Co-production of fermentable sugars and added value compounds from chestnut husks using sequential hydrothermal treatments

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Chestnut is a traditional food that is specially used to produce marron glace and chestnut flour. Husks, that are removed during the peeling process constitute between 10-15% of the whole fruit's weight. The development of new strategies to recover valuable compounds from chestnut husks could contribute to an integral valorization of this by-product having into consideration a more sustainable circular economy approach. Therefore, this work aimed to assess the feasibility of sequential hydrothermal treatments to recover different fractions: a milder treatment to solubilize a phenolic and hemicellulose-rich fraction, and a harsher treatment followed by saccharification for the recovery of fermentable sugars from the cellulosic fraction.
Different sequences of one or two non-isothermal treatments (only heating and cooling ramps) ranging from 160ºC to 200ºC were applied. The different fractions were subjected to enzymatic hydrolysis using the enzymatic cocktail Cellic CTec2. Structural carbohydrates, phenolic composition and antioxidant activity were assessed using colorimetric and chromatographic methods. Higher solubilization was observed in the sequential treatment of 180ºC followed by 200ºC, reaching a maximum of 42%. This totaled approximately 50g/L of carbohydrates being 15g/L monosaccharides. Glucose and xylose were the most abundant sugars with arabinose, glucuronic acid, and rhamnose in minor concentrations. For the fermentation inhibitors, higher acetic concentrations were present in the condition of 200°C (0.4g/L) whereas furfural and hydroxymethylfurfural were below 0.1g/L in all conditions. The oligosaccharide fraction was mostly composed of gluco-, xylo- and arabinooligosaccharides, reaching nearly 35g/L. In all treatments, saccharification yields surpassed 85%. Higher severities also resulted in high phenolic content with substantial antioxidant activity.
This work showed that the combination of hydrothermal treatments with enzymatic hydrolysis is a feasible approach to recovering several fractions with multiple applications. Specifically, phenolic compounds, oligosaccharides and fermentable sugars-rich-fractions may be obtained and used as ingredients in food formulation as technological agents with antioxidants and/or prebiotic properties. The final cellulosic fraction may be used as a substrate in fermentation processes to produce different commodities (e.g. bioethanol and bioplastics).

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