

Food & Biobased Research



FOOD & BIOBASED RESEARCH
WAGENINGEN UR



Healthy and sustainable choices: now and in the future

The world around us is changing rapidly. Raw materials are becoming scarce, greenhouse gases affect our climate and health problems occur due to overweight and malnutrition. Prosperity does bring progress, but it also brings new issues that need new solutions. Finding these solutions means combining in-depth knowledge, game-changing innovation and scientific expertise translated to practical applications. Researchers at Wageningen UR Food & Biobased Research tackle these complex issues supported by a firm understanding of the working practice.

Food & Biobased Research develops insights and technologies that support industries, governments and consumers to make the right choices and to innovate responsibly and effectively. Our in-depth knowledge of the entire chain, from raw materials through processing to end product, drives our approach. We partner in the creation and production of healthy and tasty foods, of truly-sustainable food chains, and in developing chemicals and materials that use biomass instead of fossil resources.

Driven by a perceptive, knowledge-based curiosity, our multidisciplinary researchers, from diverse yet complementary backgrounds, approach problems with scientific rigor and creativity. Working closely together, we solve complex questions through a combination of intelligent analysis and pragmatic invention. Grounded in science and business, our researchers bring a no-nonsense attitude to their work.

Fresh, healthy and delicious

We see opportunities for improvement throughout the entire food chain, from raw material to end product and from producer to consumer. The better we can control the quality and shelf life of fresh food, for example, the less waste there will be. That is why our clients engage us to help them produce, transport and preserve fresh food products in more efficient and smarter ways. Getting fresher foods to the consumer is just one of our focus areas. For example, we also research the health effects of nutrition; developing protein-rich meals that help prevent malnutrition in the elderly. We improve foods, making them healthier without compromising the features that make them so appealing to the consumer: delicious soups with reduced salt levels and tasty, attractive goat's cheese with reduced fat content.

Greener economy

Together with our customers, we develop production processes and biobased materials that will transform the current economy into a sustainable, Biobased Economy. With our innovative technologies, we turn side streams and residues from the food industry, agriculture and natural infrastructure into marketable products: foods, feed, chemicals, materials, fuels and energy. Our research helps clients to launch competitive, innovative products made from renewable raw materials. Using our understanding of the application of chemistry and biotechnological processes to the conversion of biobased resources, we produce new chemicals and develop innovative materials that are strong, sustainable and marketable. Materials such as resins and coatings but also composites and bioplastics for the packaging, automotive and electronics industries.

Smart connections

Wageningen University & Research centre's mission– *to explore the potential of nature to improve the quality of life* – gives meaning and direction to the activities of Food & Biobased Research. Our researchers have direct access to the latest scientific findings and have a firm grasp of what modern technology offers.

Making smart connections between various disciplines, we investigate and develop at all stages: upscaling from lab to pilot and from initial idea to the production processes that deliver real products for our customers. To fulfill our promise, we ensure that the solutions we create are applicable in daily practice. Every day, we work with national and global companies, governments and other research institutes to create innovative solutions for a healthier, more sustainable and prosperous world; now and in the future.

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Biorefinery generates maximum value from biomass

We can create much more added value from crops and residual flows from the agrifood industry by the sustainable production of biobased chemicals, fuels and materials. Food & Biobased Research develops new, tailor-made technologies to isolate valuable intermediate products from different biomass sources.



Biorefinery consists of technologies that enable the sustainable conversion of biomass into its ingredients and marketable products such as food and feed, materials, chemicals, fuels and energy. The concept of biorefinery focuses on resource efficiency and generating maximum added value out of all parts of the available biomass and, therefore, plays a crucial role as we move towards a biobased economy.

“Examples of side streams that we work with include residues of potato, beet, corn wheat, wood residues and (verge) grass,” says Gülden Yilmaz, programme manager biorefinery at Food & Biobased Research. “We use a toolbox full of technologies, such as specific separation, physical and chemical processing technologies to extract high-quality components from side streams. These components can be used as raw materials for chemicals and materials. Natural fibres, carbohydrates, proteins, and fatty acids are examples of such high-value raw materials derived from biomass.”

Enabling biorefinery

Pretreatment, separation and extraction are key technologies to fractionate biomass into valuable components. Food & Biobased Research develops new, tailor-made technologies in these fields in order to fully use the potential of biomass and its fractions. Pretreatment is often the first step in the biorefinery process to stabilise the biomass and to increase the efficiency of subsequent processing steps such as enzymatic hydrolysis, fermentation, separation or extraction. Mild separation technologies are developed to retain the natural functionality of the biomass components. This includes dry fractionation technologies, where no subsequent drying of components is required, as well the use of supercritical CO₂ as a mild alternative extraction fluid compared to organic solvents, like hexane. In this respect, Ben Langelaan, manager of the Food Technology research group of Food & Biobased Research, refers to a method in which the use of supercritical CO₂ is combined with extrusion technology: “Tests have shown that this innovative continuous extraction process is less time-consuming, requires less energy and runs at lower costs.”

High-quality cellulose pulp

The palm oil industry is an example of an industry which offers many opportunities. In the Greenpalm project, scientist Paulien Harmsen and her colleagues conducted research on the empty fruit bunches of the oil palm. “The empty fruit bunches are now returned to the plantations, partly for use as fertilizer,” says Harmsen. “They are, however, very suitable as a raw material for valuable materials.” Supported by the Dutch government, Food & Biobased Research has developed an efficient biorefining process for extracting high-quality cellulose pulp from the empty fruit bunches. “We can use this pulp as raw material such as bioplastics or textiles”, continues Harmsen. “But we could also use the empty fruit bunches as a source of glucose, which is an alternative raw material for chemicals that are now being produced from petroleum.”

New businesses with biorefinery technologies

Food & Biobased Research is involved in many different biorefinery projects, ranging from projects developing small-scale biorefinery concepts for regional solutions to large-scale concepts for high volume applications of biomass. “Biorefinery is an essential step in creating sustainable value chains and new biobased products,” concludes Yilmaz. “A tipping point for the biobased economy is on its way. Together with the industry, we tackle food security and resource efficiency, while creating added value, new markets and new businesses with our toolbox full of biorefinery technologies.”

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Aiming to reduce food waste by half

Every year, in the Netherlands alone, billions of Euros in food is thrown in the bin or used for unnecessarily low-grade purposes. Solutions for reducing waste are within easy reach and reductions of between 40 and 50 percent are possible in the longer term.



Around the world, more and more organizations are convinced that reducing food waste throughout the supply chain can help meet the ever-increasing demand for food. According to the latest FAO figures, in 2050 the world will need 60% more food to feed an estimated 9 billion people. To produce more food with less resources and environmental impact is only part of the solution; reducing food waste is an essential component and favourable option to be incorporated in a strategy for food and nutrition security.

Toine Timmermans, Programme Manager Sustainable Food Chains at Food & Biobased Research believes that a complex societal issue like food waste demands an integral, public-private approach. "We need food manufacturers and retailers to come up with innovative solutions; the government should facilitate this process by creating a level-playing field, offering incentives and taking away obstructive laws and regulations. Imagine, for example, supporting companies by educating consumers about the actual shelf-life of products."

Uniquely broad approach

Food & Biobased Research has taken a leading role in reducing food waste.

"We support partners throughout the global supply chain in their efforts, from primary producers to retailers, from small enterprises to multinationals, and from those leading the way in sustainability to those taking their first steps." Its work includes agenda-setting, monitoring and measuring activities, developing novel technologies, setting-up campaigns to increase public awareness and the creation of international sustainability networks.

"We developed a Food Waste Monitor – a tool that maps food waste in a systematic, detailed way, based on a set of definitions; it is a basis for government and industry to achieve comparable insights and take targeted measures", says Timmermans. Another project has focussed on food waste assessment at healthcare institutions that introduced new meal concepts, thereby substantially reducing waste and saving tens of thousands of Euros a month. Yet another success is Food & Biobased Research' contribution to the development of the groundbreaking Pasteur Sensor Tag. This tag allows prediction of shelf-life of food products, taking into account factors such as harvest quality and supply chain circumstances.

Targeted measures

Timmermans also mentions the Food Battle Estafette project which revealed that consumer awareness alone could deliver a 20-25% decrease in food waste. Also noteworthy is the fundamental research carried out within the public-private partnership TI Food and Nutrition. "This project will deliver a Decision Support System, allowing manufacturers and retailers to take targeted measures to reduce losses in fresh foods."

He sees the key challenge for the coming year as extending Food & Biobased Research's integral approach towards other areas of expertise – for example the development of high value applications for raw materials that are currently managed as waste - and to work with the leading international organisations to achieve leverage. "We have high expectations of two more initiatives: the EU FUSIONS project that will develop a public-private approach to reducing food waste in Europe, and the European Framework for Action that we are creating, together with leading food industries. Objective is to contribute to food waste reduction in Europe by 30% in 2030."

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New tests trace microorganisms rapidly and simply

New microarray tests for determining quality and safety can deliver lightning-fast results. Food & Biobased Research uses the technology for a range of applications at different scales – on-site and lab-based. Varying from rapid tracing of harmful microorganisms and biomolecules in organisms to determining the authenticity of products.

The microarray test is the advanced alternative to the well-known single-analyte diagnostic tests. According to Aart van Amerongen, senior scientist Biomolecular Sensing & Diagnostics, multi-analyte diagnostics offer major benefits: “For the microarray test we use several platforms that are suited for on-site up to laboratory application. In the so-called ELISA plate, which consists of 96 small cups, every cup is made up of dozens of little spots. This way, we can measure up to twenty different components per single sample and simultaneously diagnose multiple samples with one test.”

Clear results in a matter of hours

Microarray testing has also been combined with the lateral flow technology, which is similar to the pregnancy test. This is how Food & Biobased Research scientists developed a rapid method for tracing the

dreaded VTEC bacteria. “Rapid results are the major benefit here,” says van Amerongen, “Test results will be clear in a matter of hours – a dramatic improvement on traditional test methods when conclusive results would take days.”

Potential for broad application

Multi-analyte diagnostic tests can be applied in many fields, ranging from detecting human, animal and plant diseases to measuring allergen proteins in bakery products. “The microarray test also offers opportunities for establishing the authenticity, safety and/or quality of food and biobased products,” concludes van Amerongen. “If the test confirms that the product in question fulfils the requirements, it may for instance be awarded a quality certificate.”

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From biomass to biobased products with smart chain design

The step from biomass feedstock to market introduction of biobased products is often difficult and requires smart design of the biobased business chain. Wageningen UR Food & Biobased Research supports companies and governments in this field.



According to scientist Harriëtte Bos a lot of aspects are involved in developing a good chain design. “It requires knowledge about aspects such as the logistical, economic and sustainability aspects of biomass in relation to its availability”. Food & Biobased Research also develops pretreatment and conversion technologies and biobased products such as biomaterials, biochemicals and bio-energy. Bos: “This combination of knowledge is unique and allows us to design and analyse sustainable and commercially viable chains for the biobased economy.”

Preferred partner for companies and governments

It is this integrated approach that makes Food & Biobased Research a preferred project partner for companies and governments. Bos: “For example, for a production site in the Dutch province of Gelderland, we studied the technological and economic opportunities of the production of new products via biorefinery, combined with the existing infrastructure of the pulp and paper industry. Based on our conclusions the site can be developed further, by linking its biomass flows with new biorefinery processes.

Policy advice

Sometimes policy changes are needed to boost the biobased economy, and Food & Biobased Research can also provide support in this respect. “For the EU and national governments we are studying the effects of policy changes on the development of the biobased economy in various projects,” Bos explains. “In addition we give policy advice for the implementation of the biobased economy in specific countries. A good example of this is our focus on linking local opportunities to the global demand for biobased products.”

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Breakthrough for biobased chemicals

The final breakthrough for biobased chemicals is imminent as the production technologies become more and more advanced. The industry is taking the lead having found in biomass a sustainable and high-quality alternative to petroleum.

Food & Biobased Research has been working on producing biobased chemicals and materials from biobased feed stocks for more than twenty years. The institute develops new fermentation and strain engineering technologies to create a portfolio of biotechnologically produced alcohols and acids. Furthermore, biomass conversion technologies allow the conversion of sugar, lignin and fatty acids into a variety of building blocks for the production of bioplastics. There has been a boom in the last few years, resulting in numerous large-scale bilateral and public-private programmes in which Food & Biobased Research cooperates with partners throughout the value chain, from agrifood companies to chemicals manufacturers and chemicals users.

Sugars for biobased chemicals

The potential for the conversion of sugars into building blocks for chemicals and materials is significant. Jacco van Haveren, programme manager for Biobased Chemicals: "Sugars are increasingly known as 'the new naphtha', since they can serve as building blocks for a potentially infinite number of products." Scientists at Food & Biobased Research are further developing technology for the biotechnological production of acids and alcohols such as lactic acid, itaconic acid, acetone, butanol, ethanol, and isopropanol. They are also increasingly becoming engaged in the biotechnological production of fatty acids.

Chemocatalysis is another promising method. To underline this, van Haveren points to the conversion of sugars from sugar beet pulp into second-generation furan dicarboxylic acid (FDCA): "This acid is a biobased alternative to PET, out of which the well-known PET-bottles are produced. FDCA is a real platform molecule from which a whole variety of different products – in addition to bottles – can be produced, including coatings, adhesives, polymer additives and detergents."

Lignin

Another major focus area of research is on lignin, the natural glue component which gives trees, grass and straw their rigidity and flexibility, and which is cheap thanks to its abundance in nature. While its potential is considerable, lignin is currently mainly used as low value solid fuel in the production of paper. According to Richard Gosselink, senior scientist at Food & Biobased Research, the industry is looking for sustainable alternatives to the fossil aromatics which are used in a variety of daily consumer products such as polymers, adhesives and coatings. This is where the potential for a more high-quality use of lignin comes into the picture. "Companies are eager to cooperate with us on the cost-efficient conversion of lignin into bioaromatics and products. For example, together with partners we have developed a glue for plywood in which fifty per cent of the toxic substance phenol is replaced by lignin. In addition, lignin also has properties that make it easy to process in, for example, flexible coatings or rigid polyurethane foam."

The Dutch government is also aware of the possibilities of lignin. In the framework of its policy of support to top sectors in knowledge and innovation, the Dutch government provided a subsidy in 2014 to the LigniFAME project. "Within this project, we cooperate with several SMEs and multinationals to develop sustainable methods for converting lignin into a number of valuable products," Gosselink states. "Examples include fuel additives for the shipping industry, roofing materials and biochemicals."

In 2013, Food & Biobased Research identified a couple of other promising platform molecules that can be based upon sugar beet pulp or bagasse. These research lines will be expanded in 2014.

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Making the flower sector more sustainable and cost effective

The Netherlands have always been famous for their flowers. However, the flower sector needs to make major improvements in sustainability and cost reduction. The GreenCHAINge project offers partners throughout the chain the insights needed.

Once, the florist and garden centre were the only places where one could buy flowers. Today, they are on sale almost everywhere. Flower prices are under pressure, while quality requirements are becoming stricter.

Multimodal chains

Most flowers are transported by air – a fast but energy consuming and expensive option. Replacing air transport by ship or train would offer no less than 82% CO₂ reduction. GreenCHAINge, running from 2013 to 2016 and carried out in collaboration with trade organizations LTO Glaskracht and VGB, is supporting the flower sector to developing these

so-called multimodal chains. The project brings together partners throughout the chain; experts from Food & Biobased Research provide them with new insights into chain design, intelligent monitoring, flower properties and post-harvest treatments.

Sea container

A pilot-study of the transport of roses from Kenya to the Netherlands by ship demonstrated that sea transport does – in flower batches of sufficient quality and with the right treatment – offer a viable alternative to air transport.

Food & Biobased Research aims to increase awareness in the flower sector of this alternative. Currently, the sector uses five sea containers per year, versus five planes a day. If every chain partner gets involved, significant cost savings could be made, while improving the sector's sustainability profile.

The GreenGHAINge project is subsidised by the Dutch Ministry of Economic Affairs, Topsector Tuinbouw and Productschap Tuinbouw

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Rapid emotion Indicator to predict market success

Over 70% of new food products disappear from the shelves within a year, despite extensive consumer testing. Apparently these tests poorly predict how consumers will appreciate foods in real life. Application of a novel Rapid Emotion Indicator could turn the tide.

Why we like or dislike certain products might be better captured by physiological and behavioural measures of the autonomic nervous system (ANS) than by conscious or classical consumer tests. Consumer behaviour, including selection and appreciation of foods, is mainly driven by automatic and unconscious processes that are difficult to identify and put into words.


Unconscious responses

Food & Biobased Research has developed and tested an innovative *Rapid Emotion Indicator* that measures autonomous responses to food – initial reflexes occurring within tenths of a second: changes in heart rate, skin temperature and conductance and facial expressions of fear, surprise or disgust. These unconscious responses precede conscious responses such as recognition and memories of previous use.

Food & Biobased Research aims to identify the responses that are most relevant in predicting both initial and long term product appreciation. In 2014, the organisation published a paper on temporal unfolding of emotions, in *Frontiers of Psychology*.

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Making profitable materials with nature's help

Together with our partners, we develop innovative biobased materials that are strong and durable. These materials can compete with fossil-based plastics and help industry make the most of the biobased economy.

Food & Biobased Research has been conducting research on biobased materials for more than twenty years. The institute is leading in the Netherlands in this field and has a strong position in the world. A great deal of research takes place in contract research projects with companies and a lot of work is carried out in major public-private partnerships on biobased materials that focus on realising major breakthroughs.

For example, the Biobased Performance Materials programme sees more than 30 large, medium-sized and small companies, five research organisations and the Dutch government cooperate under the supervision of Food & Biobased Research. In this programme, scientists are working on the development and application of new biopolymers for the production of a wide range of beyond state-of-the-art materials. Developed materials can i.e. be applied as packaging or building materials; train, plane and car parts; computer housing, paints and floor coverings.

Christiaan Bolck, programme manager Biobased Materials at Food & Biobased Research, endorses this type of cooperation: "Since the whole chain is involved, research results will directly be available for the industry to develop new products, and their time-to-market will be shorter too."

Utilising the application areas of commercial bioplastics

An example of a biobased material with huge potential is polylacticacid (PLA), which Bolck says is one of the most applied bioplastics. "PLA has unique natural characteristics which make it ideal for producing materials for which high transparency and stiffness are needed. It also has the huge advantage that it's fully compostable. Together with partners, we are working hard on improving the heat resistance of PLA. One of the results already achieved is producing a heat-resistant coffee cup for coffee machines."

Fibres and other natural biopolymers

One specific field of study is developing materials out of natural biopolymers. "We can use cellulose fibres from non-wood sources such as flax or straw for producing an almost infinite range of products, including building or packaging materials," says Bolck. "It's all about utilising the unique qualities of nature for the production of profitable biobased materials." Scientists recently succeeded in producing a packing tray for tomatoes that is made of tomato leaves. "Until now, such biomass has mainly been collected and converted into compost. This example shows that it's possible to apply biomass for more high-level purposes too."

Organic waste as source for biobased materials

Bolck also has high expectations for the conversion of organic waste flows into biobased materials such as shampoo bottles, coatings and rubber. Wastewater and organic waste can easily be converted into fatty acids which can be converted into polyhydroxyalcanoates (PHAs). This family of polymers has excellent properties but up to now its quality has been inconsistent and the production and extraction costs are still too high. To change this, Food & Biobased Research has taken the initiative to start a PHA research and development programme. This programme is a partnership with various members of the entire chain. The final objective is the cost-effective production of PHAs and derived products.

The Biobased Materials programme allows Food & Biobased Research to showcase its key role in realising the biobased economy. "It gives my team a genuine sense of pride whenever we see one of our partners introduce a material or product that we've been able to develop together" concludes Bolck.

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Towards guaranteed year-round top quality fresh produce

Major improvements in delivering consistent top-quality fresh fruit and vegetables are possible by organizing the chain from an integral perspective, states Henry Boerrigter, Post-Harvest Expert at Food & Biobased Research: "A better understanding of quality aspects like juiciness or tastiness, and methods enabling prediction of quality decay are key."



Mealy apples, melons without taste and avocados that won't ripen are just a few examples of experiences with inconsistent fresh produce quality on the shop floor; a common situation that often results in disappointed consumers that decide not to buy the product again for a while or, even worse, go to another shop for their groceries.

Different suppliers

Delivering year-round, constant, high-quality fresh fruits and vegetables is, despite all efforts of primary producers, suppliers and retailers, an almost impossible task, states Boerrigter: "Because of seasonality it needs multiple suppliers, from different locations around the world, to provide retailers with the desired products and in the right stage of ripeness. This global sourcing policy may result in differences in appearance, taste, texture and shelf-life, due to differences in varieties, harvest time, post-harvest treatments and transport." A late season avocado grown in South-Africa, for example, is much tastier than its early season Peruvian counterpart, and strawberries cultivated in summer taste sweeter than the ones you find on the shelf around Christmas.

Predicting batch quality

According to Boerrigter, year-round consistent quality comes within reach when you can predict what is and what will happen with the quality of fresh produce. "Getting grip on product quality allows the making of well-considered decisions about the storage and distribution options of products which are still possible, without disappointing the consumers", he explains.

"A consistent quality will result in increased consumer satisfaction and ultimately in increased consumption of fruits and vegetables. Moreover, you reduce unexpected losses and, thus, food waste."

Measuring and prediction of the quality of fresh fruits and vegetables is one of the core activities of Food & Biobased Research. "Throughout the years, we have built up a strong track record in the area of fresh-food chains", says Boerrigter. "Our expertise is broad and ranges from biomarker analysis, plant physiology and product quality to post-harvest techniques, monitoring, modelling and supply-chain management."

Integral approach

According to the expertise gathered over the years, an integral approach - with multiple disciplines and chain partners involved - is key to success in delivering constant top-quality fresh produce. "Major steps can only be made by sharing insights, ideas and profits with all participants in the supply chain." Chain transparency is almost a prerequisite to make this quality control ideas work.

Illustrative for the opportunities for improving the fruits and vegetable chain is the Dynamic Control System for fruits. "We have developed a method using advanced sensors that measure the yearly varying metabolic activity of the stored apples", says Boerrigter. Depending on the respiration activity of the batch, the conditions in the storage room are adapted precisely and dynamically. The use of a floating instead of fixed set point method results in apples that are in perfect condition even after one year of storage. "Imagine the benefits across the chain if we could apply this method to all fresh fruits and vegetables?"

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PEF offers alternative to pasteurisation of fresh fruit juices

Pulsed electrical field (PEF) technology can inactivate micro-organisms, making it a valuable process in the preservation of chilled food products. However, all PEF equipment and applications are not the same and therefore careful regulation of process conditions is needed.

PPS Mild Preservation

In the PPS Mild Preservation end users, technology suppliers, the Dutch Food Safety Authority (Voedsel- en Warenautoriteit) and Wageningen UR Food & Biobased Research work together on the further development of mild preservation technologies that deliver added value for the food and technology sector, to assure safe and healthy food products for consumers and to increase the sustainability of food.

There is an increasing demand for mild preservation processes that extend shelf life of food products without affecting the quality and safety, and use of chemical preservatives. Pulsed electric field (PEF) technology offers a promising alternative for the pasteurisation of, for example, fresh fruit juices. The technology inactivates vegetative bacterial cells, yeasts and moulds. Microbial spores resist PEF treatment, making the technology unsuitable for sterilisation aims.

Experts from Wageningen UR Food & Biobased Research investigated – within the context of the *PPS Mild Preservation* (see text box) – the impact of industrial relevant process parameters and juice composition on the PEF's capability to inactivate common spoilage micro-organisms and pathogens in apple, orange and watermelon juices.

Different degrees of inactivation

In tests, *Saccharomyces cerevisiae* was the most sensitive micro-organism, whereas *Listeria monocytogenes* showed the most resistance to the treatment. Different juice compositions resulted in different degrees of inactivation, predominantly determined by pH. PEF treatment was successful in orange juice, but not in watermelon juice unless it was acidified.

The outcomes highlight the importance of pre-evaluation of process conditions, in order to ensure safe PEF treatments. Food & Biobased Research uses these new insights in the development of a range of PEF applications, in cooperation with industries.

A paper on the study outcomes has been published in the International Journal of Microbiology (173; 105-111). Food & Biobased Research is planning follow-up research with other chilled food products.

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Developments in AlgaePARC research

Algae belong to the simplest organisms in the world and are presently considered as a future pillar of the biobased economy. This is understandable as these microscopic plants are rich in energy and offer considerable benefits when compared to other biomass.

Both the food and non-food industries are showing great interest in algae, since they are an abundant source of oils, fats, proteins and sugars. Together with the private sector, scientists at Food & Biobased Research and Wageningen University are working on developing and implementing cost-effective growth, harvesting and refining processes for microalgae.

From functional proteins to fuels and bioplastics

Research manager Maria Barbosa works at the epicentre of algae research: AlgaePARC. Barbosa: "AlgaePARC is an innovation institute with pilot facilities from Wageningen UR where fundamental and applied research into microalgae is carried out." An impressive amount of different research projects takes place here, varying from algae as a source for functional proteins in the food and feed industry, to the sustainable production of biofuels and bioplastics from microalgae. Barbosa: "The major benefit of algae is that they don't need lots of space for large-scale production: they only require carbon dioxide and sunlight and grow very well in seawater, or in arid locations."

Cheaper biomass production

A number of major steps are still required before algae can become one of the pillars of the biobased economy. The process from growth to final product must become cheaper, faster and less energy-consuming. "A major step forward in this respect is the research at the AlgaePARC pilot facilities into the development of cheaper cultivation processes that use different cultivation systems and materials," concludes Barbosa.

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Tasty food improves quality of life of the elderly

Elderly people who eat sufficient healthy food are expected to live independently for longer and require less care. If they fall ill, they recover much faster. The programme *Voeding en ouderen* (Nutrition and the elderly) will help provide products and services that support these goals, for example via the Cater with Care project.



Ten per cent of the elderly, living at home, are malnourished. In nursing homes, the number rises to 20% – and in hospitals to 25%. A problem with serious consequences, including slower recovery from illness and surgery and an increased risk of complications. This can lead to a negative health spiral with longer hospital stays, and increased use of medication and care needs.

Voeding en ouderen, initiated by Food & Biobased Research and carried out in cooperation with various partners, aims to deliver food products and services that improve nutritional status. Much is to be gained, physically, economically and in quality of life.

Cater with Care

One of the projects is Cater with Care (2012-2015, www.caterwithcare.nl) that aims to develop and test high-quality, (protein-)enriched and tasty foods that fit into a normal diet, in order to achieve health gains in a relatively simple way. The project has been running for three years and a wide range of food products has been developed and tested by, amongst others, the SenTo panel (see text box). "People appreciate the taste of our products more than the taste of existing clinical nutrition", says Herman Peppelenbos, Programme Leader Target-Specific Nutrition at Food & Biobased Research. "Taste is appreciated also after prolonged intake and the products help to increase protein consumption in elderly people."

An extensive intervention trial is planned for end 2014, to be conducted at the Gelderse Vallei Hospital. It will investigate the effects on daily protein intake and eating experience of the comprehensive Cater with Care menu versus separate products.

To increase awareness

Initial results are promising, but some challenges remain. "Cater with Care products are a bit more expensive than supermarket products, so we need to increase awareness, among senior citizens, of their added health value", says Peppelenbos. "Currently, many people associate protein with obesity. They are happy that, with age, they have finally been able to manage their weight. The idea that they could be malnourished does not come to mind."

Moreover, differences in financial reimbursement of clinical foods and enriched foods blocks introduction in the market. According to Peppelenbos, the market should be organized differently in order to move forward with products like those developed in Cater with Care: "Government and industry should, together, agree on solutions. Food & Biobased Research is facilitating this discussion, by talking with the different stakeholders and by bringing them together in the late-2014 workshop."

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SenTo

SenTo, the consumer panel of the future, comprises over 800 people aged 55 and over, living at home. There is no such thing as a single, all-encompassing senior citizen profile and this panel allows segmentation by, for instance, age or ability to smell or taste. The panel contributes to research on the valuation of new products, meals and meal components.





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