TECHNISCHE UNIVERSITÄT DRESDEN

Dendromass4Europe.eu

D4 EU

Opportunities and requirements for the usage of poplar bark from short rotation coppices for eco-fungicidal packaging materials

Daniela Einer[1], Javane Oktaee[1], Martina Bremer[2], Frank Jornitz[3], Steffen Fischer[2], André Wagenführ[1]

About the project

Dendromass4Europe (D4EU, 2017 – 2022) aims at establishing sustainable, Short Rotation Coppice (SRC)-based, regional cropping systems for woody biomass (dendromass) production on marginal agricultural land. The dendromass produced in SRC (ligneous biomass, bark and wood) is supplied to dedicated bio-based value chains that create additional income and job opportunities in rural areas. The supply chains will be tailored for optimum efficiency of supply logistics and for reducing CO_2 emissions. Innovative bio-based materials, including eco-fungicidal packaging materials, will help to replace fossil-based materials.

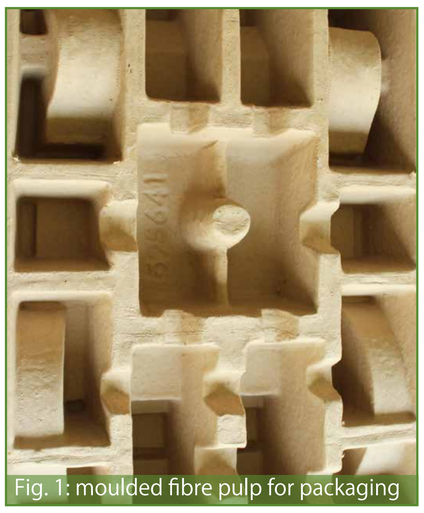

Fig. 1: moulded fibre pulp for packaging

Our tasks

Since bark is usually a by-product within the production of various wood-based materials and has so far been disposed of or thermally used, the potential of this raw material has not yet been fully exploited.

Fungicidal substances or intermediate products obtained from poplar bark are added to moulded pulp products to provide protection against effects of mold fungi for a period of at least six months. This effect is based on the protective impact of bioactive compounds (e.g. phenolics, terpenoids, resins, alkaloids, saponins) in the tree bark. Our research group focuses on the identification of the potential fungicidal substances in the bark of various poplar hybrids. The aim is to find out which substances are the most effective in stopping the mold growth as well as identifying the poplar clones with the highest concentration of these substances in their bark. A treatment method is to be developed to apply these relevant substances to fiber molded packaging material.

Realization

Two approaches were considered to add bio-fungicidal properties of the bark to the packaging materials:

- to add bark straight to the structure of the pachaging material
- to apply the isolated substances to finisched products

The decisive factor for the choice of process here is usually the service life of the packaging product itself.

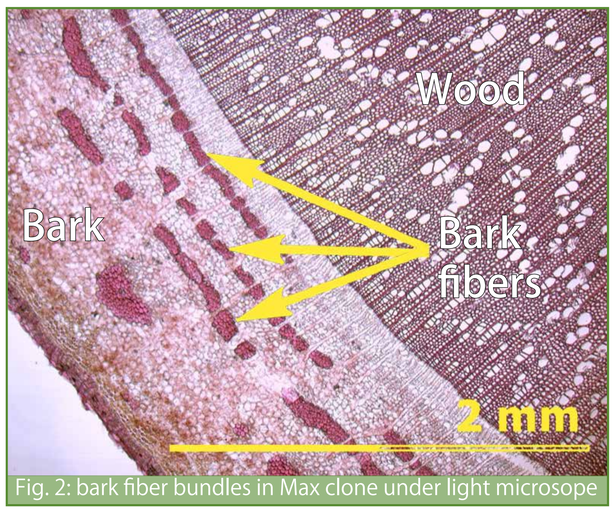

Fig. 2: bark fiber bundles in Max clone under light microsope

Methods and Materials

To obtain fungicidal active substances, bark material from various poplar clones was treated using different extraction methods (Batch, Soxhlet) and solvents (water, ethanol, toluene, hexane). The combinations of the extracts were analyzed by gas chromatography-mass spectrometry (GC-MS) method. In this way, phytochemicals were obtained that are worth considering for an eco-fungicidal treatment of packaging materials (see Fig. 5).

Extracts were tested in slowing the mold fungi growth on the surface of fiber molded packaging materials. Sheets were soaked in extract solution, a mixture of mold fungi was applied. The growth over several weeks was monitored (see Fig. 3). Fungal growth was also monitored using liquid media for better evaluation of increase rate (see Fig. 4).

Fig. 3: Bark extracts (top left), impregnation of fiber casting samples with bark extracts (top right) and fiber casting samples with applied bark extracts (bottom)

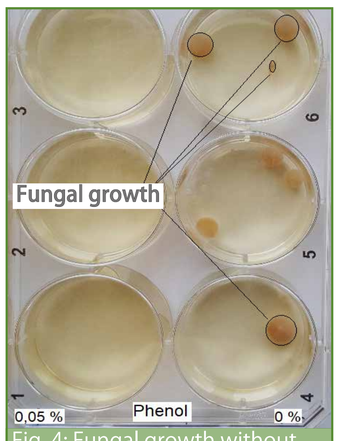

Fig. 4: Fungal growth without phenol (right) and no fungal growth with 0.05% phenol (left).

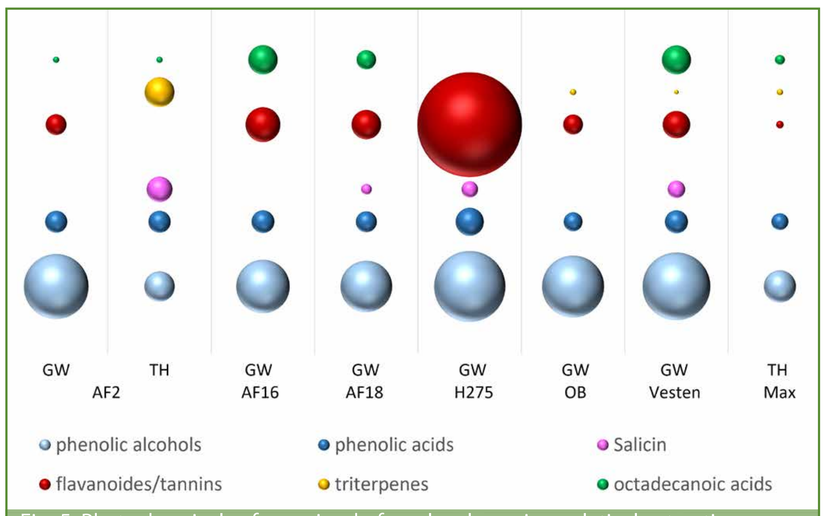

Fig. 5: Phytochemicals of examined of poplar clones in analytical extraction (GW – Greenwood Poland, TH – Tammenhein – Germany)

Application

© Pulp-Tec

Fig. 6: Eco-fungicidal plant pots (Bioform®)

© Pulp-Tec

Fig. 7: Bioform® plant pots are mold-resistant for at least six months and fully home compostable afterwards

The amount of available phytochemicals varies significantly depending on the clone type (see Fig. 5), but also on age, harvest time and cultivation site. Clones with high potential of fungicidal extracts of their bark are AF2, AF16, Max1, and H275. The extraction method itself also leads to significant differences. The Soxhlet process mainly produces fat-based phytochemicals and triterpenes. Batch extraction results in higher contents of phenolic compounds. In general, it can be stated that not all commercially available poplar clones are equally suitable for the production of fungicidal substances.

Applying **fungicidal substances as additives** to molded pulp products for packaging material creates a number of advantages. The economic transport to manufacturers of appropriate packaging materials is very advantageous due to low transport weight. The application of extracted fungicidal substances is particularly suitable for medium term packaging products with higher requirements for moisture and mold resistance (e.g. plant pots for transport and trade, see Fig. 6).

An alternative to the complex extraction of chemical substances is the **direct use of fibrous material from bark**. Pretreatment is also necessary here, for example to remove sugars. In case of packaging materials for short term usage with comparatively low risk of harmful external effects (e.g. transport packaging for food, beverage, electronics, see Fig. 8), the addition of fibrous bark material causes a positive effect on the resistance of the packaging material against the effects of moisture and mold. As a side effect it compensates at least a part of the shortage of raw materials for pulps. Transport distance is decisive for the economic efficiency of the process. Therefore, the processing of fibrous material from bark as close as possible to the place of occurrence is the most appropriate.

© Pulp-Tec

Fig. 8: Eco-fungicidal fibre parts for packaging

[1] Technische Universität Dresden, Institute of Natural Materials Technology, Chair of Wood and Fibre Material Technology, [2] Technische Universität Dresden, Institute of Plant and Wood Chemistry, [3] Pulp-Tec Sp.Z.o.o.Sp.K.

Project Coordination:
Technische Universität Dresden
Forest Policy and Forest Resource Economics
Pienner Straße 23
D-01735 Tharandt

BBI JU

Bio-based Industries Consortium

Horizon 2020
European Union Funding
for Research & Innovation

D4EU has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement 745874.