CommNet
COMMUNICATING THE BIOECONOMY

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2013 Innovation Catalogue

Selected bioeconomy research projects

European Commission

SEVENTH FRAMEWORK PROGRAMME

PRACSIS
PUBLIC RELATIONS COMMUNICATION STRATEGY SPRL

Introduction

CommNet, the communications network for the bioeconomy, is delighted to present its first *Innovation Catalogue*. This publication contains a series of case studies from projects in the field of bioeconomy, funded by the European Union's Seventh Framework Programme for Research. In addition to presenting their specific features, the main objective of the catalogue is to assess each project's innovation and market potential.

The twelve selected projects operate in two sectors of the bioeconomy field: agro-food and bioplastics. They focus on new solutions for end users of bioeconomy products, enabling us to glimpse what the future could look like, even though the selected projects are still at an early stage of development.

To convert money into knowledge and knowledge into money: that is, in brief, the goal of the EU's Innovation Union, a flagship initiative to achieve the goals of the EU2020 strategy, the pathway towards smart, sustainable and inclusive growth for Europe. The bioeconomy includes diverse areas such as food, food processing, nutrition and health as well as agriculture, forestry, fisheries and biotechnology. With technological expertise, new products and service applications, research is one of the uncontested contributors to Europe's sustainable growth.

Innovation can be seen as a cyclical process: a linked chain of research, development and management. The research, development and innovation cycle (which may vary from field to field) includes a number of stages, from research to product. The self-assessment of a project's position within its research, development and innovation cycle is a necessary prerequisite and the starting point for cooperation between science, industry and other stakeholders.

The European Commission's Communication *Innovating for Sustainable Growth: A Bioeconomy for Europe* shows the economic growth potential for the bioeconomy sector. The EU bioeconomy already has a turnover of nearly EUR 2 trillion and employs more than 22 million people, accounting for 9% of total employment in the EU. Between 2014 and 2021 the EU will spend more than EUR 4,5 billion for bioeconomy research under the new funding programme HORIZON 2020, which is set to give a boost to the sector.

Research, Development and Innovation Cycle

To reach, and even go beyond, market forecasts in the bioeconomy field, more effort must be made to bridge the communications gap between the worlds of research and business. Initiatives such as CommNet must be encouraged, to make known the innovations developed by Europe's remarkable researchers.

In order to stimulate communication with the business world, coordinators and communication officers of selected projects have provided the descriptions of the case studies featured in this catalogue. This publication has been edited by a CommNet consortium member, the Brussels-based communications agency PRACSIS, specialised in in communication strategies and in research and innovation policy.

With the publication of the *Innovation Catalogue 2013*, CommNet intends to facilitate the interaction between featured projects and technology transfer experts, representatives of the industrial and commercial sectors as well as SMEs in the field of bioeconomy. It thus hopes to concretely and effectively contribute to the dissemination of European research results.

Brussels, October 2013

Table of contents

INNOVATION IN THE AGROFOOD CHAIN

INNOVATION IN THE BIOPLASTICS SECTOR

THE CAMERA IN THE STY MAKES PIGS FEEL GOOD

How the ALL-SMART-PIGS technology improves animal welfare

The project: Development and testing

The ALL-SMART-PIGS project aims to establish technologically improved living conditions for pigs, that optimise feeding, and enhance animal health, leading to increased growth and better meat quality.

The project is to develop a multi-sensor control technology for livestock farms. The barn will be turned into a film studio, including microphones and cameras. These will provide data on the lives of the pigs, leading to improvements in their living conditions. A better environment for the animals will lead to increased growth and improved meat quality, happier lives for pigs and farmers, and more transparency and a clean conscience for meat consumers.

The product: Technology to improve animal welfare

Up to now getting a full picture of livestock living conditions in the stys was a time-consuming exercise with many flaws delivering fragmented, non-objective results. The Smart Pig Farming Technology is a collection of sensors and algorithms. When installed in a sty and connected to a computer, the technology provides a clear picture of the animal's living conditions. With these improved controls livestock farmers can achieve better results. The sensors will assist farmers in optimising environments: climate, air quality, feed, space and materials can be quickly adapted because the animals are monitored 24 hours a day. Cameras, sound monitors, air quality meters, feed counters and weight sensors record data enabling farmers to determine livestock well-being. Software processes the data and delivers a daily report on the status of a herd. The data indicate if the temperature, air quality, humidity and ammonia concentration are the most appropriate ones. Feed quality is directly linked to observed weight gain and behaviour. The continuous weight measurement will enable farmers to accurately determine when pigs should be sent to the slaughterhouse. The collection of sensors will make a real difference—a win-win for both pigs and farmers—improving the acceptability and quality management of modern pig farms.

The end users: Farmers, feed providers, meat producers, retailers, consumers

Through having their needs satisfied as soon as they arise, animals perform better which leads to increased pay-offs for all stakeholders.

The farmer: better meat quality, animal welfare labels and improved growth rates that will save time and money for farm management.

The feed provider: the data delivered will help them to adapt and improve the composition of feed and the management of raw materials, which is crucial to food security challenges in times of food scarcity.

The abattoirs: animals will be delivered in their prime, enabling the provision of top quality products to the market.

The retailers: benefit from objective data and can create robust animal welfare and meat quality labels.

The consumers: will benefit from better quality meat and more transparency regarding the animals' living conditions.

Policy makers and agriculture legislation: ALL-SMART-PIGS delivers relevant real-time data on animal welfare from farms, including air quality parameters (in particular ammonia concentration) leading to improved respiratory health and traceability. Policy makers should take advantage of these new technologies so that health safety standards for farm workers and food safety standards can be improved. Consumers moreover get more evidence to make informed choices.

The inventors: SMEs, research and technology organisations

ALL-SMART-PIGS is a continuation of the groundbreaking project BrightAnimal where researchers analysed pig, poultry, dairy and aquaculture sectors and presented new technological solutions to improve the quality of animal farming. It became apparent very quickly that individual efforts were quite advanced, but that researchers and engineers never really implemented their inventions on real farms. For farmers the purchasing decision was too challenging since the available technologies were too fragmented and covered only certain aspects, making returns on investments were difficult to estimate. ALL-SMART-PIGS concentrates on creating a consistent product package measuring real-time data in order to deliver evidence for better and more informed choices for farmers. The product was co-created with farmers, feed providers and slaughterhouses in a Living Lab, ensuring future market acceptance.

Development stage: Pilot tests towards proof of concept

The project will deliver a proof of principle and the basis for a validated product package, including results from four real-farm installations in Hungary and Spain,serving as Living Labs. A cost-benefit analysis will be conducted to provide data to clients, detailing what return they can expect from purchasing this solution. Socioeconomic aspects will be included in the analysis, e.g. working hours, availability of staff, peers' perception, and environmental impact. Not developed so far: a commercialisation strategy for the product package, and an acquisition strategy for public or private investors.

Policy impact: Feed chain regulations

The optimisation of animal feed through the data delivered by the ALL-SMART-PIGS technology may influence food security policy and the related chain regulations towards a more efficient composition of feed and less feed waste.

Next steps: Out of the comfort zone of science into the business battlefield

ALL-SMART-PIGS is only beginning. Currently installations exist on the four test farms in Spain and in Hungary. Farms have finished testing the technology under the real commercial pig farming conditions, while gathering relevant socioeconomic data. This is a key moment, when the project moves out of its comfort zone of science to the battlefield of business. In 2014 the technology will be tested for eight months in the field with all stakeholders. There is an opportunity for integrating other technologies from SMART FARMING start-ups such as the sister project EU-PLF (www.eu-plf.com). The goal is to bring the real product to the market. Disseminating information on the benefits of these products in expert and professional media is key to successful market uptake.

ALL-SMART-PIGS

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WHAT PRECISELY DOES MY DINNER CONTAIN?

How EuroFIR harmonises food composition data

The project: Promoting standards in food composition

Several hundreds of thousands of food products are on the market. These include fruit and vegetables, meat, fish and milk as well as crafted and processed foods ranging from noodles and yoghurt to highly composite products such as ready-to-eat-meals and complex dishes with sauces and other ingredients. It goes without saying that consumers, retailers and producers want clear-cut definitions of foods and their sub-categories, i.e. what distinguishes white from dark/brown bread, what are they made from and which nutrients they contain.

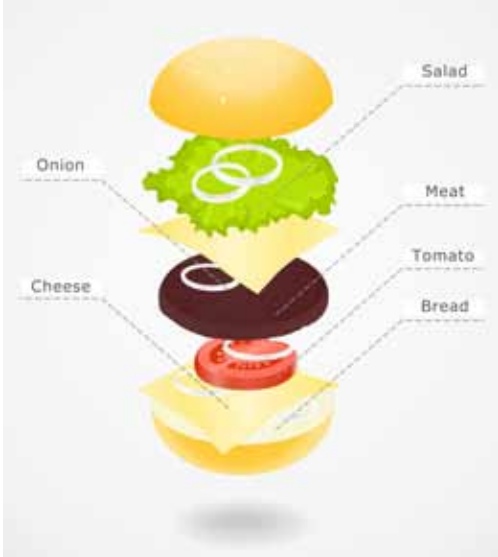
To date, only national food tables have been used to gain insights into food composition but each uses different definitions and methods of analysis. EuroFIR AISBL, an international, member-based, non-profit association under Belgian law was set up in 2009 as a successor to several EU-funded projects, offering a global perspective.

EuroFIR's purpose is to develop, manage and exploit food composition data, and promote international cooperation in best practice and harmonisation of standards. This cooperation has improved data quality, storage and access, and supports comparable activities among organisations with similar goals. EuroFIR is dedicated to increasing awareness and understanding of the value of food composition data and its importance for consumers, enabling them to make healthier dietary choices. EuroFIR wants to ensure sustained advocacy for food information in Europe.

The product: etools

EuroFIR AIBSL members have developed four etools for different user groups to facilitate the nutrition analysis and the application of food composition information. These are:

- FoodEXplorer is a new innovative interface for food composition data, which allows users to search information from most EU Member States as well as Australia, Canada and the USA simultaneously. Users have access to a wide range of data, linking foods and nutrients through harmonised data description (LanguaL), standardised components and value description with the use of EuroFIR thesauri (standard vocabularies) and associated nutrient value information. Ready for market;
- FoodBasket supports users, particularly dieticians and SMEs, with the calculation of composite and prepared foods. The user-friendly, multilingual interface enables any food composition dataset to be selected and linked to FoodEXplorer. FoodBasket runs on mobile devices (e.g. smart phones and tablets) as well as desktop computers, and is fully integrated with other resources. Recipes calculated in advance can also be used as ingredients in new meals, and the results can be exported as text as well as XML-files. Ready for market;
- EuroFIR ebook collection complements existing food composition tables (online and hard copy). EuroFIR developed these in collaboration with national compiler organisations, and the data are presented in English or English and Greek, Swedish or Slovak, facilitating cross-national comparison. eBooks can be purchased online and downloaded immediately. They are fully searchable PDF files—the food composition tables are sorted alphabetically. They are presented in a user-friendly format and the data are standardised across all publications and represent the best available content in Europe. Ready for market;
- EuroFIR elearning modules are designed to help users acquire a comprehensive understanding of the different aspects of food composition data. They are aimed at all those involved in food composition work including graduate students. The modules use animations and visuals to assist students in understanding nutrient analysis. Four major areas of nutrient analysis are covered - fats and fatty acids, proteins and amino acids, carbohydrates and fibres, and



minerals. The module includes interactive exercises that should motivate students and help them digest the information presented. The elearning modules are not designed to replace general courses on the application of food composition data but rather are designed to be an integral part of these courses. The elearning modules were created together with the Wageningen University (NL) and the software company Topshare International BV (NL). Ready for market.

The end users: Food industry, publishers, health professionals, consumers

Delivery of high quality, validated food composition information is essential to address food quality, nutrition, and public health challenges in Europe. Users of EuroFIR products include the private sector as well as public bodies, education, and food data publishing organisations and editors.

Food and biotech industries, particularly SMEs, will benefit from standardised global data that can be used for creating and marketing new products.

Consumer organisations, health professionals and consumers rely on food composition know-how, including access to tools for the delivery of digestible information such as nutritional content for dietetic planning and health management for families and individuals.

Research organisations and funding bodies benefit from provision of standardised international food composition information that supports research and helps with responding to project calls and procurement.

Regulators and policy-makers depend on reliable data to make informed choices in law-making.

The inventors: A network of food research organisations

The Institute of Food Research in Norwich (UK) coordinated the first EuroFIR Network of Excellence, which was funded by the EU 6th Framework Research Programme (EU FP6, 2005-2010) building on 25 years of collaboration and sustained activity in food composition research across Europe.

In the early 20th century, demand for information about nutrient content led to the creation of national food composition tables, which are still used to develop diets with specific nutrient content in clinical practice, to determine emergency food supplies, and to assess the nutritional value of foods consumed by individuals and the wider population. EuroFIR has provided the first comprehensive pan-European food information resource, which has allowed for effective management and improved functionality including the comparison of data across sources and amongst countries.

The follow-up project, EuroFIR NEXUS (EU FP7, 2011-2013), sought to consolidate earlier developments; to further implement and refine these resources to support food and health research in Europe; and to increase awareness, application and exploitation of national food data and the wider implementation of standards and best practice.

As a third step, EuroFIR AISBL, now a financially independent organisation, aims to be the best and only independent broker of validated food composition information in Europe, facilitating improved data quality, storage, access and delivery, and encouraging better application of food composition data through harmonisation and training.

Development stage: Ready for market

All four etools are developed and ready for market.

Previously, EuroFIR has focused its marketing activities among project beneficiaries and users, including national food composition database compiler organisations, researchers, and dieticians. With established products and services, EuroFIR wants to move its focus towards potential customers and/ or partners with whom they can:

- Develop, maintain, or improve marketing of existing tools and resources;
- Secure further investment to enhance the existing infrastructure, and;
- Develop new tools/ platforms that anticipate the future food composition information needs of European research areas and food and biotech industries.

Policy impact: Address public health challenges

EuroFIR AISBL is the only EU-wide independent food composition resource bringing together food composition datasets from 26 European Member States, Australia, Canada and the USA at a single point of entry, as well as working alongside FAO INFOODS outside Europe. EuroFIR is recognised as an independent resource and promotes trust throughout its proven network of contacts, facilitating access and cooperation among national food composition database compiler organisations and other key users including the food industry, education, and policy-makers. While the commercial potential of food information is limited—these data will be freely available—there is an increasing demand to support its interpretation and application in research and/or clinical practice, which is essential if governments globally are to address public health challenges e.g. energy intake.

Next steps: Promotion

The key objectives for EuroFIR AISBL in 2013-2015 are to:

- Support, facilitate, and promote the compilation of validated and documented food composition data by national food composition database compiler organisations in Europe and globally;
- Develop and implement the EuroFIR Food Platform, embedding it in the wider European food and health research infrastructure (RI);
- Promote and deliver training and continued professional development (CPD) for food composition researchers and students, and other target stakeholders and users (non-member compilers);
- Provide a forum for networking and information exchange, and new funding streams for food composition and nutrition researchers, food analysts, industry professionals, and other stakeholders and users;
- Represent and lobby to increase visibility/awareness, impact and promotion of the importance of food composition research among key stakeholders and users.

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SMART LABELS TELL CONSUMERS HOW FRESH THEIR FOOD IS

IQ-FRESHLABEL improves food quality and safety through intelligent labels

The Project: Optimisation of technologies and new biosensors

Consumers ask for transparency and food safety. Now, 'intelligent labels' on food packages provide important information. The labels change their colours - from green to red or from blue to white - when the freshness is waning. Has the temperature of frozen fish been too high for too long? If so, the label changes from green to orange or red. Has a MAP-packed chicken lain too long outside the chilled shelf? Then a label on the pack will detect it: the dark blue colour starts to fade. The current 'best before' regulation in the EU, informing consumers of the possible expiry date, is a rather conservative approach. A lot of unnecessary waste, in supermarkets as well as in households, is caused because products are thrown away at the 'best before' date although, properly stored, food products are edible after this date.

The optimisation of existing smart label technologies and the development of new biosensors, measuring the real state of freshness, is therefore the goal of the project named IQ-FRESHLABEL.

The Product: Smart labels for food packaging

Improper handling of products along the cold chain – especially exposure to high temperatures during production, transport, and storage - results in decreased sensorial quality and premature spoilage of food. Deterioration in flavour, increased microbial growth, and subsequent altered oxygen concentration in the packaging are some of the indicators of the quality loss and spoilage of chilled or frozen foods. The principle of the technology behind smart labels is to correlate changes in quality with time and temperature in a visual colour signal. The project is the successor of two projects funded under the 6th Framework Research Program of the EU, FRESHLABEL and CHILL-ON.

So far four types of smart labels have been developed or optimised:

- Eye- and machine-readable oxygen sensor (prototype). The sensor is based on a two-step process in which the active material of the sensor is activated with UV light and subsequently the O2 concentration is detected by straightforward luminescence technology. The sensor (a label) changes from a 'non luminescent' state (no oxygen) to a luminescent state (oxygen detected) according to the concentration found. The luminescence is a sign of decreasing freshness;

- Aluminium time temperature integrators (TTIs) for chilled MAP poultry products (produced by FreshPoint Quality Assurance Ltd.). The TTI contains a layer of aluminum, giving an initial silver colour to the label. To activate the TTI it is necessary to stick a reactive label over it. With time and temperature, the silver layer dissolves to indicate the corresponding decrease in quality of the product. The background colour of the label (yellow) becomes visible. When the label is totally yellow, the food product is bad;
- Enzymatic time temperature integrators (TTIs) for frozen products (produced by Vitsab International AB). The TTI comprises two small pouches: on the one side with enzymes and on the other side with substrate. The device is activated by pressing on the pouches and mixing enzymes and substrates. The initial colour of the label is green. Over time, and according to temperature variation, the colour changes to orange/red to indicate the decreased quality of the food product;
- Photochromic time temperature integrators (TTIs) for frozen products (produced by BIZERBA).

The TTI is printed with intelligent ink containing organic crystals that change colour according to the accumulated temperature history of the product. The crystals are activated by UV radiation. The initial colour is dark blue. The colour fades to pale blue according to time and temperature variation to indicate the decreased quality of the product.

The end users: Food producers, retailers, packaging industries, consumers

Supply chain: SMEs and producers of chilled and frozen food, packaging and distribution over long distances.

Retailers: offering specific information about food quality on products; avoidance of food spoilage and waste by precise detection methods; avoidance of quality defects

Consumers: assurance of safe and fresh food, objective information and transparency over the whole supply chain and avoidance of spoilage of edible food.

The inventors: Industry, research and technology organisations, academia

Technologies behind enzymatic, aluminium, and photochromic TTI belong to project partners Vitsab International AB and FreshPoint Quality Assurance Ltd., both companies being smart labels producers. The collaboration with RTD performers Rheinische Friedrich-Wilhelms-Universität Bonn, National Technical University of Athens and ttz Bremerhaven has enabled the validation of smart labels for chilled and frozen food products along the cold chain.

In addition, the RTD performer Universität Bayreuth has developed, together with Yoav Eichen, a brand new technology as base for an oxygen sensor. The sensor is based on a two-step process in which the active material of the sensor is 'sensitised' with UV light and subsequently the 02 concentration is detected by straightforward luminescence.

To support optimal design of smart labels and their short-term uptake and implementation, RTD performers Valtion teknillinen tutkimuskeskus VTT and Taloustutkimus Oy have conducted socioeconomic impact analysis of chain's stakeholder and consumer acceptance.

The IQ-FRESHLABEL project has 17 project partners including research institutions, industry associations and SMEs.

Development stage: Prototypes and/or ready for market

The readable oxygen sensor is at prototype stage, whereas the three other labels - enzymatic, photochromic, aluminium Time Temperature Integrators - are developed and ready for market.

IPR (Intellectual Property Rights) are currently under definition.

Policy impact: Food safety policy

The IQ-FRESHLABEL project aims to influence the research and legislative areas in food labeling and packaging. Currently 'best before' dates are the only legally required assurance of desired properties of food products. These, however, are not always a satisfactory measure of quality. The smart labels could therefore bring a paradigm shift in food safety policy.

Next steps: Acceptance tests and consumer education

Flexible tools for the determination of the economic impact of the implementation of TTIs are still to be developed and tested. There are still some hurdles to overcome before the product can be available on the market: acceptance of food chain stakeholders and consumers, education of stakeholders and consumers about the use and utility of the labels. Consumers have to be trained, or informed via extra labeling, about the different meanings of the colour-changing pouches and strips. Tests of consumer and retailer acceptance are underway. Standardisation questions may arise.

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BRAIN POWER FROM BRAIN FOOD FOR CHILDREN

NUTRIMENTHE contributes to research on the association between diet and mental performance

The project: Studies from birth to age nine

NUTRIMENTHE has added to the growing evidence that prenatal and childhood nutrition influences later mental performance. Fish intake, folic acid availability, and iodine may influence the development of a child's mental capacities, such as language development and behaviour. This has been demonstrated by a series of studies conducted and analysed by the project. These results could have major implications for public health practice, policy development, economic progress and future wealth creation.

The five-year study, due to end in December 2013, aims to research the role of specific nutrients in the cognitive, emotional and behavioural development of children from before birth to age nine. Nutrients being studied include B-vitamins, iron, iodine, protein in formula and breast milk and omega-3 fatty acids. Consumer (parents and teachers) perceptions regarding the term 'mental performance' and the economic benefits of improving mental performance have also been addressed. More than 17 000 mothers and 18 000 children have taken part in epidemiological (population) and nutritional studies in centres around Europe.

The product: Recommendations for brain food composition

NUTRIMENTHE's results could pave the way for health claims about how diet affects mental performance, leading to the development of innovative evidence-based supplements or the fortification of existing foods with beneficial micronutrients.

No specific product will be generated by the project. However, a global database has been created that includes mental performance data, physical activity data, dietary intake data, and anthropometric data, from children taking part in NUTRIMENTHE's studies around Europe.

NUTRIMENTHE has generated new knowledge including:

- Folic acid intake by mothers during pregnancy helps reduce the risk of behavioural and emotional problems during childhood;
- Iodine levels during pregnancy are linked to verbal IQ at age 8 and reading ability at age 9;
- Poor maternal thyroid function during pregnancy is a risk factor for the development of language delays in childhood;
- Genetic variation can influence nutrient status in maternal and foetal tissues. NUTRIMENTHE recommends that future epidemiological and nutritional studies take genetic heterogeneity into account;

NUTRIMENTHE will continue issuing new information from its research through peer-reviewed publications.

The end users: Parents, health professionals, industry

Consumers, especially parents, will be informed as to how diet affects their child's mental performance, enabling women to make better dietary choices when pregnant or planning a pregnancy. Parents will also be better informed on childhood dietary requirements.

Researchers will benefit as NUTRIMENTHE's publications will continue to contribute to the global knowledge of how diet affects mental performance.

Health professionals could use these project results to inform pregnant women and the parents of young children of the benefits of certain nutrients and foods—to support brain development and mental performance.

Industry could use NUTRIMENTHE's findings for innovations in the food industry such as the production of supplements and/or the biofortification of food products.

The inventors: Multi-disciplinary academia

The Global Database. This is the invention of multiple organisations involved in NUTRIMENTHE.

NUTRIMENTHE has been measuring different areas of mental performance including; perception, motor skills, attention, memory, language, behaviour and executive functions, in different studies—including long-term epidemiological and nutritional intervention studies looking at different nutrients—involving children of varying ages from seven different countries. The project developed a harmonised battery of mental performance tests to enable comparison of results from different studies. The results from these studies have been collected to form the global database which will be made available to researchers within the NUTRIMENTHE consortium. In the future, access to the global database may be extended.

NUTRIMENTHE has brought together a team of leading international scientists from major research centres across Europe and beyond who are leaders in key areas of nutrition and mental performance. This combination of expertise together with the research consortium of partners from eight EU countries and the USA, covers the following fields: nutrition, paediatrics, child psychiatry, child psychology, neuroscience, food technology, genetics, epidemiology, biochemistry, consumer research, market research, economic analysis, statistics, communications and project management.

Development stage: Research

No development yet, ongoing research.

Policy impact: Health care policy

The project could potentially influence future healthcare policy, especially advice given to women during pregnancy and that given to parents of young children, in terms of the best foods to eat to maximise children's brain power.

Next steps: Promotion

To help towards widespread usage of these results, steps should be taken to bring these key messages to the attention of consumer groups and policy makers.

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HEALTH INFORMATION ON BOTANICALS: PLANT EXTRACTS, PILLS, CAPSULES AND HERBAL SUPPLEMENTS

PlantLIBRA analyses and assesses 'green substances' in food

The project: Food safety research and product development

Are there health benefits to taking Ginko biloba capsules? Can cinnamon tablets have any adverse effects?

The PlantLIBRA project aims to provide new science-based data and an integrated approach to better evaluate these questions. Moreover, it focuses on the safe use of plant food supplements (PFS) made from plants or botanical preparations, referred to as botanicals.

PFS and food compounds of plant origin are closely examined in the project. These are defined as concentrated sources of nutrients (or other substances with a nutritional or physiological effect) whose purpose is to supplement the normal diet and which are marketed in dose form as pills, tablets, capsules, or liquids in measured doses.

As yet undetermined number of plant species can currently be used legally in the EU, mainly based on their history of use and differences in national permission lists. So far, EU legislation distinguishes between plant food supplements and traditional herbal medicinal products, but this categorisation can vary between countries, and the boundaries are fuzzy. This can lead to consumer confusion and regulatory inconsistency across Europe. To respond to the increasing demand of decision makers for quality data on botanicals, adequate methodologies, including vast, sustainable, immediately accessible databanks, need to be made available.

PLantLIBRA has also investigated the intake and consumption patterns of botanicals in six European countries, delivering data in support of food risk management and food marketing. After the project's four-year lifespan, one major final deliverable will be a multipurpose internet metadatabase. PLantLIBRA closely cooperates with the EuroFIR project, which has developed the edatabase structure for standardised plant food data.

The product: Validated health information, quality data and etools

An internet-deployed database, ePlantLIBRA, has been developed for use by researchers and health professionals, the food industry, regulators and policy makers.

Users can access data on the composition of produce, botanical information, inherent active compounds, bioeffects data (beneficial and adverse), contaminants and residues, as well as PFS-specific information on claimed effect, ingredients, active substances, target groups, and contraindications.

Risk assessment know-how: Due to the variety of products and consumer habits, lack of shared definitions and harmonised methodology, data on the intake and consumption patterns of PFS in Europe are largely unknown. Such data would be extremely useful for conducting risk and benefit assessments. Regulations and controls required for PFS vary at the European and international level and pose barriers for market development.

PlantLIBRA set out to provide harmonised approaches, validated methodologies and new data. The array of features includes a combined database of quality-assessed data on plant composition and compounds, extracts, analytical methods, case-reports of adverse events, literature on benefits and risks, and the beneficial and adverse effects of component compounds.

The end users: Lawmakers, supply chain, pharmacists, consumers

Lawmakers and regulators: Because of the many sensitive health effects of PFS and botanical preparations, including food safety issues, PlantLIBRA's data are of high interest to lawmakers. They currently form the biggest stakeholder group for the product. The active involvement of stakeholders through PlantLIBRA's Policy Advisory Board (PAB) has provided the opportunity to address problems and receive input on regulatory bottlenecks, priority plants, Member State (MS)

differences, and limitations in the sector from government officials dealing with the regulation of botanicals. At present, the PAB includes delegates of 25 countries from 21 EU MS, non-EU countries and Norway, and international representatives from China, the USA, and Argentina. Such broad membership extends the impact of the project's outputs, like ePlantLIBRA, to countries with large plant food supplement markets.

Supply-chain: Food manufacturers, pharma firms, food marketers and retailers are increasingly interested in user-friendly data on botanicals for quality control and traceability for plant authentication, cases of adulteration, and related contaminants and residues.

Health professionals: Poison emergency centres, hospitals, medical doctors, pharmacists, and nurses should have easy access to information on beneficial or adverse effects of PFS and botanical preparations, which the database provides.

Education and consumers: In order to help the public make informed choices and learn the use of health databases, a user-friendly version of the database will be provided.

The inventors: Academia, SMEs and associations

The EuroFIR Network of Excellence, coordinated by the Institute of Food Research (UK), has built on 25 years of collaboration and sustained activity in food composition research in Europe. This expertise has been used by the PlantLIBRA project. Overall coordination of the PlantLIBRA project is provided by the coordinator, Patrizia Restani of UMIL, (Università degli Studi di Milano, Italy). The consortium comprises leading academics, public research institutions, SMEs, industry and non-profit organisations.

The added value of the ePlantLIBRA database is not only the targeted expansion of existing databases and its food composition data, but also the inclusion of the methodology and data being generated by the PlantLIBRA work packages which started in 2010 under the EU-FP7. Its holistic approach includes the interface and links to other databases like the transfer of relevant data from the MoniQA database information on residues and contaminants into ePlantLIBRA.

Development stage: Piloting and test phases

The ePlantLIBRA web platform has already gone through the first phase of system and reporting revisions resulting from the first usability testing during September 2012 which consisted of remote, unsupervised access to the database for 2-3 weeks by project stakeholders: partners, experts, policy and special interest advisory groups.

The second cycle of usability testing will start soon, and once again the project partners, potential users from the PlantLIBRA Policy Advisory Board (mainly national regulators) and other experts from industry will be invited to test and provide feedback on the database. For this second cycle, poisons emergency centres are also being invited to access the database and test a dedicated section to search for adverse effects of botanicals.

With regards to the potential benefits for industry, manufacturers, associations, consumer groups, pharmacists, retailers and stakeholders, the second round of usability testing of ePlantLIBRA will take place in September 2013, displaying the database's features and giving you the opportunity to share your expert opinion in order to improve its functionality and usability for your special needs.

Please contact Carlos Ramos at cr@eurofir.org if you would like to be involved.

Policy impact: Better regulation

While research on the biological effects of plants is carried out worldwide, only a small proportion is specific to PFS, and takes place mostly as a national effort in the USA. Without pre-existing cooperation with stakeholders and local intelligence, it is difficult to identify, prevent and control food safety crises, including those involving PFS. PlantLIBRA forms an international research community, contributing to international law-making and harmonisation of standards, and ultimately helps increase science-based decision-making by regulatory authorities and players of the PFS supply chain in the EU and in exporting countries.

The PlantLIBRA consortium is made up of 25 beneficiaries, spanning four continents: 20 are from EU Member States (Austria, Belgium, Finland, Germany, Italy, the Netherlands, Romania, Spain, and UK); one is from Switzerland, an Associated Country; and four are from International Cooperation Partner Countries (ICPC): Argentina, Brazil, China and South Africa, where botanicals are widely used and exported.

To potentially influence future PFS legislation, the usability testing gives stakeholders an opportunity to have their say.

Next steps: Updates, launch and IP rights

Testing, improving and enlarging the database and its dissemination.

After the project's end, the continuity and sustainability of the ePlantLIBRA is a key issue. To address it, a sustainability task force has been formed to:

- Promote and deliver training, e.g., webinars to target stakeholders and key users;
- Meet users' needs and requirements;
- Involve experts in continuous updates of new data;
- Conduct appropriate dissemination and promotion, including launch and IP protection;
- Develop membership model, pay-per-access and income.

PlantLIBRA

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SMELL, TASTE AND TEXTURE: WILL THE LOW-FAT, LOW-SALT PIZZA EVER PLEASE?

How the PLEASURE project changes the food processing matrix

The project: Searching for concepts and novel technologies

More than 60% of all reported diseases in modern industrial countries originate from malnutrition due to low vitamin intake and high caloric food. The cause of this high consumption of fat saturated and trans-fatty acids, salt (sodium) and sugar (mono- and disaccharides) — is that Western diets contain a considerable amount of processed foods such as pizza, ready-to-eat sauces and pastry products that are energy-dense and over-seasoned. These fatty products such as pizza and puff pastry – the model products of the PLEASURE project – are among consumers' favourites. If healthier versions of these products can be accepted in future, the sensory properties of the new products such as smell, taste and texture will have to be reformulated. This process will go together with sustainable concepts of caloric reduction and ingredient reduction.

The PLEASURE project addresses this challenge from the processing side and the search for new food micro-structures. Novel technologies will lead to new textures (solidity, crispiness, softness, elasticity, etc.) of well-known food products and different dispersion of salt and fat in the food layers will be achieved. This will allow for reductions in fat (in particular saturated and trans-fatty acids), salt and sugar (mono- and disaccharides) while the new micro-structures in these food products will help reduce the use of additives like sweeteners and emulsifiers, achieving an optimised taste. The sensorial perception of sugars, salts and fats present in these new products will be key to acceptance by consumers.

The product: Traditional models with new properties

The goal is to optimise model-products—pizza dough, mozzarella-type cheese, sausages and fruit/vegetables sauces—with five or six new recipes. The end-products will contain 10% to 30% less salt, fat and sugar. Fat will be substituted with fibres, natural ferments and enzymes, changing the micro-structures of these products to reformulate taste and other properties.

Another approach will be to test and implement novel processing technologies for the market uptake of innovative production know-how.

The concepts will first be developed for four mono food systems:

- Bakery (pizza dough and puff pastry);
- Cheese (mozzarella style);
- Meat (bologna-type sausages and cooked ham);
- Fruit and vegetable preparations.

In a second step these novel processes will be applied to three Ready-To-Eat (RTE) meals gathering the mono food systems which have been previously optimised: a pizza system (dough, mozzarella, sausages/ham and tomato sauce), a puff pastry with a meat filling and a puff pastry with a sweet fruit filling.

To substitute fat in sausage batter the use of carbohydrates such as starch, pectin, guar as well as soluble and non-soluble fibres will be tested. Salt replacements will be used to reduce salt content as well as enhancing saltiness through processing. To facilitate reduction in fat content in cooked and raw sausages saturated animal fats will be replaced by plant oils.

For cheese, a model based on mozzarella—low in sodium and fat—for immediate consumption and for the use on pizza products will be tested. High pressure homogenisation and enzyme technologies will be investigated to modulate taste and texture and enhance the flavour intensity of fat mozzarella-style cheese with reduced sodium. The aim is to achieve 30% reduction in salt and a reduction in fat contents from 0.95% to 17%.

The end users: Food manufacturers, marketing, retailers, consumers

SMEs and consumers: PLEASURE involves novel processing approaches and tailor-made technologies that can be used by food producers to manufacture healthier food for European

consumers.

Retailers and marketing: PLEASURE will contribute to the CLEAN LABEL movement, which removes any substance from food formulation that is not food based (i.e. conservatives, substitutes, etc.). This will support future marketing and labelling strategies.

The inventors: SMEs, research and technology organisations, academia

The project has 16 partners—with more than 50% from private businesses or private institutions. Other participants include universities and non-profit research institutions.

The lead partner is BIOZOON Food Innovations GmbH, an SME specialised in molecular gastronomy and specific food segments.

Development stage: Proof of principle and patenting

The patent is pending for a biotech process for sugar reduction in apple juice by fermentative and enzymatic processes. The process is to be transferred also to tomato juice.

Sensory and perception tests for salt and sugar taste and its alternatives will be prepared *in vitro* and *in vivo* (expert panels and consumer blind tests).

The pizza model is the ambassador of the reduction strategies concept, as pizza is a widely consumed product. Having such a popular product as model has the potential for wide communication actions to the European food industry and to the general public.

Policy impact: Adjustment of nutritional indices

The key elements of the PLEASURE concept aim to contribute to improving scientific understanding of the perception of saltiness and sweetness in mono food systems and in complex food systems. It will also provide a new opportunity to amend existing regulations on nutrition using specific salt, fat and sugar indices developed in this project.

A thorough dialogue through direct consultation with European policy makers such as DG SANCO and EFSA, national ministries and others will be established to obtain their support for this approach.

Next steps: Testing and transfer workshops, marketing strategies

PLEASURE will organise a conference, 17-18 June 2014 in Nantes. During this event, the state-of-the-art in flavour perception techniques using *in vivo* and *in vitro* approaches will be benchmarked against other projects and methodologies. Recent results obtained within the project and in selected parallel initiatives in Europe on salt, sugar and lipid reduction will be presented. This will include tasting new products developed within PLEASURE which will be benchmarked against a control product.

The study on the perception of saltiness in assembled solid food is a distinctive feature of the PLEASURE project. Coffee breaks and lunch breaks will be used as opportunities to taste and compare different products based on the salt, sugar, and lipid reduction process.

Additionally:

- Several demonstration workshops will be carried out to ensure efficient technology transfer into the European food industry to facilitate the widespread uptake of the results from the PLEASURE project;
- The development of detailed exploitation and marketing strategies is key for the participation of SME beneficiaries;
- Several consumer acceptance studies will be organised to test the sensory acceptance as this, along with the affordability of these new food products, is one of the most important success factors.

PLEASURE

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WHEN PLASTIC DUCKS ARE MADE FROM PLANT RESIDUES

BioConSepT - a novel way of using natural residues for green products and chemicals

The project: Demonstrating second generation white biotechnology processes

Second generation biomass – agro-food residues, wood residues and non-edible oils and fats – could deliver the raw material for the plastics of the future, without taking material from the food chain.

The BioConSepT project focuses on producers and users of bioplastic materials in industry and consumer-oriented businesses. The EUR 13 million EU-funded project contributes to the ongoing 'food or fuel' debate: agro-food residue streams, wood residues and non-edible fats and oils replace edible biomass which competes with the food chain. These inedible feedstocks are considered to be the future ingredients for many applications of bioplastics in industrial and consumer products.

BioConSepT aims to demonstrate the technical feasibility of white biotech processes for the conversion of second generation biomass into platform chemicals, which are 30% cheaper and 30% more sustainable than existing chemical routes or first generation processes. The project uses lignocellulose and inedible oils and fats as cheap, abundantly available feedstocks, which cannot be used as food.

The main achievements expected for BioConSepT are:

- To develop the robust enzymes and microorganisms suited to the more dirty second generation feedstocks;
- To reduce equipment costs and the number of process steps by the integration of bioconversion and highly selective separation technologies;
- To facilitate easy integration in existing production chains by deploying combinations of bio- and chemical conversions and by proving the suitability of the produced platform chemicals for biobased polymers, resins, plasticisers, solvents and surfactants;
- To realise the first demonstration of integrated production chains from second generation feedstocks to platform chemicals at an industrially relevant scale.

The product: Biobased chemicals, bioplastic applications, novel technologies

The markets for itaconic and succinic acid are expected to grow rapidly until 2020, replacing oil-based chemicals by bulk applications like biobased plastics (rubbers, polyamides, polyesters).

Others like α- and ω-dicarboxylic acids from natural fatty acids have a similar potential, especially for the production of commercial plastics like polyesters, polyamides or polyurethanes. The furane dicarboxylic acid (FDCA) market is currently small because of high prices. But FDCA has huge potential as a replacement for terephthalic acid, which is used for the production of PET plastic materials. A prerequisite for the use of these platform chemicals in bulk markets is to be competitive with oil-based or glucose-based alternatives.

The end users: Industry supply chain and private users

BioConSepT focuses on producers and users of bioplastic materials in industry, but also consumer-oriented businesses.

The main target groups of the project are technology suppliers, engineering companies and producers of production chains from second generation feedstocks to end-products, which aim at a 30% cheaper and 30% more sustainable production. It is expected that both, SMEs and large companies will contribute and benefit from the transition to bioplastics.

The inventors: Research and technology organisations, industry, SMEs

An experienced consortium of five research and technology organisations (RTOs), ten large industrial companies and 16 small and medium-sized enterprises (SMEs).

The project is led by TNO – Netherlands Organisation for Applied Scientific Research, Delft, The Netherlands.

Development stage: Proof of principle, upscaling

BioConSepT will bring novel technologies from laboratory to pilot scale by high-level applied research, including

upscale process development of the usage of feedstock by fragmentation and fermentation.

In a detailed market report on the relevant platform chemicals the BioConSepT team learned what the market potential of the individual platform chemicals will be. Project partner Pöyry organised four conceptual process design workshops where BioConSepT scientists discussed and defined process chains. Data and calculated balances were further used as input for life cycle assessments carried out by partner QNorm. Upcoming research results will be published soon.

Policy impact: Lead Markets Initiative, Environmental Technology Plan, Knowledge Based Bioeconomy Strategy and HORIZON 2020

BioConSepT contributes to realising the objectives of environmental and industrial European policy initiatives, such as the Lead Market Initiative in Biobased Products (LMI), the Environmental Technology Action Plan (ETAP) and the EU Strategy for Key Enabling Technologies (KET). The EU funded project aims at enhancing the competitiveness and sustainability of European industries by substituting limited fossil resources with renewable resources and integrating cleaner bioprocesses into the production chain. In addition, the use of second generation biomass in integrated processes, with new separation and product removal features, reduces process and product costs and enhances the competitiveness of the chemical industry.

The Knowledge Based BioEconomy (KBBE) is a key element in the EU strategy under HORIZON 2020, which as well as enhancing competitiveness, also addresses the need to reduce the dependence of Europe on raw materials and energy from regions outside Europe. The reduced use of primary raw materials and sourcing energy from renewables contributes to clean and environmentally friendly processes and products and a significant reduction in the emission of greenhouse gasses.

Next steps: Novel microorganisms, new equipment, new processes

In the near future the core activities in BioConSepT promise inventions in the following areas:

- Novel microorganisms and enzymes improving the production of biobased platform chemicals from second generation feedstocks;
- Novel equipment and processes for conversion of second generation feedstocks;
- Processes and equipment integrating conversion and separation;
- Novel equipment and processes for cost-effective and energy efficient separation and purification of platform chemicals, and novel applications and products derived from the platform chemicals.

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IT'S ALL FROM SUGAR: BIOPLASTICS FOR TRUCKS AND BUSES

BRIGIT focuses on new applications of green polymers in the transport sector

The project: Exploring potential ways to convert wood waste into plastic composites

The recycling of transport vehicles, trucks, and trains poses severe challenges due to a high percentage of non-degradable parts and materials. With rising demand for lifecycle assessment of manufactured goods, the market for sustainable and biodegradable components in the transport sector is set to increase. This is the baseline of the BRIGIT project.

BRIGIT's focus is on bioplastic applications in the transport sector, such as headrests, floors, ceilings, and coatings, in combination with natural fibres. PHBs, PBS and its co-polymers from waste-derived lignocellulosic sugar feedstock liquor or wood sulfite pulping processes are the starting point. From the resulting new biopolymers the project intends to develop high-tech fire-resistant bioplastic applications. The biocomposites in combination with natural fabrics will be used to produce new 3D sandwich panels as an end product in the transport sector. These new panels will be a lightweight alternative to the current panels made out of thermostat resins reinforced with glass fibres. The new panels will be easily integrated in continuous manufacturing processes and value chains.

The product: Process innovation and purification technology, fire-resistant polymers

All potential products of the BRIGIT project are in development or licencing stage:

- Process for PHA and PBS production from waste (spent sulfite liquor). The main innovation in BRIGIT is the use of an existing sugar-rich waste stream and the process integration with the existing industrial operation, the in situ fermentation process. As an example, pulp production can be used for the integrated fermentation technology using engineered yeast strains. The fermentation, including its conversions into polymers, will take place in the waste stream of pulp;
- This will permit an overall reduction in resource consumption and in greenhouse gas emissions and a dramatic reduction of operational costs due to the use of non-sterile steps. No intermediate discontinuous bioreactors will be needed. Waste transport will be avoided. Applications can lie in valorisation of the by-products from paper and pulp production, processors of agro-forestry raw materials and its biorefined polymers. Possible patent protection, licencing to industrial players, technological services;
- New processes for environmentally friendly purification of PHAs and PBS, which can upgrade current purification technology. Possible patent protection, licencing to industrial players, technological services;
- Process for the preparation and modification of high molecular weight lignosulfonates. Application: plastic transformation. Possible patent;
- Engineered yeasts converting ligno-sugars to PHA and PBS. Applications are anticipated for industrial biotechnology (white biotechnology). Possible patent protection, licencing to industrial players, technological services;
- Synthesis of intrinsically fire-resistant PHB based polymers and lingosulfonates - PHB copolymers. Application: FR master batches in polymer compounding industry. Possible licencing agreement;
- Development of fire-resistant biocomposites (PHB/PBS blends). Application: fire-resistant biocomposite such as granules. Possible patent protection, licencing to industrial players, technological services;
- Development of fire-resistant 3D sandwich panels from biocomposites. Application: fire-resistant panels for transport sector. Possible patent protection, licencing to industrial players, technological services.

The end users: White biotechnology, transport vehicle manufacturing and consumers

The chemical industry and the (goods and passengers) transport sector, technology services are among those who will work with the processes developed, including the application of chemicals such as lignosulfonates for the plastic transformation process. Fire-resistant biocomposites for the transport industry will lead to new applications for manufacturers of vehicles and their users.

The construction sector will benefit from the use of newly developed, recyclable 3-D-sandwich panels.

The inventors: Industry/SME partners, research and technology organisations

The company SNIACE was working in a national project (CENIT) developing polymers from lignin sources. AIMPLAS was interested in working with these types of polymers to improve flame retardancy of standard thermoplastic materials (mainly polyolefins) as alternative to halogen based flame retardants. But during a meeting, the company GREENSOURCES (part of SNIACE group) explained that they have a blend of sugar waste from their current process which lacked a suitable application. AIMPLAS proposed then to produce PHB and PBS for high added-value applications. The BRIGIT project was then designed to focus on the production of flame retardant panels, where these polymers could be used.

The project is composed of sixteen partners, covering the entire value chain from feedstock, biosynthesis of the polymer or polymer precursor, until the optimisation of product recovery, purification and further conversion towards the final product.

The consortium is formed by seven SMEs, three industrial companies and six research centres and universities. All have recognised expertise in their respective fields.

Development stage: Proof of principle, upscaling and pilots

Despite the fact that the project consortium covers the entire value chain, the researchers and industry partners still need to solve different issues during the project such as the integration of the project developments into the current production process of raw material producers, inhibitors removal, purification developments, and the modifications required by polymer manufacturer partners to scale up the biopolymer production.

Being in the development stage, all potential BRIGIT products need to be assessed for application in other sectors. The publication of BRIGIT objectives in this innovation catalogue will increase the industry awareness, facilitating the further exploitation of its products and technologies.

Policy impact: Lifecycle regulations and biopolymer standardisation

By offering biodegradable solutions, the added value of potential BRIGIT products is on the lifecycle costs of manufactured goods and technologies, especially in the transport sector. BRIGIT will propose new testing methodologies and contribute in particular to the necessary future standardisation of biopolymers.

Next steps: New application fields and demo project

Project dissemination as described in the project workplan (brochures, workshop organisation, papers and journals, conferences) and close cooperation among project partners is required to find potential customers outside the project. At the end of the project, the results will be exploited directly by the project partners or licenced. Results which require further industrialisation will generate a new project proposal within HORIZON 2020 (probably a demonstration project) with a reduced number of partners.

BRIGIT

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A PLASTIC FUTURE FOR SHELL WASTE

ChiBio investigates sustainable solutions for residues produced by the seafood industry

The project: Cracking the chitin

Global shell waste is estimated at 6 million tonnes per year, and growing fast. In Europe alone estimations are as high as 750 000 tonnes per year. Shrimp and lobster are among consumers' most popular fisheries products, made widely available by global aquaculture breeding. However, the waste produced by the seafood industry has significant issues beyond contributing to landfills or maritime dumps. Due to flesh or speck residues left in the shells, seafood waste is also a breeding ground for pathogens. Archaic and environmentally dangerous methods of waste treatment are consequently used; shell waste has to be burnt and the ashes dumped at sea or on land.

In many Asian countries, shrimp waste is already converted to chitosan, a commercially valuable compound with myriad applications ranging from use as a biopesticide to biomedical solutions in tissue engineering, non-viral gene delivery and enzyme immobilisation. The problem is that European crustacean shells harbour higher levels of calcium carbonate, thus making the Asian approach unviable.

This is where ChiBio comes in. The project seeks to establish a biorefinery process which breaks down the chitin present in shells into basic components and tries to convert them into precursor compounds for the plastic industry. These components could be used as building blocks in the synthesis of polymers such as nylon or polyester. Whereas current industrial shell processing focuses on the extraction of the chitin from the shells, ChiBio is the first to take the process a step further and tries to integrate the biowaste stream into biorefinery processing using its cascade of potentials.

The product: Novel biobased compounds, process innovation, demonstrators

ChiBio's goal is to gain an array of biobased polymers as precursor plastics for the chemical industry. This could lead to new fibres and fabrics, made from nylons and polyesters.

The protocol used in the project should also lead to other novel biogenic materials - such as insect carapaces, fungi and other chitin-rich derivatives - to be considered for application in pharmaceutical and chemical products.

Another gain of the project is the discovery of new methodologies and processing steps. ChiBio works with white biotechnology along the entire process- and value-chain of waste treatment and waste conversion. New pretreatments with respect to eco-efficiency and sustainabilitiy for European, African and Asian fisheries industries are tested. Novel enzymes for depolymerisation are evolved, and cheap separation processes for proteinogenic and lipoid by-products are developed.

A novel chemo-enzymatic/microbial route to synthesize N-containing bifunctional monomers starting from glucosamine will be established, and the fermentative production route for bifunctional olefins starting from glucosamine and/or N-acetylglucosamine will be developed. The new polymers emerging from this process will have potential for new applications in the marketplace.

The study of the technical feasability of new biotech methods and prototypes of novel polymers will also be used for further demonstration acitivites.

Moreover the potential of energy-rich by-products as feed for anaerobic biogas production will be evaluated. A lifecycle analysis of the entire process chain will supplement the products gained from the project.

The end users: Producers of chemicals, enzymes, pharmaceuticals, neutraceuticals, recyclers

Chemical industry, pharma, food and packaging industry. Bifunctional fatty acids and n-containing heterocycles generated from purified chitin/chitosan display potential building blocks for novel bioplastics and consumables. New polymer characteristics will lead to new fields of application to be evaluated by the chemical industry.

Recycling and biomass-based energy suppliers.

At present, the fishing industry has disposal costs of about 7500 €/t for chitin-rich fishery wastes. The fishing industry pays also for the transport of waste. By directing the waste stream into the production process, cost savings are evident in the first step of the ChiBio biorefinery process.

The inventors: Research and technology organisations, academia and industry

The project consists of five academic partners, four SME partners, and two large industry partners. ChiBio is led by Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (research organisation, Germany). Participating institutes: Fraunhofer IGB and Fraunhofer ICT.

Special contributions:

- Letterkenny Institute of Technology (Ireland): Novel (more sustainable) pre-treatment methods for crab shells;
- UMB (Norway): Novel enzymes and enzyme cocktails for the depolymerisation of chitin/chitosan;
- UMB: Novel oil yeasts to produce high amounts of lipids
- Fraunhofer IGB – Project group BioCat: Novel multi-enzymatic process to produce N-containing heterocycles for polymeric application;
- Fraunhofer ICT – Novel purification methods for bifunctional monomers;
- Apronex (Czech Republic): Optimised expression protocols to upscale enzyme production;
- TUM (Germany): Life cycle analysis;
- Energieinstitut an der Johannes Kepler Universitat Linz GmbH (Austria): Process-Analysis;
- Clariant: optimisation of downstream processing ;
- Evonik: characterisation of polymers;
- Earagail Eisc Teoranta Ltd. (Ireland), Institut National des Sciences et Technologies de la Mer (Tunisia) and PT. Biotech Surindo (Indonesia) : technology transfer options to alternative substrates.

Development stage: Proof of principle, upscaling, piloting

One of the final project goals is the upscaling of the full process chain to make needed enzymes/microbial strains available in kg-scale. Currently the aim is to develop a 1kg demonstrator of a biobased polyamide – current status is at 5-10g dummies for initial testing.

One of ChiBio's current research aims is to find ways of enzymatic depolymerisation of chitin/chitosan as well as the successful separation of new monomers to polymer grade (minimum of 10g for initial testing).

Policy impact: Competitive with petrochemical based products

Enhanced capacity of sustainable processes to compete with petrochemical-based processes is one of the major goals of ChiBio. This will lead to new standards and regulation.

ChiBio contributes to environmental policy action plans, energy policy and eco-technological road maps.

Next Steps: Process optimisation and dissemination

- Characterisation of new polymers and their properties (such as stability, consistency, thermo-mechanical behavior) will be provided by partners from the chemical industry;
- Implementation of large scale processes for the whole production chain is needed for reliable evaluation of lifecycle and process analysis;
- Optimisation of process for different substrates, meaning the processing of chitin containing fishing wastes from different origin. This would be accomplished by ChiBio contributors in Tunisia and Indonesia (Pacific Ocean fishing wastes). Furthermore the technology platform will be evaluated for possible use of different chitin-containing natural recources;
- For a more profitable export, inventions will be included in further publications and secured in patents;
- The new ChiBio technology platform will strengthen the European biotechnology sector on the global market.

ChiBio

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BIOPLASTIC, FIBRES, ROPES MADE FROM ALGAE

SPLASH converts algae sugars and hydrocarbons to polymers

The project: Re-combinant biomass cultivation, extraction and conversion

The four-year SPLASH project, which started in November 2012, aims to use microalgae as raw material for the sustainable production and recovery of hydrocarbons and exopolysaccharides and to further convert these to renewable polymers.

Initially two industrial bioproduction platforms will be explored: the green algae Botryococcus braunii and the green microalgae Chlamydomonas reinhardtii, to which the unique hydrocarbon- and polysaccharide-producing genes from Botryococcus will be transferred. These algae should then be cultivated as new biomass. The biomass cultivation is targeted to reach a pilot scale. Subsequent steps will develop procedures for the production, *in situ* extraction, and isolation of sugars and hydrocarbons, which will be further processed into polymers: polyesters from sugars and polyolefins from hydrocarbons.

The product: Biobased food packs, fibres and new technology

The end products will include biobased food-packaging, as well as fibres for yarns, ropes, and nets. The project will develop the product to a proof-of-principle stage. The biomass cultivation should reach pilot scale through the project. The pilot scale is also anticipated for the conversion process from algae sugars and hydrocarbons to the polyesters and the polyolefins. Industrial upscaling will be done after the SPLASH project.

SPLASH will result in

- An infrastructure for the exploitation of microalgae;
- The development of new products such as bioplastics and biobased production technologies;
- The substitution of conventional petrochemical products with renewables;
- Highly skilled personnel with expertise in algal biotechnology, micro-algal cultivation, and processing technology;
- Knowledge transfer into the several SMEs associated with the project.

As the project started less than a year ago, no proofs of principle are available yet. Demonstration of the concept on a small scale is expected in the fourth year.

The end users: Industry, aquaculture, manufacturing, recyclers

- Chemical industry bioplastics industry, for the application of bulk chemicals;
- Biomass cultivation, aquacultures, recycling industries;
- Manufacturing, consumer goods, food and packaging industries, private consumers.

The inventors: Academia, research and technology organisations, SMEs/ Industry

At this stage of the project no invention has been made.

It is envisioned that in the long term the developed bioplastic products will be obtained in high purity for application in 'drop in' or new processes.

20 partners are collaborating in the project with 45% of universities and research institutes and 55% SMEs and large industries. The project is managed by Wageningen University,

Research centre/ Food & Biobased Research.

Development stage: Preparation of proof of principle and piloting

We hope to demonstrate the concept of conversion of algae sugars and algae hydrocarburats into polymers/ polyolefins on a small scale in 2016.

The project carrying out performs a stakeholders analysis to identify parties who, in addition to project partners, can influence the economic, social and market success of the newly developed microalgae production platform. By involving all stakeholders at an early stage information will be gathered about their perception of the project's added value. The stakeholder analysis aims to establish a dialogue between the project and the market/other stakeholders to enable demand-driven research and development.

The Dissemination, Exploitation and Intellectual Property Advisory board (DEIPAB) will advise the programme management team on matters to do with project strategy and the exploitation of the scientific and technological results of the project, including intellectual property management. Industrial project partners are important advisors.

Algae ponds and bioreactors: 4 different production systems of 24 m2 each and 3 of 2.5 m2 each are established (see pictures).

Policy impacts: Addressing political action plans through renewable feedstock

Currently, the majority of organic chemicals and polymers are based on fossil raw materials. Global petrochemical production is estimated at around 330 million tonnes. The primary output is dominated by a small number of key building blocks, which are mainly converted to polymers and plastics. This production requires large amounts of fossil fuels as feedstock and generates huge quantities of CO2. It also contributes to the depletion of world resources.

A significantly increased use of renewable feedstock in chemical or energy-related industries would not only reduce the impact of global warming, it would also significantly reduce Europe's dependence on foreign crude oil imports.

SPLASH addresses several European action plans and political measures that have been put forward in the last few years concerned with socio-economic, geopolitical and environmental challenges such as: (1) actions to continue and stimulate research and development by building a European knowledge-based bioeconomy; (2) decrease of CO2 emission (Kyoto Protocol; Copenhagen Climate Summit); (3) actions to broaden the carbon-resource basis from fossil to natural resources. The development of policies on biobased chemicals by the EC, however, similar to what has been done for biofuels, would positively stimulate the development and introduction of bulk chemicals from microalgae and other renewable sources on the market.

Next steps: Data gathering, future funding, upscaling

Microalgae biotechnology research is still at an early stage, even though industry clearly recognises its longer term industrial potential. There are two main hurdles to clear in order to push production of biopolymers from microalgae to the next level:

Speeding up hydrocarbon and polysaccharide metabolism to a level at which it becomes possible to set up larger-scale demonstration facilities which can be used to test and establish the quantity and quality of the produced hydrocarbon.

Establishing and corroborating technical and economic data on the cultivation and processing of microalgae in an industrial setting. There is no doubt that the market demand for hydrocarbons is there, but it is unclear when microalgae can reach price parity with petroleum and natural gas. Studies will deliver credible data on which to base further research and investment in microalgae.

Once the principal obstacles are overcome, the industry will be in a position to work with the scientific community on further tailoring the hydrocarbons toward desired molecule lengths that reduce energy consumption during cracking. Increasing production to (semi) production level should be possible within the next ten to fifteen years.

The concept of biorefineries, needed to cultivate and harvest hydrocarbons from microalgae, requires a multidisciplinary and transnational approach. So far scientific knowledge is spread over small research communities across Europe and applications exist only on a small scale. The technological development is at too early a stage for the existing sector to produce significant breakthroughs in unaided research: current costs are too high and technical risks too many.

It is therefore important that the European Commission has set a clear innovation agenda which connects industry needs with national policies towards sustainable international competitiveness for Europe's biochemical businesses. Funding of future projects will be essential.

SPLASH

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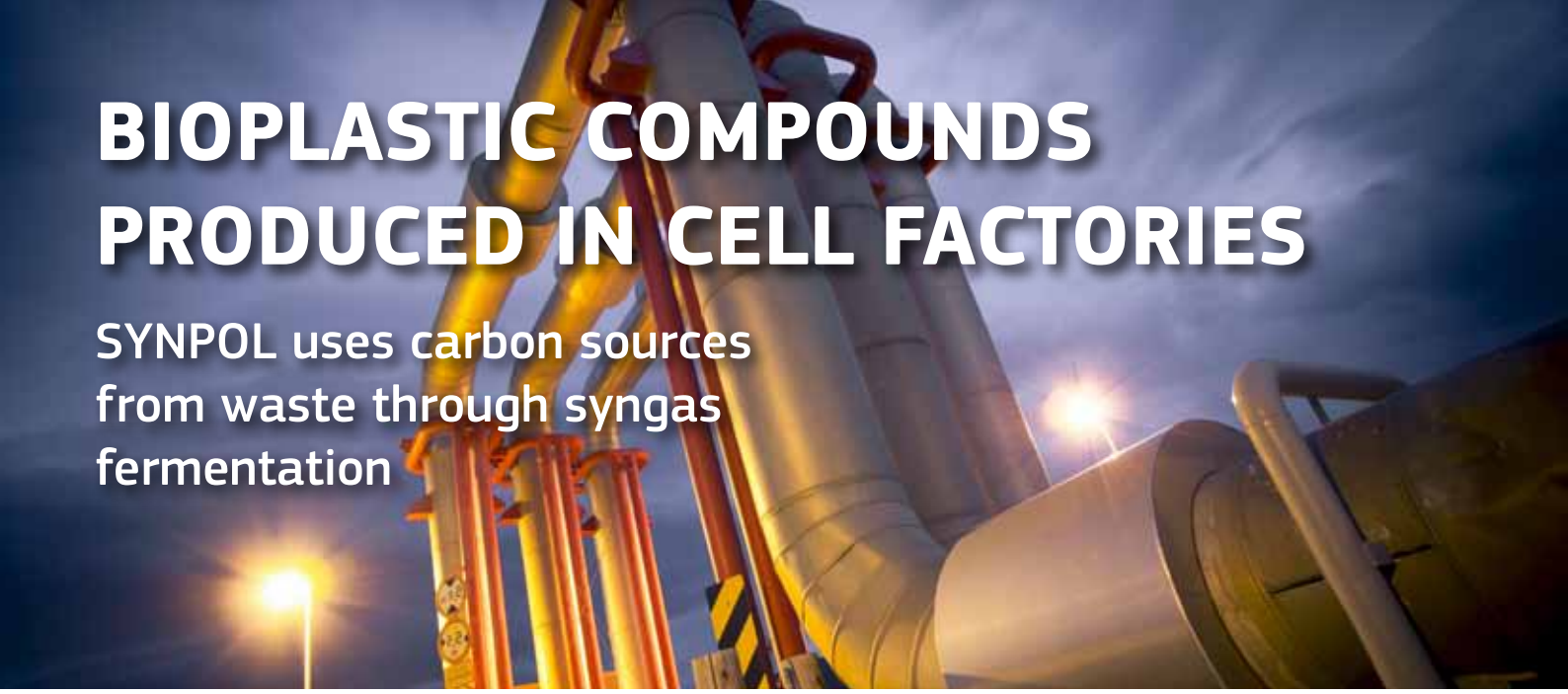

BIOPLASTIC COMPOUNDS PRODUCED IN CELL FACTORIES

SYNPOL uses carbon sources from waste through syngas fermentation

The project: Introduction of novel technology and biotech approach in Europe

Complex waste raw materials - such as municipal and chemical waste - which are pyrolyzed, gasified and then fermented by microorganisms, are the starting point of the SYNPOL project, which aims at producing 100% biodegradable bioplastic compounds.

Pyrolysis and gasification are widely regarded as the main viable large-scale options for biowaste disposal. Gasification, combined with biosynthesis processing systems, has become a promising industrial procedure. Research related to fermentative production of chemicals from CO/CO2 has

greatly increased in recent years since the potential for using biological means of converting CO/CO2 to chemicals has been recognised. Now the fermentation of synthetic gas (syngas) is an attractive technology for the production of biofuels and several industrial processes for ethanol production from syngas are already available from companies in the USA, New Zealand and Canada (e.g., Coskata, INEOS Bio, LanzaTech, Syngas Biofuels Energy, BRI Energy).

Unfortunately, these promising industrial processes have not yet been implemented in Europe. This is the point where SYNPOL starts. SYNPOL´s syngas fermentation technology opens a new window for the rational design of an innovative process to convert complex wastes into new biopolymers.

The product: Green plastics compounds, high added value chemicals, new processes

Bacteria will fermentatively produce bioplastics' basic compounds, the so-called PHAs (polyhydroxyalkanoates), out of the carbon fractions of the gas.

Different prototypes of biopolymers and their blends will be prepared from SYNPOL. Finally, the PHA, plasticizers and nano-clays will be further assessed for their physical and mechanical properties, for their appropriate end use in different sectors of the bioplastics industry as bulk chemicals, and as fine chemicals.

SYNPOL aims to convert complex waste into new cost-efficient biopolymers in three major steps:

- Gasification of different waste streams (urban and industrial waste) to produce synthesis gas (syngas);
- Fermentation of the carbon fractions of the syngas (CO and CO2) by using different natural and recombinant acetogenic bacteria to produce bioplastic building blocks and PHAs;
- Synthesis of biobased plastic prototypes with well-defined structures and improved properties for wide commercial use, through chemical and enzymatic catalysis by utilising the monomers and polymers produced during syngas fermentation.

Novel processing technologies are another end product: in particular the combination of new microwave-supported waste pyrolysis with syngas fermentation microbiology. To this end, SYNPOL will establish an integrated platform for biopolymers production. Reduced energy input and optimised purification of waste streams will contribute to the economic viability of end products.

The end users: Chemical industry, manufacturers of consumer goods

- Chemical and biotech industry (bulk chemicals, fine chemicals), bioplastic producers;
- Recycling industry and related services;
- Manufacturers, pharmaceutical industry, food producers, consumers.

SYNPOL links the notion of adding value to waste to representative members of European bioindustries, distinguished by an interest in the development of biotechnological processes, to produce biopolymers using wastes. The ultimate scope of SYNPOL is to establish a win-win situation between these bioindustries and the polymer industry, as a branch of the chemical industry.

The inventors: Research and technology organisations, academia and industry/SME

SYNPOL is coordinated by the Biological Research Centre (CIB), Madrid. The CIB is a publicly funded national research institute that belongs to the National Spanish Research Council (CSIC, Consejo Superior de Investigaciones Científicas).

Partners are: the Spanish National Institute of Carbon (INCAR-CSIC); UNIMAN (The University of Manchester); UULM (Universität Ulm); UCD (University College Dublin); HES-SO (Haute Ecole Spécialisée de Suisse Occidentale); KTH (Kungliga Tekniska Högskolan); WWUM (Westfälische Wilhelms-Universität Münster); UNISTRA (Université de Strasbourg); Biopolis (Biopolis S.L., Spain); Bioplastech (Bioplastech Ltd., Ireland); OWS (Organic Waste Systems NV, Belgium); BIONET (Bionet Servicios Tecnicos S.L., Spain); INFORS (Infors AG, Switzerland); BEFESA (Befesa Gestión de Residuos Industriales S.L., Spain).

Development stage: Proof of principle, upscaling

The ultimate goal of the project is the up-scaling to pilot stage and the design of technology for bioreactor plants and industrial fermentation, including lifecycle and cost assessments of future developments.

Strain design. Studies will be aimed at discovering the most efficient strains for syngas conversion into biobased chemical building blocks and biopolymers.

Process optimisation. The main steps of the process - syngas production, syngas fermentation, downstream process and biopolymer synthesis - will be optimised to increase the yield, reduce costs, and decrease environmental impact.

Exploitation Studies. Studies concerning degradation, lifecycle and production plant design will be undertaken in order to demonstrate the commercial viability and sustainability of the SYNPOL technology. These studies will also include activities for dissemination of results, training, and management.

Policy impact: Environment and economies

Over recent years, new environmental policies and social concerns have triggered intensive research into the production of specialised high added value chemicals from biochemical technologies, that are cost effective and benign to the environment. The knowledge generated through the innovative biotechnological approach of the SYNPOL project will not only benefit the environmental management of terrestrial waste, but also reduce the harmful environmental impact of petrochemical plastics. The strategy will enable a switch from the current state of negative development to an alternative development independent of fossil resources, which is an unquestionable environmental need.

Additionally, the SYNPOL project can provide the core knowledge for potential exploitation of different industrial biowastes, further promoting the integration of heterogeneous industrial sectors and expanding their business and service opportunities. Moreover, it will have an important impact on social, economic, ethical, legislative and educational aspects of everyday life, since its support of research in the production of biobased materials may lead to potential breakthroughs in the industrial sector, and to benefits for derived sectors such as food production, pharmaceuticals, packaging industries, recycling.

Next steps: Platforms, dialogue with industry

2013 is the first of SYNPOL's four years. In the next three years, SYNPOL will:

- Build durable partnerships between the project partners and the European biotech industry;
- Actively engage in mobilising private and public funds through competitive participation in research projects;
- Make use of research results by entering into dialogue with the European industry, so that novel products may find their way to the market;
- Provide the grounds for integrating research, training, and education within the bioeconomy;
- Stimulate public dialogue to attract young researchers to biotechnology research.

SYNPOL

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HOW FRUIT & VEG BIOMASS IS CONVERTED INTO BIOPLASTICS AND FINE CHEMICALS

TRANSBIO is searching for a sustainable way to get value from industrial plant residues

The project: Finding cascade concepts for biorefineries

The fruit and vegetable processing industry produces huge amounts of as yet unused residues and byproducts. The TRANSBIO project therefore aims to implement an innovative cascading concept to convert the residues into green plastic and chemical products. This involves environmentally friendly biotechnological solutions like fermentation and enzyme conversion strategies to obtain valuable bioproducts from the industrial residues.

The concept stems from the necessity of using renewable raw materials in a sustainable and environmentally sound manner, as increasing demand for industrial products and energy from biomass will inevitably lead to an expansion of global arable land at the expense of natural ecosystems. Besides, industrial biowaste, normally sent to landfills, is an important potential feedstock resource for use in biorefineries.

The product: Bioplastic packs, neutraceuticals, detergents for household application

The end products will be biopolymers (PHB) for bioplastic packaging, nutraceuticals/platform chemicals and enzymes for household applications such as detergents.

The products will be produced through different strains of microbiome such as bacteria, proteolytic and lipolytic fungi and yeasts for succinic acid production, using their metabolic systems as 'cell-factories'. Great effort will also be put into scanning and selecting the right hydrolysate-substrates for building the carbon sources for the micro-organisms, substrates such as potato flour, pea pods, apple peels, turnip waste, banana peels, vegetable waste (e.g. grass, chicory).

The project aims to reduce production costs for biopolymer PHB for use in packaging applications, to improve production of biobased succinic acid, and to develop a solid state fermentation process (biocatalysts) for the production of enzymes for detergent applications. Finally, remaining biomass will be evaluated for potential use in biogas production. The partners will scale up the results to technical pilot scale to obtain information for possible implementation. Industrial scale to follow after project finalisation.

The end users: Industry, retail, consumer

Bioplastics industry, fine chemical industry, packaging industry, pharmacy, biomass and recycling industry, retailers and consumers

The inventors: Academia and SMEs

The TRANSBIO consortium – a mix of SME and academic partners – has been built as a well-balanced and equal partnership between European and Latin American countries. This partnership is based on a number of factors: proven expertise in the exploitation of fruit and vegetable by-products, microbial strain selection (bacteria, yeasts, fungi), fermentation strategy development, downstream processing, end-product stabilisation and utilisation, as well as sustainability and economic feasibility.

Screening methods for strain identification and genetic selection of microbiomes have been developed by project partners before.

The partners will scale up the results to technical pilot scale to obtain information for possible implementation at industrial scale after project finalisation.

Development stage: Towards pilot scale

The screening of raw materials and characterisation of microbiome, including strain selection, has been done. The first cultivation experiments in TRANSBIO hydrosylates have been conducted.

The obtained biopolymer PHB will be tested for potential application in food packaging. Enzymes will be tested for use in detergents, and succinic acid will be purified for food applications or to be used as a platform chemical. Tests in controlled bioreactors will be conducted.

Policy impact: Waste policy and key enabling technologies for industrial biotech

The successful implementation of TRANSBIO will also support several other European policies and initiatives. Through its demand driven approach it supports the Lead Market Initiative in the field of biobased products and renewable energy; by providing value-added solutions for fruit and vegetable by-products, it supports the Directive (1999/31/EC) requiring the reduction of biodegradable waste in landfill sites; through the development of cleaner industrial products and processes based on the use of enzymes and fermentative processes (biocatalysis) it supports the strategy on life sciences and biotechnology. It also contributes to the initiative for developing a coherent European strategy for promoting technology in the area of industrial biotechnology.

Next steps: Partner search and licencing procedures

The partners will exploit the project results as individual partners but also within the value chain via group exploitation. When protection measures are in place it is also hoped to exploit the project results outside the consortium, via licences. Therefore, during the project's duration several workshops and conferences will be organised to ensure wide contact with possible end users.

TRANSBIO

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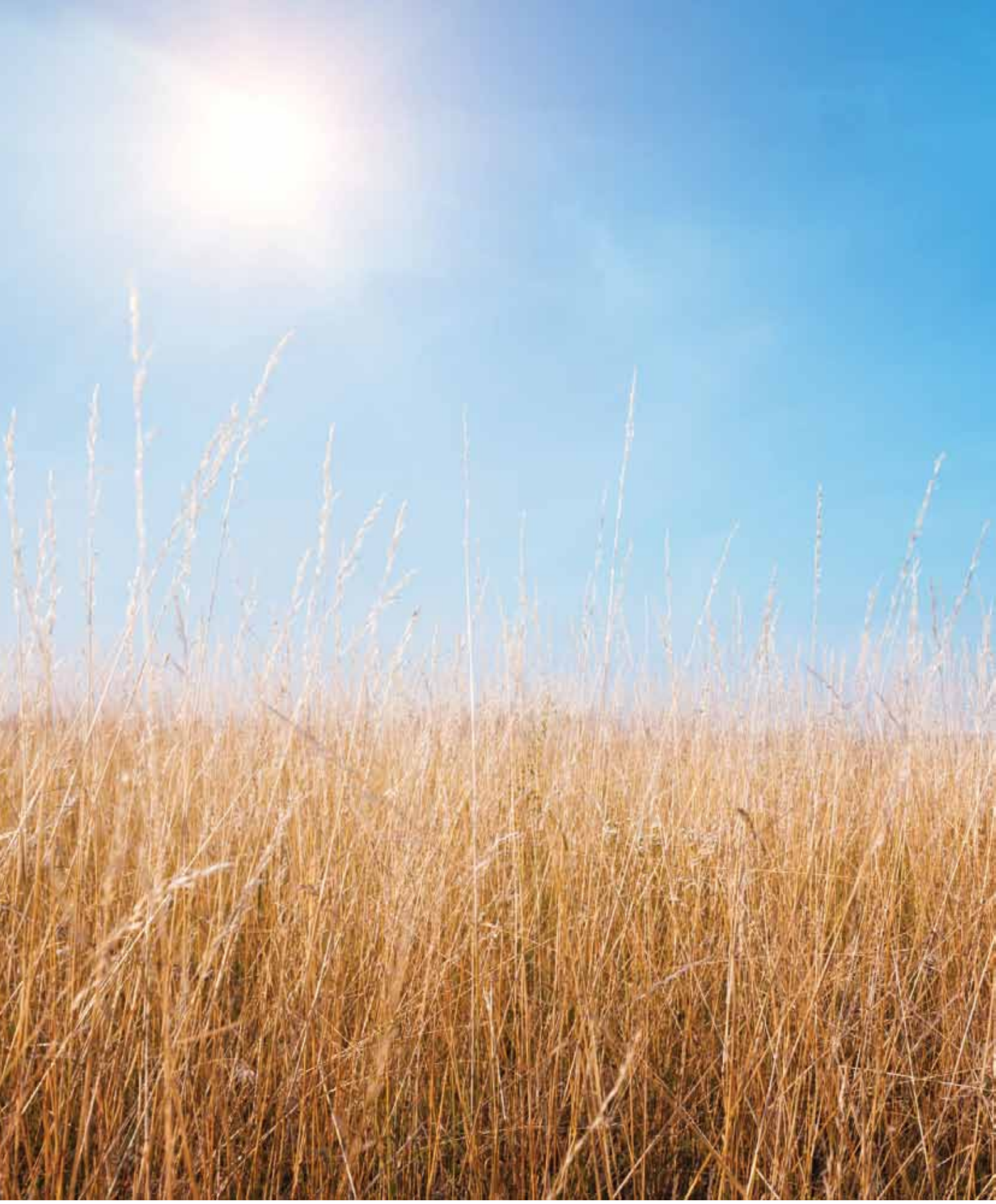

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