Topic overview

Genetic engineering of lactobacilli for mucosal vaccination

Research group:

Environmental Ecology and Applied Microbiology (ENdEMIC), University of Antwerp

Promotor:

Prof. Dr. ir. Irina Spacova

Tutor:

Ir. Ilke Van Tente

Short Description:

The COVID-19 pandemic highlighted an urgent need to develop novel vaccination strategies. Mucosal vaccination is an effective strategy to generate potent mucosal immunity, which is especially important against respiratory infections and sexually transmitted diseases. Genetically engineered lactobacilli have a great potential to serve as mucosal vaccine delivery vehicles as they are generally recognized as safe, can adapt and thrive at human mucosal surfaces and have strain-specific immunostimulatory properties. Here, we aim to develop a modular genetic system in selected lactobacilli strains for niche-specific delivery of vaccine antigens to the respiratory and vaginal mucosae.

However, the biotechnology toolbox of lactobacilli is limited thereby hampering their implementation in medical and industrial applications. In this master thesis project, the genetic engineering potential of beneficial lactobacilli will be enhanced by identifying and testing different genetic tools and elements such as promoters and regulatory elements. Genetic circuits will be developed with the goal to express vaccine antigens and/or therapeutic molecules by selected lactobacilli isolates. The goal of this project is to expand the genetic toolbox of lactobacilli thereby facilitating the implementation of lactobacilli in medical applications such as mucosal vaccination against respiratory viruses and sexually transmitted diseases. Used techniques are among others: general microbiology, genetic engineering (PCR, electroporation, …) primer and construct design using bioinformatical tools, fluorescence microscopy, Western blotting…

Keywords:

Genetic engineering, mucosal vaccination, lactobacilli, heterologous expression

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A spatiotemporal analysis of crop yields in the Argentinian Pampas: ENSO sensitivity in relation to fertilizer use and soil properties

Research group:

Biobased Sustainability Solutions

Promotor:

Dr. Kevin Van Sundert (team of Prof. Dr. Sara Vicca)

Co-promotor:

Prof. Dr. Josefina De Paepe (University of Buenos Aires)

Short Description:

Agricultural intensification and crop selection have led to remarkable crop yield increases in the Argentinian Pampas over the last decades. However, this also resulted in losses of soil carbon and phosphorus, which potentially contributes to increased sensitivities of soy, wheat and maize yields to weather phenomena (El Nino-La Nina Southern Oscillation, or ENSO) and climate change. This thesis will assess if and how crop yield sensitivities to El Nino-La Nina weather phenomena varied over time (intensification) and in space (differences in weather, climate and soil properties). Productivity and soil data at county level are available from the Argentinian Ministry of Agriculture, plus an earlier field campaign by local researchers. An additional limited add-on field campaign with soil sampling and stay at the local research group is possible.

Keywords:

sustainable agriculture, climate change, soil, Global South

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Current producing lactobacilli in the vagina?

Research group:

Lab for Applied Microbiology and Biotechnology

Promotor:

Prof. Dr. ir. Sarah Lebeer

Tutor:

Ir. Caroline Dricot

Short Description:

In this masterthesis project you will have the unique opportunity to work at two of the most interesting research groups of the department of Bioscience Engineering at the University of Antwerp: A-sense lab of Prof. Karolien De Wael and LAMB of Prof Sarah Lebeer. While the first lab is specialized in sensor development and measurements (for ex. wearable devices), the latter is rooted in microbiology and biotechnology of Lactic Acid Bacteria from different environments, such as fermented foods, the vagina and the skin. The goal of this master project is to map the extracellular electron transfer (EET) capacity of vaginal lactobacilli form the largescale Isala project (www.isala.be) by measuring their (in)direct current production with highly specific sensors. In general, EET is a hybrid form of metabolism that allows the shuttle of electrons, coming from fermentation, towards the extracellular environment by enzyme complexes involved in oxidative phosphorylation. Consequently, EET will offer oxidative stress release and thus an important growth advantage. Yet, EET by Lactic acid bacteria has only been described in food fermentations, and the role in human niches such as the vagina is still very much unclear. In this project we will 1.) investigate which vaginal lactobacillaceae species can perform EET 2.) elucidate which molecules (e.g. quinones, vitamins, ...) and genes are involved in EET 3.) study their regulation in vaginal synthetic communities and 4.) measure the impact of EET on the vaginal epithelium by studying adhesion and collagen type I expression. The following techniques will be addressed/touched: microbial culturing, spectrophotometry, synthetic ecology, electrochemical sensing and processing, qPCR, human cell culture, (fluorescence) microscopy, PCR, RNA sequencing, metabolomics.

Keywords:

Microbiology, vaginal bacterial communities, Probiotics, EET, sensors

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A circular and sufficient peri-urban food system for Brussels

Research group:

Sustainable Energy, Air and Water Technology (DuEL)

Promotor:

Prof. Siegfried Vlaeminck

Co-promotor & tutor:

Dr. Anastasia Papangelou

Short Description:

Urban and peri-urban agriculture have the potential to transform food systems. A closer linkage between food production and consumption can reduce food miles, enhance the quality of local ecosystems and contribute to the democratization of the food supply chain. What is more, proximity of food production and consumption can enhance food system circularity, by allowing for better utilization of existing resources, such as secondary nutrients from human excreta.

In this project, you will explore the peri-urban food system around Brussels with a focus on nutrients. Based on an existing analysis of nutrient supply and demand in central Belgium, you will focus on Brussels Capital Region and the two Brabant provinces, and you will develop and analyze scenarios for increased nutrient circularity and sufficiency in the region. Your study will contribute to a deeper understanding of how to better utilize local resources in peri-urban food systems.

For this project, prior knowledge of QGIS and R, or a strong motivation to learn these tools, are necessary. A basic understanding of French could also help with data collection.

Keywords:

Nutrients, nitrogen, phosphorus, carbon, circular economy, sufficiency

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Microneedle-based electrochemical sensors for plant health monitoring

Research group:

A-Sense Lab

Promotor:

Prof. Dr. Karolien De Wael

Tutors and copromotors:

Dr. Marc Parrilla Pons, Dr. Annemarijn Steijlen

Short Description:

Wearable plant health monitoring (figure 1) represents a pioneering frontier in agriculture and environmental science. In an era marked by the fusion of cutting-edge technology and sustainability, these wearable devices have emerged as invaluable tools for tracking and safeguarding the well-being of plants. By seamlessly integrating them on plant leaves, they offer real-time insights into crucial parameters, such as moisture levels, nutrient status, and stress indicators, allowing farmers, researchers, and conservationists to optimize plant growth, mitigate disease outbreaks, and enhance resource management practices. In this era of data-driven precision agriculture, wearable plant health monitoring holds the promise of revolutionizing how we nurture and protect our crops, introducing a new era of sustainable and efficient farming practices.

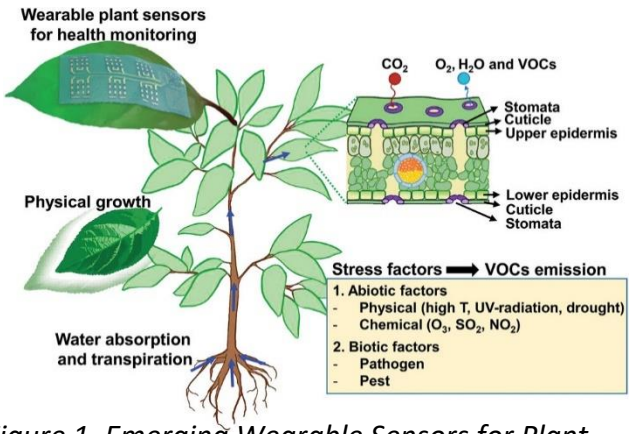

Figure 1. Emerging Wearable Sensors for Plant Health Monitoring (G. Lee et al. Adv. Funct. Mat.

A-Sense Lab dedicates a significant research effort to the development of 3D-printed microneedles. These microneedles offer distinct advantages as they are not only cost-effective but also highly adaptable to various plant types. Furthermore, they can be customized to incorporate electrochemical sensors. These integrated sensors enable the precise measurement of a wide range of plant biomarkers, including pH, H_2O_2, and glucose, among others. As a result, this breakthrough technology opens up a plethora of applications for accurately assessing plant health and optimizing growth strategies.

The assignment focuses on three main objectives. Firstly, we are working to fine-tune microneedle designs to suit different plant species, ensuring they are a perfect fit. Next, we are taking these microneedles to the next level by integrating sensors into them. This development allows us to collect real-time data directly from the plants. Ultimately, our goal is to use these advanced microneedles to gain a deeper understanding of plant physiology. In essence, we're delving into the secrets of plant health to support farmers and researchers in making more informed decisions for healthier and more productive plants and crops.

The project includes the following tasks in the lab:

- Review existing methods for fabricating microneedle-based sensors (state of the art).
- Create cost-effective 3D-printed microneedle arrays.
- Assess the piercing capability of the 3D-printed microneedle arrays.
- Modify microneedle arrays with conductive materials to create microneedle electrodes.
- Functionalize the microneedle electrodes for pH sensing, H_2O_2 sensing, and/or glucose sensing.
- Insert the device into the plant for studying physiological dynamics under normal & stress conditions.

Do you like to craft your own sensors, characterize them and test them in the field on plants? If so, this project is a perfect for you!

Keywords:

Sensors, Plants, Microneedles, Electrochemistry

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Reduced titanium dioxide nanotubes for photoelectrochemical detection of phenolic compounds

Research group:

A-Sense Lab

Promotor:

Prof. Dr. Karolien De Wael

Tutor:

Sensu Tunca

Short Description:

Due to their photoactive nature, easy miniaturization and low-cost fabrication semiconductor nanomaterials have received great attention in photoelectrochemical (PEC) sensor applications. Unique charge transfer reactions between electroactive species and semiconductor bands provide high sensitivity and signal-to-noise ratio for PEC sensors[1,2]. Mechanism of such a sensing platform is the separation of charge carriers (electrons and holes), produced via the absorption of photons by the semiconductor and diffusion of those charge carriers to the electrode surface for the generation of surface reactions and PEC signals. However such an uncontrollable charge separation mechanism causes the recombination of charge carriers hampering the practical applications of traditional semiconductor-based PEC sensors[3].

Electrochemically produced 1-D TiO_2 NTs became a highly demanded nanomaterial due to its high surface-to-volume ratio, well-ordered architecture, size-dependent intrinsic optical properties, low cost and straightforward production. The structure provides effective electron percolation pathways along the axial direction, promoting the charge transfer rate and enhancing the electron-hole separation. Aside from its NT structure, a challenging yet feasible aspect of TiO_2 is the ability to modify its properties by creating imperfections in its crystal structure via defect engineering, where R-TiO_2 NTs with narrowed band gap (1.5 eV), improved visible light absorption and electrical conductivity can be obtained[4].

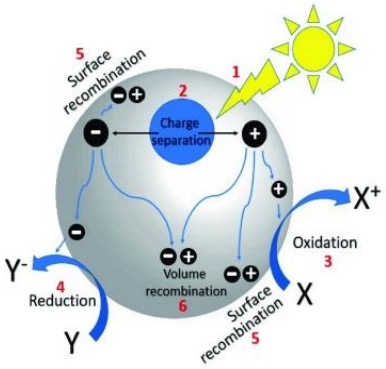

Figure 2. Charge carriers after photo-excitation of a semiconductor. X/Y electron donor/acceptor[3].

In this project, an electrochemical approach will be performed to fabricate (R-)TiO_2 NTs which provides effective control of each experimental parameters. R-TiO_2 NTs will be fabricated via electrochemical hydrogenation/reduction of the TiO_2 NTs and a relationship between the EH parameters and the PEC behavior of the NTs will be analyzed. Following that R-TiO_2 NTs will be tested and compared with pristine TiO_2 NTs under the illumination of different wavelengths to observe its PEC characteristics towards the sensing of phenolic compounds in water.

[1] Shchukin, D. G. *et al. Sensors Actuators, B Chem.* 76, 556–559 (2001)

[2] Zang, Y. *et al. Chem. - A Eur. J.* 24, 14010–14027 (2018)

[3] Pan, H. *et al. Nanomaterials* 10, 1–24 (2020)

[4] Liu, X. *et al. Adv. Energy Mater.* 6, (2016)

Keywords:

Sensors, Photo-electrochemistry, Titania

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Enhancing our understanding of vulvovaginal candidiasis and the protective role of lactobacilli

Research group:

Lab for Applied Microbiology and Biotechnology

Promotor:

Prof. dr. ir. Sarah Lebeer

Mentors/tutors:

Ir. Maline Victor

Dr. Sarah Ahannach

Short description (ENG):

The human vagina hosts a diverse array of microorganisms, creating a highly complex ecosystem that plays a vital role in women's health. When this microbial ecosystem gets disturbed, it can lead to alterations in functional composition and metabolic processes, potentially inducing a state of microbiome imbalance or dysbiosis. For example, an overgrowth of *Candida* yeasts in the vagina often results in one of the most prevalent conditions occurring in women, namely vulvovaginal candidiasis (VVC). Despite the widespread occurrence of this fungal infection, research on the role of the microorganisms in VVC pathogenesis remains limited. Furthermore, novel microbiome-targeted therapies against VVC are lacking. In this master's thesis, we will investigate the vaginal microbiome in women with (recurrent) vulvovaginal candidiasis. Firstly, we will focus on identifying *Candida* yeasts and other microorganisms using various molecular techniques: DNA isolation, qPCR, high-throughput sequencing (*16S rRNA* for bacteria; *18S rRNA*/ITS for fungi; shotgun), etc. Secondly, we investigate the potential protective roles of beneficial microorganisms in combatting this vaginal infection. Hereby, we will mainly focus on lactobacilli and their anti-pathogenic activity against *Candida* strains (established using culturomics techniques, colony PCR, Sanger sequencing, etc.). Several anti-pathogenic assays that will be performed include anti-hyphae assays, growth assays, adhesion assays, anti-biofilm assays, etc. The goal of this master's thesis is to enhance our understanding of the human microbiome in context of (recurrent) vulvovaginal candidiasis and how this could have a potential protective role. This could ultimately lead to the identification of new biomarkers and the development of new therapeutic strategies.

Keywords:

Microbiome analysis, (recurrent) vulvovaginal candidiasis, anti-pathogenic testing, *Candida* spp., lactobacilli, citizen-science

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Air quality improvement in and around urban road tunnels

Research group:

DuEL - Sustainable Energy, Air and Water technology

Promotor:

Prof. Dr. ir. Siegfried Denys

Tutor:

Marjan Demuynck

Short Description:

Urban road tunnels offer a promising solution to extend existing infrastructure while mitigating air pollution and nuisances affecting nearby residential areas. However, road traffic within tunnels still contributes to atmospheric pollution (particulate matter PM), necessitating effective management measures both inside the tunnels for user safety and well-being, and at tunnel outlets to limit environmental impacts.

In this project we try to accurately simulate air flow and pollution in and around road tunnels using CFD (COMSOL or OpenFOAM) and/or other numerical methods in order to exploit innovative technologies and methods to minimize PM-exposure. Research projects can be discussed according to the students' interests and prior knowledge. Some research examples include: performing measurements in a wind tunnel and simulate the workings of a lab-scale PM capture device, simulating the impact of air-purification or dispersion enhancement techniques (i.e. the deposition of PM on a noise barrier covered in plants), building a user-friendly application (in COMSOL or OpenFOAM) in order to easily build tunnel models, …

Keywords:

Modelling, Computational fluid dynamics, air pollution, road tunnels, wind tunnel

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The impact of viral infections on the airway microbiome in young cystic fibrosis patients

Research group:

Lab for Applied Microbiology and Biotechnology

Promotor:

Prof. Dr. ir. Irina Spacova

Tutor:

Ir. Joke Bastiaenssen

Short Description:

Cystic fibrosis (CF) is the most common life-threatening hereditary disease in Belgium. It results from a dysfunctional CFTR channel, leading to increased mucus viscosity and impaired mucociliary clearance. Consequently, CF patients are unable to efficiently clear their lungs, which causes frequent airway infections and ultimately chronic lung disease. These infections are often viral induced and are linked to increased colonization of the airways with pathogenic bacteria, such as *Pseudomonas aeruginosa*. Moreover, infection leads to an increase in inflammation and mucin production. However, the interactions between viral infections, the microbiome and inflammatory/mucin biomarkers in CF remain underexplored. Understanding the mechanisms by which viral infections induce a more pathogenic microbiome, will help formulate preventive and therapeutic strategies for CF patients.

During this thesis, oropharyngeal swabs of young CF patients (collected at different timepoints including during exacerbation) will be used to profile the CF airway microbiome and study its correlation with inflammation and mucins. Inflammatory cytokines and mucins in the swabs will be quantified using multiplex ELISA and qRT-PCR. Bacterial DNA will be extracted from the swabs and analyzed through metagenomic shotgun sequencing. Swabs obtained during exacerbations will be screened for viruses using multiplex qPCR. Additionally, swabs will be cultured using different growth media and conditions, to obtain at least 40 isolates of key pathogens and commensals. These isolates will then be identified using Sanger sequencing.

Keywords:

Microbiome, Cystic fibrosis, Inflammation

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Adoption of nitrogen and phosphorus recovery technologies

Research group:

Sustainable Energy, Air and Water Technology (DuEL)

Promotor:

Prof. Dr. Siegfried Vlaeminck

Tutor:

Julia Santolin

Short Description:

Phosphorus (P) and nitrogen (N) are essential for all forms of life and their demand is constantly growing, since the global population needs more and more fertilizer to grow food. The EU has declared an urgent need to reinvent our farm-to-fork value chain, since the the current linear system causes serious environmental impacts. Flanders has a large potential for N and P recycling from concentrated waste streams, which would reduce environmental burdens while reducing import dependency. A previous study in Flanders identified manure, food processing waste, and sewage sludge as the waste flows with the highest recycling potential. There are also many available recycling technologies that can be used to achieve a more circular economy in this region. However, at the moment they are not being widely implemented.

With your thesis, you could contribute to change this! You will interview relevant stakeholders in the agri-food system to identify technological attributes that are necessary for the adoption of N and P recovery technologies. You will use qualitative methods, such as causal loop diagrams, to identify leverage points for intervention (or places where a small change can lead to a large shift in the system). Your thesis will reveal bottlenecks in the implementation of alternative nutrient sources and propose effective solutions for increasing circularity in the agri-food system.

Keywords:

Nutrient recovery, circular economy, choice behavior

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Identifying the most promising technologies for nutrient circularity

Research group:

Sustainable Energy, Air and Water Technology (DuEL)

Promotor:

Prof. Dr. Siegfried Vlaeminck

Tutor:

Julia Santolin

Short Description:

Phosphorus (P) and nitrogen (N) are essential for all forms of life and their demand is constantly growing, since the global population needs more and more fertilizer to grow food. The EU has declared an urgent need to reinvent our farm-to-fork value chain, since the the current linear system causes serious environmental impacts. Flanders has a large potential for N and P recycling from concentrated waste streams, which would reduce environmental burdens while reducing import dependency. A previous study in Flanders identified manure, food processing waste, and sewage sludge as the waste flows with the highest recycling potential. There are also many available recycling technologies that can be used to achieve a more circular economy in this region. However, at the moment they are not being widely implemented.

With your thesis, you could contribute to change this! You will identify available technologies and interview technology providers to identify the best way to move towards a circular nutrient system. You will do a literature research and interview stakeholders to investigate advantages and disadvantages of different nutrient-recovery technologies and apply multi-criteria decision analysis to rank their adoption potential.

Keywords:

Nutrient recovery, circular economy, recycling technologies

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Microbial protein production via Purple phototrophic bacteria

Research group:

Lab for Microbial Cleantech and Systems Analyses for Water, Nutrients, Food and CO2

Promotor:

Prof. Dr. ir. Siegfried Vlaeminck

Tutor:

Dr. Luis Diaz Allegue

Short Description:

As the world's population increases, so does the demand for protein-rich food. Traditional sources, such as livestock farming, have a considerable environmental impact, including deforestation, greenhouse gas emissions and high-water consumption. Microbial protein can be produced using far fewer resources, with faster production cycles and very favorable nutritional profiles. In addition, waste products, such as agricultural and industrial by-products, can be used as growth substrates for their production, as part of the circular economy. Our research focuses on purple phototrophic bacteria, an incredibly versatile group of microorganisms capable of growing using sunlight as an energy source. The topic will delve into the lab-based production of microbial protein in a novel bioreactor, its nutritional evaluation and functional properties, and its potential to meet worldwide food needs while lessening environmental impacts.

Keywords:

Microbial protein, Fermentation, Bacterial communities, Probiotics

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Purple bacteria as a sustainable protein source

Research group:

Sustainable Energy, Air and Water Technology Group (DuEL)

Promotor:

Prof. Dr. ir. Siegfried Vlaeminck

Tutor:

Ir. Naïm Blansaer

Short Description:

By 2050, our population will surpass 9 billion people. This rise in population and shifting living standards will negatively influence the ecological impact of our food production system. A big opportunity to minimise the impact lies in sustainable production of microbial protein. However, most microbes still require inputs from agriculture or from fossil fuels for feedstock.

Chemoautohydrogenotrophic (i.e. oxygen for energy, carbon dioxide as a carbon source and hydrogen gas for electrons) growth of purple bacteria is rather unexplored. However, this production method for microbial protein forms an interesting opportunity, as it allows us to produce the bacteria without inputs from agriculture and fossil fuels. Your role for this project will be assisting in building and testing a bioreactor for chemoautohydrogenotrophic production of purple bacteria. Your tasks will include reactor operation and analytical techniques to evaluate the reactor build and performance.

Keywords:

Purple bacteria, microbial protein, alternative protein, sustainability, food security

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Improving a quantitative soil nutrient availability metric

Research group:

Biobased Sustainability Solutions

Promotor:

Dr. Kevin Van Sundert (team of Prof. Dr. Sara Vicca)

Short Description:

The availability of nutrients in soil is crucial for plant growth, carbon storage and the management of both natural and man made ecosystems, including in forestry and agriculture. However, at larger scales, it is difficult to quantitatively compare nutrient availability – something that would be useful for instance to accurately estimate how nutrient availability influences ecosystem sensitivity to climate change. In this thesis, a recently developed nutrient availability metric will be evaluated and further improved based on newly available coupled biomass production and soil property data from forestry in Sweden, agriculture in Argentina and globally distributed data points from a database of climate change experiments. The aim is to establish relationships between ecosystem productivity and soil properties (after accounting for other factors such as climate), to evaluate the earlier nutrient availability metric based on these, and to potentially improve the metric by better incorporating phosphorus availability.

Keywords:

soil fertility, forestry, ecology, data analysis

Further reading:

Van Sundert, K., Radujković, D., Cools, N., De Vos, B., Etzold, S., Fernández-Martínez, M., Janssens, I.A., Merilä, P., Peñuelas, J., Sardans, J., Stendahl, J., Terrer, C. & Vicca, S. (2020). Towards comparable assessment of the soil nutrient status across scales – review and development of nutrient metrics. *Global Change Biology*, 20: 392-409. doi.org/10.1111/gcb.14802

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BioNScrub – Sustainable and innovative nitrogen recovery from wastewater

Research group:

Sustainable Energy, Air and Water Technology

Promotor:

Prof. Dr. ir. Siegfried Vlaeminck

Tutor:

Ir. Patricia Gutiérrez

Short Description:

Nitrogen management in agriculture is shifting from a treatment viewpoint to one that focuses on N recovery. The ability to create a fertilizer product from gas and/or liquid waste produced during farming can aid in better nutrient management in the industry, which is accountable for most N emissions globally. The study aims to analyse the viability of implementing a stripping-scrubbing system coupled with a biological nitrification reactor under extreme conditions as a method to improve current N recovery techniques in an agricultural context. In this thesis, a lab-scale experiment will be carried out to explore the biochemical limitations and control strategies of the concept. Key components such as reactor design and operation and biochemistry will be considered.

Keywords:

Nitrogen recovery, Nitrification bioreactor, Stripping - scrubbing

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Impact of diet on the vaginal microbiome

Research group:

Lab of Applied Microbiology and Biotechnology (LAMB), ENdEMIC

Promotor:

Prof. Dr. Ir. Sarah Lebeer

Tutors:

Ir. Isabel Erreygers
Dr. Sarah Ahannach

Short Description:

The microorganisms inhabiting the human body play an important role for our health. These microbial settlers, or collectively called 'microbiota', can be found at different body sites. For example, the vaginal microbiome has a crucial role in women's health and human reproduction. One of the goals of the research team of Prof. Sarah Lebeer at the University of Antwerp is to characterize the vaginal microbiome in Flanders, to get to know its inhabitants and to study its dynamic nature. These aims are combined into the large-scale Citizen Science project on women's health, named Isala (https://isala.be/). However, further research is needed to investigate the different factors influencing the vaginal microbiome and to better understand its dynamic profile. A major knowledge gap exists with regard to the human diet and its effect on the microorganisms harboured by women's vaginas. In this master's thesis, we will investigate whether dietary habits have causal relations with the microbial composition of the vagina. An important focus will be on the putative existence of a gut-vagina axis for commensal microbiota members, food compounds and microbially-produced metabolites (e.g., vitamins). In addition, special attention will be given to the development of a definition of a healthy diet, specifically with regard to microbiota members. This will hopefully enable us to explore diet modulation to improve the vaginal microbiome and thus women's health. The goal of this master's thesis is to come to a better understanding of the impact of diet on the vaginal microbiome constellation. The following techniques will be addressed in this thesis: analysis of food frequency questionnaires (FFQ), metabolite identification and quantification (LC-MS), cultivation on different media, microbiological co-culturing techniques, next-generation sequencing, molecular downstream analyses, etc. In addition, several soft skills will be developed as well, such as presentation skills, team work within the Isala project, strategic communication, collaborations with external partners, etc.

Keywords:

Vaginal microbiome, human diet, gut-vagina axis, lactobacilli, metabolomics, women's health

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Using beneficial lactic acid bacteria to combat plant pathogens on strawberry plants

Research group:

Lab for Applied Microbiology and Biotechnology

Promotor:

Prof. Dr. ir. Sarah Lebeer

Tutor:

Ir. Jari Temmermans

Short Description:

Plant protection products are essential for ensuring food production. Still, their use poses a threat to human and environmental health, and their efficacy is decreasing due to the acquisition of resistance by pathogens. Stricter regulations and consumer demand for cleaner produce drive the search for safer and more sustainable alternatives. Microbial biocontrol agents, such as microorganisms with antifungal activity, have emerged as a promising alternative management strategy, but their commercial use has been limited by poor establishment and spread on crops.

In this master thesis, the student will help investigate the use of lactic acid bacteria as potential biocontrol agents against the notorious plant pathogenic fungus *Botrytis cinerea* on strawberry plants. The delivery of these lactic acid bacteria to the strawberry flowers is done via bumblebees which is called the *flying doctor* or *entomovectoring* system. The focus will be on spray drying the lactic acid bacteria for optimally loading the bumblebees with beneficial bacteria and delivery of the bacteria to the plant to protect them against *Botrytis.* Additionally, the survival of the bacteria on the flowers, characterizing the bacteria's beneficial properties, and investigating the bacteria's adaptation to living on flowers/bees can be embedded in the thesis.

The following techniques will/can be used: DNA isolation, PCR, Cultivation on different media, high throughput phenotype screening (bioscreen), spray drying, plant experiments, and bumble bee experiments.

Keywords:

Microbiology, Plant protection, Lactic acid bacteria, Bumblebees, *Botrytis cinerea*

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Enhancing botanical biofiltration for indoor air treatment

Research group:

Sustainable Energy, Air and Water Technology (DuEL)

Promotor:

Prof. Dr. ir. Siegfried Denys

Tutor:

Ir. Allan Augusto Alvarado-Alvarado

Short Description:

People spend > 90% of their time indoors, where a group of pollutants, "volatile organic compounds" (VOCs), is of concern since even low concentrations are detrimental to our health. Their traditional treatment involves techniques that demand high energy consumption, generate byproducts, and do not degrade VOCs. Botanical biofiltration merges traditional biofiltration with phytoremediation, translating it into a botanical biofilter (BB). A BB consists of a substrate and botanical compartment with bacteria that grant more degradation mechanisms, making it more robust in the degradation of VOCs. Nevertheless, research is limited in this field, and disparities exist regarding BB's design, operation, and efficiency. Furthermore, clear relationships between a BB and an indoor environment are absent, limiting the spread of the technology. Different substrates, plant species, and airflow can lead to varying removal efficiency. An innovative manner to overcome the discrepancies is by combining experiments in a climate chamber where the VOC-removal capacity of the BB is evaluated. Parallelly, environmental microbiology analyses must be conducted to understand the bacteria involved. Finally, multiphysics modeling is a powerful tool for studying the technology in depth and optimizing it according to the needs of the indoor environment.

Keywords:

Bioremediation, botanical biofilter, environmental microbiology, green wall, indoor air purification, multiphysics modeling

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Licht-gedreven milieu- en energietoepassingen (meerdere topics)

Onderzoeksgroep:

Sustainable Energy, Air & Water Technology

Promotor:

Prof. Dr. Ir. Sammy Verbruggen

Begeleider:

Te bepalen op basis van finale onderwerp

Korte samenvatting:

In ons labo onderzoeken we de impact die gratis zonlicht kan hebben in het verduurzamen van allerhande katalytische toepassingen in een milieu- of energiecontext. Afhankelijk van je interesse kunnen we een onderwerp definiëren dat ofwel erg fundamenteel is (bv. het bestuderen van nieuwe katalysatoren op basis van wijd beschikbare elementen), ofwel zeer toegepast is (bv. het ontwerpen en testen van nieuwe reactoren). Je hebt de mogelijkheid om te werken aan vernieuwende technologieën die volledig licht-gedreven zijn, of waarbij een synergie gezocht wordt tussen licht en een meer conventionele vorm van katalyse (bv. thermische katalyse of elektrokatalyse). Concreet kan je een impactvolle bijdrage leveren tot één van de volgende actieve onderzoekslijnen:

- Waterstofgasproductie (fotokatalytisch en/of foto-elektrokatalytisch)
- CO_2 conversie (fotokatalytisch en/of foto-thermisch)
- PFAS destructie (fotokatalytisch en fotolytisch)
- Zelfreinigende coatings (fotokatalytisch)

Aarzel niet ons te contacteren om je ideale onderzoeksvoorstel op maat samen te stellen!

Trefwoorden:

Fotokatalyse, CO_2, waterstof, materiaalsynthese, reactoren

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