Waste2go: Development and verification of an innovative full life sustainable approach to the valorisation of municipal solid waste into industrial feedstocks

European Union's Seventh Framework Programme (FP7).

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Waste2go is a research and technological development (RTD) project co-funded under the European Union’s Seventh Framework Programme (FP7), where a multidisciplinary consortium formed by eight partners from six European countries pools its knowledge in different fields in order to achieve the project's objective. The aim of the project is to develop a process in which the biogenic fraction of municipal solid waste (MSW) is transformed into industrial feed-stocks, bringing economic value to the MSW and reducing its notable socio-economic costs and severe impact at the same time. The scope of the project extends beyond the state-of-the-art in enzyme-based technologies for fine-tuned biomass processing and combines them with intelligent technologies for MSW fractionation and downstream processing.

Annually, more than 180 million tonnes of MSW are discarded in the EU27, that is more than 1 kg per citizen per day. In order to alleviate the socio-economic impact and environmental stress, Waste2Go develops technologies to improve waste management and increase value (social, economic & environmental). The main focus of the project is the fractionation of the cellulose contained in the MSW into fractions of cello-oligomers of different molecular weight. The economic potential of these cellulose oligomers lies in their suitability as starting materials for the production of new surfactants as well as their direct applicability as feed-stocks in several industries, such as the personal care industry, while being renewable materials.

The overall process for MSW transformation is divided into the following sections: firstly, MSW is subjected to thermo-mechanical processing (WP2) followed by a biodegradation process (WP5) using enzymes produced on site (WP4); secondly, the resulting cellulosic material is purified and fractionated (WP6); and, finally, selected fractions are derivatised (WP7).

The cellulosic material resulting from the biodegradation process (WP5), enzyme-degraded thermo-mechanically treated MSW (TM-MSW-D), is characterized by a wide range of molecular weights. The objective of the technologies developed in WP6 is to fractionate and purify this material in order to obtain a range of discrete, narrow molecular weight fractions.

Four different technologies based on different principles are investigated within WP6: metal complexes (DMAc/LiCl), ionic liquids, alkali metal hydroxide solutions, and supercritical water.

Mixtures of N,N-Dimethylacetamide and lithium chloride have been proven to be suitable solvents for cellulosic materials. The concentration of LiCl is the key factor that determines the suitability of the solvent to dissolve cellulose depending on its molecular weight: at low concentration of the salt in the solvent the mixture is able to dissolve just the low molecular weight cellulose, while as the amount of lithium chloride increases, its ability to dissolve higher molecular weight cellulose increases commensurately. This makes it possible to fractionate the cellulose in the MSW by consecutive dissolution in mixtures containing increasing amounts of lithium chloride.

A wide variety of ionic liquids can be used successfully to dissolve cellulose. Dissolution of cellulose in the ionic liquid leaves the polymer chains accessible for chemical transformation, thus fractionation of the polymer can be carried out in the presence of an acid catalyst. In this approach, the key parameter for fractionation is time with longer times leading to shorter cellulosic chains in the product.

Sodium hydroxide solutions are suitable solvents for cellulose at low temperatures. The potential of this technique is the fact that the solvating power of these aqueous mixtures depend on temperature: higher molecular weights fractions can be dissolved at lower temperatures. Cellulose can be therefore fractionated by successive dissolution in the solvent mixture at decreasing temperatures.

Finally, water under supercritical (sc) conditions is an excellent solvent for hydrophobic organic compounds, due to its low dielectric constant under such conditions. Apart from acting as a solvent in the process, sc-water can also act as an acid catalyst for cellulose hydrolysis, thus allowing the generation of different molecular weight fractions from the same raw material by varying the reaction time. Furthermore, treatment of MSW with sc-water can also lead to the destruction of non-desirable components that may be present in the waste stream.