

Biochemical High-Pressure-Cascade for Creating Added Value from Raw Coffee-Silverskin

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Motivation

The processing of green coffee results produces side streams and wastes such as silverskin, which can accumulate to 10.000 t/a at single locations. So far, this biomass has only been used for thermal purposes (heating) without considering valuable components. Silver skin composition is mainly cellulose (24 wt-%), hemicellulose- (17 wt-%), lipids- (4 wt-%), proteins- (19 wt-%) and lignins (29 wt-%). Depending on pre-treatment, the market price for lignin varies from 200 – 2000 EUR/t.

Approach

A fixed-bed high-pressure “one stop” process cascade (40 L) has been developed at TUHH (simplified draft Figure 1). Processing sequence consists of : 1) Extraction of fats and lipids using supercritical CO₂ as a solvent; 2) weakening the fibrous structure of lignocellulosic residues via steam treatment; 3) proteins and 4) sugars are solubilized in several hydrolysis operations with step wise increase of severity; 5) solid residues are liberated from left-over cellulose.

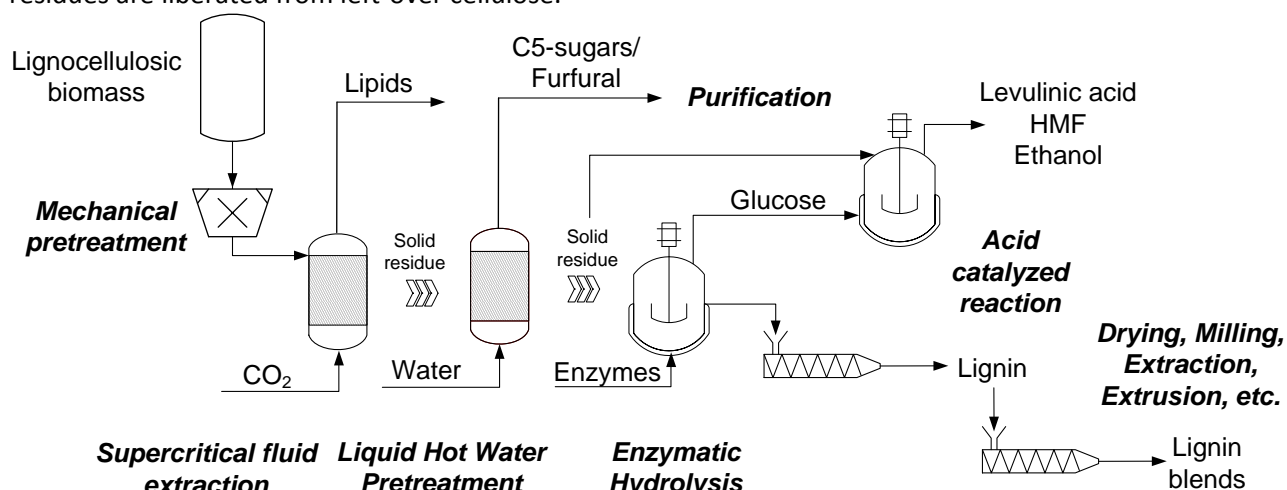


Figure 1 : Flow sheet of the High Pressure Biorefinery Process Line at Hamburg University of Technology

Supercritical CO₂ Extraction and Protein Yield

A conventional SFE process to extract fats (yield 3.34 %) and polyphenols/antioxidants has been optimized being run at 450 bar and 60 °C. Protein yields reached 6.3 % after applying hot-water-parameters at 120 °C for 30 min in a weak alkaline environment ([NaOH]=0.05 mol/L).

Hemicellulose by Auto-Hydrolysis or Steam-Treatment

It was possible to hydrolyse the hemicellulose fractions at roughly 210 °C for 90 min. Alternatively, hot steam treatment (180 °C) under high pressure (10 bar) with subsequent washing has been applied.

Enzymatic Hydrolysis and Lignin Residue

The treated biomass is liberated from residue cellulose using a NOVOZYMES CTec2 cellulase complex during enzymatic hydrolysis at 45-50 °C and a pH of 5.0-5.5. The residue is washed and dried. The Lignin can be functionalized and adapted to a bulk chemical for various products and applications in Life Science and Civil Engineering Industries.

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