Final Evaluation Report

In this annex the Life+ project Cellu2PLA is evaluated, based on the two main project objectives set out in the Grant Agreement.

Objective 1	**An innovative and appealing treatment process that produces bioplastics from the cellulose, recovered from raw municipal waste water.**

Unfortunately we did not succeed in reaching the main goal of our project: producing biobased plastic out of cellulose recovered from domestic waste water. We were able to produce a glucose solution with the pilot plant, out of cellulose recovered from waste water with the finescreen installation. Only this glucose doesn't meet the specifications necessary to eventually produce PLA.

Screening material waiting for conversion

The optimal conversion of cellulose to glucose could not be reached due to a contamination with two kinds of bacteria: Lysinibacillus Fusiformis and Bacillus Cereus. They transformed the glucose into lactic acid and eventually CO_2 and H_2O. The conversion rate towards glucose was 13% to 29%, while during lab conditions over 50% was reached.

It seems that, with the knowledge gained in the project, the choice for building a demonstration plant for glucose production was made to early. The decision was based on lab results, which showed that the conversion of cellulose recovered from domestic waste water toward a glucose solution was possible. Jumping immediately towards a demonstration plant was a to big step. It would have been better to first validate the lab results in a bench scale installation.

Setting up the glucose plant at Attero

Mr. H. Laan from IMEnz Bioengineering, member of the advisory group for Cellu2PLA, still sees potential in the idea of this project and would encourage more research. The same accounts for Mr. H. Temmink of the Wageningen University. The Wageningen University wants to do more research and make cellulose contribute to the bio based economy. A call for partners is already placed on their website (see appendix 1).

Objective 2 A significant sustainable and economical improvement of the current waste water treatment process by removing the cellulose from the influent.

The project did provide the Dutch Water Authorities much insight in the finescreen technique, the effect on the WWTP and the composition of the screening material. It proved to be an economically and environmentally good option to expand the treatment capacity of a WWTP with finescreens. The benefits are not that significant yet, the energy consumption for example only decreases with 3%. But the full-scale finescreen installation at WWTP Beemster was one of the first in Europe, so these benefits will be optimized in future projects.

Thanks to Cellu2PLA, more finescreen installations are planned at other WWTP's in the Netherlands. The picture below shows which WWTP's already collect cellulose and where the installation of finescreens are planned.

Harvesting cellulose at Dutch WWTP's

In time more screening material becomes available and the cellulose already found its way into other products (as additive in asphalt and as board/panel). Also for Attero it opened new business potentials. Before Cellu2PLA the water authorities were not so much in their scope, but now already there is more cooperation and opportunities to contribute to a circular economy.

HHNK and STOWA participate in a joint initiative of all Dutch water authorities, called the Energy and Resource factory. Within this platform different workgroups are formed, to concentrate on a specific subject. Also for the resource cellulose a workgroup is active. Mr. B de Boer is chairman of this group and Mr. R. Kras from the advisory group is also a member. They discuss the various results on cellulose projects, like Cellu2PLA, ensuring an efficient transfer of know-how and experience in order to foster its replication in similar contexts. More information is available on the website https://www.efgf.nl/producten/cellulose/.

The Dutch water authorities have set the next dot on the horizon concerning cellulose:

> "In 2030 all water authorities are capable to collect cellulose form waste water in a cost effective way. The technology for harvesting and cleaning the material is optimized. There is a market uptake for this cellulose, economic viable and sustainable. Even the water authorities themselves make use of the product in their own field of work. In society reusing cellulose from waste water is as common as glass recycling."

Annex C5

Appendix 1

Unlimited possibilities for cellulose in bio-based economy

Cellulose is used on a large scale as a raw material for paper, textiles, paints, plastics, and other products. This natural material has the potential to replace a substantial part of the fossil resources used in products. Wageningen Food & Biobased Research collaborates with partners in the development of sustainable solutions for existing technological challenges. The starting point: there are suitable applications available for every cellulose source and vice versa.

Ask your question about cellulose:
ing. JJCF (Jeroen) van Bon

Contact form

"Cellulose is the most abundant natural polymer in the world," says Jeroen van Bon of Wageningen Food & Biobased Research. "Many industries already use this material on a large scale in their production process. We see enormous potential for wider use of cellulose, e.g. in making building materials, bioplastics, and packaging that currently use a lot of petrochemical resources. Thanks to 25 years of experience with cellulose research, we are able to oversee the whole process from raw material to end product. This is why we want to bring all parties in the chain together, to jointly work on better technologies for existing and new applications."

> *" We can help producers of raw materials and processors of cellulose by finding the most suitable application for cellulose and we can assist manufacturers by finding the most suitable cellulose material for their end products. "*
>
> Jeroen van Bon, Wageningen Food & Biobased Research

Most suitable route from raw material to end product

There is no shortage of cellulose resources: from flax and trees on the land, to residual streams like straw, leaves, and coconut husks. Additionally, material streams like textile waste and organic municipal waste are also rich in cellulose. Finding the most suitable route from raw material to end product is a challenge for researchers which, in Van Bon's opinion, is not only caused by the great diversity in biomass streams: "The quality and composition of cellulose types vary widely. In Wageningen, we have a wide variety of techniques available to extract cellulose from all those resources and modify it in such a way that it can be used for specific applications. The challenge is to retain the valuable and useful intrinsic properties of cellulose as possible, while limiting the use of energy and chemicals to a minimum.

During every processing step

Wageningen Food & Biobased Research wants to support partners in several areas, says Van Bon: "We can help producers of raw materials and processors of cellulose by finding the most suitable application for cellulose and we can assist manufacturers by finding the most suitable cellulose material for their end products. However, we don't only look at the technical challenges: we also want to help partners in the creation of an efficient and economically appealing value chain."

Call for partners

Van Bon invites interested companies to join in. "There could be companies that are already working with cellulose, and who want to take a technological step forward. However, I would also like to meet companies that are looking for alternatives to petrochemical resources in the field of construction materials, packaging, and plastics."

More information

- Natural fibres

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