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Cradle to cradle design for wood products

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Wood is a bio-based and renewable material with superior properties, however, dimensional constraints or limitations in specific properties exist. During the past century different engineered wood products have been developed to overcome these limits. Formaldehyde-reacting adhesives are currently widely used in the wood industry. Existing regulations are limiting formaldehyde emissions, but the bio-based resource wood is still combined with a petrochemical component, with a separation of these components at the end of the product life cycle being practically impossible. The aim of this research is to develop sustainable products without toxic chemicals, which enables added-value creation within a natural cycle. Here, the cradle to cradle design principle is adopted, as proposed in the 1990s by Braungart and McDonough, which defines products optimized for a biological cycle, a technical cycle, or the combination of both. To apply this for engineered wood products, two possibilities exist: (1) separate material components at the end-of-life, or (2) use only non-toxic and biodegradable materials. Within that frame a lignin-starch adhesive was developed and tested for three recycling scenarios using the Automated Bonding Evaluation System (ABES). The novel gluing process allows to re-open the glueline for recycling purposes, achieving overall a 100 % bio-based and biodegradable material concept. The developed adhesive turned out to be highly promising, as it shows very acceptable mechanical properties.

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Kinetics analysis of the curing reaction of UF-based adhesives

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Urea-formaldehyde (UF) is a leading thermosetting wood adhesive for the production of wood composite panels, such as medium-density fiberboard (MDF) and particleboard due to its outstanding properties, like fast curing and good bonding performance. However, the main risk is probably that formaldehyde is suspected to cause cancer. Thereupon, a possible solution is the development of novel hybrid adhesive systems with reduced formaldehyde content and improved properties, e.g. hybrid adhesives based on UF resins mixed with other non-formaldehyde added systems. In order to realize this approach, the kinetics of the curing reaction of UF resins have to be fully understood. The kinetics of the curing reactions strongly depend on the type and amount of available reactive positions in the amino resins. Reducing the formaldehyde content in the hybrid adhesives will have a significant effect on the reactivity or kinetics of the curing processes as well as the mechanical properties of the adhesive. Differential scanning calorimetry (DSC) is broadly used to study the kinetics of curing reaction of traditional adhesives. The kinetic parameters are determined using two types of cure kinetic analysis, namely multi-step model-fitting methods, which include *n*th-order and Kamal-Sourour approaches, and model-free kinetics (MFK) methods, including the Friedman (FR) and Vyazovkin (VA) approaches. The main focus of this work is to develop models based on activation energies, which enable a prediction of the kinetic contribution of the individual steps of the reaction. These modeling methods assist in simulating a process or characterizing adhesives and predicting how the kinetics of the adhesives will change by purposefully varying the formaldehyde content. This supports the development of hybrid systems that match or beat the chemical, mechanical and thermal properties of the state-of-the-art adhesives.

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The limits of auto-ignition of spherical beech and spruce wood

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Opposed to piloted-ignition, where a substance is ignited by an external flame or spark, the term auto-ignition describes the onset of combustion by spontaneous ignition without an external source [1]. In this study, the influence of the size of spherical wood samples and the temperature surrounding the samples were investigated by performing ignition experiments in a muffle furnace with beech and spruce wood. On a specially constructed rig, spheres with four different diameters (8 mm, 12 mm, 18 mm and 25 mm) were put into a preheated furnace at five isothermal temperatures (240 °C, 270 °C, 300 °C, 330 °C and 360 °C). For every temperature, diameter and wood species the experiments were repeated eight times, positions of the spheres on the rig were changed for every measurement. Temperatures inside the samples were recorded with thermocouples positioned in holes drilled to the middle of the spheres.
With rising size and temperature, samples were more prone to auto-ignition, due to a larger, highly reactive pyrolyzed surface. During heating, isothermal phases were present at approximately 360 °C in the recorded temperature curves. Simultaneous thermal analysis (STA) measurements show decomposition of hemicelluloses and cellulose is highest around 360 °C. It is concluded that pyrolysis and disintegration of the main wood constituents use up all arising energy. Due to differences in the composition of the major wood polymers, beech wood samples already ignite at lower temperatures compared to spruce wood samples with the same diameter.
It can be concluded that, the size is a critical factor for auto-ignition at the used temperatures. Bigger samples will produce more volatile species during pyrolysis and have a bigger pyrolyzed porous surface were heterogenous oxidation reactions can happen.

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Effect of thermoplastic component addition on the performance of two-component melamine-urea-formaldehyde

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With the increasing importance of bio-based materials, especially wood and wood composites, adhesive materials play a significant role in using wood more sustainably in construction and other applications. On macro- and microscale, knowledge of adhesive properties is essential to understand the performance of constituents and the interaction with the surrounding environment. The present study investigates the effects of thermoplastic component addition to a thermosetting melamine-urea-formaldehyde (MUF) adhesive system with the change in moisture.

Axially split spruce lamellas were planed and glued with MUF adhesive containing various amounts of the thermoplastic second component. The lap-shear samples tested in dry (A1) and cooked (A4) conditions according to EN 302-1 resulted in tensile shear strength similar to the shear strength of solid spruce wood at the respective conditions. In addition, moisture-dependent elastic properties were investigated using in-situ nanoindentation. Apparent differences in elastic modulus, hardness, and indentation creep were observed with an increase in the amount of thermoplastic second component.

The data resulted from nanoindentation confirmed the sensitivity of thermoplastic components in the adhesive towards moisture. The higher the amount of thermoplastic components in the MUF system, the lower the mechanical properties (elastic modulus and Hardness) appeared. Additionally, MUF systems show a statistically significant increase in indentation creep, with increasing moisture content. This study also proves nanoindentation is a suitable method for characterizing minor differences in polymer materials with changes in surrounding conditions.

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Genome-wide association study for common bunt resistance in a wheat diversity panel

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Common bunt is a seed-borne disease caused by the fungi *Tilletia tritici* and *T. laevis*. Due to the replacement of wheat grains by so-called “bunt balls” or *sori* (masses of teliospores) which break open during harvest, the disease leads to yield and quality losses already at very low contamination levels. Seed dressings with systemic fungicides which are very effective for disease prevention are not allowed in organic agriculture. The most sustainable and economically efficient way to manage the disease in organic farming systems are resistant cultivars. Since known resistance genes are already overcome by certain bunt races, this study aims to support the search for new and durable sources for common bunt resistance by conducting a genome-wide association study in a wheat diversity panel assembled by the USDA National Small Grains Collection. Gordon et al. (2020) have identified a locus conferring dwarf bunt resistance on chromosome 6D in this panel consisting of 292 accessions genotyped with the 90K SNP array for wheat. A subset of 235 genotypes was phenotyped for common bunt incidence in field trials in Tulln from 2019 to 2021. With 125 genotypes, more than half of all accessions were completely resistant, i.e. showing less than 1% common bunt infection. Significant marker-trait associations were identified for three SNPs mapped to wheat chromosomes 1A, 2B and 7A, respectively. The marker on 1A is located in an chromosomal region to which Muellner et al. (2020) have mapped a resistance QTL against dwarf bunt in a population derived from the cross ‘Bonneville’ *x* ‘Rainer. None of the identified markers has yet been published as being associated with common bunt resistance in wheat. Accessions possessing the resistant alleles could therefore serve as valuable new resources for common bunt resistance in bread wheat.

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Characterization of phosphorus fertilizers

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Phosphorus (P) is an essential nutrient for all life forms. Crops grown in soils with low P content need to be fertilized so that optimal yields can be obtained. Most mineral P reserves are located in Morocco, and Europe only has one small P mine in Finland. Concurrently, there are numerous side-waste streams from which P can be recovered and used as fertilizers, broadening the raw materials from which P fertilizers can be obtained.

Currently, the Regulation (EU) 2019/1009 establishes water (H2O) and neutral ammonium citrate (NAC) extractions as test methods to ensure compliance with quality regulations regarding P content and solubility for many P fertilizer types (European Parliament 2019). We have compared these methods with three alternatives: a sink extraction using phosphate adsorption on ferrihydrite ("Iron bag"), $NaHCO_3$ extraction and a vacuum-assisted water extraction (electro-ultrafiltration) on 38 recycling and mineral reference fertilizers. Additionally, we have evaluated the biomass production and shoot and grain P content of a subset of 32 P fertilizers in a pot experiment with wheat grown up to maturity under controlled conditions. Our preliminary results indicate that the fertilizer H_2O solubility does not correlate with plant P availability. The correlation of the three remaining methods with plant biomass and shoot P content looks promising but still needs to be fully evaluated. Besides, the simplicity of these chemical extractions will be taken into account to formulate a recommendation for the EU regarding the most adequate compulsory testing method to evaluate the P content of conventional and recycling P fertilizers.

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Soil Silicon: Impact of the earthworms on the Si uptake of plants

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Silicon is not an essential plant nutrient but a beneficial element, it has a role in increasing the plant's resistance against biotic and abiotic stress. A major fraction of Si in the soil is in the form of insoluble silicates or oxides and thus is not available for plant uptake. Only Si in the form of orthosilicic acid ($Si(OH)_4$) can be taken up by plants [1]. Available Si pool in the soil is limited, and taking the biomass out of the fields leads to its depletion. Silicon is solubilized from minerals, soils, and Si-rich plant material.

For many nutrients it is documented that flora and soil fauna influence solubility [2, 3, 4], but the role of soil biota and especially the earthworms on Si solubilization is not well described yet.

We run 3 experiments in order to investigate (1) the difference in plants' Si content, depending on availability of Si-rich material and presence of different earthworms' species, (2) the influence of earthworms on Si solubilization from soils and minerals, and (3) solubilization of Si in the areas surrounding earthworms' galleries.

In order to complete task 3, we develop a new DGT (diffusive gradients in thin films) approach for Si availability estimation and visualization. The results obtained so far demonstrate that DGT can be a useful tool for visualization of soluble Si in soil, as well as that the activity of at least one species of earthworms has an influence on Si solubility in the areas surrounding their galleries. The results of this study are important for understanding of Si turnover in soil - plant system. So far there are only a very few studies about the role of soil fauna in Si solubilization, and this study is only the first one to assess the role of earthworms in details.

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Enzymatc Coupling of Functional Molecules onto Lignosulfonates to Increase Hydrophobicity

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Lignin is the second most abundant biopolymer in nature and yet mainly used for low-value applications. A water-soluble form of lignin is presented by lignosulfonate (LS). This can have advantages for bioprocesses such as for enzymatic polymerization or modification, since it allows the processes to be conducted at milder conditions. However, for certain applications a higher hydrophobicity would be beneficial [1]. Therefore, we have developed a strategy to enzymatically graft hydrophobic molecules onto lignin moieties in lignocellulose materials. The prove of covalent binding was achieved by LC-MS and NMR analysis [2]. Based on these findings we herein used 4-[4-(trifluoromethyl)phenoxy]phenol, which gave the best results in the previous study, as an easy to detect model molecule for the enzyme mediated hydrophobization of LS. It turned out that the enzymatic coupling worked best at 33°C, a pH of 7 and with 2% (w/v) FP added. In the FTIR spectrum the appearance of a new band at 1,320 cm^{-1} suggested the formation of a covalent bond between the FP and the LS backbone. Similarly, other techniques like XPS indicated enzymatic binding of the fluorophenol (FP) molecules. In terms of hydrophobicity, an increase of 59.2° in water contact angle and a decrease of 216.8% in the swelling capacity was observed for the modified samples. These findings showed that enzymatic functionalization of LS with FP indeed lead to an increase in hydrophobicity. Thus, it would be interesting to use this novel approach for studies with a wider range of functional molecules.

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Endoglucanase enzymes as energy savers during paper production

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Refining of pulps is an integral part of the paper production for achieving desired paper properties by applying shear stress to the pulps, thereby leading to increased hydrogen bonding and tensile strength. The application of enzymes results in considerable energy savings during this process. However, commercial enzyme formulations containing a number of different individual enzymes are commonly applied in the pulp and paper industry with their individual effect still not completely understood [1]. Therefore, a detailed knowledge about the enzyme mechanisms is required for better enzyme dosage and process control in pulp refining. Different commercial enzyme formulations were characterized regarding beta-glucosidase, xylanase and endoglucanase activity. Endoglucanase enzymes were purified using Hydrophobic Interaction Chromatography and Anion Exchange Chromatography and their individual effect was studied in laboratory refining trials. Based on activity using derivatized cellopentaose (CellG5) substrate, endoglucanases were demonstrated to be mainly responsible for the refining effect [2]. The enzyme treatment led to an increase of the degree of refining of up to 47.9 [°SR] at 6000 PFI refiner revolutions while the tensile index was improved by up to 76.0 Nm g^{-1}. Results showed that derivatized cellopentaose is indeed a suitable parameter for enzyme dosage, leading to similar paper properties, thus being a major improvement to the previously used reducing sugar assays. With the application of endoglucanases less revolutions of the refiner are required for reaching a certain degree of refining and therefore endoglucanases can be attributed to energy reduction.

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Surface modification for the enhancement of the lignin polymerization and functionalization using Myceliophthora thermophilia laccase

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Lignosulfonate, byproduct of the paper and pulp industry has been used as energy source for the last few years until the valorization of lignin through different functionalization methods has grown in importance. Polymerization using oxidative enzymes (*Myceliophthora thermophila* laccase) is one such method, which enhances properties such as hydrophobicity, flame retardancy, bonding, antimicrobial properties and aesthetic features of materials. Appropriate downstream processing methods are needed to produce solids that allow the preservation of particle morphology, a vital factor for the adhesive industry. In this work, an optimization of the enzymatic polymerization via spray drying of lignosulfonates was investigated. Response surface methodology (RSM) was used to optimize the drying process, reduce the polymerization time and maximize the yield of dried mass. Particles are formed with concave morphology, enhanced solubility and temperature sensitivity of spray drying protects the phenolic content that directly affects the polymerization. The inlet temperature, atomization pressure and feeding rates were kept as independent variables while carrying out the optimization process. Reduced quartic model was used where the statistical analysis showed a significant effect of the temperature and the feeding rate on the responses and the optimized conditions authenticated the model. Optimum processing conditions of spray drying the lignosulfonates in a lab scale dryer were 190 °C, atomization at 45.6 ml/min and feeding rate of 12 ml/min. With these optimized values, the yield of 65% and the polymerization time of 13 mins. was obtained. The experimental values agreed with the predicted values of the factors (R2: 95.2% and p-value: 0.0001) indicating the suitability of the model in predicting polymerization time and yield of the spray drying process. The optimized enzymatic polymerization process had the highest viscosity of 5000 mPa.s at a shear rate of 200/s and temperature of 25 °C; 293 mPa.s at the optimum point and molecular weight of 2.84×105 kDa.

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Fluorescence labelling of the C-1 oxidized reducing ends of Cellulose

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Fluorescence labelling of oxidized reducing ends of cellulose is key to follow the activities of LPMO enzymes which can cleave the cellulose chain by oxidation at the C-1 position. A proper understanding LPMO's mode of action is needed to apply these enzymes effectively in pulp modification processes. To do so, a novel method for fluorescence labelling of cellulose's oxidized ends is developed. Different fluorophores and coupling methods using carbodiimides have been tested on low molar mass model compounds and cellulose. The procedure will be integrated into a gel permeation chromatography (GPC) system with refractive index (RI), multiple laser light scattering (MALLS) and fluorescence detection. The coupling reaction is optimized with the model compounds lactobionic acid (LB) and cellobionic acid (CB) regarding reaction conditions, presence of catalysts and yield. The optimized protocol will then be applied to cellulose. The labelling reaction of the model compounds proceeds fast and with high yields. The reaction products were isolated by flash chromatography and characterized by NMR. Reaction kinetics as well as the thermal stability of the product in DMAc/LiCl (2.5%, w/v) were tracked by HPLC.

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Development of an RGB3 image database for deep learning in agriculture

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Digitalization in agriculture is an enabler for smart farming applications. Precision agriculture techniques like site-specific management and remote sensing technologies can help to reduce agrochemicals without reducing yield. The used farming machinery and sensors accumulate high amounts of data. With modern technologies like cloud computing and artificial intelligence, these data can be structured, processed, and analyzed to get new insights into plant development and farming management. In our work, we collected an image dataset from a stereo camera setup and annotated the data to be used for a plant classification model. The data was collected on several field trials performed at the experimental farm of BOKU in Großenzersdorf. The goal was to achieve a highly heterogeneous image dataset of crops and weeds under natural light conditions. By now the dataset contains more than 2.000 images and annotations of over 40 different plant species. The first step in plant classification is the so-called plant segmentation, which aims to distinguish between plant and soil pixels in the image. We could achieve plant segmentation quality (interception over union) of 0.81 for the pixel-wise segmentation, using decision tree classifiers based on 20 training images for 100 evaluation images. That outperforms classical color index methods like Excess Green for our dataset. For the plant classification part, it is planned to add depth and shape information to widely used convolutional neural networks to produce more stable and reliable classification outputs.

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Life cycle assessment (LCA) of innovative agricultural systems with a focus on multi-output processes

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Innovative agricultural systems contain a new and innovative approach and should be assessed with quantitative sustainability assessment methods to estimate environmental impacts linked with the integration of such new approaches. Most agricultural systems have more than one output (e.g. growing grain results in the outputs corn and agricultural residues), which leads to the necessity to distribute environmental impacts estimated by the life cycle assessment (LCA) method, to the different outputs. This distribution can be done through different approaches, whereby the choice can have a great impact on the result. Although there is a prescribed hierarchy in the LCA ISO standard 14040 [1] of how to deal with multi-outputs, which favors system expansion (including co-products and their upstream chains) as the most scientific solution over the allocation approach (dividing environmental impacts based on an allocation factor), the latter is still most common. Hence, the handling of multi-outputs in life cycle assessment is a controversial topic in both the LCA application practice and the literature. For this reason, the aim of the doctoral research is to implement a fair evaluation of multi-output processes for selected innovative agricultural systems by using a system expansion approach. Further, this approach should be compared to the commonly used method, the allocation procedure. A second aim is to combine the quantitative evaluation of environmental impacts via LCA and qualitative sustainability assessments (e.g. multi-criteria analysis; MCA) to assess further impacts beyond the border of LCA. MCA is chosen since it is already reported as tool that can be combined with LCA quite well [2]. Nevertheless, the combination of LCA and MCA in a multi-output system is not yet comprehensively researched, especially in innovative agricultural systems. Overall, the research aims to contribute to more robust comparative studies in the field of agricultural innovations.

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Production of carbohydrate based adhesive precursors

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Rising awareness of environmental problems and rising demands for bulk chemicals are a driving force for the search of more sustainable alternatives to fossil fuels. The only widely available carbon source besides these fossil fuels is biomass and 75% of the available biomass are carbohydrates (starch, cellulose and hemicellulose).[1] Carbohydrate conversion into platform chemicals like hexose-derived 5-hydroxymethylfurfural (5-HMF) is therefore an important topic and these platform chemicals can be used in the development of sustainable binder systems.[2] In our work, we produced carbohydrate solutions rich in 5-HMF using a continous flow microreaction system with diluted H_2SO_4 as the catalyst for carbohydrate dehydration reactions, thereby avoiding the use of organic solvents that could interfere with subsequent resin synthesis. Optimization of the process conditions (temperature, reaction time, catalyst content) lead to a 5-HMF yield of 49%. Extensive product rehydration was avoided by efficient immediate cooling of the reaction solution. A batch reactor with pressurized dosing system is tested in the scale-up process of the reaction. The obtained solutions can be used directly in the development of a sustainable binder system. No additional purification, filtration or extraction steps are needed.

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A fast method to measure the degree of oxidation of dialdehyde celluloses using multivariate calibration and infrared spectroscopy

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Periodate oxidation of cellulose to produce dialdehyde cellulose (DAC) has received increasing attention in recent years due to the need for bio-based materials. The properties of the generated DAC are highly dependent on its aldehyde content, i.e. its degree of oxidation. However, the measurement of the degree of oxidation of DAC is not straightforward and requires time and resource-consuming methods like oxime reaction followed by nitrogen determination or titration[1], solid-state NMR spectroscopy[2], or indirect methods based on UV/VIS spectroscopy[3].
Here, we present a new quick and simple method to measure the degree of oxidation after periodate-oxidation of cellulose multivariate calibration and infrared spectroscopy. In this study, more than 60 DAC samples were analyzed, providing a reliable basis to estimate the oxidation degree of a given DAC sample very quickly. Additionally, pulp and cellulose samples of different origins were applied to the model. Taken together, the new chemometric approach provides a simple way to reliably determine the degree of oxidation after periodate oxidation of pulp and is an excellent choice in daily research to save time and resources.

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Lab-scale testing of carbohydrate-based adhesives for wood-based products

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Adhesives are an important part in the manufacturing of numerous industries ranging from the automotive to the wood product manufacturing industry. Many industries still rely strongly on the use of fossil-based binders. In wood adhesive formulations, the use of carbohydrates has been reported for many decades. Unfortunately, the technological performance of these alternative adhesives for particle boards is considerably lowered by their reduced reactivity. This results in increased production costs. [1]

In the development of a bio-based adhesive, fructose is used as green raw material for producing 5-Hydroxymethylfurfural (5-HMF) as reactive intermediate. These 5-HMF-rich carbohydrate solutions react with amines in the adhesive production.

The developed fructose-based adhesives must meet various criteria in terms of technical suitability. Important aspects to evaluate are reactivity, curing behavior and storage stability. Their practical applicability was investigated by combining rheological studies with tensile shear strength measurements. Ensuring a rapid cure behavior even at low temperatures (105-120°C) is a major challenge in the adhesive development. Special interest was on the temperature-dependent material behavior.

It was found that the addition of small amounts of 5-HMF (5% based on fructose content) has a positive effect on the reactivity and performance of fructose-based adhesives. The performance of the developed adhesive was bench marked with urea-formaldehyde (UF), a conventional industrial resin. The produced fructose-5-HMF-amino resins have a comparable tensile shear strength.

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Enzyme Based Solutions for Prevention of Opioid Abuse

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Opioid analgesics have been the treatment of choice for severe and chronic pain for many decades. Over the past years opioid prescriptions have increased exponentially, and so has the prevalence of abuse, addiction, and mortality. In the US, numbers of overdoses have risen to such levels that the term “opioid crisis” was coined, and urgent action was needed. To counter the abuse of prescription opioids, abuse-deterrent-formulations were created. The goal is to make the manipulation of pills and their subsequent abuse more difficult and to inhibit the reward inducing effects.

Within this work, biotechnological solutions are explored to prevent the misuse of prescription opioids. When the pills are manipulated in vitro to prepare for injection, two different mechanisms are activated: The first one is based on the enzymatic modification of the opioids, rendering them biologically inactive and making abuse no longer desirable. For this, various enzymes – especially oxidoreductases – were tested, and the reaction products were analyzed with regards to their structure and their biological function.

The second mechanism uses functionalized chitosans which are enzymatically crosslinked in the case of abuse. This leads to a rapid formation of hydrogels, making abuse no longer possible. Suitable chitosan derivatives were synthesized and a multitude of crosslinkers were screened, to create reaction conditions that can entrap the drugs as quickly as possible.

When incorporated into prescription opioid pills, both of these new approaches can provide a viable method to prevent their abuse.

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Estimation of canopy parameters using inverted radiative transfer modelling in wheat

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Many previous studies employed empirical relationships to estimate canopy parameters, e.g. regression analyses between vegetation indices and LAI, nitrogen content and other canopy characteristics. In comparison, radiative transfer models (RTMs) have certain advantages. They allow for more generalization and thus do not have to be calibrated and validated continuously. Furthermore, they can utilize all relevant spectral information available in contrast to typical vegetation indices, which are often based on two or three spectral bands.

A training dataset was simulated based on the radiative transfer model PROSAIL and typical input parameter ranges for wheat from literature. This simulated dataset was used to train an artificial neural network to achieve the RTM inversion.

To test the model, results of a wheat field experiment with autumn- and spring sowing as well as different nitrogen fertilization levels were used, including hyperspectral reflectance data as well as LAI, nitrogen content and many other canopy traits.

Preliminary results show promising estimations of canopy parameters. Nevertheless, the current model can still be optimized to combat the ill-pose problem of model inversion.

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Studies on wheat and soybean allergens

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Exposure to allergens is a major factor determining whether an atopic individual can become sensitized to a given allergen and explains why allergic populations from different parts of the world exhibit different molecular sensitization profiles. It has been recently shown that man-made replanting of landscapes can cause a profound alteration of the profile of allergic sensitization already in two generations of inhabitants suggesting that it is in principle possible to influence allergic sensitization by anthropologic changes of the biome. Wheat and soy represent some of the most important plant foods and represent common allergen sources. Wheat pollen and wheat seeds contain potent inhalant and food allergens, respectively as well as antigens involved in celiac disease (CD) and non-celiac wheat sensitivity (NCWS). This study aims to identify hypoallergenic wheat and soy varieties, which lack or contain lower levels of allergens but preserve their nutritional value and can be easily cultivated. To identify hypoallergenic wheat and soy varieties, different wheat species and soy varieties from collections of genetic resources from Europe will be screened with allergen-specific antibody probes for the presence and amounts of important food allergens and pollen allergens. In addition, a screening of species/varieties and their tissues with IgE antibodies from allergic patients will be performed and the allergenic activity of the species will be tested in basophil activation tests to identify hypoallergenic cultivars.

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Evaluation of influences on antigen content and sampling techniques for airborne allergenic fungi

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Bioaerosls are airborne particles of biological origin. They include bacteria, viruses as well as fungi and their cell wall and metabolic products. Frequent contact with high concentrations of bioaerosols, may lead to specific or unspecific reactions of the immune system. This can range from irritation to swelling of the nasal mucosa (1), over allergies and respiratory symptoms (2) to chronical lung disfunctions. For fungi diseases like allergic reactions, allergic alveolitis and allergic asthma are diagnosed (3–5).

To assess the concentration of fungi in air, various sampling devices can be used. One goal of our studies was to evaluate different devices and methods to sample airborne fungi for subsequent assessment by ELISA. To further understand why and when potential allergic material is produced, another goal is the assessment of influencing factors like substrate, colony age or light condition or drying on the recognition of fungi with ELISA.

The comparison of two sampling devices (sampling into microtiter stripes vs filtration) under controlled conditions in a bioaerosol chamber with *Aspergillus amoenus* and *Aspergillus fumigatus* shows higher efficiency for filtration. Farther we tested the usability of a high volume impactor (on foam discs) to collect outdoor samples for allergenic evaluation.

To produce controlled conditions, we used fresh as well as freeze dried spores, and found no profound influence onto the recognition with ELISA by the drying, for five fungal species. Further we investigated the influences of growth conditions onto the production of recognized antigens for *Aspergillus amoenus,* and could find differences between two species as well as for the used growth media.

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Development and Assessment of Pre-Treatment of Organic Waste Fractions for Carboxylate and Fibre Platform

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Organic waste can be considered a valuable renewable resource [1]. Suitable pre-treatment methods can be applied to generate products and at the same time ensure proficient waste management [2]. The carboxylate platform is a newly introduced platform in which short chain carboxylates are formed. These products function as building blocks for chemicals or substrate for fermentation [1].

Within this thesis project, pre-treatment of different organic waste fractions will be developed, optimized, and evaluated. The soluble substances in the resulting liquid fraction can be utilized within the carboxylate platform. In line with the biorefinery approach, the remaining solid fraction can be further valorised via the fibre recovery platform, e.g. for the production of fibre-polymer composites [3]. In this case, the focus lies on mechanical and enzymatic pre-treatment methods. The aim is to develop sustainable procedures by avoiding high pressure or temperatures. Therefore, enzymes are applied under mild conditions to release soluble compounds that can be further valorised.

First experiments show that released carbohydrates were metabolized into lactic acid and acetic acid during enzymatic hydrolysis of organic fraction of municipal solid waste. Within future experiments, different factors are evaluated using statistical experiment design in order to obtain an optimised enzymatic hydrolysis process. An artificial substrate is introduced to reduce variability in the results caused by the heterogeneity of the organic waste. Additionally, the process of enzymatic hydrolysis and microbial conversion (simultaneous saccharification and fermentation) is improved by inoculation with suitable microorganisms to direct product formation towards lactic acid.

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Preparation of Immunogens for the Molecular Measurement of Food Allergens with Immunoassays

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Food Allergy is a world-wide occurring health issue affecting 2-10% of the worldwide population. Although food allergy is mainly a pediatric phenomenon, most of the affected children outgrow their food allergy and develop tolerance. Nevertheless, some food allergies can be persistent for a life time and have a major impact on the life quality of allergic patients. The most common "treatment" of food allergy is allergen avoidance, based on food labelling. Existing labelling regulations do not indicate any threshold levels or detection methods of allergens, but knowing the real amount of allergenic material in food is crucial for allergen avoidance. State of the art for food allergen detection are immunoassays such as Enzyme-linked immunosorbent assays (ELISA) or lateral flow devices (LFD), based on the availability of allergen-specific antibodies binding to the allergen of interest. The crucial step of antibody production is the preparation of well-defined immunogens including the food allergen of interest, which are used for the immunization of model animals. Common approaches to produce suitable immunogens based on the size of the allergen include Cut-off filtration, Size-exclusion chromatography (SEC) in combination with high performance liquid chromatography (HPLC) or recombinant allergens, although the use of natural extracts obtains higher yields of antibodies. We use these approaches to generate well-defined immunogens from crude food material based on the size of allergens of interest. These immunogens are used to generate monoclonal antibodies. The most specific antibodies will be used for developing highly sensitive and specific immunological assays for measuring food allergen exposure in food samples by detecting the real molecular allergen amount, ideally suitable for a personalized manner.

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