RESEARCH NEWS

Paludicultures as an alternative, bio-based raw material for paper packaging

Sustainable Packaging from Peatland Plants

Paludicultures such as peat moss, reed and reed canary grass are already used as construction materials, animal feed and foodstuff. Due to their low lignin content, however, peatland plants could also be an attractive alternative to wood as a raw material source for sustainable paper packaging. Researchers at the Fraunhofer Institute for Process Engineering and Packaging IVV have already demonstrated in feasibility tests that peatland plants have great potential for the manufacture of folding boxes, trays and similar items.

The most important component of paper is the raw material, wood. Against the backdrop of sharply increasing market prices and a very high import ratio for wood raw materials in Germany (approx. 80 percent), alternative raw material sources are becoming more and more important for manufacturing paper packaging. This motivated the researchers at Fraunhofer IVV in Freising and Dresden to study the potentials of peatland plants such as reed, sedge or reed canary grass for sustainable packaging and to test corresponding manufacturing processes in the PALUDI project. The project runs within the scope of the Fraunhofer Biogenic Value Creation and Smart Farming initiative, supported by the German Federal Ministry of Education and Research (BMBF), the Bavarian Ministry of Economic Affairs, Regional Development and Energy, and the Ministry of Science, Culture, Federal and European Affairs of Mecklenburg-Vorpommern.

The peatland plants studied in the project are deliberately cultivated in rewetted peat bogs and fens. In the future, peatland plants will be given more space. This is because at least 30 percent of the surfaces of forests, grasslands and wetlands have to be rewetted and renatured according to the EU Nature Restoration Law of February 2024. This is also known as paludiculture. "This refers to farming in wet peatlands with locally adapted plant species. Paludicultures help to maintain the peatlands and contribute to climate protection since they minimize carbon emissions — another reason to study them further," says Fabian Kayatz, who heads the project at Fraunhofer IVV.

The lower the lignin content, the lower the use of chemicals

Compared to wood, reeds and similar plants are characterized by a low lignin content, allowing the use of fewer chemicals during the pulping of plant fibers to reach a sufficiently high-quality fiber needed for packaging applications. This was the result of the chemical characterization of paludicultures from the Freisinger Moos fen region. Depending on the plant, the researchers achieved a lignin content of between 20 and 23 percent. The harvested material had a lignin content of 25 or 15 percent lower

Contact
Monika Landgraf | Fraunhofer-Gesellschaft, Munich, Germany | Communications | Phone +49 89 1205-1333 | presse@zv.fraunhofer.de
Karin Zacher | Fraunhofer Institute for Process Engineering and Packaging IVV | Phone +49 8161 491-359 | Giggenhauser Str. 35 | 85354 Freising, Germany | www.ivv.fraunhofer.de | karin.zacher@ivv.fraunhofer.de

compared to soft- and hardwood. "The less lignin content, that is, the natural adhesive in the plant cell walls, the lower is the use of resources, such as acids or alkalis, during chemical pulping and the more stable is the fiber network that forms," Kayatz explains. In addition, the pulp from these plant fibers has better mechanical properties than pulp from other straw pulps, such as corn or bamboo.

Fiber pulping methods with temperatures under 100 °C

Furthermore, lignin from non-woody plants can be easier released or separated from the fibers so that pulping methods as, for example, alkaline soda pulping, end up being less energy-intensive than conventional paper manufacturing processes made from wood fibers. In the case of the pulping process developed in the project, which was tested on reeds and transferred to other paludicultures, the researchers were able to work with temperatures of less than 100 °C, which are up to 45 percent below the lowest values for chemical fiber pulping methods and therefore require less energy. The results showed, that depending on the settings, up to 83% of the lignin could be released using the Fraunhofer IVV method. "After the peatland plants were harvested, the obtained biomass could be further processed on an industrial scale in the pulp factory. The pulp production would then take place by pulping the plant fibers there," which is how Kayatz explains the initial steps in the process of packaging production, although the work in the project was still done at a laboratory scale. The pulp yield was up to 53 percent, depending on the combined parameters, which is within the expected range for conventional chemical processes.

Subsequent experiments demonstrated that the produced flat, fiber-molded papers had a good processability. The tensile strength of flat, fiber-molded laboratory samples was significantly higher than the values of the reference sample, which had the shape of an egg carton. By adding additives such as starch and sizing agent, was feasible to further increase the tensile strength and elasticity as well as the water-repellent properties of the papers even more. In addition, the papers produced from paludicultures turned out to be suitable for processing methods such as folding, gluing and printing.

Innovative packaging for the non-food sector

With fiber-molding and deep-drawing processes, the researchers were able to produce sturdy paper jars and trays from reed fibers without using additives. They had developed a laboratory plant specifically for the production of these packaging demonstrators. "Peatland plants have a great potential for manufacturing innovative, bio-based packaging, as we were able to show with our successful development of resource-friendly processes for pulp production. The environmental aspect is very important to us — we support the preservation of our peatlands by rewetting agricultural lands and using them for paludicultures, for example," Kayatz summarizes. However, additional optimization processes are necessary to move production to an industrial scale and designing consumer-accepted packaging for consumer goods requires further properties optimization steps, for example, regarding to sensory perception or the coating of the

material. Initially, there are plans to manufacture packaging for the non-food sector such as cosmetics, logistics and office materials.

Fig. 1 Compared to wood, reed canary grass is characterized by its low lignin content.

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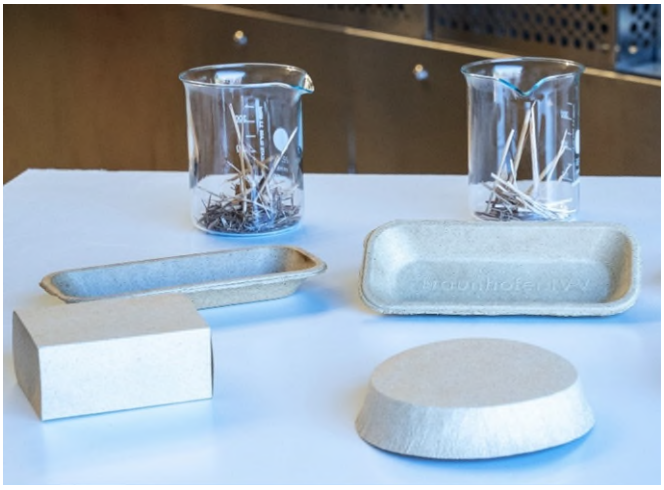

Fig. 2 Sustainable packaging from peatland plants manufactured using fiber-molding and deep-drawing processes

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