

ECOLOGY AGRICULTURE FOOD BIOTECHNOLOGY



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The patent commercialisation business unit identifies and evaluates product ideas and research results on behalf of customers and offers them for licensing or purchase worldwide. The portfolio of services covers all fields of technology. This offer is complemented by services for holistic innovation management from idea to market-ready product in the business segment Managed Innovation Services (MIS), in particular funding consultancy and project management for small and medium-sized enterprises. In addition, the business segment Cooperation Networks & New Markets initiates and supports networks between SMEs that wish to proactively develop further.

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GO-BIO-INITIAL – FOR A SUCCESSFUL START

With the Go-Bio initial funding initiative, the BMBF supports the identification and further development of new project ideas and research approaches from the natural and life sciences with recognisable innovation potential. The focus is particularly on ideas and inventions from the fields of therapeutics, diagnostics, research tools and platform technologies.

The programme is aimed at scientists from the three universities in Central Hesse, who are in a phase of professional (re)orientation: graduate students, PhD students and postdocs, who want to develop their applicable ideas or inventions further, ideally to the point of commercialisation and could imagine starting their own company, as well as experienced professionals who are looking for a new perspective.

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IP protected technologies

FOOD

- Fermentative production of a beverage from saffron side streams
- Manufacturing of natural flavor substances
- Supply of a specific, direct and fast detection method for Cholesterol dependent Cytolysin (CDC)
- Optimisation of classical livestock farming and in-vitro-meat-production by use of tetrapeptides
- Test system for food by simulation of metabolism processes

AGRICULTURE

- Tension controlled plant watering system
- Intuitive calf feeder



IP protected technologies

BIOTECHNOLOGY

- Production of protein-grafted cellulosic fibers by a simple two-step process
- Yeast Surface Catalysis (YSC) Platform
- Tool using BRET for determination of CRISPR/Cas9 restriction efficiency
- Expression of proteins via a two-vector based inducible system
- ACIT – A new tool for fermentation processes with non-model bacteria
- Biocatalytic production of NADH and aromatic/aliphatic aldehydes

ECOLOGY

- Aquatic ecotoxicological method for testing chemical substances
- Material made from renewable aquatic raw materials

Fermentative production of a beverage from saffron side streams

beverages, saffron, food biotechnology

DESCRIPTION OF TECHNOLOGY

Spices are enjoying increasing popularity around the world. In the case of saffron plants, *Crocus sativus* L. in particular, the focus is just on a single part, the stigma, which in its dried form is known as saffron, being one of the most expensive spices in the world.

The remaining parts of the plant (side streams) are either used for agricultural purposes (added to a compost heap to be used as fertilizer) or thrown away, although it is known that the side streams of the flower (stamina and petals) are rich in valuable ingredients such as crocins and polyphenols (Vignolini *et al.* 2008).



Consequently, these flower side streams can serve as a fermentation basis with fungi of the Basidiomycota division and thus experience a valorisation and value-added utilisation.

APPLICATION EXAMPLE

Fermentation by *Fomitopsis pinicola* (red-belted conk)

Fragrance: plum, pear, quince, honey, fruity, floral

Flavour: *sour, apple, sweet, tea, astringent*

Colour: peach tea, quince jelly

Samples showed no significant differences in smell, taste or colour after 10/20/30 min pasteurisation.

AT A GLANCE ...

Application Fields

- Beverage production

Business

- Beverage producers
- Food biotechnology companies

USP

- Use of “waste” parts of saffron plants
- Wide range of flavours and aromas

Development Status

- Tested fermentation process on laboratory scale

Patent Status

Priority application filed on 02.09.2022 at the European Patent Office.

PCT Application is possible within priority year

ADVANTAGES OVER THE PRIOR ART

- Use and economic enhancement of spice plant side products (saffron, but also others)
- Wide range of flavours and fragrances, achievable by fermentation

STATE OF PRODUCT DEVELOPMENT

- Screening of 70 different fungi
- Sensory analysis + sample tastings
- Tested parameters for fermentation with *F. pinicola*
- Reduction of oxalic acid content
- Pasteurisation & carbonisation were performed

MARKET POTENTIAL

The global saffron market has very good growth dynamics and *Future Market Insights* forecasts the market value to almost double from US\$428 million in 2022 to US\$804.4 million in 2032.

The market for fruit-flavoured beverages is also expected to grow by US\$23.95 billion by 2026, especially in Asia-Pacific, according to *Technavio analysis 2022*.

COOPERATION OPPORTUNITIES

On behalf of Justus-Liebig-University Giessen, TransMIT GmbH is looking for cooperation partners or licensees worldwide.

Reference:

Vignolini, Pamela; Heimler, Daniela; Pinelli, Patrizia; Ieri, Francesca; Sciuillo, Arturo; Romani, Annalisa (2008): Characterization of By-products of Saffron (*Crocus sativus* L.) Production. In: Natural Product Communications 3 (12), S. 1959–1962.

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Manufacturing of natural flavor substances

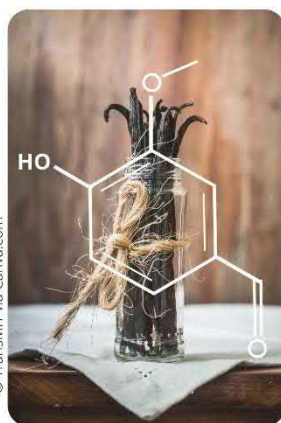
Flavors, fragrances, enzyme-based manufacturing process, green chemistry, white biotech, food biotech

DESCRIPTION OF TECHNOLOGY

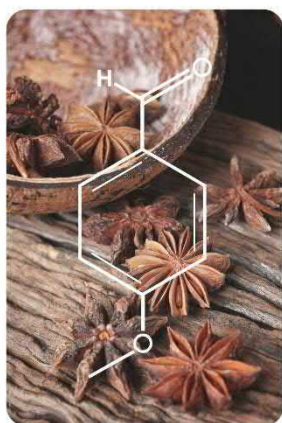
A wide variety of flavors make food and beverages even tastier. Consumers are increasingly paying attention to products with natural flavors.

Scientists from the University of Giessen have successfully identified an enzyme for the synthesis of aromatic compounds with methylated hydroxy and/or thiol groups in the edible fungus *Pleurotus sapidus* and developed a biotechnological process for natural flavor synthesis.

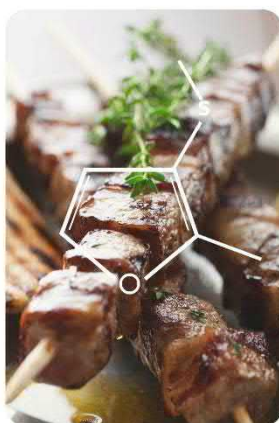
The process is highly scalable, resource efficient and has a broad substrate spectrum.



Vanillin



p-Anisaldehyd



2-Methyl-3-(methylthio)furan

SYNTHESIS EXAMPLES

p-Anisaldehyde (Odor: coumarin, anise, vanilla)
Taste: sweet, spice anise, almond-like, creamy, nutty
Use: *Baked goods, dairy products, confectionery, beverages (alcoholic & non-alcoholic)*

2-Methyl-3-(methylthio)furan (Odor: sulfurous, meaty)
Taste: meaty
Use: *meat/fish products, spices, soups, flavoring of meat alternatives, sauces*

AT A GLANCE ...

Application Fields

- Food biotech
- Beverage and food processing
- Vegetarian/ vegan food
- Cosmetics & body care
- Household Items

Business

- Flavor and fragrance industry
- Food and beverage manufacturers

USP

- Synthesis of natural flavors
- Broad substrate spectrum
- Reduction of toxic environmental pollution
- Principles of Green Chemistry

Development Status

- Proven synthesis of different flavorings in the laboratory

Patent status

Priority applications filed on 07.04.2022 with the European Patent Office.

ADVANTAGES OVER THE PRIOR ART

- Synthesis of flavoring substances of natural origin
- Substrate spectrum covering several substance classes
- Compliance with the *principles of green chemistry**
- Scalability

*By using enzymes, the ***principles of green chemistry*** are met. These include waste reduction, energy efficiency, less environmentally harmful syntheses, nuclear economy and the use of renewable raw materials.

STATE OF PRODUCT DEVELOPMENT

- Proven synthesis of different flavorings in the laboratory
- *Technology Readiness Level 3 (Proof of Concept)*
- Samples can be provided

MARKET POTENTIAL

Many people associate natural products with food quality and safety. An increasing number of consumers want to reduce or avoid artificial flavorings in their diet.

In 2021, the global market volume for flavors and fragrances was 37.5 billion US dollars. Forecasts predict strong growth rates for the food and beverage industry.

Consumers are also showing great interest in sustainable production and natural ingredients for cosmetics, personal care, pharmaceuticals and household products.

The market for meat alternatives has also been growing for years. According to Statista, global sales of vegan meat products are forecast to triple by 2035.

COOPERATION OPPORTUNITIES

On behalf of Justus-Liebig-University Giessen, TransMIT GmbH is looking for cooperation partners or licensees worldwide.

Funding projects to implement industrial application are also possible.

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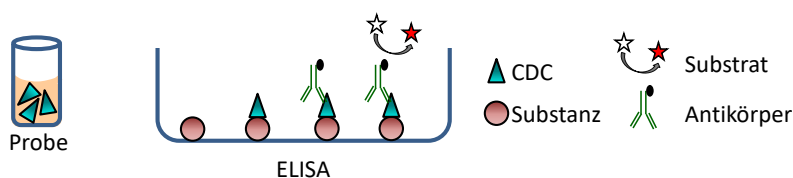


Supply of a specific, direct and fast detection method for Cholesterol dependent Cytolysin (CDC)

Diagnostic of CDC producing pathogens, Food safety

DESCRIPTION OF TECHNOLOGY

Cholesterol dependent Cytolysin (CDC) is secreted by gram-positive bacteria. The CDCs are able to cause serious and life-threatening endogenous and exogenous human and animal infections. *Streptococcus pneumoniae*, *Streptococcus suis* and *Listeria monocytogenes* are important CDC producing pathogens. Due to the high lethality rate and the significance for humans and animals, it is important to specify and diagnose those pathogens in order to therapy the patients, to identify and eliminate the source of infection and ensure the food safety. The released CDCs are bound to a specific substance and can be detected with conventional methods like ELISA and Western Blot.



© Dr. Helena Pillich, JLU Gießen

APPLICATION FIELDS

Application fields are in microbiological and clinical diagnostics, in food- and environmental analysis. Solid and liquid samples can be used.

AT A GLANCE ...

Application Fields

- Clinical diagnostics (Human and animal samples)
- Food samples
- Environmental samples
- Immunotherapy

Business

- Microbiological laboratories
- Clinical laboratories
- Food analytics

USP

- Reliable and rapid method for the detection of CDCs
- No necessity for elaborated and expensive technologies and laboratories
- Fast and cost-efficiently method

Development Status

- Detection of bounded CDC in human and animal body fluids and in food and environmental samples
- Development and test in the routine laboratory of the university hospital Giessen
- Further steps: Development of a lateral flow test

Patent Status

Priority application filed on Dec. 22, 2017 in EP.

ADVANTAGES OVER THE PRIOR ART

The test is carried out by using established methods (ELISA, Western Blot) and is **highly specific** for CDCs.

There is only a **small amount of sample material** needed. The toxins can be verified in a **short period of time** and directly out of the patient's sample.

STATE OF THE PRODUCT DEVELOPMENT

A reliable, safe and fast detection method for Cholesterol dependent Cytolysin can be provided.

MARKET POTENTIAL

The product idea is in the market segment of medical analytics and food diagnostics. In case of a market ready lateral flow test and for ELISA tests the technology is also interesting for the smaller segment of consumables in immunochemical reagents. The largest market share in the area of IVD is in the US (47%), followed by the European market with 31% share. Until 2021 an increase of the market size up to 20,575 billion US-\$ is predicted. This corresponds to an annual growth rate of 5,1%.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-Universität Giessen TransMIT GmbH is looking for cooperation partners or licensees for distribution / further development in Germany, Europe, USA and Asia.

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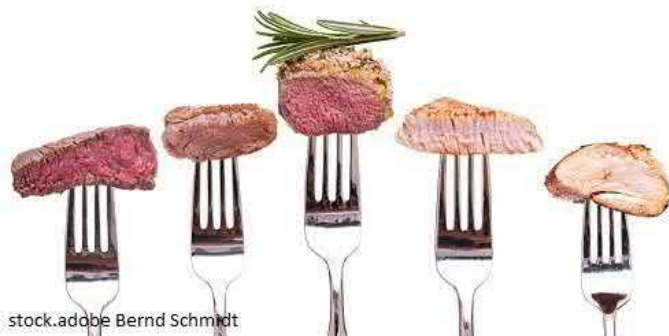
Optimisation of classical livestock farming and in-vitro-meat-production by use of tetrapeptides

Sustainable nutrition, culture meat, tissue engineering, 3D-cell-culture

DESCRIPTION OF TECHNOLOGY

In large-volume livestock farming, up to date large quantities of antibiotics are used prophylactically to support the muscle growth of the animals, although the resulting adverse effects are already generally known (especially development of resistances by pathogens).

In order to ensure a sustainable protein supply for the world's growing population, the extent to which muscle mass can be produced by "apparatus" ("cultured meat", etc.) is therefore being intensively investigated in order to decouple land consumption for livestock farming from meat production.



At the Department of Veterinary Medicine at the Justus-Liebig-Universität Gießen, upon investigation of myoblasts, i.e. precursor cells of skeletal muscle fibres, it was discovered that certain tetrapeptides promote the growth and differentiation of myoblasts, thus supporting muscle growth.

As basic mode of action the interaction of the tetrapeptides with the ZIP9 receptor on the cell surface of myoblasts was identified, i.e. the tetrapeptides only need to be used in therapeutic amounts.

AT A GLANCE ...

Application Field

- Livestock farming
- Production of culture-meat

Business

- Food industry

USP

- Remarkable reduction of use of antibiotics in livestock farming
- Natural and cost-effective growth- and differentiating-factor for manufacturing culture meat

Development Status

- Efficacy successfully proven on laboratory scale

Patent Status

Priority application, filed 23.11.2020 at the European Patent Office; subsequent PCT-application, filed at the EPO on 23.11.2021: PCT/EP2021/082608.

REFERENCE NO.: **TM 1095**

APPLICATION FIELDS

In the field of food technology, there are basically two independent fields of application:

By using these tetrapeptides in animal fattening, prophylactic administration of antibiotics can most likely at least be massively reduced, possibly even completely limited and restricted to real cases of disease, as muscle growth is already stimulated by the tetrapeptides - administration of antibiotics is then no longer necessary for that purpose).

In the area of artificial meat production ("culture meat"), the tetrapeptides can be used as cost-effective growth-promoting additives to nutrient media which are already effective in low concentrations.

ADVANTAGES OVER PRIOR ART

In animal fattening, the tetrapeptides enable the massive reduction of the application of antibiotics.

In artificial meat production, they are harmless, inexpensive and effective additives for the growth media, even in low concentrations. In addition to just growth, they also actively promote fibril formation of myoblasts.

STATE OF PRODUCT DEVELOPMENT

Feasibility is proven on lab-scale. There is cell culture-based evidence of efficacy on L6 myoblasts (muscle mass-forming progenitor cells) available.

MARKET POTENTIAL

Food production for a growing world population is of global importance, and a drastic reduction of the use of antibiotics in animal fattening is essential to avoid a medical emergency regarding the effectiveness of antibiotics. Therefore, a high market potential can be assumed for these tetrapeptides.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-University Giessen TransMIT GmbH is looking for cooperation partners or licensees for distribution or further development in Germany, Europe, US, and Asia.

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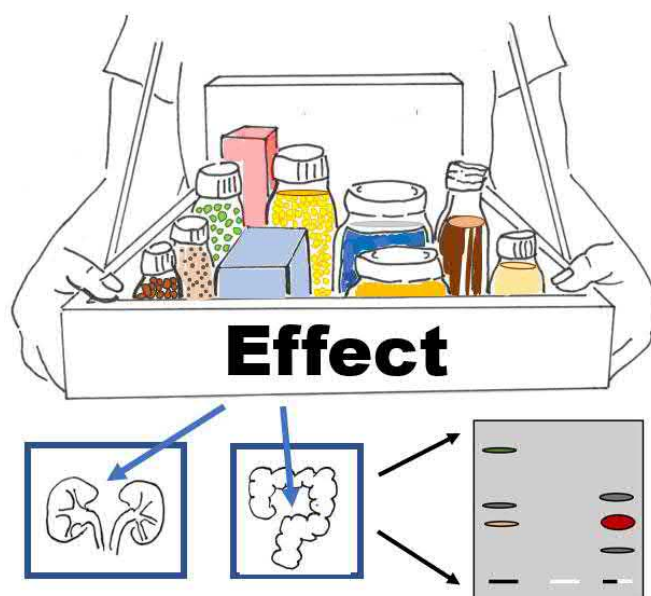
SYSTEM PARTNER FOR INNOVATION

Test system for food by simulation of metabolism processes

Food safety, analytics, biological effectiveness

DESCRIPTION OF TECHNOLOGY / PRODUCT

More and more chemical substances are used in food without knowing their effect on the human body, especially the digestive system. These chemical substances can trigger unpleasant consequences such as intolerances and allergies or even be involved in tumour diseases. The new test procedure simulates on a carrier material how the chemical substance or food acts on a certain metabolic process of the human body, e.g. on the gastrointestinal tract. On this carrier, both an analysis of the substance composition of a food and a subsequent biological test are possible. Thus it is possible to show negative but also positive effects of chemical substances or food on human metabolic processes.



Source: TransMIT GmbH

SCOPE OF APPLICATION

The fields of application are medical nutritional advice, as well as food and environmental analysis. The method can be used in any analytical or microbial laboratory that is accredited to test food and environmental samples.

AT A GLANCE ...

TECHNOLOGY FIELD / SCOPE OF APPLICATION

food safety, nutritional medicine, pharmaceutical research

MARKET / BRANCH

- food analysis
- nutritional advice
- functional food
- health food

USP

- Reliable and fast procedure
- Analytics and biological effectiveness on one carrier
- Less expensive than conventional methods

DEVELOPMENT STATUS

- ✓ Alignment of gastrointestinal processes
- ✓ Tests on various food samples
- ✓
- Next step: approval for food analysis

PATENT PORTFOLIO

Priority application filed at the EPA European Patent Office on 17.07.2020. International PCT application filed on 15.07.2021.

REFERENCE NO.: **TM 1096**

ADVANTAGES COMPARED TO STATE OF THE ART

The method combines for the first time on a single carrier the analysis of substance mixtures by means of high-performance thin-layer chromatography with biological tests to demonstrate the biological effectiveness of the separated substances. This is done quickly, reliably and cost-effectively. Very little sample material is required. A variety of designs are possible, adapted to the most diverse metabolic processes. The method can also be applied to metabolic processes in animals.

DEVELOPMENT STATUS

The functionality has already been successfully demonstrated with different food components and substance mixtures and their effect on the human gastrointestinal tract including the liver. The use of biological tests on the carrier material has been demonstrated with adherent cells and a variety of different bacterial species.

MARKET POTENTIAL

The product idea lies in the market segment of nutritional medicine, medical analysis and food analysis.

In 2018, the Industry Association for Laboratory and Analytical Technology presented good sales figures and drew a positive balance: The 330 German manufacturers of analytical, bioanalytical and laboratory technology achieved a sales increase of 6.8 percent in 2018 compared to the previous year. Positive impulses came both from the domestic market (+4.3%) and, above all, from international business (+8.7%). The number of employees rose by 6.3% to around 47,000. In 2019, the sales growth was increased by 2.3%, and the industry expects a similar increase in sales for the following year.

OFFER

On behalf of its shareholder Justus-Liebig-University Giessen, TransMIT GmbH is looking for cooperation partners or licensees for the production, distribution or further development in Germany, Europe, the USA and Asia.

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System Partner for Innovation

REFERENCE NO.: TM 1096

Tension controlled plant watering system

watering system, plant cultivation, agriculture, gardening, hydrology, water management, water supply, precision watering

DESCRIPTION OF TECHNOLOGY

Sustainable and efficient watering strategies are more important than ever in view of current and future climate developments. In addition to known factors such as nutrient supply, soil characteristics and plant development status, water supply is crucial for optimal growth and yield performance of the plant.



Known watering systems do not take into account the variable water needs of the plant, but those of the soil and are based only on timers and soil moisture sensors.

Each soil has a fixed tension value that reflects the suction tension for liquid. This value is influenced by the water consumption of the plant, as well as environmental conditions. By measuring the tension, the watering system recognizes the actual water demand of the plant and, with the help of a sophisticated water system, maintains a constant tension. This allows the optimal assimilation rate to be maintained under a wide range of conditions.

By focusing on the actual water requirements of the plants, optimal watering can be ensured for a wide range of varieties and development stages. Especially in drought regions, untargeted water consumption can be limited.

The device consists of a porous plate connected to a water reservoir on which a rootable substrate is placed.

AT A GLANCE ...

Applications fields

- gardening
- industrial agriculture
- sports and green areas
- grazing land- and field areas
- cities/communities /private households

Business

- agriculture & forestry
- Market gardens

USP

- tension-controlled
- constant irrigation on demand-based on tension
- water-saving
- adaptable to different soils, plants and cultivation methods

Development status

- prototype
- next step: scale-up

Patent status

European Patent will be granted in 2022

ADVANTAGES OVER THE PRIOR ART

- Consideration of the variable water demand of the plants.
- Tension controlled, with constant tension depending on the setting (season, plant size, etc.)
- Provides optimal germination conditions
- Adaptability to different substrates and plants
- Porous plate can be of different materials
- Targeted fertilizer/herbicide application possible
- Avoidance of under- or over-watering, as well as sensible watering by eye when deficiency is already prevalent

STATE OF THE PRODUCT DEVELOPMENT

A prototype has been developed and the next steps should aim towards scale-up.

Addition for existing systems as well as extension with other devices are possible.

MARKET POTENTIAL

According to the German Chamber of Commerce and Industry (IHK), the market share and sales of watering systems have been increasing constantly for several years.

Changing climate patterns and environmental conditions (long periods of drought, soil degradation, higher temperatures and humidity, lack of rainfall, etc.) as well as ever increasing yield/yield requirements will continue this trend worldwide.

Worldwide, about 43.6% of all agricultural land is located in drylands (Statista). Existing yield areas can be optimized and new yield areas can be developed with the system. Variations in the structure as well as in the materials used allow a wide range of applications with regard to the area and location of use. Exemplary applications would be, among others, in industrial horticulture or as a technology demo in entrance areas or at communal places.

COOPERATION OPPORTUNITIES

On behalf of the Technische Hochschule Mittelhessen, TransMIT GmbH is looking for cooperation partners or licensees for the implementation and/or further development.

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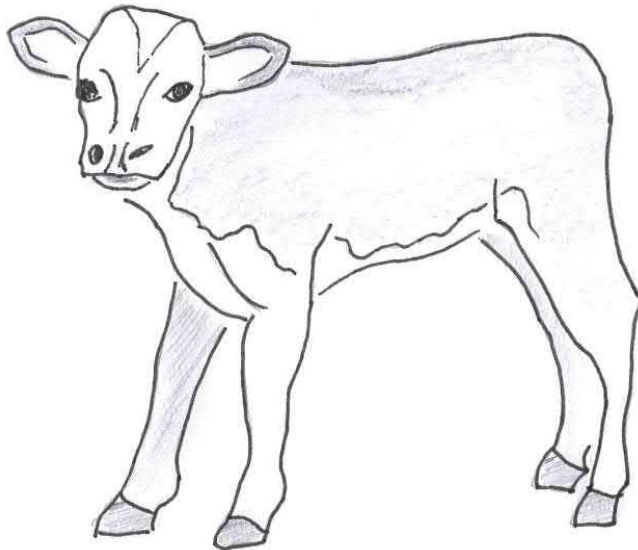


Intuitive calf feeder

Guiding feeding system for calves, shortened learning phase

DESCRIPTION OF TECHNOLOGY

In dairy farming, calves are usually fed from day one by trained personnel using teat buckets and later also automatic milk feeders. Since calves can often not find the teat of the feeders on their own, they must be intensively monitored and trained during the first days of life. This learning phase is labor-intensive and requires a lot of care. If there is a lack of time, it can have a massive impact on the health and development of the calves.



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The new feeding system offers a solution. A simple technical component, which can also be used as a retrofit kit for existing feeding systems, intuitively guides the calves to the teat. This means that intensive training of the calves is no longer necessary, as they learn more quickly and reliably how to find the teat for the first time and how to return to the teat of the feeding system after an interruption.

APPLICATION FIELDS

The new feeding system has been developed for use with calves. Through simple technical modifications, it can also be adapted for use with lambs, fawns or other young mammals.

AT A GLANCE ...

Application Fields

- Feeder for calves
- Feeder for lambs, fawns and other mammals

Business

- Agricultural supply
- Dairy farms
- Animal transport

USP

- Shortens the learning phase for calves
- Reduces the working time
- Simple technical solution
- Can also be implemented by sparsely trained personnel
- Can be retrofitted at low costs

Development Status

- Prototype created and tested

Patent Status

Priority application filed on 16. November 2021 with the European Patent Office.

ADVANTAGES OVER THE PRIOR ART

The new feeding system encourages the calf to find the teat on its own, without much help from the staff. As a result, calves learn to drink more quickly on their own and can easily find their way back to the teat in case of an interruption, which is essential for the health of the calves, especially in the first days of life or during the short feeding breaks at control posts during calf transportation. In addition, the new feeding system uses an angled teat that supports the calves' natural physiological sucking position. This prevents rumen drinking.

STATE OF THE PRODUCT DEVELOPMENT

A prototype was created and tested with great success in calves (KTBL publication 520).

MARKET POTENTIAL

In rearing calves, a considerable proportion of calf losses and diseases occur as a result of inadequate milk intake in the first few days of life. The new feeding system offers a great reduction in the workload when feeding calves, as the training phase can be significantly shortened. This gives the staff more time for the health monitoring and care of the calf.

In addition, the intuitive nature of the new feeding system allows that its functionality is less dependent on staff motivation, time pressure or poor understanding of the calves' physiological needs. It therefore facilitates the calves' learning phase until successful sucking is established, even in the case of poorly trained or unmotivated employees.

In this way, the new drinking system can promote good calf development, as well as reduced illness and mortality, and is therefore an improvement for animal welfare and farm management workflows.

In Germany, there are about 133,000 cattle farms with about 11.3 million cattle, of which about 2.34 million are calves (Federal Statistical Office, November 2020). The production value of the total cattle farming in Germany is about 13.9 billion Euros, and the sales revenue for calves alone is about 218 million Euros (BMEL 2020).

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-Universität Giessen TransMIT GmbH is looking for cooperation partners or licensees for further development in Germany, Europe, US, and Asia.

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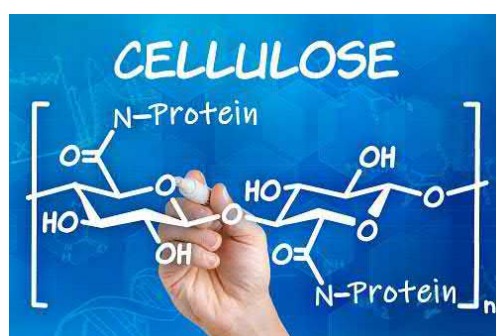


Production of protein-grafted cellulosic fibers by a simple two-step process

Cellulose-modification, grafting with proteins, hydrophobins, cellulosic functional materials, hydrophobic materials and textiles

DESCRIPTION OF TECHNOLOGY

Cellulose is the most abundant organic polymer on Earth usable for many purposes ranging from paper sheets to textiles. There is great demand for chemically modifying cellulose in order to create additionally tailored functional materials from cellulose, e.g. for creating drug delivery systems for the pharmaceutical industry. But up to date it is difficult and strenuous to specifically modify cellulose fibers (e.g. by usage of highly reactive NCO-terminated oligomeric compounds).



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The new method presented herein consists of two simple steps for chemically modifying the surface of cellulosic materials, e.g. macroscopic sheets, microscopic fibers, filaments or nanoparticulate cellulose.

Step one is a chemical or enzymatic oxidation, transforming the C6 carbon atoms of the cellulose to a carboxylic group (-COOH) without degradation of the backbone-structure of cellulose. The second step is the covalent coupling of a protein, e.g. a hydrophobin, by formation of amide bonds between the primary amine side-groups of the protein and the newly created carboxylic groups on the surface of the cellulosic material. The attached proteins provide the modified cellulosic surfaces with new characteristics, in case of hydrophobins a resistant and repellent surface which is very durable because of the chemical bonding of the protein to the cellulosic surface.

AT A GLANCE ...

Application Fields

- biomedical applications - drug delivery systems
- Industrial textiles
- Clothing textiles

Business

- Pharmaceutical Industry
- Textile industry

USP

- Simple grafting process
- Manifold adjustable process
- Low energy demand

Development Status

- Process is proven on laboratory-scale by use of hydrophobin

Patent Status

PCT-application pending, filed on November 11th, 2019

APPLICATION FIELDS

The fields of application are very numerous, depending on the specific chemical modification. Currently the most intensively tested modification is increasing the hydrophobicity by grafting with hydrophobins. A major field of application for hydrophobised cellulose is the textile-industry, not only regarding clothings but also the broad field of industrial textiles. Many other possible fields of application are, for example, drug delivery systems, fabrics with anti-microbial surfaces etc.

ADVANTAGES OVER THE PRIOR ART

Compared to the established chemical and physical processes for modifying cellulosic materials, proteins are environmentally friendly tools for the functionalization of cellulose. The oxidation-process (step one) can be performed by use of enzymes, providing a very low energy demand in combination with high chemical specificity.

STATE OF THE PRODUCT DEVELOPMENT

The complete two-step process for protein-based functionalisation of cellulosic materials is already proven on laboratory scale by use of hydrophobins as sample proteins. The chemical modifications are assured by spectroscopic measurements (FT-IR-analysis) and material testing (measurement of contact angle with and without hydrophobin-modification).

COOPERATION OPPORTUNITIES

On behalf of the Universität für Bodenkultur Wien (University of Natural Resources and Life Sciences, Vienna) the TransMIT GmbH is looking for cooperation partners for further development or licensees in Germany, Europe, US, and Asia.

A TECHNOLOGY OF



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SYSTEM PARTNER FOR INNOVATION

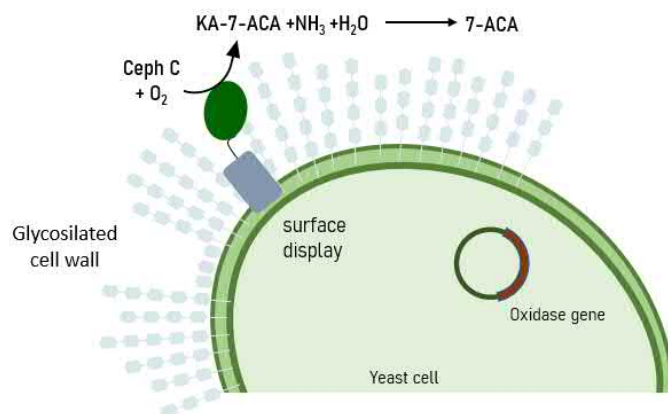
Yeast Surface Catalysis (YSC) Platform

Cephalosporin, Antibiotic production, 7-ACA, Single-pot conversion, Immobilisation, Surface Display

DESCRIPTION OF TECHNOLOGY

This technology provides D-Amino Acid Oxidase immobilized via surface display on yeast cells. It can be easily produced and used for the production of the Cephalosporin antibiotics precursor 7-ACA. No undesirable H_2O_2 is produced, and a single-pot conversion is possible saving valuable process time and production costs.

7-aminocephalosporanic acid (7-ACA) is a key precursor in the production of Cephalosporin antibiotics. In the traditional process D-Amino Acid Oxidase (DAAO) deaminates Cephalosporin C (Ceph C) under production of H_2O_2 and α -ketoadipyl-7-ACA (KA-7-ACA). H_2O_2 causes the degradation of KA-7-ACA into glutaryl 7-ACA (GL-7-ACA). GL-7-ACA Acylase (GA) transforms both compounds into 7-ACA. The main drawbacks of this process are that H_2O_2 causes undesirable byproducts and inactivates the enzymes, and a 2-3 step process is necessary.



The D-Amino Acid Oxidase is immobilized on the surface of a yeast cell via surface display (SD). The modified yeast cells can be easily produced in large amounts and with high oxidase activity. Cells can be used for the conversion of Ceph C to 7-ACA. The yeast surface thereby catches the formed H_2O_2 and hydrolyzes it with its natural catalase. No H_2O_2 production can be detected in the process. The enzymes are stably immobilized on the cells and can easily be separated from the reaction mixture.

AT A GLANCE ...

USP

- Single-pot conversion of cephalosporin C to 7-aminocephalosporanic acid
- Instant H_2O_2 degradation by native yeast catalase
- Direct expression of enzyme in, and immediate immobilization on the surface during yeast fermentation
- Simple purification of SD cells by filtration of fermentation broth
- Stabilization of SD enzyme through immobilization
- Co-immobilization of Glutaryl 7-ACA Acylase possible

Development Status

- Proof of Concept
- Developed in cooperation with DirectSens GmbH

Patent Status

Priority application filed 2020 with the European Patent Office and PCT application 2021.

ADVANTAGES OVER THE PRIOR ART

- Single-pot conversion of cephalosporin C to 7-aminocephalosporanic acid
- Instant H₂O₂ degradation by native yeast catalase.
 - No formation of GL-7-ACA
 - No catalase or H₂O₂ addition necessary
 - No enzyme activity loss due to oxidation by H₂O₂
- Direct expression of enzyme in, and immediate immobilization on the surface during yeast fermentation.
- Simple purification of SD cells by filtration of fermentation broth
- Stabilization of SD enzyme through immobilization
- Co-immobilization of Glutaryl 7-ACA Acylase possible

STATE OF PRODUCT DEVELOPMENT

- Proof of Concept
- Developed in cooperation with DirectSens GmbH

COOPERATION OPPORTUNITIES

On behalf of University of Natural Resources and Life Sciences, Vienna (BOKU); TransMIT GmbH is looking for collaboration partners and license Agreements (exclusive/non-exclusive) worldwide.

A TECHNOLOGY OF



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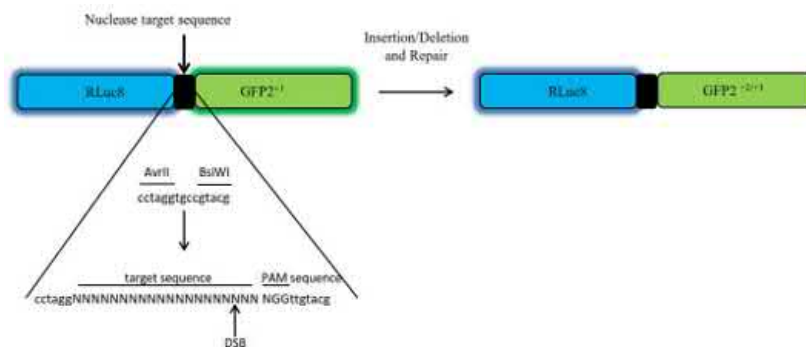
Tool using BRET for determination of CRISPR/Cas9 restriction efficiency

Biosensor / CRISPR/Cas9 / restriction efficiency / BRET

DESCRIPTION OF TECHNOLOGY

The technology comprises a new method involving bioluminescence resonance energy transfer (BRET) ratio for determination of restriction efficiency of endonucleases or endonuclease systems comprising a guide-RNA that are used for induction of double-strand breaks at a DNA target sequence of interest for genome editing approaches.

The method is suitable for high throughput analyses of potential DNA target sites in combination with different endonuclease-guide-RNA complexes, e.g. CRISPR-Cas9-gRNA complexes.



© K. Stieger, T. Wimmer, JLU Giessen

Fig. 1: Schematic representation of the biosensor. The DNA target sequence and a PAM sequence are cloned into the plasmid. During a double-strand break (DSB) in the DNA target sequence, by action of CRISPR/Cas9-gRNA, nucleotides are inserted or deleted. In 66% of the DSB events these insertions or deletions stay when the DSB is repaired by non-homologous end-joining (NHEJ), thereby leading to a frameshift in the gene encoding GFP2 and therefore expression of GFP2 gets lost. However, the expression of the luciferase (RLuc8) is not affected.

AT A GLANCE ...

Application Fields

- Determination of CRISPR/Cas9 restriction efficiency in genetic applications of biotechnology or medicine

Business

- Pharma / Biotech / Medical Technology

USP

- Biosensor for CRISPR/Cas9 efficiency
- Less elaborate, cheap, highly sensitive
- Tool uses BRET
- Applicable for high throughput analyses

Development Status

- Tested in laboratory with selected targets
- Proof of concept and adaptation to high throughput application are next steps

Patent Status

- EP Patent granted.

APPLICATION FIELDS

Off-target mutations are an important caveat of endonucleases used for genome editing approaches, for example the CRISPR-Cas9 system, that need to be addressed. Even a low frequency of unintended mutations might have deleterious effects, so improving CRISPR-Cas9 specificity is essential for a reliable genome editing.

For the development of CRISPR-Cas9 systems comprising highly specific gRNAs that induce much less or even no off-target mutations, a reliable and cost-effective method for analysis of newly synthesized CRISPR-Cas9 systems and the DNA double-strand breaks induced by them is needed, which is furthermore suitable for high-throughput application.

The tool presented here provides a solution for this.

ADVANTAGES OVER THE PRIOR ART

The state of the art lacks methods that are less elaborate, cheap and sensitive enough. Furthermore, the known technologies are not suitable for high throughput analyses.

All of these disadvantages are overcome by the newly provided tool using the BRET system for determination of CRISPR/Cas9 restriction efficiency.

STATE OF THE PRODUCT DEVELOPMENT

The tool has been developed and tested with certain selected targets. Proof of concept and adaptation to high throughput application will be the next step.

MARKET POTENTIAL

A growth of the CRISPR/Cas systems market of up to US\$ 25 billion is predicted by 2030. The market for genome editing, where CRISPR/Cas9 already accounts for more than half of the market, will expand strongly in the coming years. By 2021, the CRISPR/Cas9 market is expected to have annual sales of approximately \$3.61 billion.

The market for screening libraries and gRNA design tools still has low market penetration. However, comprehensive end-to-end screening, design, and gRNA platforms are not yet available and therefore represent a key factor.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-Universität Giessen TransMIT GmbH is looking for cooperation partners for further development or licensees.

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REF. NO: TM 1006

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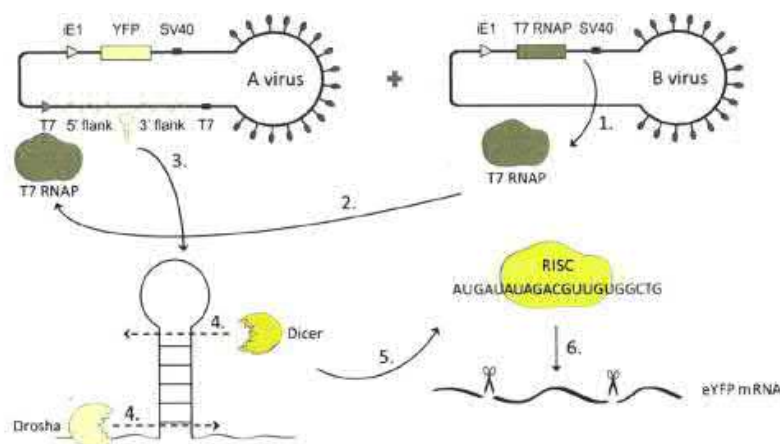
SYSTEM PARTNER FOR INNOVATION

Expression of proteins via a two-vector based inducible system

protein expression, baculovirus expression system

DESCRIPTION OF TECHNOLOGY

Products, such as proteins, VLPs and other nanoparticles are often produced in insect cells using the baculovirus system. However, purification of the final product is difficult and requires several tedious steps, because the baculovirus particles are present as a DNA containing contaminant in the supernatant. Therefore, strategies have been tested to abolish baculovirus system secretion during the protein production process. Usually, a gene that is essential for virus budding, is deleted from the baculovirus genome, and a helper cell line providing the missing gene is generated, that allows propagation of this virus. However, these helper cell lines suffer from instability and poor virus production. Antisense-RNA based strategies have been established in insect cell, usually targeting cellular genes. Most of these approaches are not efficient. The technology requires cell specific polymerase 1 promoters for exact transcription of the guide RNA. For identification of such promoters, the whole genome sequence must be available.



© Prof. Grabherr, BOKU Wien

APPLICATION FIELDS

Application fields are in biotechnology medicine and pharma where high-quality proteins are used.

AT A GLANCE ...

Application Fields

- protein expression
- insect cell

Business

- Biotechnology
- Pharma, Medicine

USP

- improved production of high-quality protein based products such as proteins, VLP's and bio-nanoparticles
- Inducible expression in insect cells without the use of helper cell lines
- Suitable for downregulation of essential genes on the baculovirus genome
- Downregulation mechanism can be used in insect and mammalian cells
- Baculovirus free protein production

Development Status

- Proof of Concept

Patent Status

International patent application (PCT) filed on 13.09.2019.

ADVANTAGES OVER THE PRIOR ART

The invention provides a baculovirus based expression system for targeted downregulation of any gene on the baculovirus genome or the cellular genome. By antisense RNA or CRISPR/Cas9 technology, genes that are essential for baculovirus budding are being downregulated during the time of protein production. The downregulation mechanism is induced only when a combination of two different baculovirus species is present (dual vector system) and is regulated by the bacterial T7-System, which allows universal use in all insect cells as well as mammalian cells (no cell specific Polymerase 1 promotor required). The baculovirus species can be produced individually to high titers, only in combination, baculovirus production is hampered or abolished virus.

STATE OF THE PRODUCT DEVELOPMENT

Baculovirus free protein production as proof of concept.

COOPERATION OPPORTUNITIES

On behalf of University of Natural Resources and Life Sciences, Vienna TransMIT GmbH is looking for cooperation partners or licensees for distribution / further development in Germany, Europe, USA and Asia.

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ACIT – A new tool for fermentation processes with non-model bacteria

Sustainability, usage of waste streams, curdlan, polyhydroxybutyrate (PHB)

DESCRIPTION OF TECHNOLOGY

Biotechnological manufacturing of compounds and materials by fermentation is the most important way of transforming chemical manufacturing to sustainability. But there are two major disadvantages of currently available fermentation processes: First, often feedstock material is needed which should preferably be used for food production (cf. for example the plate-tank issue with bio fuels). Second, many fermentation processes are performed with model bacteria (e.g. *Escherichia coli*), which are not naturally producing the desired product, so that it can hinder growth of the microorganism and reduce the yield of the product.

Both problems can easily be solved with the invention presented herein, being called **ACIT** ("**A**lphaproteobacteria **c**hromosomally **i**nserting **t**ranscription-control **c**assette"). The method allows to easily modify not only model bacteria, but also any type of non-



© Dr. Matthew McIntosh / JLU, Purified curdlan from *Agrobacterium tumefaciens*

model bacteria, so that for the production of a desired product a bacterium may be chosen which is already naturally producing (and therefore being adjusted to) the desired product.

Because this bacterium is by nature already used to producing the desired product, genetical modification in order to raise the yield should not negatively interfere with the viability of the bacterium. Alternatively a bacterium may be chosen for modification and fermentation which is able to use biological waste material, so that instead of using food crops as feedstock, waste material may be used for production.

AT A GLANCE ...

Application Field

- Chemical manufacturing
- Biotechnology
- Waste management

Business

- Biologically based polymers
- Active pharmaceutical ingredients (APIs)
- Food additives

USP

- Applicable to model and non-model bacteria

Development Status

- Proof of principle shown on laboratory scale
- Samples of produced material (curdlan) available on kg-scale for own experiments

Patent Status

Priority application, filed August 17th 2021 at the European Patent Office.

APPLICATION FIELDS

The fields of application of ACIT are numerous due to the general applicability of the method for model bacteria as well as non-model bacteria, ranging from sustainable chemical manufacturing (compounds, polymers, fuels etc.) over production of pharmaceuticals to handling and using biological waste materials, for example from food industry.

ADVANTAGES OVER PRIOR ART

The two major disadvantages of currently available fermentation methods, viability-problems of model bacteria if modified to produce non-native products and difficulties for using biological waste material as feedstock for fermentation processes can be solved with ACIT by either genetically modifying and applying non-model bacteria already adapted to the desired product (improving yield) or genetically modifying and applying non-model bacteria already able to digest biological waste material for fermentation.

STATE OF PRODUCT DEVELOPMENT

Functioning of the ACIT-System for genetic modification of non-model bacteria has already been shown by example of applying it to *S. meliloti*, *A. tumefaciens*, *R. capsulatus* and *R. sphaeroides* for producing curdlan and PHB.

MARKET POTENTIAL

Transforming the whole economy towards sustainability is one of the major global challenges humanity is facing. Fermentation processes are important instruments for sustainably providing material supply for many production processes of chemistry, pharmacy and energy supply. The market potential of ACIT is therefore considered to be quite enormous in many areas.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-University Giessen TransMIT GmbH is looking for cooperation partners or licensees for further development in Germany, Europe, US/Canada, and Asia/Australia.

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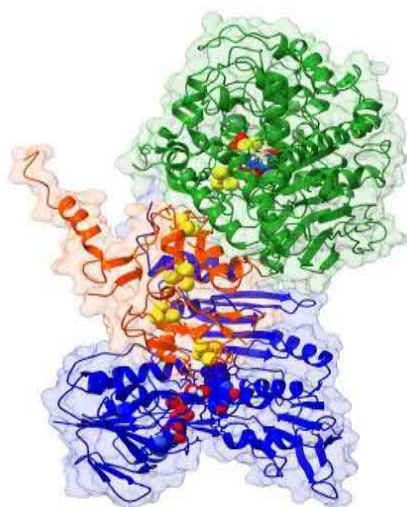
SYSTEM PARTNER FOR INNOVATION

Biocatalytic production of NADH and aromatic/aliphatic aldehydes

Biotechnology, enzymatic reduction of carboxylic acids, reduction of NAD⁺, „NADH recycling“, PtX-technologies

DESCRIPTION OF TECHNOLOGY

Biotechnological processes are essential methods for the sustainable production of numerous types of chemical compounds, base chemicals as well as functionalized specialty chemicals. For the efficient run of fermentation processes it is generally also very supportive to provide sufficient supply of NADH, the universal „energy compound“ for nearly all biological processes in cells.



The invention presented herein provides a biocatalytic (enzymatic) process for the reduction of either carboxylic acids (primarily providing aldehydes and subsequently alcohols) or NAD⁺ (providing NADH). The process is using the enzyme aldehyde oxidoreductase (AOR, left) as biocatalyst and requires only hydrogen as readily available and cheap reductant.

© Agnieszka Winiarska,
Jerzy Haber Institute of Catalysis and
Surface Chemistry

APPLICATION FIELDS

The first variant of the biocatalytic reduction process is well suited for the manufacturing of flavouring compounds (aldehydes) and biofuels (alcohols), the second variant is applicable for improving all types of fermentation processes, for it provides a facile way of „NADH-recycling“ during fermentation processes generally. The products from the first variant can also be used as intermediate compounds for chemical synthesis (production). Thus the application fields of the invention are quite manifold.

AT A GLANCE ...

Application Fields

- Fermentation processes of all types

Business

- Chemical manufacturing generally
- Production of biofuels, flavouring compounds, chemical intermediate compounds
- Recycling of NADH (from NAD⁺)

USP

- Simple application of hydrogen as reducing agent
- Easily adjustable to the product of desire.

Development Status

- Both variants are shown to be running on laboratory scale.

Patent Status

Priority applications filed on 29.03.2021 at the Polish Patent Office.

ADVANTAGES OVER THE PRIOR ART

The biocatalytic reduction process is already elaborated in two variants, the first one providing chemical compounds which can be directly used for different purposes, the second one being a NADH-recycling process which can be easily „attached“ to already existing fermentation processes in order to enhance their performance.

The biocatalytic reduction process is working with hydrogen as sole reducing agent, thus being perfectly predestined for the application of „green“ hydrogen for chemical synthesis (PtX-technologies).

STATE OF THE PRODUCT DEVELOPMENT

The applicability of both variants are proven to be working on laboratory scale. Further development is already under way.

MARKET POTENTIAL

Due to the broad applicability of the biocatalytic reduction process, especially in connection with PtX-processes, it is considered to have high market potential in the area of sustainable chemical production, thus effectively supporting the „metamorphosis“ of the chemical industry towards being based on renewable feedstock.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Philipps-Universität Marburg TransMIT GmbH is looking for licensees or cooperation partners for further development in Europe and worldwide.

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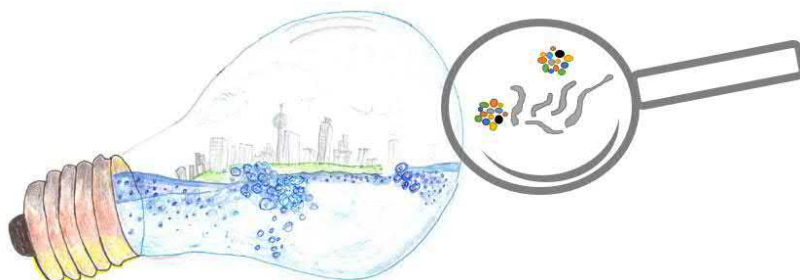
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Aquatic ecotoxicological method for testing chemical substances

DESCRIPTION OF TECHNOLOGY

Chemical substances introduced into an ecosystem often also influence the microorganisms living there without this being the primary intention. In most cases, flowing waters are affected, as pesticide contamination from agricultural sources flows in as runoff or drift. Added to this is the ever-increasing input of microplastics. The high concentration of these substances has a negative impact on aquatic fungi and their functions on the self-purification potential of water bodies. As a result, leaves and litter are no longer decomposed and degraded and the water body "overturns".



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The new ecotoxicological method for testing active substances such as fungicides and microplastics on aquatic fungi is carried out with a novel artificial substrate and can therefore be performed under standardized and replicable conditions in the laboratory, but also in the field.

It provides rapid and reliable test results on the extent to which a substance has a negative impact on aquatic fungi and biofilms.

APPLICATION FIELDS

The method is used in environmental analysis and toxicology for the approval of new active substances and for the safety testing of already approved active substances.

AT A GLANCE ...

Application Fields

- Environmental Analytics
- Environmental Monitoring
- Approval/testing of plant protection products

Business

- Environmental Toxicology
- Analytics
- Risk assessment of chem. Substances
- Authorization authorities for plant protection products

USP

- Procedure with standardized and replicable conditions
- Implementation under laboratory conditions, but also in the field
- fast and reliable test results

Development Status

- Development of an artificial substrate for aquatic fungi
- Established test system for fungicides
- as multiple test system extendable to bacteria and algae

Patent Status

Priority application filed on Dec. 04,2018 in EP.

ADVANTAGES OVER THE PRIOR ART

A standardized artificial substrate for aquatic fungi to colonize by a defined fungus or community of organisms. Colonization of aquatic fungi on a defined colonization surface. Acute, i.e. short-term and short-term, as well as chronic, i.e. long-term and long-term effects of the active substance or microplastic to be tested on aquatic fungi can be demonstrated and documented. The method can be standardized and replicated.

STATE OF THE PRODUCT DEVELOPMENT

Established test method for the effect of fungicides on aquatic fungi.

MARKET POTENTIAL

The global market for plant protection products amounted to €42.7 billion in 2014, with Latin America accounting for 28.5%, Asia incl. Japan and Oceania for 25.9%, the EU for 24.5% and the USA, Canada and Mexico for 17.3%.

Sales in Germany totaled €1.6 billion in 2014.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-University of Giessen TransMIT GmbH is looking for cooperation partners or licensees for distribution / further development in Germany, Europe, USA and Asia.

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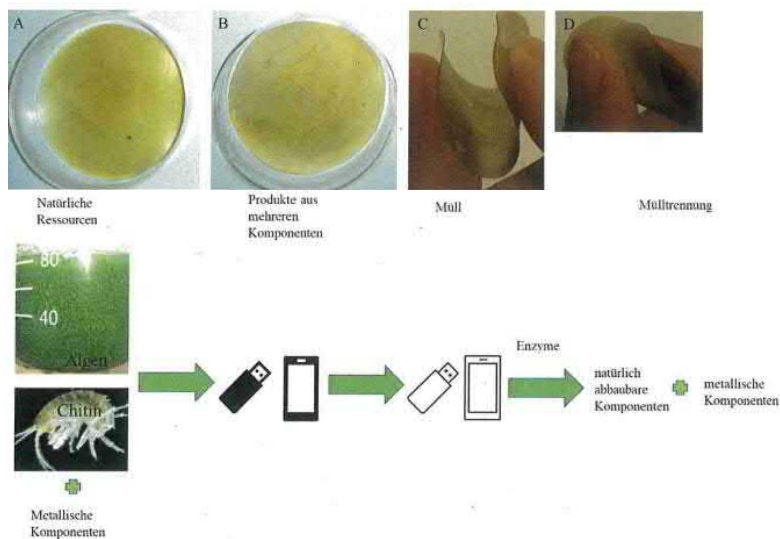
Material made from renewable aquatic raw materials

bioplastic, renewable raw materials, recyclable, composite

DESCRIPTION OF TECHNOLOGY

Electronics and plastic products have become an indispensable part of today's everyday life. However, poor levels of recyclability and increasingly scarce raw materials require new technologies and concepts.

The plastic-like material consists of an artificial biofilm, which is obtained from renewable aquatic raw materials or fishery waste. The biofilm is smooth, flexible and can be completely degraded. Properties such as flexibility, stability and colour can be modified according to requirements.



© Dr. Elisabeth Pohlen

For composite materials such as printed circuit boards, complete separation into metallic and natural components can be achieved by microbial recycling, allowing the reuse of the metallic component without loss of material and toxic chemicals.

AT A GLANCE ...

Application Fields

- Composite materials
- Electronics
- Biodegradable plastic replacement

Business

- Electronics e.g. printed circuit boards
- Consumer goods e.g. tableware or toys
- Packaging industry

USP

- Compostable & fully recyclable
- No agricultural land required
- Material properties adaptable
- In combination with metal - complete recovery of the metal component

Development Status

- Prototype
- Test specimens were tested for stability and durability

Patent Status

EP Priority application was filed on Nov. 18., 2022

APPLICATION FIELDS

As a composite product, for example, printed circuit boards & USB sticks. Further applications, for example as floor coverings are to be tested.

ADVANTAGES OVER THE PRIOR ART

- Fully compostable and environmentally friendly
- Complete decomposition into initial component when used as composite product e.g. in printed circuit boards
- Quick and flexible adaptation of the formulation according to desired flexibility, stability and colour.

STATE OF THE PRODUCT DEVELOPMENT

The biofilm shows a stability and durability of more than 18 months (at room temperature) and a high flexibility.

MARKET POTENTIAL

The high number of plastic products is countered by low recyclability and high amounts of waste. These not only pollute the oceans and ecosystems worldwide, but also promote resource scarcity. Especially with composite materials (combination of plastic and metal), recycling rates are low and valuable metal components cannot be reused.

According to the Global E-waste Monitor 2020, 53.6 million tonnes of e-waste was produced globally in 2019. Of this, only 17.4% was recycled. Instead of being reused, precious raw materials including gold, silver, copper, etc., worth approximately \$57 billion US dollars were dumped or incinerated.

COOPERATION OPPORTUNITIES

On behalf of its shareholder Justus-Liebig-University of Giessen TransMIT GmbH is looking for cooperation partners or licensees for distribution / further development in Germany, Europe, USA and Asia.

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