Workshop
"Advancing Green Chemistry Technologies"

AIM

To discuss the green technologies of biobased fine chemicals and APIs.

To facilitate proactive engagement and collaboration among industrial and academic partners.

To foster interactive information exchange, raise awareness, and showcase successful applications of green chemistry methodologies.

To map developments with a focus on sustainability, circularity, and carbon footprint reduction.

WHEN?
11 December 2024

WHERE?
Ghent – Rozier 1 & 3

WHO SHOULD ATTEND?

THIS WORKSHOP WILL BE OF INTEREST TO ACADEMIC AND INDUSTRY PERSONNEL

WORKING IN ALL GREEN TECHNOLOGIES APPLICATIONS, INCLUDING:

SYNTHESIS - FORMULATION – BENIGN BY DESIGN - ANALYSIS

PROGRAMME

Registration & Welcome Coffee

Introduction

Greening pharmaceutical synthesis – more sustainable methodology

Lunch

Benign by Design

Artificial Intelligence

Coffee Break

Production / scale-up plants

Network Reception

Catering + registration: Boekentoren at Rozier 3, 9000 Ghent
Workshop: Auditorium Vandenhove at Rozier 1, 9000 Ghent

Registration link:
https://event.ugent.be/registration/workshopgreenchemistry

Organised by:

TRANS PHARM

GREEN CHEM
Global green chemistry network

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101057816

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Workshop
"Advancing Green Chemistry Technologies"

09:00 – 09:30	**Registration & Welcome Coffee**
09:30 – 09:45	Introduction

Greening pharmaceutical synthesis – more sustainable methodology

09:45 – 10:35	State-of-the art and challenges of (Electro)chemical flow synthesis **– interactive session** Christian Stevens (Ghent University) & Renzo Luisi (University of Bari) & Aigars Jirgensons (LIOS)
10:35 – 11:10	State-of-the art and challenges of mechanochemistry **– interactive session** Christophe Len (PSL University)
11:10 – 11:35	Hydrothermal Methods: Advancing Green Polymer Chemistry Katrien Bernaerts (Maastricht University)

Lunch at Rozier 3

Benign by Design

13:00 – 13:25	To identify greener and more potentially sustainable alternatives to APIs Klaus Kümmerer (Leuphana University of Lüneburg)
13:25 – 14:05	Redesigning APIs with low ecological risk: why (or why not) and how? **–– interactive session** Karel De Schamphelaere (Ghent University)

Artificial Intelligence

14:05 – 14:30	AI-Driven Compound Screening and Reaction Planning for Greener Organic Synthesis Maarten Dobbelaere (Ghent University)

Coffee Break at Rozier 3

Production/ scale-up plants

15:15 -15:40	Mapping and Reducing Scope 3 CO_2 Emissions: Strategies for a Sustainable Future in Pharmaceutical CDMO Operations Dries De Clercq (Ajinomoto OmniChem)
15:40 – 16:05	Betulin containing birch outer bark extractives: research, development, scale-up and potential application possibilities Jānis Rižikovs (State Institute of Wood Chemistry (LSIWC))
16:05 – 16:30	Chemistry for a Greener World – Online presentation Brian Kelly (KelAda Pharmachem)
16:30 – 16:50	Industrial Technological Hall at Tarbes (France) "AGROMAT" - Video Plateforme AGROMAT - LAB CONNECT (univ-toulouse.fr)

Network reception at Rozier 3

Registration link: https://event.ugent.be/registration/workshopgreenchemistry

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Workshop
"Advancing Green Chemistry Technologies"

Speakers

Greening pharmaceutical synthesis – more sustainable methodology

1. State-of-the art and challenges of (Electro)chemical flow synthesis **– interactive session**

Christian Stevens
(Ghent University)

Renzo Luisi
(University of Bari)

Aigars Jirgensons
(LIOS)

2. State-of-the art and challenges of mechanochemistry **– interactive session**

Christophe Len
(Chimie Paris Tech, PSL University, CNRS)

3. Hydrothermal Methods: Advancing Green Polymer Chemistry

Katrien Bernaerts
(Maastricht University)

Benign by Design

4. To identify greener and more potentially sustainable alternatives to APIs

Klaus Kümmerer
(Leuphana University of Lüneburg)

5. Redesigning APIs with low ecological risk: why (or why not) and how? **–– interactive session**

Karel De Schamphelaere
(Ghent University)

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Workshop
"Advancing Green Chemistry Technologies"

Speakers

Artificial Intelligence

6. AI-Driven Compound Screening and Reaction Planning for Greener Organic Synthesis

Maarten Dobbelaere
(Ghent University)

Production/ scale-up plants

7. Mapping and Reducing Scope 3 CO_2 Emissions: Strategies for a Sustainable Future in Pharmaceutical CDMO Operations

Dries De Clercq
(Ajinomoto OmniChem)

8. Betulin containing birch outer bark extractives: research, development, scale-up and potential application possibilities

Jānis Rižikovs
(Latvian State Institute of Wood Chemistry (LSIWC))

9. Chemistry for a Greener World – Online presentation

Brian Kelly
(KelAda Pharmachem)

10. Industrial Technological Hall at Tarbes (France) "AGROMAT" - Video
Plateforme AGROMAT - LAB CONNECT

Philippe Evon
(INPT-ENSIACET)

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Greening pharmaceutical synthesis – more sustainable methodology

1. State-of-the art and challenges of (Electro)chemical flow synthesis

General Introduction – Use of Renewable Resources

Prof. Dr. Ir. Christian Stevens
SynBioC Research Group, UGent, Coupure Links 653, Ghent, Belgium

Almost all sectors in industry are striving to make their activity more green and more sustainable. This tendency is also very important in the pharmaceutical industry. It relates to all stages in the development of an API. In order to make the production more green, several methods are introduced. It ranges from design principles, over the choice of building blocks to the introduction of new process technologies. In the first part, some general principles will be introduced and more specifically the use of renewable resources will be discussed. How to deal with renewable resources in API production? How fast will these be introduced? How will these be provided? An open discussion between academic groups and industry will confront ideas and challenges.

Prof. Dr. Ir. Christian V. Stevens is professor at the Department of Green Chemistry and Technology at the Faculty of Bioscience Engineering (Ghent University). He graduated at the same department as bio-engineer in chemistry in 1988 and obtained a PhD in 1992 as fellow of the National Fund for Scientific Research. During his PhD he also worked as a research assistant of the University of Southern California (USC), Los Angeles, USA with Prof. C.E. McKenna.After his PhD at Ghent University under the direction of Prof. N. De Kimpe, he did post-doctoral work at the Center for Heterocyclic Compounds at the University of Florida, under the direction of Prof. A. R. Katritzky as a NATO Research Fellow. He became group leader in the group of Prof. Katritzky in 1993. He returned as a postdoctoral fellow of the National Fund for Scientific Research. In 1994, he also made a short postdoctoral stay at the University of Alicante (Spain) under the direction of Prof. M. Yus. In 1995, he became group leader of the National Fund for Scientific Research and became guest professor in 1997 at Ghent University. In 2000, he became professor at the current Faculty of Bioscience Engineering and developed the research group SynBioC of which he was director for 10 years . Since 2014, he is senior full professor.

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Greening pharmaceutical synthesis – more sustainable methodology

1. State-of-the art and challenges of (Electro)chemical flow synthesis

Flow Technology for the Development of Green Synthetic Chemistry

Prof. Renzo Luisi
Flame-Lab, University of Bari "A. Moro", Via E. Orabona, 4, 70125 Bari - Italy

Flow chemistry is transforming the landscape of chemical synthesis by enabling more efficient, scalable, and sustainable processes. Unlike traditional batch methods, flow technology operates continuously, offering precise control over reaction conditions such as temperature, pressure, and mixing. These features result in improved reaction efficiency, reduced waste, and enhanced safety, particularly for handling hazardous or unstable intermediates. The integration of automation and real-time monitoring ensures reproducibility and accelerates development timelines. Flow reactors also facilitate greener processes by supporting the use of renewable solvents, catalysts, and energy-efficient conditions. This presentation will highlight key advancements in flow chemistry, showcasing its application in modern synthesis, fine chemical production, and industrial scale-up, ultimately demonstrating its potential to drive innovation and sustainability in modern chemical manufacturing.

Prof. Renzo Luisi is full professor of Organic Chemistry at the University of Bari and head of the Flow Chemistry and Microreactor Technology Laboratory (Flame-Lab).
After his first diploma in 1990, he was employed as an analytical chemist in a wine factory until 1994 while studying chemistry at the Faculty of Pharmacy of the University of Bari. In 1996, he received a degree (cum laude) in Chemistry and Pharmaceutical Technology at the University of Bari and, in 2001 a Ph.D. in Chemical Sciences at the same University under the supervision of Prof. Saverio Florio. In 1999, he has been a Visiting Scholar at the Roger Adams Lab at the University of Illinois at Urbana-Champaign working in the group of Prof. Peter Beak on organolithium-mediated stereoselective syntheses. In 2001, he was appointed Assistant Professor at the University of Bari and in 2005 promoted Associate Professor of Organic Chemistry at the same University. In 2020, he was appointed full Professor of Organic Chemistry.

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1. State-of-the art and challenges of (Electro)chemical flow synthesis

Organic Electrosynthesis: Opportunities & Challenges

Prof. Aigars Jirgensons
Latvian Institute of Organic Synthesis, Aizkraukles street 21, LV-1006, Riga, Latvia

Organic electrosynthesis uses electricity as a non-expensive and safe alternative to chemical oxidants and reductants. As such, it is very attractive technique for sustainable manufacturing of pharmaceuticals. However, the use of electricity is just one of the aspects of electrosynthesis. Other important components comprises electrodes, electrolyte, reaction solvent, sacrificial reaction and reactor set-up. All these components should be taken into account when developing efficient and green electrosynthesis process.

Prof. Aigars Jirgensons is a group leader and scientific director at Latvian Institute of Organic Synthesis (LIOS) and professor at Riga Technical University (RTU). A. Jirgensons earned his PhD in chemistry from the University of Latvia in 2000. In 2002, he completed post-doctoral studies at the University of Perugia, Italy, group of professor R. Pellicciari. He is a principal scientist at LIOS since 2004 and head or Organic Synthesis Methodology group since 2006. Since 2017, he serves as scientific director at LIOS. In 2016, he was promoted as full professor at RTU. In 2017, he was elected as a full member of the Latvian Academy of Sciences.

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Greening pharmaceutical synthesis – more sustainable methodology

2. State-of-the art and challenges of mechanochemistry – interactive session

Prof. Dr. Christophe Len
Chimie ParisTech –PSL, 11, rue Pierre et Marie Curie, 75231 PARIS Cedex 05, FRANCE

Building on the current momentum to advance green chemistry for sustainable development, chemists have recently pioneered catalytic reactions using innovative technologies. Among these, mechanochemistry stands out as a powerful tool for the synthesis of active pharmaceutical ingredients (APIs), synthetic pharmaceutical intermediates and catalysts. This is achieved by using established chemical reactions and/or by exploiting previously unexplored reactivity. Although several APIs with a simple molecular architecture, such as paracetamol, or a more complex one, such as axitinib, have been synthesised using mechanochemical methods, the synthesis of APIs using mechanochemistry is still limited.
We discuss how mechanochemistry contributes to reducing the environmental impact of synthetic organic chemistry and API synthesis. We also highlight its key features and examine the challenges that remain in making mechanochemical approaches more robust and scalable.

Prof. Dr. Christophe Len received his Ph.D. in 1995 from the Université de Picardie Jules Verne followed by a post-doctoral fellow at the University of Hull (UK). In 1997, he became assistant Professor at UPJV and was promoted to full Professor in 2004 at the Université de Poitiers (France). In 2010, he moved as full Professor to the Université de Technologie de Compiègne – UTC (France). Since 2017, he has developed his research at Chimie ParisTech (France). He has published ~ 260 original publications and review articles, 11 book chapters, and 12 patents (H 51, 7905 citations, Scopus). Among recent awards and recognition to his scientific career, he was promoted Honorary Professor of the University of Hull, England (2012–2018), Honorary Professor at the University of Delhi, India (2022), Honorary Professor at the Xi'an Jiaotong University, China (2022-2025) and Fellow of the Royal Society of Chemistry (FRSC, 2015). In 2017, he was honored with the 2017 Glycerine Innovation Award sponsored by the American Cleaning Institute and the National Biodiesel Board. His current research explores organic chemistry and continuous flow.

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3. Hydrothermal Methods: Advancing Green Polymer Chemistry

Prof. Dr. Katrien Bernaerts
Maastricht University, Urmonderbaan 22, 6167 RD Geleen, the Netherlands

Hydrothermal methods have emerged as a versatile and sustainable approach in polymer chemistry. These techniques leverage the unique properties of water under subcritical or supercritical conditions, providing a green alternative to conventional synthesis and processing methods. In this presentation, two cases studies will be discussed: hydrothermal synthesis of polyazomethines and hydrothermal processing of polyamides.

In the case of polyazomethines, *hydrothermal synthesis* facilitates the formation of Schiff base linkages under mild conditions. Compared to traditional solvent-based synthetic routes, the hydrothermal method avoids the use of (toxic) organic solvents like N-methylpyrrolidone and catalysts, and gives polyazomethines in high efficiency (10 min stead of 12-24 h) and excellent yield after a simple work up procedure. Furthermore, this green method was also applied for the preparation of biobased polyazomethines, derived from vanillin, 5-hydroxymethylfurfural and cardanol. [1]

Hydrothermal processing of polyamides offers a milder alternative to traditional melt processing, as demonstrated by the blending of biobased polyamide 11 with lignin. Incorporating lignin into biobased polymers not only reduces costs but also imparts multifunctional properties. However, conventional melt-blending often involves high temperatures that degrade lignin, leading to suboptimal material performance. To address this, a green and efficient aqueous processing method was employed, blending PA11 and lignin at 170 °C, which is 70 °C lower than the 240 °C required for melt-blending. A comparison between the thermal, mechanical and UV-blocking properties of polyamide 11/lignin blends produced by both methods will be made.[2]

These applications underscore the potential of hydrothermal methods to enhance sustainability and efficiency in polymer science.

References:

[1] Guotai Li, Kui Yu, Jurrie Noordijk, Monique H. M. Meeusen-Wierts, Bert Gebben, Petra A. M. oude Lohuis, Anton H. M. Schotman and Katrien V. Bernaerts, *Chem. Commun.* **2020**, 56,9194
[2] Yawen Yao, Panos D. Kouris, Michael D. Boot, Emiel J. M. Hensen, Jules A. W. Harings, and Katrien V. Bernaerts, *ACS Appl. Polym. Mater.* **2024**, 6, 13630−13640

Katrien Bernaerts holds a PhD in Polymer Chemistry from Ghent University (Belgium). After obtaining her PhD with Prof. F. Du Prez, Katrien spent 7 years in industry, doing research in the field of coatings and fibers. Since 2012, she has been an Associate Professor at Maastricht University, where she is leading the Sustainable Polymer Synthesis group. Her main research focus is on the design and synthesis of sustainable polymer materials with tuneable properties for the circular economy. Sustainability entails biobased building blocks (but no biorefinery) instead of fossil raw materials, green routes for polymer synthesis/processing, as well as (chemical) recycling methods to make the end-of-life of polymers more sustainable. Structure-property relationships of the resulting polymers are evaluated in several fields of application e.g. stimuli-responsive polymers, coatings, fibres, engineering plastics and biomedical materials. Katrien has a growing focus on the use of artificial intelligence techniques to support and accelerate the experimental work, e.g. data interpretation and prediction of structure-property relationships.

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Benign by Design

4. To identify greener and more potentially sustainable alternatives to APIs

Prof. Dr. Klaus Kümmerer
INSC, Universität Lüneburg, Universitätsallee 1, 21335 Lüneburg/D

Pharmacy is indispensable for a high standard of living and health. For long time pharmacy came along with heavy environmental pollution by toxic waste, exhausts, and effluents from production and application. Recently, circular economy was introduced to address pollution by products and shortage of resources, in general. Pharmaceuticals, however, cannot be recycled. Therefore, the active pharmaceuticals ingredients (APIs) and the excipients must be designed from the very beginning for complete and fast mineralization at the end of their life after they have delivered their service. We could demonstrate that design of such molecules for environmental degradation, is feasible thereby contributing to clean water and reducing the challenge of antibiotic resistance. However, such molecules have to be synthesized in a greener manner, too. This needs systems thinking starring with service and function needed and if possible the deliver the service needed by non-material approaches, even.

Further reading:

EU: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31996L0061
EU: https://environment.ec.europa.eu/strategy/chemicals-strategy_en
EU: https://www.europarl.europa.eu/doceo/document/TA-9-2020-0226_EN.html
Kümmererer, K., Green Chem., 9, 899 (2007)
Kümmererer, K., et al., Science, 361, 6399 (2018)
Leder, C., et al., ACS Sustainable Chem. Eng. 9, 9358 (2021)
Suk, M., et al., Green Chem., 22, 4498 (2020)
Brodin, T.,et al., Nature Sustainability 7, 949 (2024)
Bading, M. et al. Chemosphere, 352, 141298 (2024)
Puhlmannn, N. et al. 2024, Science of the Total Environment, 921-171027 (2024)
Puhlmann, N.et al. European Journal of Pharmaceutical Sciences, 192, 106614 (2024)
Lorenz, S., et al. ACS Sustainable Chemistry & Engineering, 9, 12461 (2021)
Puhlmann, N., et al. Green Chemistry, 14, 5006 (2021)

Prof. Dr. Klaus Kümmerer is Professor of Sustainable Chemistry and Material Resources at the Institute for Sustainable Chemistry (INSC). His research areas include green and sustainable chemistry and pharmacy, applied cheminformatics and material chemistry, environmental behavior of chemicals, material resources, and Benign by Design. Klaus Kümmerer's research and consulting activities have a strong international focus: He has been Director of the Research & Education Hub at the International Sustainable Chemistry Collaborative Center since 2017 and member of the High Level Roundtable on the Chemicals Strategy for Sustainability of the European Commission since 2021. In 2023, he was ranked 16th worldwide out of a total of 99,567 scientists in the field of environmental sciences according to the Stanford University Ranking. In terms of citations, he was ranked first in Germany. In 2023 he was awarded with the Verdienstkreuz am Bande des Verdienstordens der Bundesrepublik Deutschland („Bundesverdienstkreuz"; Cross of Merit on Ribbon of the Feral Republic of Germany, awarded by the President of Germany Frank Walter Steinmeier) as well as with the Wöhler Award of the German Chemical Society for Sustainable Chemistry.

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Benign by Design

5. Redesigning APIs with low ecological risk: why (or why not) and how? -- interactive session

Prof. Karel De Schamphelaere
GhEnToxLab Research Group, UGent, Coupure Links 653, Ghent, Belgium

Designing APIs with low ecological risks is a key of TransPharm (WP2), but why should we pursue and how to approach this aim? The plenary discussion, in the lead of prof. De Schamphelaere, UGent, will focus on analyzing if it is possible and/or desirable to consider ecological risk (accounting for not only hazard but exposure as well) in developing greener APIs?

Two questions will be raised:

- Is it possible and/or desirable to consider ecological risk (= exposure x hazard) in developing greener API's (during R&D)?
- Is it even possible to design an **effective antimicrobial/antibiotic** that does not contribute to AMR development in the environment?

Karel De Schamphelaere is associated professor at GhEnToxLab, Ghent University.
The Ghent University Laboratory for Environmental Toxicology (GhEnToxLab) aims to advance the understanding of environmental and ecotoxicological problems and processes across all levels of biological organisation (from genomes and cells to populations and ecosystems).

GhEnToxLab ultimately aims to improve the ecological relevance of environmental risk assessment of chemicals and other natural and anthropogenic stressors and to support science-based environmental quality management and policy.

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Artificial Intelligence

6. AI-Driven Compound Screening and Reaction Planning for Greener Organic Synthesis

Maarten R. Dobbelaere, Istvan Lengyel, Christian V. Stevens, Kevin M. Van Geem
Laboratory for Chemical Technology, UGent, Technologiepark 125, Ghent, Belgium
ChemInsights, LLC Dover DE 19901, United States of America
SynBioC Research Group, UGent, Coupure Links 653, Ghent, Belgium

Machine learning (ML) can accelerate chemical tasks such as retrosynthesis, outcome prediction, property prediction, and condition recommendation. However, current databases and algorithms face challenges that hinder (experimental) experts in the field from fully utilizing ML-based tools. The first challenge is that databases are not tailored to real-world structures and applications. Second, the applications often remain confined to theoretical proofs-of-concept. In response, we present user-friendly software solutions that address these database and applicability-related issues on three levels: the molecule, the reaction, and the catalysts. In the first part, we introduce chemperium, a ready-to-use geometric deep learning tool that can achieve "chemical accuracy" for a wide range of molecules, catering to various branches of the chemical and pharmaceutical industry (1). Next, we demonstrate how to predict potential reaction conditions based on popularity and similarity using the open-source software tool Rxn-INSIGHT (2). Finally, we showcase a human-in-the-loop active machine learning workflow that optimizes catalysts and reaction conditions. In this process, the user's expertise is combined with the machine's learning capabilities, allowing for a more efficient and adaptable optimization process (3). These user-friendly tools address various needs in green chemistry and lay the groundwork for self-driving laboratories of the future.

References

(1) Dobbelaere, M. R.; Lengyel, I.; Stevens, C. V.; Van Geem, K. M. Geometric deep learning for molecular property predictions with chemical accuracy across chemical space. Journal of Cheminformatics 2024, 16 (1), 99. DOI: 10.1186/s13321-024-00895-0.
(2) Dobbelaere, M. R.; Lengyel, I.; Stevens, C. V.; Van Geem, K. M. Rxn-INSIGHT: fast chemical reaction analysis using bond-electron matrices. Journal of Cheminformatics 2024, 16 (1), 37. DOI: 10.1186/s13321-024-00834-z.
(3) Kuddusi, Y.; Dobbelaere, M. R.; Van Geem, K. M.; Züttel, A. Accelerated design of nickel-cobalt based catalysts for CO2 hydrogenation with human-in-the-loop active machine learning. Catalysis Science & Technology 2024, 10.1039/D4CY00873A. DOI: 10.1039/D4CY00873A.

Maarten Dobbelaere is a final-year PhD-student in the group of Kevin Van Geem at Ghent University's Laboratory for Chemical Technology. His research is in close collaboration with the SynBioC research group of Chris Stevens and focused on using machine learning to guide chemical reactions in flow to optimal conditions.
His expertise is artificial intelligence in chemistry.

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Production/ scale-up plants

7. Mapping and Reducing Scope 3 CO_2 Emissions: Strategies for a Sustainable Future in Pharmaceutical CDMO Operations

Dries De Clercq

Ajinomoto Onmichem, Cooppallaan 91, Wetteren, Belgium

Ajinomoto Omnichem is a CDMO specializing in the production of pharmaceutical APIs, intermediates, and fine chemicals. Accurately mapping the Scope 3 emissions associated with these operations is a complex task, yet it offers crucial insights into the most effective strategies for emission reduction. This presentation will detail our ongoing efforts to comprehensively map these indirect emissions throughout our supply chain, with an emphasis on improving transparency and precision in our carbon footprint analysis. The various strategies we are deploying to lower these emissions, including solvent recycling, enhanced waste management, sustainable raw material selection, and the application of the best available technologies will also be covered during the presentation.

Dries De Clercq is research chemist process engineer at Ajinomoto Omnichem.
Dries studied Master of Science at KULeuven (Industrial Engineering – Chemical Engineering) followed by a Master of Science at Ghent University (Chemical Engineering).
Ajinomoto Omnichem is a leading global business partner for Pharmaceutical APIs and intermediates, green fine chemicals, amino acids, tannines, plant-based biostimulants and Tensiofix® surfactants. Ajinomoto Omnichem is a member of the Ajinomoto Group, which operates more than 100 manufacturing facilities and supporting offices globally. Over 100 years ago, the Ajinomoto Group was founded with the aspiration to help people "Eat Well, Live Well." Today, they are a solution-providing group of companies for food and health issues, serving over 700 million consumers around the globe.
Ajinomoto Omnichem has a long history in Belgium and beyond, with in total 6 locations in Belgium, Spain and India.

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Production/ scale-up plants

8. Betulin containing birch outer bark extractives: research, development, scale-up and potential application possibilities

Janis Rizikovs, Aigars Paze, Daniela Godina, Rudolfs Berzins, Sanita Vitolina and Laura Andze

Latvian State Institute of Wood Chemistry, Dzerbenes 27, LV-1006 Riga, Latvia

The outer white layer of birch bark is an underrated, renewable resource for the industrial production of sustainable bio-based materials and chemical compounds. Birch wood processing industries, such as plywood and pulp manufacturing, are highly developed in Europe, where large quantities of birch bark accumulate as a by-product, most of which is burned for heat energy. In recent years, there has been growing interest in the role of natural compounds in pharmaceuticals, cosmetics and food product development. A widely studied class of natural compounds is triterpenes and their functionalized forms – triterpenoids – such as betulin, betulinic acid and lupeol.

At the Latvian State Institute of Wood Chemistry (LSIWC), there are over 13 years of experience in developing and scaling up betulin extraction and purification technologies through various scientific and commercialization initiatives. As a result of these activities, a scalable technology has been developed, reaching TRL6 in close collaboration with one of Europe's largest plywood producers, A/S Latvijas Finieris. Based on the data obtained, the first birch outer bark betulin production plant in the Baltic region was designed, constructed and officially opened on May 5, 2022. For commercialization purposes, the "Betulin Lab" brand was established, along with a dedicated website (https://betulin-lab.com/en/betulin/). Through these projects, efficient, industrially scalable, and economically viable production technologies have been developed for obtaining birch outer bark extractives with varying chemical compositions, tailored to the specific requirements of the final product. The birch outer bark extractives microparticles and their application as a multifunctional raw material for the formation of gels and Pickering emulsions for the needs of the food, nutritional supplements, cosmetics or pharmaceutical industries are currently being studied.

Dr. sc. ing. Jānis Rižikovs is leading Researcher at Latvian State institute of Wood chemistry. He obtained his doctoral degree of engineer sciences in chemistry at the Faculty of material sciences and applied chemistry at the Riga Technical University. The title of this thesis was "Activated carbon from hydrothermally treated and pelletized wood". At the Latvian State Institute of Wood Chemistry, the research area is related to biomass thermal and chemical processing, including physical activation, fast and slow pyrolysis, torrefication, hydrothermal treatment, densification and extraction underpinned by detailed analytical quantitative and qualitative characterisation, mechanical testing, feasibility studies and practical tests on laboratory scale units.

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9. Chemistry for a Greener World

Brian Kelly

KelAda Pharmachem Limited., Science Centre South, Belfield, Dublin 4, Ireland

In this presentation, Brian Kelly from KelAda Pharmachem will explore the commercial and financial aspects of implementing green chemistry practices within the fine chemicals sector. Highlighting the increasing market demand for sustainable solutions and the regulatory landscape driving change, he will provide insights into the financial implications of adopting green methodologies. Sharing real-world experiences from KelAda's journey towards greener synthesis, he will discuss the challenges faced, successes achieved, and the importance of collaboration among small and large companies.

Dr. Brian Kelly is CEO of KelAda Pharmachem Ltd.. He is an experienced life sciences industry managing director with specialties in Innovation, Entrepreneurship, Fine Chemicals, Pharmaceuticals, Biotechnology, Nanotechnology, Green Energy and Life Sciences. He is adjunct professor at the University College Dublin.
KelAda is based in Ireland and is situated at the nexus of a global pharmaceutical manufacturing hub (with 24 of the world's top 25 pharma companies having significant operations on the island), and a world-renowned agri-food technology sector (with major international players headquartered in Ireland).
KelAda's mission is to be a catalyst for the integration of green technologies into the manufacture of pharmaceutical ingredients. This mission is underpinned by their focus on performing their own in-house world-class research and collaborating with other world-class researchers. They also have an active program of technology identification whereby they identify, in-license and develop novel chemistry into scalable processes which can then be utilized by major pharmaceutical and fine-chemical players.

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Production/ scale-up plants

10. Industrial Technological Hall at Tarbes (France) "AGROMAT" - Video Plateforme AGROMAT - LAB CONNECT

Dr. Philippe Evon
Université de Toulouse, 41, allées Jules Guesde - CS 61321, 31013 TOULOUSE - Cedex 6, France

A video will be presented about the industrial technological hall at Tarbes. Some examples conducted at AGROMAT and the main equipments used will be shown.

Dr. Philippe Evon is research engineer in Laboratory of Agro-industrial Chemistry (LCA) in the Institut National Polytechnique de Toulouse (INPT). He is the Manager of the LCA's Industrial Technological Hall "AGROMAT" dedicated to agromaterial's, which is located in Tarbes (South-West of France).
He specializes in the valorization of wastes from biomass to produce extracts and to design agromaterials. He is mainly developing studies for using biomass as raw material for producing bioactive extracts through fractionation processes using "green" solvents and the twin-screw extrusion technology as continuous extraction technique. And the manufacture of agromaterials by combining single- or twin-screw extrusion technologies with molding processes (*e.g.* injection-molding or thermopressing).

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