**Valorization of effluents from wood processing industry by removal of bioactive polyphenols and subsequent fermentation**

Martin Lindemann1\*, Bernhard Widhalm1, Cornelia Rieder-Gradinger, Thomas Kuncinger2, Ewald Srebotnik3

*1 Competence Centre of Wood Composites and Wood Chemistry, Linz, Austria; 2 Fritz Egger GmbH & Co. OG, Tiroler Straße 16, Unterradlberg, Austria; 3 Institute of Chemical, Environmental and Bioscience Engineering, Technische Universität Wien, Vienna, Austria*

*\*Corresponding author: m.lindemann@wood-kplus.at*

**Highlights**

* Novel use of effluents from wood processing industry / Circular Economy approach
* Isolation of bioactive polyphenols
* Effluents as cultivation medium for *Pseudomonas sp.*
* VOC reduction by microbial degradation of aldehydes and terpenes

**1. Introduction**

Large quantities of effluent arise from MDF (Medium Density Fiberboard) production by squeezing out water from steam-pretreated softwood chips, resulting in a high load of TOC (total organic carbon). This process water stream is rich in wood extractives and is mainly composed of various carbohydrates, polyphenols, and organic acids, particularly fatty and resin acids. Process water treatment is laborious and costly, requiring sedimentation, flocculation, biological treatment as well as membrane filtrations and reverse osmosis. In this project, we therefore focus on the utilization of this currently unused process stream by recovering valuable bioactive compounds such as resin acids, lignans, and stilbenes as well as using the remaining carbohydrate rich stream as a carbon source for cultivation of VOC- (volatile organic compound) degrading microorganisms [1]. Since aldehydes and terpenes are among the main sources of VOC in the wood processing industry, these microorganisms may be applied onto woody raw materials as a possible approach to lower VOC emissions of wood products such as fiberboards.

**2. Methods**

A scalable fixed bed adsorption system for the removal and selective recovery of polyphenols (lignans and stilbenes) from MDF process waters was developed. Before adsorption, fibers and non-colloidal substances were removed from process water by centrifugation, while colloidal fatty and resin acids were removed by filtration through a 30 kDa cut-off membrane. Polyphenols where then isothermally adsorbed on a medium pressure liquid chromatography column packed with a regenerable macroporous, cross-linked pyrrolidone-based (PVPP) resin. Gradient elution of the adsorbed polyphenols from MDF process waters was optimized using a Ø 25 mm adsorber column (5.8 g resin, 15 ml min−1). The carbohydrate rich stream resulting from polyphenol removal was used as a pre-cultivation medium for *Pseudomonas sp.* with terpenes as additional carbon source. The microbial biomass was then applied onto pine wood strands. VOC emissions from manufactured boards were collected on Tenax TA, desorbed in a thermal desorber and analyzed by means of GC-MS.

**3. Results and discussion**

Lignans and stilbenes were adsorbed onto PVPP, while highly polar substances such as sugars and sugar alcohols, however, were not retained and remained in the flow-through. Adsorbed lignans were then eluted in successive fractions containing the individual lignans in different proportions, followed by pinosylvin in a separate fraction. (**Figure 1**). The capacity of the PVPP for 7-hydroxymatairesinol (HMR) as a model lignan was determined to be 37.4 mg g-1 at 1% breakthrough (data not shown).



**Figure 1** (A) Gradient elution (10 mM H3PO4, Methanol) of polyphenols after adsorption monitored at UV 280 nm. (B) Distribution of polyphenols in the collected fractions from gradient elution shown in (a).

Cultivation of *Pseudomonas sp.* in process effluents, after removing polyphenols by adsorption onto PVPP, did prove successful. Microbial pre-treatment of the pinewood strands resulted in a 20% reduction of the TVOC (Total VOC) value within only 6h, increasing to 55% reduction after 48h.

**4. Conclusions**

PVPP was shown to be particularly suitable for the selective adsorption and subsequent recovery of lignans and stilbenes from complex process effluents. The resulting carbohydrate rich stream after adsorption was successfully used as a cultivation medium for *Pseudomonas sp.* without further adjustments. These results provide a solid basis for technical implementation and, furthermore, the profitable utilization of otherwise valueless industrial process effluents.

**References**

1. M. Lindemann, C. Rieder-Gradinger, T. Kuncinger, E. Strebotnik, Holzforschung, (in press) 2019.