# Posters
# Domein Applied Science
# Applied Science R&D Congress 2025

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# Inhoud

## Agriculture, Water & Food

# 1. Inkjet printing of functionalized materials for the detection of volatile organic compounds

**Auteur(s):** J. Hermans

**Affiliatie:** NWO-Observed

**Abstract:** The aim of the NWO-ORC-Observed project is to develop a sensor platform (E-nose) that can detect veterinary diseases through emitted volatile organic compounds (VOC) in stables. In this project the focus is on the detection of VOC's when there is an ongoing infection of either red blood mites, or an infectious gut disease within the stable. The human nose is able to detect the compounds, so it is only logical that a sensor could do the same when tailored to these compounds. The ultimate goal would be to monitor air quality in stables continuously, in order to be able to prevent wide spread of the diseases in question.

Several options to achieve this goal are being pursued by partners within the project – one of these strategies is the immobilisation of sensing molecules onto a sensor platform by inkjet printing. This technique enables to deposit small droplets (pL) of ink containing the sensing molecules with micrometre accuracy. In recent experiments, functionalized covalent framework nanoparticles (COF) have been successfully jetted on gold plated wafers as well as one of the defined sensor surfaces. Resulting prints have been analysed by light microscopy, as well as SEM imaging, and EDX.

## 2. Chemische Fingerprinting van Nederlandse Honing: Pesticiden, Mineralen en Metabolomics als indicator van Kwaliteit en Authenticiteit

**Auteur(s):** Sander van Leeuwen, Ruben Buis, Lotte de Boer, Tiny Wagenaar, Gabriëlle van der Veen, Frens Pries, Mark Hoekstra, Marije Strikwold

**Affiliatie:** Van Hall Larenstein University of Applied Sciences, Inholland University of Applied Sciences

**Abstract:** Honing is een natuurlijk product dat bestaat uit een variëteit aan stoffen die kenmerkend kunnen zijn voor de oorsprong en de kwaliteit van honing. Honing geproduceerd door Nederlandse imkers is vaak te koop langs de weg of bij lokale winkels, terwijl honing in Nederlandse supermarkten vaak afkomstig is uit het buitenland (EU en/of non EU). Binnen de Nederlandse imkerij bestaat behoefte aan inzicht in de onderscheidende kwaliteit van honing. In het project imago van imkerij is onderzocht of de kwaliteit en/of authenticiteit van Nederlandse honing vastgesteld kan worden via chemische fingerprinting van de honing en het identificeren van pesticideresiduen in zowel Nederlandse als buitenlandse honing.
In totaal zijn er 300 honingen verzameld, waarvan 254 afkomstig zijn van Nederlandse imkers en 46 afkomstig zijn uit Nederlandse supermarkten, maar een buitenlandse oorsprong hebben. De honingmonsters zijn geanalyseerd op de aanwezigheid van pesticidenresiduen middels een QuEChERS-extractie gevolgd door een analyse met ultra-high-performance liquid chromatography gekoppeld aan time-of-flight massaspectrometrie (UHPLC-MS-TOF). Uit de resultaten blijkt dat er verschillen zijn tussen honing van Nederlandse oorsprong en honing van buitenlandse herkomst (EU en niet-EU) met betrekking tot zowel het type als het aantal aangetroffen pesticidenresiduen.Via een untargeted metabolomics screening met behulp van een UHPLC-MS-TOF en met elementenanalyse via inductively coupled plasma optical emission spectrometry (ICP-OES), is aangetoond dat diverse Nederlandse monoflorale honingen, waaronder heide-, lindebloesem-, springbalsemien-, koolzaad- en fruithoning - evenals bloemenhoning, onderling onderscheidbaar zijn. Dit onderscheid is gebaseerd op variaties in het metabolietenprofiel en de elementensamenstelling. Met name heidehoning onderscheidt zich van de andere onderzochte honingtypes.
Geconcludeerd kan worden dat honingen onderscheidend zijn ten aanzien van zowel geografische oorsprong (Nederlands versus buitenlands) als botanische herkomst, op basis van respectievelijk verschillen in pesticideresiduen als metabolietprofielen en elementensamenstellingen. Deze informatie biedt handvatten voor de verwaardig van Nederlandse honingen.

## 3. C. elegans als innovatieve biosensor voor gecombineerde toxiciteit in oppervlaktewater: verkennende inzichten uit het INNOWACE-project

**Auteur(s):** Amra Hajdo-Milasinovic, Nienke Stigter, Roberta Hofman-Caris, Cyrille A.M. Krul, Raymond H.H. Pieters

**Affiliatie:** HU University of Applied Sciences, Research Group Innovative Testing in Life Sciences & Chemistry, Utrecht, The Netherlands, KWR Water Research Institute, Nieuwegein, the Netherlands, Utrecht University, Institute for Risk Assessment Sciences, Utrecht, The Netherlands

**Abstract:** De toenemende complexiteit van waterverontreiniging, gekenmerkt door mengsels van persistente stoffen zoals PFAS, endocriene verstoorders (EDC's), pesticiden en microplastics, vraagt om innovatieve benaderingen voor waterkwaliteitsmonitoring. In het kader van het INNOWACE-project onderzoeken wij de toepasbaarheid van de nematode Caenorhabditis elegans (C. elegans) als biosensor voor het detecteren van gecombineerde toxiciteit in oppervlaktewater.

Onze voorlopige data tonen aan dat C. elegans een gevoelig en robuust modelorganisme is voor het signaleren van toxische effecten van individuele en gecombineerde verontreinigingen. In gecontroleerde experimenten met mengsels van PFAS, EDC's en pesticiden observeerden we versterkte toxische effecten op biologische eindpunten zoals reproductie en ontwikkeling, vergeleken met blootstelling aan afzonderlijke stoffen. Opmerkelijk is dat toevoeging van microplastics aan deze mengsels leidde tot een significante afname van de waargenomen toxiciteit, wat wijst op een mogelijk sorptie-effect of interactie tussen microplastics en andere verontreinigingen.

Deze bevindingen onderstrepen het belang van het testen van milieurelevante mengsels in plaats van enkelvoudige stoffen, en bevestigen de geschiktheid van C. elegans als alternatief diermodel voor milieutoxicologisch onderzoek. Bovendien biedt het gesloten liquid culture-systeem, ontwikkeld binnen dit project, een betrouwbare en reproduceerbare methode voor blootstelling aan zowel hydrofiele als hydrofobe stoffen.

Het INNOWACE-project levert daarmee een belangrijke bijdrage aan de ontwikkeling van een breed inzetbare, kostenefficiënte en biologisch relevante biosensor voor waterkwaliteitsmonitoring. De resultaten vormen de basis voor een grootschaliger vervolgproject gericht op de implementatie van C. elegans-gebaseerde biosensoren in de praktijk van waterbeheerders en milieutoezicht.

## 4. Zeeland in transitie: Mariene en Plantaardige Eiwitten als Regionale Kracht

**Auteur(s):** Tanja Moerdijk, Katleen Vallons, Berend Sponselee, Sandra de Reu

**Affiliatie:** HZ University of Applied Sciences, Department of Technology, Water and Environment, Research Group Marine Biobased Chemistry, Joint Research Centre Zeeland, Groene Woud 1a, 4331, NB, Middelburg, The Netherlands

**Abstract:** De eiwittransitie is in volle gang. Steeds vaker zoeken we naar alternatieven voor dierlijke eiwitten, met oog voor duurzaamheid, gezondheid en regionale kracht. Zeeland speelt hierin een bijzondere rol. De provincie beschikt over een rijke maritieme omgeving én is de grootste akkerbouwproducent van Nederland. Deze combinatie van blauwe en groene kracht maakt Zeeland bij uitstek geschikt om een voortrekkersrol te spelen in de ontwikkeling van alternatieve eiwitten.

HZ University of Applied Sciences voert praktijkgericht onderzoek uit naar hoe mariene bronnen, zoals zeewier, schelpdieren en visreststromen, kunnen bijdragen aan een duurzamer voedselsysteem. Daarbij wordt ingezet op samenwerking binnen een breed ecosysteem van ondernemers, overheden en kennisinstellingen. Waar mogelijk worden deze initiatieven ingebed in een doorlopende leerlijn van mbo, hbo en wo, zodat studenten op alle niveaus actief kunnen bijdragen aan praktijkgericht onderzoek.

In de regio lopen diverse projecten die de eiwittransitie ondersteunen. Het Marine Protein Fusion project richt zich op de ontwikkeling van hybride eiwitproducten waarin mariene en plantaardige eiwitten worden gecombineerd. Binnen het Delta Climate Centre wordt gewerkt aan het icoonproject Delta Protein, dat zich richt op de opbouw van een regionale ‘blauw-groene’ eiwitsector met onder andere zeewier, schelpdieren, bonen en quinoa. Daarnaast onderzoekt het project ProceZ hoe reststromen uit de voedselketen kunnen worden benut voor hoogwaardige toepassingen, waaronder eiwitproductie.

Deze poster laat zien hoe mariene en plantaardige eiwitten elkaar kunnen versterken. Niet alleen voor een duurzamer voedselsysteem, maar ook voor een sterke, toekomstgerichte regio.

## 5. Rapeseed Meal as an Eco-Friendly Protein Source: Matching Soybean Meal in Digestibility and Safety; In Vitro Analysis

**Auteur(s):** Alex KleinJan, Amber van der Heiden, Rachelle Balgit, Tom Vingerhoets, Jean Paul ten Klooster, Kitty van Summeren, Cyrille Krul en Raymond Pieters

**Affiliatie:** Innovative Testing in Life Sciences & Chemistry, University of Applied Sciences, Utrecht, The Netherlands. HAS green academy, research group 'Healthy Farming', 's-Hertogenbosch, Netherlands, Wageningen University, Animal Nutrition Group, Department of Animal Sciences, Wageningen, Netherlands, IRAS-Toxicology, Population Health Sciences, Faculty of Veterinary Sciences, Utrecht University, Utrecht, The Netherlands.

**Abstract:** Introduction: South American soy is a key plant-based protein source for human food and livestock feed. However, the global demand for complete protein sources persists, necessitating animal proteins. Livestock feed often includes by-products from food production. The broiler sector, contributing to the rising demand for poultry meat, faces challenges due to its large carbon footprint, driven by transportation from South America to Europe and deforestation for soy cultivation. Thus, there is an ongoing search for sustainable alternatives, prompting our in vitro research on gut health and digestible protein content.
Materials and Methods: We conducted in vitro static digestion of alternative protein sources using pepsin and pancreatin. After heat-inactivation, total protein concentration was measured via the BCA assay. Alamar Blue mitochondrial activity served as a toxicity test. The impact of boiling as a pretreatment was also examined.
Results: Protein concentrations varied significantly, with rapeseed meal showing comparable or higher levels than soybean meal. Blood meal and single-cell protein had lower available protein levels. Boiling increased soluble protein levels significantly, although gel electrophoresis revealed no differences. Toxicity was relatively high, with soybean and rapeseed meals showing no toxicity, unlike other sources. Boiling reduced toxicity, making it comparable across different materials.
Conclusion: In vitro digestion, coupled with protein determination and toxicity assessment, effectively evaluates alternative protein sources. Rapeseed meal is a highly suitable alternative, comparable to soybean meal. Boiling enhances protein levels and reduces toxicity in alternative protein sources.

## 6. Lactic acid fermentation of seaweeds: Effects on chemical composition, flavour and process optimization

**Auteur(s):** Berend Sponselee, Tanja Moerdijk-Poortvliet

**Affiliatie:** HZ University of Applied Sciences, Department of Technology, Water and Environment, Research Group Marine Biobased Chemistry, Joint Research Centre Zeeland, Groene Woud 1a, 4331, NB, Middelburg, The Netherlands

**Abstract:** Seaweed is a promising alternative protein source, rich in essential amino acids and micronutrients. However, its rigid cellular structure limits protein bioavailability, and its distinctive flavour is often unappealing to Dutch consumers. Fermentation offers a potential solution to improve both the nutritional and sensory qualities of seaweed.

This study investigated the lactic acid fermentation of three edible seaweed species (Palmaria palmata, Alaria esculenta and Saccharina latissima) using several lactic acid bacteria. The aim was to assess changes in chemical composition, flavour development and opportunities for optimization of the fermentation process.

The carbohydrates metabolized differed among seaweed species: galactose-containing sugars were metabolized in P. palmata, while mannitol and glucose-based carbohydrates were consumed in A. esculenta and S. latissima. Fermentation altered protein, ash, and free amino acid contents in a species-specific manner. All seaweeds reached a pH below 4.6, with variable acid production. The flavour analysis demonstrated an increase in free amino acid content. Notably, L-Glutamic acid and L-Alanine increased post-fermentation, enhancing the umami flavour. However, 65–74% of free amino acids migrated into the brine, again “diluting” the umami flavour. Volatile organic compound profiles became more complex after fermentation, but a consistent reduction in off-odour components was not observed. To improve fermentation efficiency, two pre-treatments were evaluated: hydrochloric acid (HCl) hydrolysis and/or pre-fermentation with Bacillus subtilis, both followed by lactic acid fermentation at 30 °C. These pre-treatments accelerated pH reduction, increased lactic acid production and enhanced the availability of reducing sugars.

These findings demonstrate that lactic acid fermentation can be successfully applied to P. palmata, A. esculenta, and S. latissima, with species-specific effects on flavour, carbohydrate metabolism and compositional changes. These results can be used to further develop innovative sustainable protein products based on seaweed.

## 7. Membraanfiltratie voor zuivering afvalwater afkomstig uit plastic recycling

**Auteur(s):** Pieter Magusin, Michiel van der Stelt, Roberta Hofman

**Affiliatie:** Hogeschool Utrecht

**Abstract:** Het recycling bedrijf Blue Plastics gaat een recycle lijn bouwen om circulair polyethyleen te produceren. PE folies worden hierin met een mengsel van organische oplosmiddelen gereinigd. De PE flakes zijn echter vaak redelijk nat, als ze in het proces worden gebracht. Het water op de flakes wordt afgevoerd naar een waterzuiveringsinstallatie. Door het contact van het water met het organisch oplosmiddel is het afvalwater ermee verzadigd. De kosten die in rekening worden gebracht voor het zuiveren van afvalwater zijn met name gebaseerd op het gehalte organische verontreiniging. Het is dus voor Blue Plastics interessant om de concentratie in het afvalwater zo laag mogelijk te krijgen.

In dit project onderzoeken we, hoe membraanfiltratie kan worden ingezet om de verontreiniging in afvalwater verzadigd met organisch oplosmiddel te verlagen.

BluePlastics en de HU zijn beide partners in het onderzoeksnetwerk Mem4Chem, dat zich richt op de energie- en kostenefficiënte inzet van membraanfiltratie voor downstream processing.

Twee van onze studenten teams zijn inmiddels met de BluePlastics casus aan de slag geweest. Het eerste team heeft de geschiktheid van een vloeistof-polariteit membraanfiltratie opstelling onderzocht om het organische gehalte in waterige model-oplossingen te verlagen. Het tweede team heeft gekeken naar de mogelijkheid om fasescheiding in het afvalwater te verbeteren door zout toevoeging. Daarnaast heeft dit team een proefopstelling ontworpen voor pervaporatie, een combinatie van destillatie (onder verlaagde druk) en membraanfiltratie.

## 8. Extending the shelf life of sugar-free lemonade syrups using plant extracts with antimicrobial properties

**Auteur(s):** Iris de Boo van Uijen, Katleen J. R. Vallons, Tanja Moerdijk Poortvliet

**Affiliatie:** HZ University of Applied Sciences, Department of Technology, Water and Environment, Research Group Marine Biobased Chemistry, Joint Research Centre Zeeland, Groene Woud 1a, 4331, NB, Middelburg, The Netherlands

**Abstract:** As consumers become increasingly mindful of what they eat and drink, the demand for healthier alternatives to sugary beverages continues to grow. Traditional flavored lemonade syrups typically contain a high amount of sugar, which not only enhances sweetness but also improves the shelf life. Sugar-free alternatives, however, often rely on artificial preservatives. With rising interest in clean-label products free from synthetic additives, the food industry is increasingly interested in natural methods to extend product shelf life.

This project explored the potential of plant extracts with antimicrobial properties to naturally preserve sugar-free flavored syrups. Three different flavored syrup types were developed, based on formulations of commercially available products, both with and without added sugar resulting in syrups containing 40% or 4% sugar, respectively. Key intrinsic factors affecting shelf life—such as pH and water activity—were analyzed. Shelf-life testing was performed over a six-week period at various temperatures. Microbial stability was assessed through colony-forming unit (CFU) counts and identification of spoilage organisms.

Plant extracts of thyme, rosemary, marjoram and lemongrass were produced using microwave-assisted extraction, and their composition of volatile compounds were analyzed using gas chromatography–mass spectrometry (GC-MS). The antimicrobial effectiveness of the plant extracts was determined using several methods, including disk diffusion method, poisoned food technique and microbroth dilution assay.

Extract mixtures were developed by leveraging synergistic effects on microbial growth to extend shelf life while maintaining a balanced flavor profile. Consecutively, these extract mixtures were used in the production of a proof-of-concept sugar-free flavored lemonade syrup, whose shelf life was benchmarked against commercial syrups.

## 9. Duckweed as a new sustainable source of protein for human consumption

**Auteur(s):** BSc Lisette Everaars, MSc Dennis ter Denge, Dr. Lizette Oudhuis

**Affiliatie:** University of Applied Science Van Hall Larenstein

**Abstract:** The Dutch Protein Strategy encourages the local cultivation of protein-rich crops to reduce dependence on imported protein sources. Duckweed presents a promising candidate due to its high protein yield and rapid biomass growth. This study examines the techno-functional properties and gastrointestinal digestibility of duckweed biomass (Lemna spp.) to evaluate its potential as a sustainable plant-based protein source for human nutrition.

Duckweed was processed using various drying techniques, including oven-drying at 40°C and 50°C, and an Agitated Thin Film Dryer (ATFD). Functional properties assessed included protein solubility across a pH range of 3 to 9, foaming capacity and stability (based on Zhang et al., 2017), and emulsion activity index (EAI) and emulsion stability index (ESI) following the method by Pietrysiak et al. (2018). Whey protein isolate (WPI) and soy protein isolate (SPI) served as reference proteins. Digestibility was analyzed using the INFOGEST in vitro gastrointestinal model (Brodkorb et al., 2019), with ongoing validation under dynamic conditions via the Tiny-TIM system (InnoGI Technologie).

Results showed that WPI had the highest solubility ($p < 0.05$), followed by ATFD-dried duckweed, then oven-dried samples at 50°C and 40°C, with SPI showing the lowest solubility. Duckweed dried at 40°C demonstrated the highest EAI (44.5 $m^2$/g protein), while samples dried at 50°C exhibited the highest ESI (105 minutes). WPI and SPI had the strongest foaming capacities (247% and 210%, respectively), followed by duckweed dried via ATFD (143%), 40°C (130%), and 50°C (120%). Notably, duckweed dried at 50°C showed the greatest foam stability. INFOGEST results indicated substantial protein hydrolysis, suggesting favorable bioaccessibility. Ongoing Tiny-TIM studies aim to confirm these findings under physiologically relevant conditions.

In conclusion, duckweed biomass demonstrates favorable techno-functional and digestibility characteristics. Processing method significantly affects performance, particularly in terms of solubility and emulsification. These findings support duckweed's potential contribution to sustainable protein innovation.

# 10. The development of an optimal bread paste - Influence of process parameters

**Auteur(s):** Dennis ter Denge, Lizette Oudhuis, Koos Oosterhaven

**Affiliatie:** Hogeschool Van Hall Larenstein

**Abstract:** In the Netherlands, approximately 150,000 tons of unsold bread are returned annually from retailers to bakeries. As this bread is no longer suitable for consumption, it is mostly reused as animal feed or biomass. To contribute to a more circular food system, a project in the northern Netherlands investigates whether this returned bread can be converted into a sugar-rich bread paste. This is done by mixing bread with water and enzymes, followed by controlled heating and stirring to hydrolyze starch into monosaccharides. The resulting paste could serve as a sugar replacer in bakery and dairy applications. This study aimed to optimize key process parameters, temperature, pH, bread-to-water ratio, and enzyme concentration, to achieve high starch hydrolysis and suitable paste viscosity. A Design of Experiments was conducted using Dutch white bread to evaluate how these parameters affect D-glucose content and viscosity. The outcomes were visualized through 3D surface plots to identify optimal processing conditions.

All tested parameters significantly ($p < 0.05$) influenced D-glucose production, with concentrations ranging from 1 to 21 g/100 g. The highest sugar conversion (20–21 g/100 g) occurred at a pH between 4.3 and 5.0, a temperature of around 50°C, a 1:1 bread-to-water ratio, and enzyme concentrations above 0.01%. Viscosity values ranged from 400 to 1900 mPa·s. The bread-to-water ratio had the strongest impact on viscosity. At the highest sugar yield (1:1 ratio), viscosity was approximately 600 mPa·s, which was lower than the maximum observed viscosity.

These findings enable the production of a white bread paste with an optimized sugar content and viscosity. A robust process is achieved with a pH between 4.3 and 5.0, temperature around 50°C, bread-to-water ratio 1:1, and enzyme concentrations above 0.01%. The results offer practical guidelines for valorizing returned bread and supporting circular food processing.

# 11. Innovatieve watersystemen

**Auteur(s):** Roberta Hofman-Caris, Michiel van der Stelt

**Affiliatie:** Hogeschool Utrecht en KWR Water Research Institute

**Abstract:** Vrijwel dagelijks worden we geconfronteerd met berichten over problemen in de watersector: droogte, wateroverlast, onvoldoende waterkwaliteit, tekorten aan drinkwater. De oplossing van deze problemen moet gezocht worden in het hele watersysteem. Door water langer vast te houden in de watercyclus, en het steeds weer te zuiveren voor verschillende toepassingen kunnen we voldoen aan de watervraag, zonder telkens water te onttrekken aan het systeem. Daarmee kunnen we ervoor zorgen dat er voldoende water beschikbaar is voor de bevolking, landbouw en industrie, én voor de natuur.

Dit vraagt echter wel om specifieke behandelingstechnieken, toegespitst op de beschikbare en gewenste waterkwaliteiten. Op de HU doen we onderzoek naar deze behandelingstechnieken. Dat doen we in samenwerking met verschillende partijen uit de regio, zoals het waterschap, drinkwaterbedrijf, de provincie, gemeente, Utrechtse Heuvelrug enzovoort. Voorbeelden van onderzoek zijn de afvalwaterzuivering van de toekomst, onderzoek naar drinkwaterzuivering uit verschillende bronnen, geavanceerde zuiveringstechnieken voor de verwijdering van geneesmiddelen en microplastics enzovoort. Hierbij gebruiken we nieuwe membraantechnieken, adsorbentia en chemische technieken als geavanceerde oxidatie.

Bij het zuiveren van water worden ook stoffen verwijderd, die wellicht op een nuttige manier kunnen worden hergebruikt. Ook hieraan wordt binnen de HU onderzoek gedaan. Voorbeelden daarvan zijn een andere manier van ontharden, waardoor de teruggewonnen kalk kan worden hergebruikt, hergebruik van ijzer(hydr)oxiden uit water, en toepassingen voor kaumera, een biopolymeer uit de afvalwaterzuivering.

# 12. Development and validation of a SFC-MS/MS method for the quantification of phenolic compounds in food and plant samples

**Auteur(s):** Bas Bijl, Remco Swart

**Affiliatie:** InHolland

**Abstract:** Supercritical fluid chromatography (SFC) is known since the early 1960's and it has gone through several ups and downs during the past 50 years. The most remarkable rebirth came at the beginning of the millennium, when SFC gained its popularity in many laboratories due to the significant improvements in instrumentation resulting in high reliability and robustness. New developments in SFC column chemistries and possibility of mixing CO2 with organic solvents allowed the analysis of various compounds differing in polarities, acid-base properties, and molecular weight. Hyphenation of advanced SFC systems with mass spectrometry (MS) provides benefits in terms of sensitivity and selectivity. SFC is complementary to the most widely used reversed phase LC due to the similar polarity profile to normal phase LC. For plants samples the target compounds such as polar flavonoids and phenolic acids are biologically active, pharmaceutically important, and belong among the most studied compounds. The aim of this study is to develop a SFC-DAD-MSMS method for the detection and quantification of phenolic compounds such as quercetin and caffeic acid in food and plants.

## 13. Molecularly Imprinted Polymer (MIP) enabled PFAS sensor

**Auteur(s):** Xiaojun Yang, Tijs Bitter, Bert Swennenhuis, Martin Bennink

**Affiliatie:** Applied Nanotechnology Research Group, Saxion University of Applied Sciences

**Abstract:** Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals known for their persistence and carcinogenic properties. Their widespread use poses significant threats to environmental and human health. A recent report of PFAS dumping at Hemond raised widespread concern in Dutch society. In the Netherlands, perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) are the most commonly detected PFAS in soil. In 2020, the Dutch National Institute for Public Health and the Environment (RIVM) reported background soil contamination levels of 1.4 µg/kg for PFOS and 1.9 µg/kg for PFOA. Current PFAS detection and quantification rely on laboratory techniques, such as liquid chromatography-tandem mass spectrometry (LC-MS/MS). While these methods are sensitive and accurate, they are time-consuming, costly, and unsuitable for field applications. Here, we demonstrate molecularly imprinted polymer (MIP)-enabled electrochemical sensors capable of precisely measuring sub-nanomolar PFOA concentrations in water. These sensors leverage the specificity of MIPs to selectively re-bind PFAS molecules, providing real-time electrochemical readouts. This technology offers high potential for low-cost, sensitive, and rapid on-site detection of PFAS in water and soil.

## 14. Realizing and improving on-shore seaweed aquaculture

**Auteur(s):** Michiel Kwantes, Kai Kniepkamp, and Rob van Haren

**Affiliatie:** Hanze University of Applied Sciences - Research Centre Biobased Economy

**Abstract:** On-shore seaweed aquaculture is still in the early stages of development in most European countries, despite its potential to make our bio-economy more sustainable and circular. Not only can seaweed be grown in basins placed on otherwise non-arable land, but it also does not require freshwater, and - when grown under controlled conditions - it can provide a healthy, allergen-free source of proteins and other valuable biomolecules.

Unlike most agricultural crops, however, seaweeds have not (yet) gone through domestification or plant breeding approaches to select for beneficial agronomic traits. As a consequence, cultivation relies primarily on wild species. Therefore, careful selection of seaweed strains that are amenable to on-shore cultivation and that simultaneously deliver high-quality yields is of utmost importance when establishing a seaweed farm.

Our AQULVA project aims at the on-shore cultivation of the sea lettuce Ulva spp., a cosmopolitan green seaweed known for its high growth rate and nutritional value. We are using molecular genotyping approaches to make an inventory of the (sub)species endemic to the Netherlands. Subsequently, automated phenotyping will be used to analyze and compare growth rates under a range of different circumstances (e.g. temperature, light intensity, and nutrient regime) and thus enable the selection of the most productive varieties. Furthermore, we will evaluate the available techniques, with a focus on sexual versus asexual reproduction, to most efficiently scale-up from laboratory to commercial production. Taken together, our research will aid in deploying sea lettuce aquaculture as an innovative and sustainable source of biomass for the food, feed, and pharmaceutical industry.

# 15. Profiling soil and lichen microbiomes in an urban heat gradient using Nanopore sequencing

**Auteur(s) :** Rens van der Kaaij, Arjen Speksnijder

**Affiliatie:** LCAB, Naturalis Biodiversity Center

**Abstract :** Biodiversity is crucial for urban ecosystems, providing ecosystem services which improve liveability. Microorganism functioning plays an important role in those ecosystems but is relatively understudied. Therefore, the Naturalis Hidden Biodiversity project aims to discover relationships between hidden biodiversity networks and urban infrastructure, climate, and public health. At UAS Leiden, we focus on the development of molecular tools for hidden biodiversity detection and monitoring. Microbial compositions of soils and lichens around trees will be assessed throughout a heat gradient to study potential differences in microbial composition throughout urban areas.

93 sampling locations in and around Leiden were selected. Soil samples were collected at all 93 locations, and 15 samples of lichen species Xanthoria parietina, Physcia adscendens and Candelaria concolor were collected throughout a heat gradient. DNA was isolated using different kits. The bacterial 16S rRNA gene and fungal ITS2 genomic region were amplified in triplicate through PCR. The triplicates were pooled together and purified, before finally being sequenced using Oxford Nanopore Sequencing.

DNA isolation, 16S PCR and ITS2 PCR protocols have been optimized and validated. Analysis of the microbial composition in soil and lichens throughout the heat gradient is still ongoing.

Molecular tools for the detection and monitoring of hidden biodiversity networks have been developed successfully. Those methods can be used to determine the microbial composition in different ecosystems, which can lead to a better understanding of their functions. Furthermore, this information can be implemented in infrastructural design, taking optimal functioning of ecosystem services into account.

# 16. Impact of fertilization practices on soil and aquatic biodiversity in polders

**Auteur(s):** Ruben Beunk, Rob Pastoor, Angela Hoogenboom, Maarten Morsink, Anita Dirks-Mulder, Arjen Speksnijder

**Affiliatie:** Research group of Metagenomics

**Abstract:** The decline in biodiversity poses a threat to ecosystem services, for example soil fertility and subsequent agriculture and food production. These are at risk due to soil depletion resulting from intensive agriculture. The biodiversity in soil and surrounding waters is declining due to intensive use of pesticides and manure in agricultural practices. Manure contains nitrogen and can disrupt the natural nitrogen balance when introduced into nature reserve. This disturbance leads to nitrogen-rich soil-dwelling plants outcompeting those adapted to nitrogen-poor soils, affecting not only plant species but also the animals reliant on them. The goal of this study is to measure the microbial biodiversity in soil and water at different types of fertilization strategies. Various types of manure and pesticides have been applied in the Vrouw Vennepolder (VVP) in a randomized plot design to gain insight into their impact on biodiversity. The methodology involves collecting soil and water samples, followed by DNA extraction using a PowerLyser PowerSoil kit for soil and chloroform extraction for water. Subsequently, DNA is amplified with a polymerase chain reaction using generic primers flanking variable regions. 16S rRNA gene will be used for the identification of bacteria, ITS2 region for fungi and CO1 gene for macro-fauna. Followed by a mixed amplicon sequencing with Oxford Nanopore Technologies. Data will be analyzed with galaxy and R-studio with alpha and beta diversity.
These results show that the methodology works and that there is a large diversity in micro-organisms. While the integration of statistical analyses is pending, this data will guide sustainable manure and pesticide use, preventing permanent damage to microbial biodiversity. Thus, methods for soil and water analysis have been optimized. A nanopore workflow for genetic monitoring has been established. Analysis of treatments effects of manure and pesticides are ongoing.

## Safety & Security

# 18. Een vinger achter illegal dumpingen van drugsafval

**Auteur(s):** Edward Knaven, Henk Haarman, Thom Snaphaan, Arian van Asten, Marchel Zomer, Marleen Gosens en Jos Brouwers

**Affiliatie:** Avans Hogeschool

**Abstract:** Het illegaal dumpen van drugsafval is een groot maatschappelijk probleem. Het zorgt voor milieuschade, gevaar voor de volksgezondheid en hoge kosten voor de publieke partij verantwoordelijk voor het opruimen. Daarnaast zorgen illegale drugslaboratoria voor criminaliteit en ondermijning van de rechtsstaat. Desondanks wordt er tot nu toe nauwelijks forensisch onderzoek aan drugsafval gedaan.
In dit project ontsluiten we tot nu toe ongebruikte informatie uit dit afval voor de justitiële keten. Door analytisch -chemische karakterisatie helderen we niet alleen het type drugslab op dat verantwoordelijk is voor de dumping maar zijn we ook in staat om synthesevoorschriften en zelfs smokkelroutes in kaart te brengen. Ook werken we aan manieren om op basis van molecular fingerprinting, laboratoria en batches te identificeren zodat meerdere dumpingsincidenten aan elkaar kunnen worden gelinkt. Uitdaging bij dit onderzoek is het grote aantal stoffen in afval dat niet eenvoudig is te identificeren met de traditionele massaspectrometrische methode van het matchen van experimentele data met bestaande databases. Daarom zetten we ons in om met behulp van computationele massaspectrometrie en machine learning tot structuuropheldering van onbekende stoffen te komen. We maken zo een database gericht op de analyse van drugsafval, die door Politie en NFI gebruikt kan worden na afloop van het project. Voor optimale integratie in de strafrechtketen en het verhalen van opruimkosten voeren we intensief overleg met de praktijkpartners.

# 19. Verborgen sporen: de invloed van begraving op bloed- en DNA-sporen op textiel ondergrond.

**Auteur(s):** Jewanne van Lenthe, Tessa Wiegman, Annemieke van Dam, Brent Maagdelijn

**Affiliatie:** Hogeschool van Amsterdam (Hva)

**Abstract:** Bloed is een van de meest voorkomende sporen op een plaats delict en wordt vaak aangetroffen op kleding van slachtoffers en/of daders. Deze kleding kan forensisch onderzoekers helpen bij het identificeren van betrokkenen en het reconstrueren van het misdrijf. Omdat daders zich vaak bewust zijn van de forensische waarde van bloedsporen, proberen zij vaak deze sporen te verbergen door het te begraven. Hierdoor hopen zij te voorkomen dat forensisch bewijs, zoals DNA uit bloed, hen aan het misdrijf kan koppelen.

De impact van begraving op de zichtbaarheid van bloedsporen en de kwantiteit en kwaliteit van het DNA is nog onvoldoende onderzocht. In het forensische werkveld bestaat daarom de behoefte aan beter inzicht in de mate waarin bloedsporen op begraven kleding degraderen en of dit bewijs nog bruikbaar is voor analyse.

Dit verkennend onderzoek had als doel om te bepalen in hoeverre begravingsomstandigheden invloed hebben op de zichtbaarheid van de bloedsporen en de DNA-kwantiteit (verlies) en -kwaliteit (degradatie) op katoen en polyester gedurende een periode van vier weken.

Hiervoor werd op stukjes katoen en polyester van 4 cm x 4 cm telkens 50 ml humaan bloed aangebracht. Deze stukken textiel werden vervolgens begraven in een speelzand. Het onderzoek vond binnen op kamertemperatuur plaats. Gedurende vier weken werden elke maandag, woensdag en vrijdag zes samples per textielsoort opgegraven en gefotografeerd om de zichtbaarheid van de bloedsporen vast te leggen. Daarna werd het DNA uit de samples geïsoleerd en geanalyseerd met behulp van de qPCR, waarmee de DNA-kwantiteit en DNA-kwaliteit werd bepaald. De degradatie index (DI) werd berekend als maat voor de kwaliteit van het DNA.

## 20. Spin, Shine, Sense: Unlocking the potential of NV centers in diamond

**Auteur(s):** Ari Ortiz-Moreno, Demetra Sitnic, Tjeerd Bollmann

**Affiliatie:** Saxion University of Applied Sciences

**Abstract:** We present recent developments in the diamond nitrogen-vacancy (NV) center-based quantum sensing platform at Saxion University of Applied Sciences. Our research focuses on developing enabling technologies for future quantum-enhanced sensors.

## 21. De steekproef

**Auteur(s):** Robin Geitenbeek, Jaap van der Weerd, Suzanne van den Bosch

**Affiliatie:** Hogeschool van Amsterdam, Opleiding Forensisch Onderzoek

**Abstract:** Verdachten worden telkens slimmer in het omgaan met bewijsmateriaal tegen hen. Waar vroeger verdachten ontkende, komen zij tegenwoordig met een alternatieve verklaring waarom sporen (DNA, vezels, glasdeeltjes, etc.) van zichzelf op een plaats delict terecht zijn gekomen of vice versa.

Een voorbeeld wat regelmatig als zaak bij het Nederlands Forensisch Instituut (NFI) terecht komt, is een steekincident waarbij de verdachte zich beroept op noodweer (exces). Het sporenbeeld is dan dat de verdachte zelf een verwonding heeft en het slachtoffer is overleden. Maar het Openbaar Ministerie kan twijfels hebben bij deze verklaring en vermoedt dat de verdachte zichzelf verwond heeft na het neersteken van het slachtoffer. Het enige verschil hierin is de volgorde van de gebeurtenissen.

Een vezeldeskundige bij het NFI kan op basis van microscopie, FTIR- en Ramanspectroscopie en LC-MS uitspraken doen op het zogenoemde bronniveau, oftewel of vezels overeenkomen met referentiemateriaal. Dit onderzoek op bronniveau zegt niet per se iets over de volgorde van de handelingen. Om te kijken of de steekvolgorde invloed heeft op het sporenbeeld zal gekeken moeten worden naar het aantal vezels en de positie van deze vezels, wat een erg tijdrovend onderzoek is.

Om genoeg data te verzamelen, en dus een goed beeld te krijgen van het sporenbeeld, is er een optische opstelling gemaakt waarin fluorescerende vezels gefotografeerd kunnen worden na excitatie met UV-straling. De resulterende foto’s kunnen vervolgens middels image recognition software geanalyseerd worden.

In dit onderzoek hebben we met deze opstelling gekeken naar het sporenbeeld op verscheidene messen voor, tijdens en na het steken door verschillende stukken textiel en hoe dit sporenbeeld ons iets kan leren over de volgorde waarmee er gestoken is.

# 22. Tijd traceren in kleur: Carbon dots voor de detectie en verouderingsanalyse van biologische sporen

**Auteur(s):** Rebecca van Oostrom (Daniël Sievers, Ruud Peters, Martin Bennink)

**Affiliatie:** Saxion

**Abstract:** De schatting van de tijd sinds depositie (Time Since Deposition, TSD) van forensisch biologisch bewijsmateriaal, zoals vingerafdrukken en bloedsporen, vormt een cruciale uitdaging binnen de forensische wetenschap. Hoewel de aanwezigheid van een vingerafdruk een persoon aan een plaats delict kan koppelen, biedt dit geen zekerheid over het tijdstip van afzetting. Binnen het onderzoeksproject DavinciQD2.0 werken we aan de ontwikkeling van een innovatieve analysemethode gebaseerd op multi-kleurige carbon dots (CDs) voor de niet-destructieve detectie en temporele analyse van eiwitten in latente sporen.

Binnen dit onderzoek maken we gebruik van proteomics om biomarkers te identificeren die weliswaar afkomstig zijn uit hetzelfde biologische materiaal, maar verschillend degraderen in de tijd. Sommige eiwitcomponenten zijn relatief stabiel en kunnen dienen als interne standaarden, terwijl andere sneller afbreken en daarmee informatie bieden over het verouderingsproces van de sporen. Door carbon dots functioneel te koppelen aan specifieke targetmoleculen, kan de relatieve concentratie van deze biomarkers op locatie worden bepaald aan de hand van fluorescentie-intensiteit.

In de huidige onderzoeksfase worden verschillende typen carbon dots gesynthetiseerd en toegepast voor de visualisatie van vingerafdrukken, waarbij eerste functionalisatiestrategieën worden getest. De volgende stap richt zich op de specifieke binding aan de doelwitmoleculen binnen de afgezette sporen. Daarnaast moet de invloed van omgevingsfactoren, zoals substraattype, temperatuur en blootstelling aan licht, worden onderzocht om de methode geschikt te maken voor toepassing in de forensische praktijk.

# Gecombineerde Thema's

## 24. Samen sterk in praktijkgericht onderzoek

**Auteur(s):** Dr. Rianne Veldt-Meijer

**Affiliatie:** mboRijnland en Hogeschool Leiden

**Toepassingsgebieden:** Energy Transition & Sustainability ; Health & Care ; Agriculture, Water & Food

**Abstract:** Samenwerking op het gebied van praktijkgericht onderzoek tussen mbo, hbo en het werkveld biedt grote kansen voor zowel het onderwijs als het onderzoek en de beroepspraktijk. Deze presentatie laat zien hoe een lectoraat en een practoraat effectief kunnen samenwerken aan praktijkgericht onderzoek.

Als voorbeeld wordt het project Meet de Mees gepresenteerd, waarin de koolmees wordt ingezet als biomonitoring-tool om bestrijdingsmiddelen in kaart te brengen. In dit project werken mbo- en hbo-studenten en docenten samen met analisten, een practor, lector, burgerwetenschappers en organisaties zoals de Vogelbescherming, vogelopvangcentra en het Centrum voor Milieuwetenschappen van de Universiteit Leiden.

De presentatie laat zien wat dit project oplevert voor alle betrokkenen en waarom deze vorm van samenwerking zo waardevol is. Op dit moment wordt het mbo nog te vaak buitengesloten bij zowel praktijkgericht als wetenschappelijk onderzoek. En dat is zonde, want juist mbo'ers kunnen de impact van onderzoek vergroten. Mbo-studenten zijn leergierig, nieuwsgierig en praktisch ingesteld. Wanneer zij in een gestructureerde leeromgeving werken, kunnen ze hun creativiteit benutten en omzetten in waardevolle bijdragen aan de beroepspraktijk.

Ze kunnen niet alleen helpen bij de uitvoering van onderzoek, maar ook bij het vertalen van onderzoeksresultaten naar de samenleving. Deze presentatie is dan ook een oproep tot samenwerking op verschillende niveaus, en laat zien dat mbo'ers van grote waarde kunnen zijn voor het onderzoek.

# 25. Chicken-derived R-spondin1, Wnt3a, Nrg1 and FGF1 allow branched growth of chicken intestinal organoid cultures

**Auteur(s):** Jean Paul ten Klooster, Kitty van Summeren, Francisca C. Velkers, Raymond H.H. Pieters

**Affiliatie:** Innovative Testing in Life Sciences and Chemistry, Research Centre Healthy and Sustainable Living, University of Applied Sciences Utrecht, Utrecht, the Netherlands

**Toepassingsgebieden:** Agriculture, Water & Food;Health & Care

**Abstract:** Intestinal organoids are widely used in mammalian studies to mimic and study in vivo intestinal function and host–pathogen interactions. Recently, we have shown that embryonal intestinal organoids can grow for 10-15 passages (approximately 6 weeks) when using chicken-derived Rspo1 and Wnt3, however, adult chicken organoids did not grow under these conditions and growing these organoids for longer than 15 passages was not possible. In this paper we show that replacing Wnt3 with chicken Wnt3a and adding chicken Nrg1 and human FGF1 results in efficient and long lasting growth, over 40 weeks, of embryonal chicken intestinal organoids. Moreover, the typical branching phenotype, which is normally observed for mammalian species such as mouse and pig intestinal organoids, is now also observed in the chicken organoids when Rspo1, Wnt3a, Nrg1 and FGF1 are used. This branching is enhanced by inhibiting FoxO1 with AS1842856, resulting in an increase of growth.

## Energy Transition & Sustainability

# 26. Samenwerking tussen chemische mbo en hbo learning communities

**Auteur(s):** Onno de Vreede en Manon Schrijnemaekers

**Affiliatie:** ChemistryNL, PLOT, DAS lectorenplatform

**Abstract :** Binnen het hbo chemie domein zijn de afgelopen jaren veel learning communities tot stand gekomen. In het mbo is dit in ontwikkeling: we gaan graag in gesprek met u over hoe we vanuit het hbo hieraan kunnen bijdragen.

## 27. Professional Doctorates in Applied Sciences

**Auteur(s):** Jasmijn Ruijgrok, Bart van den Bosch, Rogier Nijssen

**Affiliatie:** Hogeschool InHolland

**Abstract:** The new pilot program for the Professional Doctorate (PD) in the Netherlands has been underway for almost two years, aiming to establish a third cycle of higher education within universities of applied sciences. In this talk, a perspective will be offered from both a PD candidate and an academic supervisor, providing insights into how the trajectory functions in practice and how it contributes to the broader goals of applied research and innovation.

Questions will be treated like what are the challenges to supervise such an innovative development, when your own background as supervisor is classical PhD training? And from the candidates perspective, why would you choose to pursuit a PD rather than a PhD? What are the differences and where do these two compliment each other?

Particular focus will be given to the relevance of the PD within Energy-, and Material transition, where urgent challenges require applied, interdisciplinary solutions. The PD facilitates close collaboration between knowledge institutions, industry, and society, focusing on research outcomes with direct practical and societal relevance.

Lastly the integration of these topics into education—through internships, applied research projects, and curriculum innovation—will also be addressed, underlining the role of the PD in strengthening the connection between research and education. This contribution aims to demonstrate the PD's value and position within in both the DAS educational programs as well as its research program.

## 28. SPRONG CONNECT

**Auteur(s)**: Tim den Hartog, Gino van Strijdonck, Gijsbert Korevaar, Roberta Hofman, Raymond Pieters, Michiel van der Stelt

**Affiliatie:** Zuyd Hogeschool, Hogeschool Rotterdam, Hogeschool Utrecht

**Abstract:** The SPRONG-collaboration “Collective process development for an innovative chemical industry” (CONNECT) aims to accelerate the chemical industry’s climate/sustainability transition by process development of innovative chemical processes.
The CONNECT SPRONG-group integrates the expertise of the research groups “Material Sciences” (Zuyd Hogeschool), “Making Industry Sustainable” (Hogeschool Rotterdam), “Innovative Testing in Life Sciences & Chemistry” and “Circular Water” (both Hogeschool Utrecht) and affiliated knowledge centres (Centres of Expertise CHILL [affiliated to Zuyd] and HRTech, and Utrecht Science Park InnovationLab).
The combined CONNECT-expertise generates critical mass to facilitate process development of necessary energy-/material-efficient processes for the 2050 goals of the Knowledge and Innovation Agenda (KIA) Climate and Energy (mission C) using Chemical Key Technologies. CONNECT focuses on process development/chemical engineering. We will collaborate with SPRONG-groups centred on chemistry and other non-SPRONG initiatives.
The CONNECT-consortium will generate a Learning Community of the core group (universities of applied science and knowledge centres), companies (high-tech equipment, engineering and chemical end-users), secondary vocational training, universities, sustainability institutes and regional network organizations that will facilitate research, demand articulation and professionalization of students and professionals.

# 29. Next-Generation Batteries with Polymer-Based Solid Electrolytes

**Auteur(s):** Isabell Barnhoorn, Pieter Magusin, Patrick Baesjou

**Affiliatie:** Lectoraat Innovative Testing in Life Sciences & Chemistry – Hogeschool Utrecht

**Abstract:** The growing production of renewable energy has increased the demand for efficient and scalable energy storage. Solar and wind power are intermittent, creating peaks in the electricity grid. Batteries have an important role in storing this surplus energy. However, current lithium-ion batteries have safety issues due to their organic solvent based electrolytes, as demonstrated by battery explosions in electric vehicles. Solid-state batteries offer a safer alternative by using solid electrolytes, potentially offering higher capacity and energy density. A challenge remains improving the electrode-electrolyte interface, where the solid electrolyte can have trouble forming good contact with the electrode and even delamination can occur.

Polymer-based solid electrolytes are promising due to their easy processability, low cost, stability, and flexibility, which can enhance interface stability. Our research, as part of the BatteryNL consortium, aims to develop next-generation hybrid polymer batteries with improved capacity, safety, and energy density by optimizing the electrolyte-electrode interface. Polymer electrolytes consist of a metal salt (e.g., Li+ or Na+-based) dissolved in a polar polymer, exhibiting high ionic conductivity but poor electronic conductivity, which is essential for battery function.

We produce electrolyte films using various salt-polymer combinations, concentrations and inorganic/organic additives. Electrochemical Impedance Spectroscopy (EIS) characterisation demonstrates an ionic conductivity of approximately 10-5 S/cm (literature 10-3) which requires enhancement to compete with liquid electrolytes (10-2 to 10-3 S/cm). Improving conductivity involves increasing polymer amorphicity, polarities, salt dissolution and ion separation. This can be achieved by adding inorganic compounds, choosing compatible salts-polymer combinations, and using specific synthesis conditions like pressure, temperature, and solvents. We investigate these correlations through EIS, Differential Scanning Calorimetry (DSC), and X-ray Diffraction (XRD).

Future research will focus on optimizing ionic conductivity and integrating these electrolytes into a lithium battery cell. These developments could offer a promising solution for grid energy storage, potentially utilizing abundant sodium materials.

# 30. Simpel model om reactiesnelheden te schatten in een rotor-stator spinning disc reactor

**Auteur(s):** Petra Meeuwse, Marit van Lieshout

**Affiliatie:** Hogeschool Rotterdam, Hogeschool Utrecht

**Abstract:** In de chemische industrie zijn de meeste processen van oudsher ontworpen op een zo groot mogelijke schaal. Omdat koelen/verwarmen en roeren op grote schaal gelimiteerd is, worden deze processen soms niet onder de optimale chemische omstandigheden uitgevoerd, waardoor de reactiesnelheid ver onder het maximum ligt. Reacties met moeilijk mengbare reactanten of die veel warmte produceren zouden heel goed in een rotor-stator spinning disc reactor gedaan kunnen worden. In deze kleine reactor stroomt het reactiemengsel in smalle spleten tussen draaiende rotoren, waardoor er goede menging mogelijk is en de warmte goed afgevoerd kan worden. Het is goed mogelijk dat een langzame reactie op grote schaal in een spinning disc reactor snel genoeg is om rendabel te zijn ondanks het kleinere volume, maar dat moet wel eerst getest kunnen worden in het lab.
Er is eerder al onderzoek gedaan naar de verblijftijdsspreiding in een spinning disc reactor, die je nodig hebt om te bepalen hoe snel je reactie verloopt. Deze verblijftijdsspreiding bleek echter af te hangen van de dimensies en instellingen van het apparaat, waardoor deze resultaten moeilijk algemeen toegepast kunnen worden. Wij hebben dit onderzoek vertaald naar een algemeen model waarmee je de verblijftijd en dus de reactiesnelheid tot op 10% nauwkeurig kunt inschatten, onafhankelijk van instellingen of dimensies. We hebben dit model vervolgens getest met de hydrolyse van azijnzuur anhydride, een reactie waarvan de snelheid vaak gemeten is. De onnauwkeurigheid van ons model viel binnen de range van snelheden gevonden in de literatuur. Dit laat zien dat ons model nauwkeurig genoeg is om een eerste inschatting te maken of een reactie snel genoeg is om ook op grote schaal uitgevoerd te kunnen worden in een spinning disc reactor.

# 31. Optimization of bacterial cellulose production during Kombucha fermentation

**Auteur(s):** Bram Visscher, Anne Selten, Cleo Snelders, Sefanne Hakken and Richèle D. Wind

**Affiliatie:** HAN University of Applied Sciences, Lectoraat Biobased innovations/HAN BioCentre, Nijmegen, The Netherlands

**Abstract:** Kombucha is a non-alcoholic, naturally carbonated beverage prepared by fermenting a solution of sweetened tea with a symbiotic culture of bacteria and yeast (SCOBY). The global Kombucha market has seen significant growth in recent years, standing at USD 1.84 billion in 2019, with a projected growth rate of 23.2% by 2027 (1). The acetic acid bacteria in the Kombucha beverage produce a floating film composed of bacterial cellulose (BC), which is currently discarded by most brewers. BC can however if be used as biomaterial for various applications in the food, paper, packaging and textile industry (2).

# 32. Extraction of lignin from various biomasses for application in biobased resins

**Auteur(s):** Else Kragt, Bas Claasen, Richèle D. Wind, Karin Struijs

**Affiliatie:** HAN University of Applied Biosciences, CoE HAN BioCentre, Lectorate Biobased Innovations, Laan van Scheut 2, Nijmegen, The Netherlands, Corresponding author: Karin Struijs (karin.struijs@han.nl)

**Abstract:** To meet the Paris agreement and the goal of the Netherlands to be circular in 2050, there is a need for biobased building materials. Currently, wood is increasingly used as construction material, and lignocellulosic biomasses like fiber hemp or miscanthus are being applied as insulation material. However, in most cases the current biobased materials are not completely biobased yet. For example, to produce CLT (cross laminated timber), adhesives are being used of which the bulk is still fossil-based. Therefore, the development of a biobased adhesive is an essential step in achieving a fully biobased building industry.

One of the most commonly used adhesive to produce CLT is a phenol-formaldehyde (PF)-resin-based adhesive. Both phenol and formaldehyde are mainly produced based on fossil fuels and have serious health concerns. The first step in making a biobased alternative for PF-resin is to find an alternative source for phenol. Lignin is one of the few biomolecules which contain aromatic ring structures and is, therefore, a suitable candidate to replace phenol in PF-resins (Siahkamari et al., 2022). However, it also known that the type of lignin has a great impact on the properties of the final resin (Tejado et al., 2007). Therefore, the aim of this study is to obtain lignin from various lignocellulosic biomasses, to study the effect of lignin from various sources and obtained under various extraction conditions on the properties of the resulting resin.

A DOE approach was used to extract lignins from four lignocellulosic biomasses to find optimal extraction conditions using the soda extraction method. The results showed differences in the yields of lignin from various biomasses. The predicted optimal conditions lay outside of the boundaries of the model. In future experiments it will be studied if the different types of lignin also have different behaviors when applied into resins.

## 33. Methane to materials

**Auteur(s):** Nardy Kip, Wim van Spronsen, Richèle D. Wind

**Affiliatie:** HAN University of applied Sciences, BioCentre, Nijmegen, Netherlands

**Abstract:** Our project aims to address methane emissions from a source not yet used for biobased or circular purposes, namely landfill gas released from waste landfills. Methane-containing landfill gas, which would normally be emitted into the atmosphere, can be used for the production of biodegradable plastics. We use methanotrophic bacteria to convert methane into a biopolymer, polyhydroxybutyrate (PHB), which can be used as a raw material for bioplastics. These bioplastics are biologically degradable and perfect to substitute current non-sustainable and not degradable single use-plastics. We have shown on a laboratory scale that methanotrophs can grow on landfill gas and that they can produce PHB. In our current BiotechBooster project we are trying to optimize and adapt the system in order to scale up to a biofilter technology which can be placed at a landfill. In this way we recycle carbon, reduce methane emissions and reduce global plastic pollution and contribute to a circular waste to value system.

## 34. Fermenting fashion forward: Producing fungal-based dyes from cotton waste

**Auteur(s):** Bram Visscher, Thom de Jager, Daan Molhuijsen, Finn Elbers, Laura Claret Fernández

**Affiliatie:** Centre of Expertise HAN BioCentre, Laan van Scheut 2, 6525 EM, Nijmegen, the Netherlands

**Abstract:** We all use clothes. They provide warmth and shelter, the opportunity to fit in or differentiate ourselves, and they are a large part of a first impression. However, fast-fashion is bringing a disproportionate and severe societal, health and environmental burden on the garment producing countries, as well as a textile waste crisis. Nowadays, 45 million tons of waste cotton textiles are generated annually, of which 85% are incinerated or sent to landfills and only 1% ever comes back to the fashion industry. Additionally, 67% of garments are made of plastic fibers, and when disposed of in landfills, 5% of them turn into microplastics that can end up on our plates. Current biotechnological recycling technologies for natural fibres, such as cotton, focus on production of biogas, bioethanol and compost, bringing them far away from closed-loop recycling. Therefore, efficient upcycling technologies for cellulose-based fibers are dearly needed. Chicfashic proposes an innovative biotech process to address these issues by recovering and recycling plastic fibers while transforming natural fibers into bio-based molecules. These molecules are then used as secondary raw materials to produce bio-based pigments for textiles. The project aims to optimize this process and test it on a larger scale with the assistance of the HAN BioCentre. So far, we have achieved proof-of-concept, with enzymatic hydrolysis conversion rates of close to 60% and color production from both commercial glucose and cotton hydrolysate. Additionally, proof of scalability has also been conducted: all steps of the process have successfully been performed in 100L scale. This initiative aligns with Dutch government and EU regulations mandating textile recycling by 2050. The technology used is patent pending and does not involve the use of toxic chemicals or the release of harmful wastewater or fumes, and represents a step forward in the greening of the textile industry.

## 35. Photonic Quantum Processing Unit at Saxion

**Auteur(s):** Dmytro Polishchuk, Tjeerd Bollmann, Cas Damen

**Affiliatie:** Saxion University of Applied Sciences

**Abstract:** Quantum computing is predicted to have a profound societal impact by enabling breakthroughs in drug discovery, materials science, and our understanding of complex biological and physical systems. Following initial demonstrations of quantum computing on relatively small-scale processors, the development of quantum hardware now faces significant challenges posed by the need to scale up the number of logical qubits required to solve practical computational problems. Addressing these challenges in the pursuit of practical quantum hardware aligns closely with the mission of applied knowledge institutions, such as the Applied Nanotechnology Research Group at Saxion. As part of the strong integrated photonics community in the Twente region, our efforts are focused on applied quantum photonics—one of the leading quantum hardware platforms.

As a first step into photonic quantum data processing, with the support of our industry partner QuiX Quantum B.V., we have developed an experimental quantum processing unit based on a programmable photonic chip. The setup incorporates photon-pair generation and single-photon detection subsystems operating in the 700-1000 nm wavelength range, and functions entirely at room temperature without the need for cryogenic cooling. We have implemented quantum-correlation measurement schemes and successfully carried out on-chip benchmark quantum demonstrations such as single-photon interference and Grangier-Roger-Aspect experiment; currently, we are on the path toward the Hong-Ou-Mandel interference—the cornerstone effect for photonic quantum computing. The versatility and adjustability of the setup allow us to advance photonic technologies using quantum-specific measurement protocols with a focus on practical solutions for real-world quantum applications.

## 36. EduPED

**Auteur(s):** Martijn Kruijsse

**Affiliatie:** EU Driving Urban Transitions (DUT) programme; Future Urban Systems

**Abstract:** The DUT Partnership launched its second call in September 2023 to support transnational research and innovation projects. Together with 39 funding agencies from 27 countries and the European Commission, €80 million have been committed to projects that contribute to DUT's thematic areas, the Transition Pathways: 15-minute City, Circular Urban Economies and Positive Energy Districts.

The call is co-funded by the European Commission (EC) under the Horizon Europe framework programme.

On a global level, the DUT Partnership's Call 2023 is part of the Mission Innovation (MI) call series, i.e. MICall23. As such, some of the call topics are directly prepared in collaboration with MI missions, and all topics of the call are open for applications that directly and/or indirectly contribute to the work of MI missions.

## 37. Hyperspectral Imaging for Textile sorting

**Auteur(s):** Femke Jaarsma, Ben Wolf, Rudy Folkersma, Klaas Dijkstra

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics, Lectoraat Computer Vison & Data Science

**Abstract:** In 2024 alone, 14,9 million kilogram of textile arrived at Sympany, one of the textile collectors in the Netherlands. Those textile items are sorted by human experts based on item type and value for resale. The textile items that are not sold for reuse could be a valuable input for recycling, but sorting based on chemical composition is then necessary. Labels in clothing are often removed and don't provide information accurate enough for recycling. Therefore a quick, scalable method to measure textile composition is essential to enable a more circular approach to textiles. In the project Hyperspectral Imaging of Textiles, a consortium develops recognition of textiles using hyperspectral imaging, especially in the Short Wave Infrared (SWIR) region (935-1720 nm). The professorship Circular Plastics of NHL Stenden analyses a selection of post-consumer textile items, to create a textile collection of known samples. Also the influence of chemical composition on reflection in the SWIR region is investigated. The professorship Computer Vision and Data Science from NHL Stenden, develops artificial convolutional neural networks for image recognition of textiles on a conveyer belt. Using these methods textile types that can be recognized include cotton, PLA, PET wool, acrylic and nylon. Blends can be recognized and the ratio predicted but accuracy needs to be improved and more classes of blends need to be included. The difference between cotton and linen is not yet visible in the spectral dimension, but with microscopy they can be distinguished clearly. For future research the recognition based on the geometric properties needs to be improved to enable automatic recognition of cotton and linen. If textile can be automatically classified while on the conveyer belt, input is generated for a sorting process to send each textile item to the correct recycling process.

# 38. Optimization of the recycling process of ocean plastics for circular product development

**Auteur(s):** Judith Ogink

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics

**Abstract:** When developing a product made from recycled ocean plastic, which can influence the reuse behaviour of hotel guests to mitigate plastic pollution, knowledge about material properties is essential. Material properties relate to recycle process settings. This study focuses on the optimization of the recycling process of ocean plastic to result in high-quality feedstock for injection moulding.

To efficiently optimize the settings, parameters of the washing step (temperature of the water, the concentration and type of detergent, and the washing time) are varied and tested. Ocean plastic flakes are judged on cleanliness with the aid of microscopy and infrared technology. The relationship between cleanliness and the mechanical properties of the material is determined by mechanical testing of injection-moulded samples.

Results show that the washing step influences cleanliness of the ocean plastic flakes, and cleanliness relates to the mechanical properties of recycled ocean plastic.

This study contributes to a better understanding of the role of the washing step in the recycling process of ocean plastics and their mechanical properties. This can lead to a better understanding of the possibilities to apply these materials in circular product design and Design for Behaviour.

## 39. Plastic material closed loop in hospitals

**Auteur(s):** Mariska van Cronenberg

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics

**Abstract:** The Dutch healthcare sector, including hospitals, produces an estimated 328 million kilograms of waste per year. This waste is a mixture of 'general or non-hazardous' and 'hazardous' hospital waste. Hazardous waste, such as contaminated material, must be separately disposed of and is incinerated. Currently, only 15 to 20 percent of all hospital waste is recycled on average. Approximately 85% of the waste is non-hazardous and has the potential to be recycled.

As part of the transition to a more circular healthcare system, efforts are being made to encourage the recycling of plastic and closed material cycles. The aim of the research was to demonstrate the feasibility of setting up a local plastic material closed loop using plastic waste from the hospital. This research included determining suitable plastic materials for mechanical recycling and 3D printing. In addition, the extent to which the production of 3D-printed products could be scaled up with a view to implementing circular products and reducing the use of disposable items was explored.

## 40. Chemical Recycling of Poly(urethane)s

**Auteur(s):** Jarno Guit, Anouk Baas, Joël Benninga (Vincent Voet, Rudy Folkersma, Katja Loos)

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics, HyBRIt

**Abstract:** The development of recycling strategies for polymer materials is essential to accommodate the transition towards a circular economy. Current recycling strategies of poly(urethane)s (PU), a class of polymers with a wide variety of applications, often downcycle the PU via mechanical recycling. Although there are studies aimed to maintain the value of PU by employing chemical recycling, these mainly focus on recovery of the polyol fraction, whereas the valuable diisocyanate fraction is often discarded. Therefore, this study reports the recovery of the diisocyanate fraction of PU via chemical recycling, with a particular focus on the recovery of diamines. As matter of demonstration, a model thermoplastic poly(urethane) (TPU) (based on ethylene glycol and hexamethylene diisocyanate (HDI) units) was synthesized and successfully hydrolysed into hexamethylenediamine (HDA). For a commercial TPU (based on poly(caprolactone) (PCL) and HDI), however, a two-stage hydroglycolysis approach was required to form HDA. The commercial TPU was subjected to glycolysis at first to recover an oligo-urethane and prevent unwanted side-reactions, such as amide formation. The recovered and purified oligo-urethane was then successfully hydrolysed into HDA. Addition of adipic acid to these HDA-containing aqueous fractions resulted in the formation of hexamethylenediamine adipate (AH salt), which was successfully converted to nylon 6,6. The results of this study demonstrate the potential of converting TPU into valuable monomers for production of high-quality polymers such as poly(amide)s.

## 41. Circular Resins for Additive Manufacturing

**Auteur(s):** Kylian Janssen

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics

**Abstract:** To facilitate the ongoing transition towards a circular economy, renewable 3D printed materials that are both sustainable and competitive must be accessible. Global capacity for biobased materials will grow strongly over the next five years, much faster than for fossil-based polymers. However, the growing demand for (biobased) thermosetting resins, which are used as ink for vat photopolymerization, raises to environmental concerns in terms of plastic waste management. Therefore, photocurable materials that are renewable and recyclable at the same time are needed. We have developed a mechanically robust and reprocessable 3D print photopolymer for 3D printing, based on malic acid which has been selected as one of the 12 most promising chemicals that can be derived from sugar by the U.S. Department of Energy. The Rreaction of malic acid with glycidyl methacrylate introduces both methacrylate moieties that can undergo photopolymerization in the 3D printer, and $\boldsymbol{\beta}$-hydroxyester linkages that can function as dynamic crosslinks via associative bond exchange reactions. The resin formulations demonstrate good layer fusion and accurate print quality, while the 3D printed specimens specimen are robust and thermally stable. Notably, the printed object with the shortest relaxation time displayed Arrhenius flow (Vitrimer) behavior with an activation energy of 36.0 kJ mol−1, and its mechanical performance was maintained after being recycled three times. The use of renewable building blocks together with the design for recyclability will promote the precise and waste-free production of a new generation of 3D materials, supporting a more sustainable plastics economy in the near future.

## 42. PHA's

**Auteur(s):** Corinne van Noordenne, Rudy Folkersma, Tobias van der Most

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics

**Abstract:** Bioplastics such as polyhydroxyalkanoates (PHA) emerge as an interesting alternative to conventional fossil based plastics and as part of the solution for environmental issues. Although PHAs are biodegradable in different environments, other end-of-life scenarios are also important to investigate, especially within the context of the circular economy. To save energy and raw materials, mechanical recycling can be on option, but thermal and mechanical degradation can be a drawback. Therefore, this study reports the effect of repeated mechanical recycling on the molecular weight, the mechanical and thermal properties of poly(2-hydroxybutyrate-co-3-hydroxyhexanoate) (PHBH).

Several injection molding and subsequent shredding cycles have no significant influence on the melting behavior and the E-modulus, the tensile strength and the elongation at break slightly decreased. The molecular weight and melt viscosity decreased gradually with each recycle step. This work demonstrates that PHBH is recyclable without significant loss of properties.

## 43. Rapid Microwave-Assisted Chemical Recycling of Poly(p-Phenylene Terephthalamide)

**Auteur(s):** Joël Benninga, Bert Gebben, Rudy Folkersma, Vincent S. D. Voet, Katja Loos

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics, HyBRIt

**Abstract:** In 1965, DuPont research scientist Stephanie Kwolek discovered that poly(p-phenylene terephthalamide) (PPTA) can be dissolved into a liquid crystalline solution and spun into ultrahigh modulus aramid fibers, which are now known commercially as Twaron or Kevlar. The excellent properties of aramid fibers have led to their widespread use in various advanced applications, including ropes and cables, high-performance fabrics, advanced composites, and ballistic armor. Regrettably, these advantageous properties also pose significant challenges to the closed-loop recycling of aramid fibers. While postindustrial waste aramid fibers can undergo mechanical recycling, where they are chopped into pulp, the resulting materials typically exhibit relatively low economic value (i.e., downcycling) and are not recycled after their use. Chemical recycling, however, enables the production of virgin-quality polymers from polymeric waste through depolymerization followed by purification and repolymerization. Therefore, we investigated the microwave-assisted depolymerization of PPTA. The alkaline hydrolysis of PPTA was conducted in a microwave reactor at temperatures ranging from 240 to 260 °C with reaction times of 1–15 minutes. The highest conversion (96%) was found after 15 minutes at 260 °C. The resulting monomers terephthalic acid and p-phenylene diamine were successfully purified (>99% purity) in good yields via extraction and precipitation methods. The results of this study present the fastest depolymerization of PPTA to date under relatively mild conditions, thereby encouraging a circular value chain for PPTA.

# 44. Renewable and Repairable Coating Design with Debonding on Demand

**Auteur(s):** Max Franze

**Affiliatie:** NHL Stenden Hogeschool , Lectoraat Circular Plastics, HyBRIt

**Abstract:** A major factor hindering the recycling of plastics is the use of coatings or adhesives, which are often not designed for substrate removal. This influences the recyclability of the substrate itself. For example, in case, a thermoplastic material (remoldable) is coated with a thermoset plastic polymer (not remoldable), thesystem cannot be recycled properly before separating the coating from the substrate. This requires asignificant amount of energy and thus cost, which makes recycling inefficient and an economicallyunattractive option in these cases. 1,2 Vitrimers are a novel class of polymeric materials with covalent adaptable bonds within their network. These undergo bond exchange reactions, which remain constant at every temperature. However, their lifetime is dependent on stimulin such as temperature, making it possible for vitrimers to transition from a viscoelastic solid to a viscoelastic liquid without a decrease in connectivity. This makes it possible to reprocess vitrimer materialss, unlike conventional thermosets. 3,4 The goal of this project is to establish a polymer system for sustainable coatings, that can be triggered to allow effective removal from a substrate. To achieve this goal, different vitrimer designs based on dynamic transesterification reactions between hydroxyl and ester moieties will be used. To minimize the environmental impact, our strategy utilizes renewable carbon from biomass and CO2 as well as solvent-free photopolymerization directly onto substrates.

# 45. Covalent adaptable networks for reprocessable composite materials

**Auteur(s):** Valentino Fantozzi, Vincent S.D Voet, Rudy Folkersma, Katja Loos

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**Abstract:** When mixed with reinforcing agents to produce composite materials, thermosets can be exploited in many industrial fields, such as interior decoration, aircraft part manufacturing, and renewable energy (wind turbine blade manufacturing). Thermosets have outstanding thermomechanical properties despite the impossibility of recycling; thus, when thermoset composite materials reach their end-of-life (EoL), their management becomes crucial. In fact, a technique often employed to cope with thermoset waste is landfilling, which has a negative impact on the economy and the environment [1].

To overcome the sustainability issues of thermosets, new materials based on dynamic covalent chemistry called vitrimers are being investigated. Vitrimers can be considered a “bridge” between a thermoset and a thermoplastic material, where unlike the aforementioned thermosets, thermoplastics can be recycled owing to the absence of cross-links. Vitrimers have the outstanding feature of being reprocessable owing to the presence of dynamic cross-links. The covalent adaptive behaviour can be triggered by the action of light and/or temperature. it allows the material to flow like glass (hence the term “vitrimer”), enabling its reprocessability [2],[3].

This project aims to exploit vitrimer chemistries to manufacture catalyst-free vitrimer-based composites from biobased raw materials and/or commercially available materials. To obtain such materials, different exchange mechanisms have been investigated such as transimination, transesterification, and oxime metathesis [4],[5]. To manufacture such composites different elements have been used such conventional reinforcing fibers such as carbon fibers; glass fibers; and biobased fibers such as flax fibers, kenaf fibers, and Sisal fibers.

This work could help reduce pollution by increasing composites’ reprocessability.

## Health & Care

# 46. Scaffold Hopping Approach on New 15-lipoxygenase-1 Inhibitor Discovery

**Auteur(s):** Stefan van Rootselaar, Julianne van Ingen Schenau, Yuandi Zhao, Pedro H.H. Hermkens, Dennis Löwik, Peter J.L.M. Quaedflieg, Manon Vleeming, Samantha Hughes, Swarup De, Sedigheh Safari, Karin Colonna-Bessembinder, René P. Brinkhuis, Darya Hadavi, Ingrid Dijkgraaf, Maarten Honing

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**Abstract:** 15-lipoxygenase-1 (15-LOX-1) has been shown to be involved in various pathophysiological processes. A considerable number of 15-LOX-1 inhibitors has been developed, as targeting 15-LOX-1 holds promise as a therapeutic strategy in the management of inflammatory diseases. However, many 15-LOX-1 inhibitors have shown limited specificity, leading to discontinuation of their development. In this study, building on previous compound class research, a library of 63 heterocyclic scaffold-based compounds was designed and used for scaffold hopping to create structurally diverse new compounds. Eight different heterocyclic scaffolds (triple-heteroaromatic systems), an ethylamine linker and eleven peripheric side chains (single aromatic system with variable terminal alkyl chains) were selected and synthesized. In vitro enzymatic assay showed the inhibitory effects of these new compounds against 15-LOX-1 in micromolar range. Both cellular and Caenorhabditis elegans (C. elegans) models were used to evaluate the toxicity of the selected compounds. Reduced toxicity was found in both parent and off-spring of C. elegans. Compounds showed potent inhibitory activity, better solubility and importantly reduced toxicity, potentially delivering new hits for 15-LOX-1 and/or introducing more polarity to the compounds via further library-to-library modification

## 47. Prevention of Periodontitis by Aloe Vera Polysaccharides

**Auteur(s):** Mieke Smits, Sara Majait, Paul Kwakman, Vanessa Hollaar, Bo Dekker, Jurgen Karczewski, Jenny Cadée, Raymond Pieters

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**Abstract:** Periodontitis is an inflammation of the tissue between the teeth and gums, affecting approximately 10% of the Dutch population. Genetic factors, the composition of the oral microbiota, and lifestyle play a crucial role in the progression from early-stage inflammation, known as gingivitis, to periodontitis. Periodontitis is a bacterial infection in which microbial factors contribute to the development of systemic diseases such as cancer, arthritis, diabetes, cardiovascular diseases, and Alzheimer's disease.

Periodontitis is characterized by the formation of an acidifying bacterial biofilm, with decreasing oxygen levels. Within this dental plaque, typical pathogens such as Porphyromonas gingivalis can thrive and produce harmful substances. The preferred treatment consists of mechanical cleaning combined with antibacterial agents. A potential health-promoting strategy is to inhibit biofilm formation by targeting the bacteria's adhesion ability. Certain sugars, known as polysaccharides, derived from Aloe Vera, can reduce bacterial aggregation and may help slow down plaque formation.

Orange Pearl and the Utrecht University of Applied Sciences are jointly developing assays to study plaque formation and bacterial aggregation. With an oral biofilm model, we can analyse various stages of plaque development and assess the effects of Aloe Vera polysaccharides. The most effective polysaccharides will be tested on volunteers with experimental gingivitis. We aim to reduce the presence of pathogens characteristic of periodontitis.

# 48. Development of 3D Kidney Organoid Assays for Drug Efficacy and Toxicity Screening

**Auteur(s):** David van de Klashorst, Bart Smeets

**Affiliatie:** HAN_ University of Applied Sciences | Lectoraat Drug Discovery | HAN BioCentre

**Abstract:** Development of 3D Kidney Organoid Assays for Drug Efficacy and Toxicity Screening

The kidney plays a vital role in drug metabolism and excretion, making it especially vulnerable to drug-induced toxicity. Traditional 2D cell models lack the structural and functional complexity of human kidney tissue, limiting their predictive accuracy. Similarly, drug efficacy assessments in 2D cultures are unreliable, and animal models often fail to translate due to interspecies differences. Advances in stem cell biology now allow the generation of 3D kidney organoids that replicate key structural and functional features of the human nephron.

In our lab, we cultivate 3D kidney organoids that mimic nephron structures. We characterized the maturity of proximal tubule cells and podocytes—critical for evaluating drug toxicity and efficacy, respectively. Proximal tubule cells exhibited polarized morphology with brush borders, and drug transporters were detected at the transcript level and/or localized via immunostaining, although, the expression of the transporters OAT1 and OCT2 showed low or absent expression. Podocytes displayed foot processes and a gene expression profile closely resembling that of mature in vivo podocytes, outperforming commonly used podocyte cell lines. Quantitative assessment of podocyte integrity was enabled through foot process density measurements using super-resolution microscopy in collaboration with Nipoka GmbH.

To model injury, proximal tubule damage was induced via hypoxia, resulting in upregulation of CD44, a known injury marker. Ongoing studies aim to identify novel biomarkers for sensitive detection of proximal tubule injury that will be validated in drug-toxicity experiments. In addition we will validate the podocyte integrity assessment as a functional assay of podocyte health.

Conclusion

These findings support the development of 3D kidney organoid assays as a human-relevant platform for drug screening. By combining structural, molecular, and functional analyses, these models offer improved predictive accuracy in preclinical drug testing.

# 49. The impact of saliva collection methods on measured salivary biomarker levels

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**Abstract:** "Saliva diagnostics have become increasingly popular due to their non-invasive nature and patient-friendly collection process. Various collection methods are available, yet these are not always well standardized for either quantitative or qualitative analysis. In line, the objective of this study was to evaluate if measured levels of various biomarkers in the saliva of healthy individuals were affected by three distinct saliva collection methods: 1) unstimulated saliva, 2) chew stimulated saliva, and 3) oral rinse. Saliva samples from 30 healthy individuals were obtained by the three collection methods. Then, the levels of various salivary biomarkers such as proteins and ions were determined. It was found that levels of various biomarkers obtained from unstimulated saliva were comparable to those in chew stimulated saliva. The levels of potassium, sodium, and amylase activity differed significantly among the three collection methods. Levels of all biomarkers measured using the oral rinse method significantly differed from those obtained from unstimulated and chew-stimulated saliva. In conclusion, both unstimulated and chew-stimulated saliva provided comparable levels for a diverse

group of biomarkers. However, the results obtained from the oral rinse method significantly differed from those of unstimulated and chew-stimulated saliva, due to the diluted nature of the saliva extract.

Keywords: Biomarkers; Chew stimulated saliva; Oral rinse; Saliva; Unstimulated saliva."

# 50. Integrating education to advance FCS-free cell culturing; a collaborative approach in laboratory animal-free research

**Auteur(s):** R. Vlasblom , J.-R. van Rhijn , C. Kradolfer , A. Krippner-Heidenreich , N. Bovenschen , T. ten Broeke , J. Kamstra , S. Boersma , Y. Boon , C. Kuit , J. Hagoort , A. Loonstra , D. van Kuijck , T. de Witte , L. Nobel , B. Chouiba , J. Schoo , D. Kim , M. de Blom , A. Neshad Ashkzari , A. Schaap , S. Feyzi , R. Pieters , J. Bajramovic

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**Abstract:** In line with the 3Rs principle, the 3Rs Centre Utrecht and the Utrecht University of Applied Sciences have developed innovative educational research projects. These challenge-based initiatives aim to replace animal-derived components in cell culture media, focusing on alternatives to fetal calf serum (FCS), while creating an authentic research environment for students. This integration of education enhances scientific training and increases the project's impact by mentoring a new generation of researchers dedicated to animal-free science. FCS, derived from fetal calves, raises ethical concerns and can compromise experimental quality and reproducibility due to its undefined composition.
In 2024, third-year bachelor students enrolled in the Innovative Laboratory Animal-Free Methods course and tested serum-free alternatives in routine in vitro cellular models for muscle development (C2C12), cancer (DAOY), gene/protein expression studies (HEK293), and the immune system (THP-1). Tested alternatives included commercial media (Proliferum M and Panexin Basic) and a defined non-commercial medium .
The results were mixed. Proliferum M supported C2C12 proliferation but still required horse serum for differentiation. DAOY and THP-1 cells exhibited poor growth with Panexin Basic, while the defined medium allowed a 50% reduction in FCS for HEK293T and THP-1 cells without compromising morphology. Further studies will evaluate functional performance and freezing/thawing effects under serum-free conditions.
Supported by the FCS-free database and collaborations at Utrecht Science Park, this project demonstrates the potential to reduce serum dependency in routine cell culture. It underscores the importance of integrating education, research, and industry collaboration to further contribute to global 3Rs efforts and improving experimental reproducibility.