Valorization of Maple Bark Through a New Organosolv Biorefinery

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Abstract:

In an ongoing project we have been studying the phenolic extractives from bark of sugar (*Acer saccharum* Marsh.) and red maple (*Acer rubrum* L.). These are two widespread native hardwood species from eastern North America, notorious for maple syrup production from their sap, but also for high quality wood, the transformation of which leaves huge quantities of solid bark waste. We are presenting here a new biorefinery concept consisting of pre-extraction of maple bark with ethanol-water (50/50, v/v), yielding phenolic antioxidants, followed by catalytic organosolv pulping with the same solvent system of extracted bark, to produce a new organosolv lignin and cellulosic pulp. The organosolv process applied in this research on sugar maple bark, using ferric chloride as catalyst, has been patented recently. Organosolv lignin produced in this research from sugar maple bark was determined to be of significant purity, as confirmed by its content of total lignin (Klason plus acid soluble lignin), low remaining carbohydrates and relatively low ash content. Organosolv bark lignin was analyzed by FT-IR, ^{31}P NMR, GPC, TGA and DSC thermal analyses, in comparison to wood organosolv lignin, isolated from the corresponding sugar maple wood, by applying the same pulping conditions. The ^{31}P NMR of this bark lignin has revealed a higher proportion of aliphatic hydroxyls compared to wood lignin, which could be an interesting feature for exploring its potential formulations in polyurethane-based applications. Cellulosic pulp obtained from sugar maple bark remains available for applications in composites or nanocellulose related products. During acidic water washing of bark cellulose pulp, an interesting product was precipitated in quite an important quantity which was determined to be pure crystals of calcium oxalate which represent 10% of starting O.D. bark material. Thus, this sugar maple bark organosolv biorefinery is yielding bark extractives (polyphenolic antioxidants) from pre-extraction step, high purity lignin from catalytic organosolv pulping, along with cellulosic pulp and mineral precipitate of calcium oxalate from its washing. Thus the solid bark waste from sugar maple is transformed into a number of valuable products through a new organosolv biorefinery concept, instead of being simply burnt or disposed of in landfill.

Keywords: Sugar maple bark; organosolv biorefinery, polyphenolic extractives, high purity bark lignin, bark cellulose