Master Project Topics:

Research at the Biomass Transformation Lab (BTL)

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9 Master thesis subjects are available the BTL-Biomass Transformation Lab:

1. Biotransformation of waste sheep wool protein in to natural fiber
2. Green natural protein based films: Plastisizing the wool peptide chain using Deep Eutectic Solvents (DES)
3. Biotransformation of waste mussel shells: production of natural color from the shell
4. Self-sealing, anti-infectious wound dressing materials based on chitin hydrogel
5. Waste crustacean shells in to cationic nano chitin particles for food industry application
6. Biomass derived oligosaccharides for protection of human cells from pathogen adhesion
7. Photobiocatalysis of lignocellulose biomass with redox enzymes for biofuels fermentation.
1 Biotransformation of waste sheep wool protein into natural fiber

Wool is a renewable protein rich material with great potential in production of environment-friendly materials. A large quantity of wool wastes are produced annually, leading to the discard of protein resources and environmental contamination. The recycling of wool is of great significance for the application of keratin. This project focuses on development of a benign deep eutectic solvent (DES) solvent and will evaluate the dissolution conditions. The candidate will acquire various skills related to physiochemical characterization techniques such as thermogravimetry/differential scanning calorimetry, protein electrophoresis, scanning electron microscope, and amino acid analysis. The results of the study can lead to a green approach for the regeneration of wool keratin without damaging the long chain of peptides leading to possible reuse of waste wool at large scale for production of natural fiber.

2 Green natural protein based films: Plastisizing the wool peptide chain using Deep Eutectic Solvents (DES)

Keratinous materials such as wool, feather and hooves are tough unique biological co-products that usually have high sulfur and protein contents. Due to inter and intra-chain cross-links of cysteine disulfide bonds keratin has higher stability and lower solubility. Hydrogen, hydrophobic and ionic bonds also play an influential role in the stability and properties of the wool keratin. This project aims to suppress the rigidity of keratin chain by evaluating the interaction of DES such as cholin chloride:Urea with the OH groups of the chain, decreasing chain interactions and hence plasticizing the polymer. The plasticized polymer will be processed into films through hot pressing and will be evaluated for application as packaging materials.

3 Biotransformation of waste mussel shells: production of natural color from the shell

Marine shell waste such as mussel shell is a very rich source of several bioactive compounds and materials, such as calcium, chitin, pigments and proteins. Currently, this waste material is greatly underutilized and contributes to significant environmental problems due to off odor and concentration of minerals in landfill. Isolation of pigments from waste mussel shell can result in production of high value natural pigments. However, Decolorization of waste marine shells is normally achieved using chemicals such as acetone, chloroform, ethyl acetate, sodium hypochlorite, and hydrogen peroxide to remove the pigments. Chemical methods have strong environmental impacts due to the heavy alkali polluted waste water and high energy input. This project aim to develop green Deep Eutectic solvents to recover the pigments from waste mussel shells.

4 Self-sealing, anti-infectious wound dressing materials based on chitin hydrogel

Currently, there is an increasing trend on design and development of new wound healing/sealing materials. The focus is to use biobased materials such as chitin and its derivatives to synthesise wound healing/sealing materials with the ability to enhance the healing process at the molecular and cellular level. Chitin is an inexpensive and abundant polymer of linear 1,4 N-acetyl-D-glucosamine residues which is largely found in the exoskeleton of crustaceans shells as well as the cell walls of
fungi and yeast. This project aimed to transform and utilise the chitin for the development of wound healing hydrogel for biomedical applications. In this project catechol chemistry will be adopted as a versatile and biocompatible green method for the surface functionalization. It is expected that the partially cross-linked catechol functionalized chitin exhibit an immediate sol-gel transition, resulting in sealing of the injured tissue and prevention of bleeding.

5 Waste crustacean shells into cationic nano chitin particles for food industry application

Nano chitin particles (CNs) are normally produced through a mechanical nanofibrillation procedure, which requires a significant amount of energy to overcome the highly ordered hydrogen bond network. The high energy consumption can be reduced with the use of chemically modified. With this regard, this project aim to introduce cationic groups on chitin polymer chain to enhance nano chitin production and prevent the aggregation of the particles as a result of electrostatic. Furthermore, the project will investigate the effect of alkyl chains introduction, e.g. aminated structures, to the hydrophilic backbone of chitin which can result in the formation of amphiphilic particles. These particles have potential use as emulsifier in food industry, or as agent for colloid aggregation.

6 Biomass derived oligosaccharides for protection of human cells from pathogen adhesion

Adhesion is the first step in pathogenesis. Pathogens such as Escherichia coli strains attach to cells by utilizing the cell-surface oligosaccharides. With this regard there is a clear interest for development of antiadhesions for food and pharmaceutical applications. This project evaluate the potential of biomass derived oligosaccharides with different fraction of N-acetylated residues (FA), degree of N-acetylation (DA), the degree of polymerization (DP), the molecular weight (MW), the molecular weight distribution (PD, for PolyDispersity), and the pattern of N-acetylation (PA) acting as antiadhesion ingredients.

7 Photobiocatalysis of lignocellulose biomass with redox enzymes for biofuels fermentation.

The aim of this thesis project is to exploit the applications of the light induced electron transfer to power enzymatic reactions that convert biomass into valuable biomolecules. The energy provided by the Sunlight will be used to excite photosensitizers (chlorophyllin) to activate a potent class of enzymes: the monooxygenases LPMO. The means of activation is the photoelectron, eventually provided by an electrons-rich waste molecule: the lignin. Altogether these elements are found in lignocellulose biomass the main substrate for the production of 2nd generation biofuels. This interdisciplinary thesis consists of several fields: photo- and fungal biochemistry, bioengineering, and as it is known today PhotoBioCatalysis.


One major impediment for the application of microbial enzymes technology to plastic degradation is the speed of the reaction which needs to be ameliorated. In this regards in our
lab we pioneered a light-based technology to increase dramatically the activity rate of the enzymes involved in the biopolymers degradation such as cellulose or chitin. The biochemical mechanisms behind the enzymatic hydrolysis of PET chains remember closely the enzymatic degradation of biological biopolymers mentioned above. The light-driven technology based on the utilization of artificial or Sun-light promote activation of redox enzymes by electron transfer from a chlorophyll molecule which had captured that very same light’s photon. We believe that similar strategy could be applied to the enzymes PETase produced by plastic degrading organisms.


Every time a single photon hits planet Earth, a complex set of reactions designed for capturing its energy starts running, igniting a chain of events whose outcomes are: the oxygenic photosynthesis, the growth of biomass through reduction of carbon, and ultimately the origin of life. To close its cycle, carbon needs to be oxidized and returned to the atmosphere. Recently has been reported an efficient light-driven enzymatic system to oxidize carbohydrates from cellulose, which is the major fraction of the photosynthetically fixed carbon. The system discovered is based on photosynthetic pigment chlorophyll, and the ubiquitous enzyme lytic polysaccharide monooxygenase (LPMO) that degrades carbohydrates like plant cell wall, starch, and chitin found in all ecosystems. Since it consumes oxygen and utilizes the chlorophyll and energy of light to degrade the product of photosynthesis (cellulose), it has been called in popular term “Reverse Photosynthesis”. In this master thesis project we aim at studying the fundamentals of this process into the fungal kingdom.