Valorization of hemp residues in fermentative lactic acid production

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Abstract

Industrial hemp (*Cannabis sativa* L.) is a fast growing and a high yielding annual crop with a global production of more than 60,000 ha. The use of hemp in the production fibers and products, such as textiles and bio-composites, results in various residue streams. One of the residues appearing from hemp are shives, which are currently discarded as solid waste or used as animal bedding. Due to the high content of carbohydrates (≈50% dry weight), mainly consisting of cellulose and hemicellulose, hemp shives can be considered a potential and inexpensive source of fermentable sugars for the production of high value-added compounds, such as lactic acid.

Aim of our study was the use of hemp shives as carbon source in lactic acid fermentation after thermo-chemical and/or enzymatic hydrolysis. In order to recover sugars, such as glucose and xylose, from hemp shives. The material was first autoclaved at 121 °C for 15 min. However, this approach did not result in a considerable release of sugars. The second approach was a thermo-chemical treatment at 121 °C for 15 min in presence of 0.5 mole HCl. This resulted in the release of 10% glucose, but less than 5% (w/w) xylose from the initial material. In order to further improve the recovery of sugars, the thermo-chemically treated hemp shives were enzymatically digested using Accellerase 1500. Using this approach, 12% glucose and 15% (w/w) xylose were released. In other words, around 50% (w/w) of the present carbohydrates were digested. It was further shown, that the hydrolysate serves as appropriate carbon source for lactic acid bacteria and 0.9 g lactic acid was produced using *Bacillus coagulans* per g carbon source applied, which is close to the theoretical maximum of 1 g g^{-1}.

The obtained results are particularly of interest for the development of cascade utilization approaches of hemp biomass. Fermentative utilization of hemp shives in lactic acid production results in an additional value-added compound and can be carried out prior to energetic utilization to fully exploit the economic potential of hemp.