll AB, Älvsjö
- Smörgåsfabriken i Norrköping AB, Norrköping
- Solanum Långås AB, Långås
- Stadex, AB, Malmö
- Stora Enso Skoghall AB, Karlstad Research Centre, Karlstad
- Strovells AB, Kristianstad
- SVA, Statens Veterinärmedicinska Anstalt, Uppsala
- Sveba-Dahlén AB, Fristad
- Svensk Mjök AB, Lund
- Svenska Lantmännen Ek. för., Stockholm
- Svenska Lantägg AB, Skara
- Svenska Retursystem AB, Stockholm
- Svensson Partiaffär AB, Olle, Olofström
- Swedish Match North Europe AB, Gothenburg
- Swedish Meats AB, Johanneshov
- Swedish Oat Fiber AB, Våröbacka
- Swits Bake AB, Malmköping
- Tetra Pak Processing Systems Division, Lund
- Topp Chark AB, Bastuträsk
- Toyo Seikan Group, Yokohama, Japan
- Trensums Food AB, Tingsryd
- Ugglarps Slakteri AB, Malmö
- Unilever R&D, Vlaardingen, Netherlands
- Vaggeryds Chark AB, Vaggeryd
- Varbergskött AB, Varberg
- Västfem AB, Gothenburg
- Whirlpool Sweden AB, Norrköping
- Åbro Bryggeri, AB, Vimmerby
- Öresundscharck AB, Malmö



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