Close-up shot of extracted straw

Value chain

Coupled use of Waste Biomass creates Cross-sector Effects

Researchers from PTS/Germany, CELABOR/Belgium and the Center of Bioimmobilisation and Innovative Packaging Materials (CBIMO) at the West Pomeranian University of Technology/Poland investigated a plant extraction method that is solely based on water.

In today's production and marketing of food and cosmetics, shelf life is a key factor in safeguarding the quality of products within an extensively interwoven value chain. Customers demand fresh products at all times, whilst ingredients should be healthy, environmentally sound and "green". Thus, shifting from synthetic preservatives to natural substances means to satisfy current market and societal trends. The European demand for natural antioxidants extending the shelf life of products has boomed in the last ten years. This market is expected to outstrip that of their synthetic equivalents. Furthermore, consumers expect not only the product to be "green", but also the production process.

In a joint project on the production of natural plant extracts, researchers from PTS, CELABOR and CBIMO investigated a plant extraction method that is solely based on water and referred to as subcritical water extraction: It uses no chemical solvents associated with negative health and environmental effects. When water is heated above 100 °C and maintained in a liq-

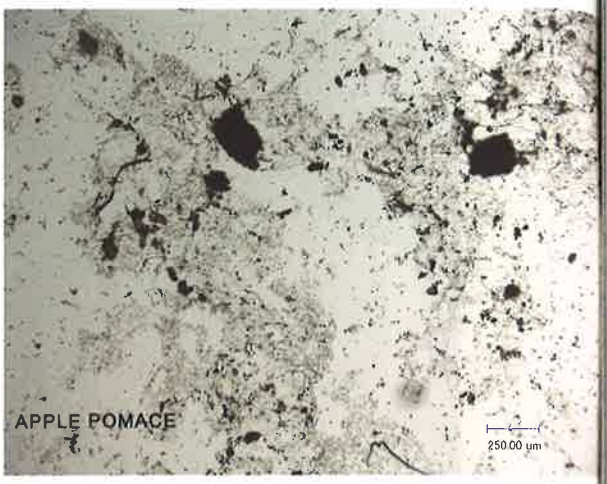
Dr. Dietz with a laboratory prototype made from agri-food residues

uid state under pressure, its polarity decreases. This allows moderately polar and non-polar molecules to be dissolved. Moreover, subcritical water can act as an acidic or basic catalyst during chemical reactions. Under subcritical water conditions, valuable chemicals can be extracted from vegetal materials. First tests on subcritical water extraction were made on a lab scale to explore suitable conditions and temperatures. The optimisation took place on a pilot scale. As feedstock, four promising materials were selected beforehand from a group of 29 agricultural and food residues: oat hulls, apple pomace, barley straw and corn straw.

The resulting process yields promising extracts under gentle conditions (maximum 160 °C at 10 bars). They contain several specific components, including in particular organic acids, cathechins and polyphenols. Fresh extracts work effectively as antimicrobials and antioxidants. In antimicrobial applications, extracts can be used against S. aureus and E. coli. Various tests suggested that applications as food and cosmetics additives can create substantial added value here, in particular when it comes to high-quality cosmetics and green, organic products.

"And why are we writing about this in the bio-fibre Magazine?"

Because the materials left after extraction are generally suitable for replacing part of the conventional fibrous raw materials in papermaking. They were tested first with a focus on packaging paper grades. Particle size distributions suitable for papermaking can be achieved by milling or refining. The materials caused no problems in pulping and lab sheet forming. To achieve high addition rates, the approach needs to be further optimised for industrial implementation in terms of drainability and process water pollution. Compared to recycled fibres, the use of up to 40 % straw pulp from the extraction at 160 °C for 60 min led to higher tensile strength levels in handsheets. However, these extraction conditions also lead to by-products in the extracts that are incompatible with food applications. These by-products can be avoided by using in more gentle extraction conditions. The resulting straw or oat hull pulps give less



Micrographs of extracted and refined agri-food residues in suspension

Pictures: PTS

tensile strength when replacing part of the recycled fibre pulp in papermaking, but lead to considerably higher volume and bending stiffness. This makes them particularly suitable for paperboard production, especially for the middle layers of multiply board. PTS researchers also assessed the industrial implementation of the extraction process chain on a conceptual level. The energy demand of the plant is mainly linked to the evaporation step needed to dry the extracts. Integrating an extraction plant on-site at a paper mill proved to be an advantage for implementation. The concept developed in this project can be expected to generate significant profits. The new technology links agriculture with the food, cosmetics and papermaking industries, thus opening up attractive new business areas for start-ups and established companies in these sectors. The results represent a unique approach to add value to agricultural and food-processing residues. With its coupled approach and full material use it goes far beyond existing approaches to biomass use.

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A report focusing on papermaking results (in German) is available at: *www.ptspaper.de/forschungsdatenbank, keyword SUBWEX.*

__ Dr. Wolfram Dietz