Higher heating value prediction of lignocellulosic crop based on their content of main components

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The efficiency of the energy recovery potential of lignocellulosic crops as solid biofuel depends on various characteristics. One of the main characteristics in this field is the higher heating value. It is defined as the amount of heat emitted by the combustion of a fuel, including the heat coming from the condensation of the water vapor. Its value depends on the content of main components of the lignocellulosic crops. Two models predicting the higher heating value have been built based on the content of main components of the following lignocellulosic crops: miscanthus (*Miscanthus* x *giganteus* J.M.Greef & Deuter ex Hodk. & Renvoize), switchgrass (*Panicum virgatum* L.), Jerusalem artichoke (aerial part) (*Helianthus tuberosus* L.), fiber sorghum (*Sorghum bicolor* (L.) Moench), fiber corn (*Zea mays* L.) and hemp (*Cannabis sativa* L.) [trials made at Libramont (Belgium) in 2007 and 2008]. The first model predicts the higher heating value of the lignocellulosic crops based on sum of the products between the higher heating value of each component and its amount. The second model predicts the higher heating value of the lignocellulosic crop based on a multiple linear regression using step by step least mean squares.
Keywords. Lignocellulosic crops, chemical characterization, higher heating value, prediction, hemp, miscanthus, fiber sorghum, fiber corn, switchgrass, Jerusalem artichoke.

Investigation of hydrogenase molecular marker to optimize hydrogen production from organic wastes and effluents of agro-food industries

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In recent years policy makers have started looking for alternatives to fossil fuels, not only to counter the threat of global warming, but also to reduce the risk of overdependence on imported oil and gas supplies. By contrast with hydrocarbon fuels, hydrogen (H_2), whether burned directly or used in fuel cells, is intrinsically a clean energy vector with near zero emission. However the main current method of producing hydrogen, steam reforming of methane, involves the release of large quantities of greenhouse gases. So although hydrogen already accounts for around 2% of world consumption of energy, its more widespread adoption is limited by several challenges. Therefore new processes are investigated, especially those using renewable raw material, *e.g.* woods and organic wastes, and/or involving micro-organisms. Indeed, for some algae and bacteria, the generation of

molecular hydrogen is an essential part of their energy metabolism. The approach with the greatest commercial potential is fermentative hydrogen generation (dark fermentation) by bacteria from the *Clostridium* genus. This biological process, as a part of the methane-producing anaerobic digestion process, is very promising since it allows the production of hydrogen from a wide variety of renewable resources such as carbohydrate waste from the agricultural and agro-food industries or processed urban waste and sewage. To date most publications on hydrogen production by *Clostridium* strains have focused on the effects of operating parameters (such as temperature, pH, dilution rate, etc.). We now need to extend this knowledge by identifying and monitoring the various different metabolic agents involved in high H_2 activity. Consequently the aim of this research at the CWBI in the University of Liege is to investigate the role of [Fe] hydrogenases, the key enzymes that remove excess electrons accumulating during fermentation. *C. butyricum* CWBI1009, the strain used for these investigations, is a particularly efficient biohydrogen producer (3.4 $mol_{H2}{\cdot}mol_{glucose}^{-1}$, 699 ml $H_2{\cdot}l^{-1}{\cdot}h^{-1}$). Molecular metabolic markers were designed to study the metabolic role of [Fe] hydrogenases and to optimize culture conditions by testing their expression via the mRNA directly extracted from pure culture bioreactor samples.
Keywords. Biohydrogen, dark fermentation, *Clostridium butyricum*, [Fe] hydrogenases.

Bioconversion of potatoes residues or surplus potatoes to ethanol under non axenic conditions

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Biofuels can offer an alternative to fossil fuels in the context of climate change and fossil reserves depletion. With 3 million tons of potatoes produced in 2007 and a high yield per hectare of 47 tons, Belgium is the 19th largest producer in the world. The residual and surplus potatoes could be used to produce bioethanol by fermentation. We examined the feasibility of a simple ethanol fermentation processunder non axenic conditions. The substrate was pretreated with commercial amylases or by adding as low as 10% FM (Fresh Matter) barley malt. It was then fermented with *Saccharomyces cerevisiae*. Ethanol and volatile fatty acids were analyzed by GC-FID and soluble sugars were analyzed with the Anthrone method. Starch from potatoes was hydrolyzed to soluble sugars. Hydrolysis seems to continue with 10% FM of barley malt after 48 h while the hydrolysis stopped or decelerate with commercial enzymes. With 10% FM of malt, 3 h of hydrolysis and 7 days of fermentation, an ethanol concentration of 42 $g{\cdot}l^{-1}$ was obtained and the conversion yield was 139 $g_{ethanol}{\cdot}kg^{-1}$ DM. The fermentation conversion yield of soluble sugars to ethanol was > 82% and the endogenous competition was limited. However, starch hydrolyzing seems to be a limiting step under the conditions tested. Commercial enzymes did not provide better results under the same conditions.
Keywords. Biofuel, bioethanol, starch, barley malt, fermentation, *Saccharomyces cerevisae*.

Optimization of hydrogen production from carbohydrates by *Clostridium butyricum* CWBI1009

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