Rehap

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Systemic approach to **Reduce Energy** demand and CO_2 emissions of processes that transform agroforestry waste into **High Added** value **Products**

Rehap is an EU-funded project that aims to strengthen the European bio-economy by creating novel materials from agricultural and forestry waste, and then considering how they can be used commercially in the green building sector.

This edition of the Rehap newsletter, we will be looking closely at the success the project has had in developing methods for the hot water extraction of tannin, the optimisation of Biochemtex's second generation technology to process lignocellulosic biomasses, and methods for producing 2,3-butanediol from bark and poplar. We will hear from each of these developments and the Rehap partners that have helped to make it happen.

Lars Wietschel and Raul Pinero both attended and represented Rehap at the prestigious European Biomass Conference & Exhibition with two posters and will be catching up with them. Finally, we would like to talk to you about Rehap's first workshop which took place in September at the University of Augsburg.

LINKS TO THE STORIES

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BIOCHEMTEX (CTXI) – optimising second generation technology

The aim of one of Rehap's subtask is to optimise Biochemtex's second generation (2G) technology to process lignocellulosic biomasses at pilot and demo scale in order to produce the lignin-rich residue and use it as starting material for the recovery of lignin and sugars for further project research.

The CTXI 2G technology is a breakthrough process able to produce fermentable sugars from lignocellulosic biomass which can be easily converted into bio-fuels and/or bio-chemicals. The main process steps for the production of bioethanol for valorisation in this 2G process include:

- Pre-treatment of biomass to disrupt the lignocellulosic matrix and solubilise specific sugars,
- Hydrolysis (a reaction with water) to reduce the cellulose and hemicellulose into fermentable sugars,
- Fermentation of sugars to ethanol,
- The separation of solid and liquid to achieve the solid lignin, the remaining ethanol is recovered and dehydrated

During the Rehap project, CTXI evaluated the woody material, poplar, together with state-of-the-art wheat straw, in order to increase the flexibility of its conversion process to several types of lignocellulosic feedstock. None of which are in competition with food and feed.
The results confirmed that just like wheat straw, poplar presents good compositional characteristics, in terms of cellulose and hemicellulose, that allow this feedstock to be treated with 2G technology for the production of bioethanol.

Poplar was selected as a lignocellulosic material for the Rehap project improving the process of obtaining bioethanol from this material. The necessary amount of lignin co-product was produced for the subsequent R&D activities carried out by partners TECNALIA and BBEPP at lab and pilot scale, respectively.

The lignin-rich stream which will be used as feedstock for the processes in the Rehap project, is generated by the separation of solid content from the stillage recovered at the bottom of the beer stripper column in the 2G plant. This solid content is characterised by having around a 60 - 70% moisture content (MC).

In order to optimise the lignin 2G co-product for it to be used in different types of valorisations, as well as improve the power plant and water recycle processes at industrial demo scale, CTXI carried out tests on separating the liquid and solids using polyelectrolytes and evaluating the drying process. This separation modifies lignin into a transportable solid.

The combination of separating large amounts of solids from liquids using polyelectrolytes as a separating agent as well as the drying technique, is a good solution to significantly reduce the moisture content (from 60-70% by 7-10%) to allow lignin co-product to be used successfully for combustion and/or chemical valorisation.

Developments in 2,3-butanediol production from biomass

Rehap have been developing 2,3-butanediol (BDO) production from two biomasses in the project, bark and poplar, and here are some of their most recent advances.

In previous research, VTT, the Technical Research Centre of Finland developed a technique for the hot water extraction of tannins from soft wood bark and successfully transferred it to the lab at BBEPP. At BBEPP, this technique to obtain cellulose and lignin/tannin fractions was performed and evaluated and successfully scaled-up to pilot scale.

In parallel to this development, partners, TECNALIA have been working on the saccharification – the process of breaking down a complex carbohydrate, in this case cellulose, using hydrolysis into its simplest sugars – of the cellulosic residue generated by the purification of lignin from the woody material, poplar.

Tests have selected the best enzymes and hydrolysis conditions that can increase the glucose yield and minimise the production of inhibitors that could affect the course of fermentation at the next step. The hydrolysate, this is the substance left over from hydrolysis, was best obtained using the purification method otherwise enzymes remain in their crude form and cannot be used.

Once the substance was obtained, BIOSYNCAUCHO, a company that aims to develop high-added value chemical products from renewable raw materials, tested and determined the best conditions for the fermentation of sugars to 2,3-butanediol (BDO), a renewable chemical building block. Promising results from poplar's second generation sugars have revealed close comparisons to 2,3-BDO production using first generation sugars; sugars found in food crops using standard processing technologies.

In other developments, the fermentability of the sugars obtained from bark in BBEPP at pilot scale, have also been optimised by BIOSYNCAUCHO with excellent results in terms of 2,3-BDO production, yield and productivity. As found with the process used in poplar, the purification procedures are critical to avoid the presence of inhibitors.
These two results demonstrate that the use of second generation sugars from agroforestry waste in the Rehap project, obtained after the processing of bark and poplar, is a real alternative to using first generation sugars for the production of 2,3-BDO, successfully reaching one of the projects vital objectives.

Next stage

The chosen protocols for the enzymatic hydrolysis of cellulose residues from poplar and the fermentability conditions to produce 2,3-BDO are being transferred to BBEPP to scale up and validate all the processes. From here, if successfully, the required amount of 2,3-BDO can be used for further project developments.

Lars Wietschel and Raúl Piñero

Rehap present two posters at renowned EUBCE

The 26th European Biomass Conference & Exhibition in Copenhagen featured some ambitious and interesting topics on the role of biomass for climate protection and sustainable development. Lars Wietschel and Raúl Piñero represented Rehap with two posters at the event and noted that the processing of biomass into biofuels for trucks and planes was one of the hot topics of the week.

Every year, thousands of delegates, speakers and presenters from around the world attend the prestigious European Biomass Conference & Exhibition (EUBCE) to discuss, collect, exchange and disseminate scientific and industrial know-how in the field of biomass.

On 14-17 May 2018, EUBCE saw participants from sectors including biofuels, biomass feedstock, waste management, bio-plastics and biopower attend. Lars Wietschel and Raúl Piñero presented two separate posters on the ground-breaking developments happening in Rehap: "Future availability of lignocellulose feedstock from agricultural harvesting residues", and "A novel and quick method for characterising lignocellulosic materials in biorefinery processes: Thermogravimetric analysis and predictive kinetic model (TGA-PKM) method".

Piñero's poster was on defining standard methods and analysis procedures for evaluating the quality of the biomass used as feedstock using faster methods than already available.

Wietshel's poster on the availability of agroforestry feedstock looked at the methodology tool Rehap has developed to forecast on a regional basis the future availability of lignocellulose feedstock from agricultural residues in Europe. Lignocellulose is a biomass component that can act as a substitute for petrochemicals.

Wietschel, after his short oral presentation on the poster, struck up conversation with Berien Elbersen who was working on the S2BIOM project with a similar assessment on feedstock potentials. Though using different methodologies, the results were similar.

The conference and exhibition were heavily focused on technical products in the field of biomass valorisation and provided delegates with an eye-opening view into the trends and technologies that are currently being hyped. One in particular, hypothermal liquefaction, is the process of converting wet biomass into crude-like oil. With enough pressure and heat, biomass can be processed into fuel and used for truck and jet fuel.

As always, EUBCE was alive with speakers, developers, professors and some of the biggest names in the biomass industry, providing Rehap with an unmissable opportunity to both share its ground-breaking work and take away an abundance of new information.

Rehap hosts first workshop in Augsburg

On the 27 September 2018 Rehap ran the project's first workshop at the University of Augsburg, Germany focusing on Rehap's research in helping strengthen the bioeconomy.

Rehap is an EU-funded project, championing the bio-economy and agriculture research in the EU. The project aims to create new products that can be used to make eco-friendly resins for wood and bio-based chemicals for greener cement.

The project has been focusing on lignin, tannin and cellulose, essential for the design of biopolymers, which are first extracted before they are transformed via pioneering new processes to create artificial chemicals that are commonly used in the construction industry, normally derived from fossil fuels.

Over one morning, just outside the bustling city of Munich, through various short presentations, panel discussions and interactive debates, Rehap's workshop focused sessions on the following preliminary topics:

- Overview of the Rehap project
- Logistics management: Procuring and forecasting how much biomass is available in Europe
- Biochemistry: Take a look at the specific protocols and extraction methods for lignin and tannin
- Process upscaling and Life Cycle Analysis
- Cascade use of wood – concept and case studies by Prof. Dr. Klaus Richter, Technical University of Munich

Find out more about the project at:
www.rehap.eu