**Comparison of Lignin Yield from Sugarcane Bagasse Using Liquid Hot Water and Ionic Liquids and Ionic Liquids Only.**

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**Highlights**

* Liquid hot water and ionic liquid pretreatment yielded higher yields of lignin (68 m/v %).
* Microwave digestion was effective in isolating the lignin.
* Optimized pretreatment time for only ionic liquids was 20 minutes.
* Ionic liquid 1-ethyl-3-methylimidazolium acetate was more effective than 1-butyl-3-methylimidazolium hydrogen sulphate.

**1. Introduction**

Globally the high cost and diminishing reserves of crude oil coupled with global warming effects have resulted in research for alternate energy and chemical sources. Lignocellulosic material is one of the largest renewable resources containing hemicellulose, lignin and cellulose. Extraction of the different components of the lignocellulosic material can lead to the valorisation of the biomass and reduce dependence on crude oil.

There are many pretreatment methods for the separation of cellulose, lignin and hemicellulose, namely: acid hydrolysis, base hydrolysis, steam explosion, mechanical and biochemical methods. All of these methods are environmentally harmful due to the release of volatile organic compounds that contribute to global warming effects. A new class of solvents known as ionic liquids are suitable for pretreatment since they have properties such as: low vapour pressure, recyclability, solubility in a range of organic compounds and liquid at room temperature that make them attractive for biomass pretreatment.

Sugarcane bagasse (SCB) is a renewable lignocellulosic resource in South Africa obtained after the sugar milling process. The annual production of SCB is approximately 6 million tons per annum produced by 14 sugar mills that are located on the north coast of KwaZulu-Natal (Paterson – Jones, 1989).

In this work, lignin yields from sugarcane bagasse pellets was investigated using liquid hot water (LHW) and ionic liquids (ILs) and only ionic liquids. The LHW process was applied to sugarcane bagasse pellets at 200 °C, for 30 minutes in a high pressure reactor for removal of hemicelluloses. The complex cellulignin residue was treated with the ILs: 1-ethyl-3-methylimidazolium acetate ([Emim][OAc]) or 1-butyl-3-methylimidazolium hydrogen sulphate ([Bmim][HSO4]), using microwave digestion at varying time intervals. Direct Ionic liquid treatment was done on sugarcane bagasse pellets with ILs: [Emim][OAc] or [Bmim][HSO4] using microwave digestion.

**2. Methods**

The sugarcane bagasse was first ground to 3-5 mm, dried to 10-12 % moisture and pelletized using a pellet mill. 1.0 kg of pelletized bagasse was used for the LHW hydrolysis at a temperature of 200 oC in a 3.0 L high pressure fixed bed reactor for 30 minutes with a volume flow of 250 ml/min of water. Hemicellulose dissolved in the water and a solid residue (cellulignin) was collected from the reactor. Compositional analysis of the sugarcane bagasse pellets, cellulignin and the complex cellulignin after enzymatic hydrolysis was done using NREL procedures.

For the extraction of lignin, a ratio 1:10 of SBP (0.5 g) and ionic liquid (5 g) was weighed in duplicate and transferred into 65 mL Teflon vessels, transferred to a microwave oven with parameters: power (80 Watt); ramp time (10 minutes); temperature (180 ˚C) and different hold times of 3, 10, 15 and 20 minutes for each run. After each run the extracted lignin was transferred to a 100 mL beaker rinsed thoroughly with 10 mL solution of 1-4 dioxane-water 95:5 (v/v), transferred into a 50 mL volumetric flask and diluted with a mixture of 1-4 dioxane-water 50:50 (v/v) for UV analysis.

**3. Results and discussion**

The amounts of glucose released in g/L during enzymatic hydrolysis of cellulignin using enzyme Cellic CTec2 or Metaplus/Rapidas was 27.5 g/L and 3.8 g/L after 6 hours of hydrolysis. The effectiveness of the combined enzyme Metaplus/Rapidas was lower than the Cellic ® CTec2 enzyme.

The IL [Emim][OAc] gave the highest lignin yield (68 %) for the LHW and IL method at 10 min. For the sugarcane bagasse pellets the highest yield was 59 98% at a reaction time of 25 min. The IL: [Emim][OAc] was the better of the two ILs used.

**4. Conclusions**

Liquid hot water and IL extraction of lignin from sugarcane bagasse pellets was successfully used to extract lignin. Although the highest yield was obtained for the LHW and IL method, the preferred method would be IL treatment on the sugarcane bagasse pellets since it eliminates the use of high energy input.

**References**

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