Research Educate Connect

BioSC
Bioeconomy Science Center

BioSC Newsletter April 2020

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Science Year 2020 - Bioeconomy: The BioSC is participating

The Science Year 2020 - Bioeconomy has got off to a successful start. There are numerous exciting contributions nationwide, especially on the Internet. Core groups of the BioSC are also participating.

KRAUTNAH - the plant research podcast

David Spencer and Caspar Langenbach, RWTH Aachen University, Institute of Biology III (Plant Physiology)

The podcast KRAUTNAH is all about plant research, plant breeding and green biotechnology. In an initial ten episodes, the history of the cultivation of plants is traced, up to today's genetic engineering. In addition to researchers, voices from politics, agriculture and breeding will be heard. In the form of listener comments, the audience can ask questions, voice criticism and express wishes.

instagram.com/krautnah_podcast
fb.com/krautnahpodcast
twitter.com/krautnah

krautnah.de

Sustainable economy through integration

A contribution by Ulrich Schurr at www.wissenschaftsjahr.de

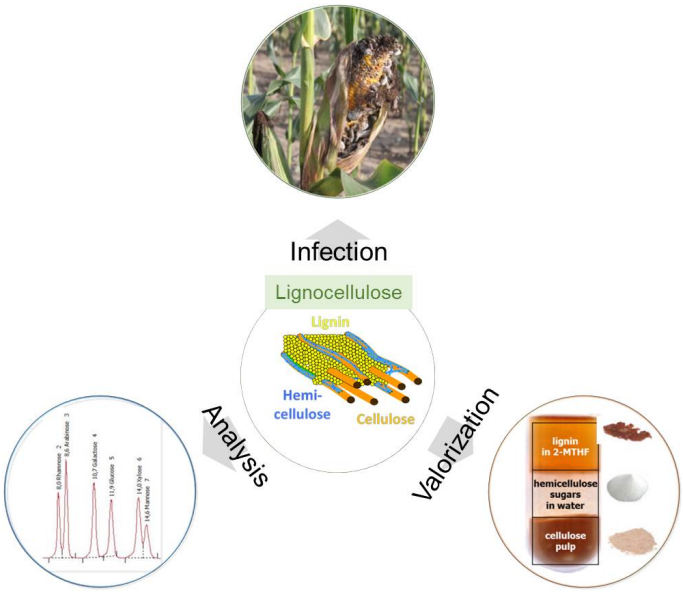
In an article in the "Heads of Change" section, Ulrich Schurr describes how new technologies open up new approaches to the sustainable use of plants, how integrated bioeconomy concepts create interactions and added value, and that regionalisation of the bioeconomy is the key to sustainable economic activity.

https://www.wissenschaftsjahr.de/2020/aktuelles-aus-der-biooekonomie/koepfe-des-wandels/nachhaltiges-wirtschaften/

SEED FUND 2.0: First projects completed

In 2018 and 2019 there were SEED FUND calls within the framework of phase 2 of the NRW strategy project BioSC. The OPEN Calls were without thematic restrictions while the LINK calls focused on topics related to the FocusLabs. A total of 10 projects were selected. The first three SEED FUND 2.0 OPEN projects were completed at the end of 2019 after a one-year term.

SEED FUND 2.0 - OPEN projects



iBiomass - Improve maize biomass for processing applying OrganoCat technology

Project coordination: Dr. Vera Göhre, Prof. Dr. Michael Feldbrügge, Microbiology, HHU Düsseldorf

Partners:

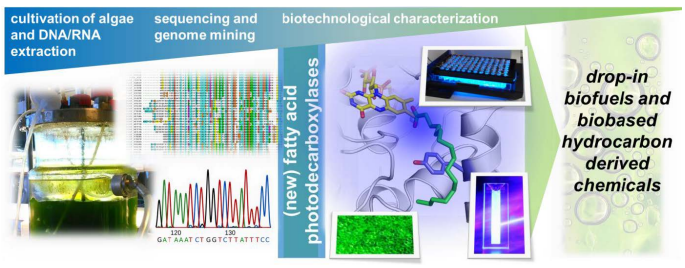
Dr. Vicente Ramirez; Prof. Dr. Markus Pauly, Plant Cell Biology and Biotechnology, HHU Düsseldorf

Prof. Walter Leitner, Technical and Petrol Chemistry, RWTH Aachen

Lignocellulose is an important raw material for sustainable processes in a commercially competitive bioeconomy. Since this material is recalcitrant to breakdown into its sugars for valorisation, the OrganoCat technology has been developed and tested on numerous plant species. So far, the raw material has always been derived from healthy plants, but it is important to understand how regularly occurring field infections

alter this process.

Therefore the aim of the iBiomass project was to evaluate the impact of cell wall changes in corn brought about by infection on processing of the lignocellulose in the OrganoCat technology. Smut fungal infections were used as an example, since they occur at low incidence in corn fields in Germany, which is not detrimental to yield, but entails changes in downstream processing of the biomass e.g. in silage conditions. During the infection of seedlings, changes in the composition of the lignocellulose in the tumor mass could be detected. However, these did not dramatically impact on OrganoCat processing suggesting that the changes are tolerated by this chemical breakdown and fractionation. In the future it will be interesting to investigate infected material from field-grown plants to verify that the robustness of the OrganoCat against smut fungal infection holds true.



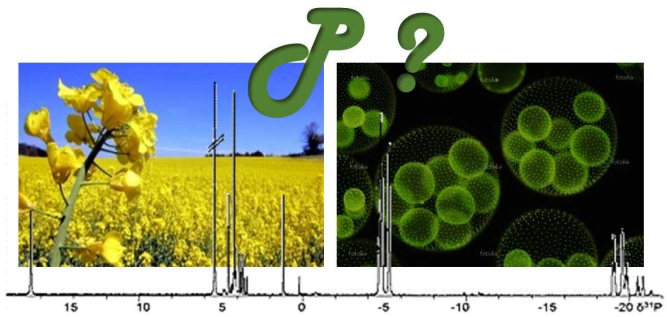
HySyn - Fatty acid photodecarboxylases for hydrocarbon synthesis

Project coordination: Dr. Ulrich Krauss, Prof. Dr. Karl-Erich Jaeger, Molecular Enzyme Technology, HHU Düsseldorf

Partners:
Prof. Dr. Björn Usadel, Botany and Molecular Genetics, RWTH Aachen
Dr. Holger Klose, Prof. Dr. Ulrich Schurr, IBG-2 Plant Sciences, Forschungszentrum Jülich

Alkanes and alkenes are one of the most important classes of hydrocarbons for the production of next-generation drop-in biofuels and plastics. In 2017, a new class of alkane/alkene synthesizing photoenzymes was discovered in the algae *Chlorella variabilis* and *Chlamydomonas reinhardtii* (fatty acid photodecarboxylases; FAPs). Despite their promise as efficient alkane/alkene-producing biocatalysts, important biotechnologically relevant properties remain largely uncharacterized and their phylogenetic distribution is unknown; hence alternative FAPs, with potentially superior biotechnologically-relevant properties, remain to be identified and explored. The HySyn project aimed at filling this gap.

Expression, purification and immobilization of one known FAP from *Chlorella variabilis* and one novel FAP of *Cocomyxa subellipsoidea* were optimized. The DNA sequence encoding the latter enzyme was identified by genome mining. Phylogenetic studies revealed, apart from numerous microalgal FAPs, a wealth of related sequences (annotated as choline dehydrogenases) in microbes. In addition, biomass for DNA extraction was produced from two different microalgal strains (*Scenedesmus* sp. and *Chlorella* sp.) which potentially could harbor superior FAP enzymes. The results obtained during this project help to accelerate the discovery and characterization of novel FAPs and pave the way towards application of this important new enzyme family for sustainable hydrocarbon production.



QuantiP - P-quantification in vivo and in vitro by Raman spectroscopy and NMR

Project coordination: Dr. Anna Joëlle Ruff, Prof. Dr. Ulrich Schwaneberg, Biotechnology, RWTH Aachen

Partners:
Dr. Ladislav Nedbal, Dr. Christina Kuchenberg, Prof. Dr. Ulrich Schurr, IBG-2 Plant Sciences, Forschungszentrum Jülich
Dr. Sabine Willbold, Dr. Stephan Küppers, ZEA-3 Analytics, Forschungszentrum Jülich

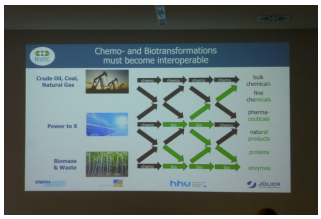
Nutrient cycling has become a crucial factor in effective resource use in modern agriculture. The essential plant nutrient phosphor (P) is a finite resource gained almost exclusively by rock mining outside Europe, making European agriculture highly dependent. Additionally, considerable amounts of phosphate leach into water or accumulate in the soil as fixed inorganic P forms or as for plant and animals indigestible form (phytate), leading to significant impact on the environment.

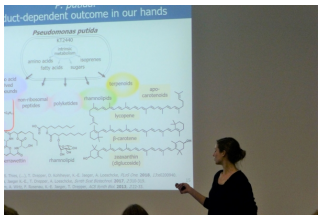
The aim of the QuantiP project was to support the development of concepts for efficient P recovery by developing a new P quantification platform, specifically for P recovery from wastewater using algae and from agricultural residues such as rape press cake using special enzymes (phytases). Algae were grown under different P-supply conditions. Rapeseed press cakes were treated with an optimized phytase. In all

sample materials 31P-NMR investigations successfully identified and quantified the different P-storage molecules (inositols, phosphates and polyphosphates). This allowed the P uptake and accumulation of polyphosphate in algae as well as the total P content in enzymatically treated rape press cake to be characterized.

7th BioSC Spotlight: Modular biotransformations in a circular bioeconomy

The 7th BioSC Spotlight took place at RWTH Aachen University on 5th February. Scientists from different disciplines discussed challenges and new developments for the production of materials and chemicals from the heterogeneous raw materials of a circular economy.



Photos: Forschungszentrum Jülich

The production of chemicals and materials in a circular bioeconomy will be characterized by new process chains in which biocatalysis with microorganisms and enzymes will play an important role. Biogenic raw materials cover a broad spectrum from perennial biomass to agricultural waste streams. In addition, there are non-biogenic carbon sources such as CO_2 or plastic waste. To deal with this broad spectrum of starting materials, the conventional "one substrate - one product" concept needs to be evolved to complex "multi substrate - multi product" process chains in which biocatalysis and classical chemocatalysis are combined.

These challenges set the content framework for the 7th BioSC Spotlight which took place on February 5th in the new research building NGP^2 of Aachener Verfahrenstechnik. After the introduction by Wolfgang Wiechert (Forschungszentrum Jülich), Gunnar Lidén (University of Lund) presented his work on the valorisation of lignin. Due to its chemical heterogeneity lignin is difficult to process and is often only thermally utilized. The concept developed at the University of Lund is designed to separate lignin at the very beginning of the digestion of plant biomass, to break it down chemically into its various monomers and to have microorganisms synthesise aromatic valuable substances from it. Subsequently, Niklas Tenhaef (Forschungszentrum Jülich) presented his work with *Corynrebacterium glutamicum* strains that have been optimised to be able to use xylose from lignocellulose-containing biomass such as bagasse or coffee grounds and produce high-quality chemicals from it.

The second session focused on the microbial production of bulk chemicals. Susanne Zibek (Fraunhofer IGB, Stuttgart) presented the development and optimisation of a production process for biosurfactants from renewable resources. Andreas Biselli and Christian Kocks (RWTH Aachen University) explained the challenges for process engineering concerning the separation and purification of biosurfactants in a biorefinery and presented the development of innovative procedures. Isabel Bator (RWTH Aachen) and Sonja Kubicki (HHU Düsseldorf) presented their work on the development and optimization of *Pseudomonas putida* strains for the production of rhamnolipids from sugar beet residues.

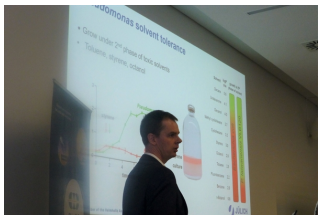
The last session focuses on the production of fine chemicals with the tools of Synthetic Biology. Markus

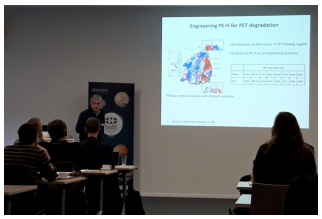
Buchhaupt (DECHEMA Research Institute, Frankfurt am Main) presented the development of *Pseudomonas putida* strains that are able to synthesize terpenoids. Ilka Axmann (HHU Düsseldorf) spoke about the use of algae as production organisms and presented the production of triterpenes in microalgae. In the last lecture of the day Anita Loeschcke and Hannah Braß (HHU Düsseldorf) presented an innovative approach of using *Pseudomonas putida* to synthesize known bioactive natural compounds and vary their chemical structure in order to generate optimal active ingredients for specific applications.

The 7th BioSC Spotlight covered a broad spectrum of current questions and problems and was used by the approximately 40 participants for intensive discussions.

BioSC Workshop „Closing Cycles in the Plastics Bioeconomy”

A BioSC workshop on the recycling of plastic waste was held in Aachen on 10th February. 45 scientists and entrepreneurs discussed different aspects of the topic ranging from depolymerisation to biotechnological and chemical conversion as well as the quantification of microplastics.






Photos: Forschungszentrum Jülich

Plastic products are an integral part of modern society. Due to their wide range of applications and the high availability of inexpensive raw materials, petroleum-based polymers can be found in many everyday objects. However, since these polymers are very durable, plastic waste is causing a global pollution crisis. The development of production of plastic monomers and polymers from plastic waste using biotechnological and chemical methods offers the opportunity to replace fossil resources and close the carbon cycle for polymer production.

The workshop was opened by Lars Blank (RWTH Aachen), who uses plastic waste as substrate for the production of bioplastics in *Pseudomonas putida*. In this process, plastics are hydrolysed in the bacteria and polyhydroxyalkanoates (PHA) are produced from the released monomers. Bacterial growth was initially optimised for ethylene glycol and butanediol as carbon sources, which then serve as starting molecules for the production of PHA. Pseudomonads also play a central role in the work of Nick Wierckx (Forschungszentrum Jülich), who is optimising them for the production of phenol and other aromatic compounds. For the production of new plastics, phenol in particular plays a major role as a precursor molecule. The *Pseudomonas* strains used have to be optimised for high tolerance to phenol and other toxic organic solvents. Benedikt Weber (RWTH Aachen) presented his work on the tailor-made enzymatic degradation of polyurethane to hexamethylene diamine (HMDA). A particular challenge here is the

extraction and purification of HMDA, which is necessary before HDMA can be used again for plastics production.

Tim Devlamynck presented the strategy of Indaver, a company which handles waste management and the recycling of materials and energy for entire companies. Indaver is thus able to make evaluations regarding the origin and type of plastic waste. The waste is used to produce styrene, which can then be used again for the production of plastic. Sonja Herres-Pawlis (RWTH Aachen) presented her work on the production of polylactide using metalloenzymes which, unlike the catalysts used to date, are non-toxic and enable PLA to be produced on an industrially competitive basis. Jürgen Klankermayer (RWTH Aachen) presented a process for recycling the mixture of PLA and PET. In this process, the starting materials can be hydrolysed to 99 % by means of temperature variation and different catalysts.

The workshop was concluded with the lectures of Ulrich Schwaneberg (RWTH Aachen/DWI Leibniz-Institut Aachen) and Karl-Erich Jaeger (HHU Düsseldorf). Ulrich Schwaneberg presented the anchor peptide technology developed in the BioSC FocusLab „*green*Release“ and its precursor projects. The anchor peptides have a broad range of applications and can be used for the targeted degradation and quantification of microplastics. In the last presentation of the day, Karl-Erich Jaeger presented his investigations into the degradation of PET by polyester hydrolases from marine microorganisms. These enzymes provide new possibilities for the recycling of plastic waste and could contribute to the reduction of plastic waste in marine systems.

Textile value creation in a sustainable bioeconomy

The textile and clothing industry is the third largest economic sector worldwide and the second largest consumer industry in Germany after the food industry. It is heavily dependent on oil. The Institute of Textile Technology at RWTH Aachen University conducts research on innovative approaches and processes for the use of natural and synthetic fibres from renewable resources.




Photos: Pixabay

From a global perspective, the textile industry represents one of the most important sectors of the economy. It covers a wide range of applications, from technological intermediates to consumer goods for end users. Of the approximately 100 million tons of textile fibers produced annually, only about one third are natural fibers. Two thirds are synthetic fibres, of which only about 10% are made from bio-based raw materials such as cellulose. This clearly shows that the textile industry, as a large and important economic

sector, depends to a considerable extent on oil. This holds great potential for the transformation towards a bioeconomy.

The Institute of Textile Technology (ITA) at RWTH Aachen University, which has been a member of the BioSC since 2019, is pursuing a holistic approach to establishing a textile bioeconomy. In addition to material and process development, this includes promoting the acceptance of biobased manufacturing methods and products by companies and end customers. Core topics of the ITA are:

- Textile method and process development; validation of industrial feasibility
- Scientific evaluation of technological, economic, ecological and social aspects of the various fields of application of bio-based textile products and processes
- Establishment of strategic alliances between research institutions, manufacturing and user companies and associated institutions
- Socio-economic and systemic accompanying research for the development of a sustainable bio-based economy

In order to establish a textile bioeconomy, innovative approaches and processes for the production of polymers based on renewable raw materials (biopolymers) must be developed that are economically scalable to an industrial level. In order to compensate for the current additional price of biopolymers compared to petroleum-based polymers, the development of new business cases and the "rethinking" of the textile value creation chain are necessary. This might mean, for example, that the additional price is compensated by different players along the value creation chain and does not reach the end consumer. New digital business models that generate savings in sales or logistics, for example, are also conceivable. Furthermore, the additional price can also be justified by an additional benefit for the customer, for example by additional functions compared to conventional textile materials.

In addition to renewable raw materials, CO_2 and recycled polymers also represent possible alternative raw material sources for the production of synthetic textile fibers. Finally, there are fields of application such as composite materials for which natural fibres such as flax or hemp are more suitable than synthetic fibres. It is important for all renewable raw material sources to be cultivated sustainably and not to compete with food and feed production.

The Institute of Textile Technology has already developed a number of innovative products for a textile bioeconomy.

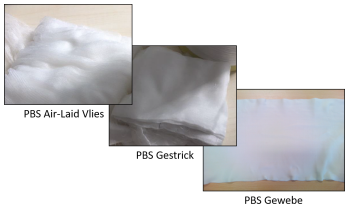


Photo: Pavan Manvi, ITA RWTH Aachen

Polybutylene succinate (PBS) is a bio-based polyester produced from plant carbohydrates and is compostable.

In the "PBSTex" project, the usability of PBS for textile applications is being investigated using a selection of suitable PBS polymer types. Using multiscale melt spinning processes, PBS filaments are produced and processed into nonwovens, knitted fabrics and wovens. These are validated with regard to their mechanical properties as well as their manufacturing processes and their application in textile products.

Photo: Pavan Manvi, ITA RWTH Aachen

CO_2 can be a sustainable alternative raw material source to crude oil in the production of polymers. Covestro Deutschland AG, Leverkusen, has developed polyols based on CO_2 and has successfully used these polyols in the synthesis of thermoplastic polyurethanes.

At the Institute of Textile Technology at RWTH Aachen University, a melt spinning process has been developed in which this CO_2-based thermoplastic polyurethane (TPU) can be successfully processed into elastic fibers on a technical scale. In cooperation with the company FALKE KGaA, Schmallenberg, socks for everyday use have been produced from the fibres.

Photo: Carsten Uthemann, ITA RWTH Aachen

Fibre composite components are usually reinforced with glass, carbon or aramid fibres. The production of these fibres requires a high energy input and generates correspondingly high CO_2 emissions. Natural fiber reinforced composites (NFRP) have the potential to significantly reduce environmental pollution.

In the AiF research project HyPer-NFK, a process for the production of a natural fibre composite material with flax fibres was optimised in such a way that the production costs could be reduced and at the same time the mechanical load-bearing capacity increased.

Events and calls

Events (selected)

4th Biobased Economy Conference - virtual
5th June 2020
More Information

International Symposium on Horticulture, Stuttgart
2nd – 6th June 2020 - WILL BE POSTPONED
More information

4th European Sustainable Phosphorous Conference - ESPC4, Vienna
15th – 17th June 2020

More information

9th International Bioeconomy Conference, Halle
17th – 18th June 2020 – POSTPONED TO 9th – 10th June 2021
More Information

ELB 2020 “Exploring Lignocellulosic Biomass: Challenges and opportunities for bioeconomy”, Reims
23th - 26th June 2020 - POSTPONED TO JUNE 2021
More information

International Conference “Fuel Science – From Production to Propulsion”, Aachen
23th - 25th June 2020
Deadline for abstracts: 12th January 2020 (extended abstracts: 19th April 2020)
More information

3rd International Bioeconomy Congress Baden-Württemberg, Stuttgart-Hohenheim
21st - 22nd September 2020
Deadline for abstracts: 15th April 2020
More information

Interdisciplinary Circular Economy Conference 2020, Freiburg
21st - 22nd September 2020
More Information

10. ProcessNet-Jahrestagung und 34. DECHEMA-Jahrestagung der Biotechnologen 2020, Aachen
21st - 24th September 2020
Deadline for poster abstracts: 30th June 2020
More information

European Forum for Industrial Biotechnology and the Bioeconomy (EFIB), Frankfurt/Main
5th -6thOktober 2020
More Information

SAVE THE DATE: International BioSC Symposium 2020, Berlin
16th -17th November 2020
More information

Calls (selected)

Deutscher Nachhaltigkeitspreis Forschung
Deadline for application: 30th April, 2020
More information

Prize for "Renewable Resources"
Deadline for application: 30th April, 2020
More information

BMBF-Call "Travelling Conferences"
Deadline for application: 8th June, 2020 and 20th November, 2020
More information

Funding for research projects in the bioeconomy for "Future technologies for the industrial bio-economy: focus on biohybrid technologies"
Deadline for application: 3rd August, 2020
More information