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Valorization of biosourced chiral platform molecules trough mecanochemistry: toward innovative high added value products

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PURPOSE OF THE ABSTRACT

Climate emergency and the depletion of fossil resources are no longer a secret. This is why many governments are pushing for the use of natural resources instead of the fossil ones. In this context, more and more researches are carried out on the valorization of biomass, including lignocellulosic biomass. The latter is widely studied because of its renewable nature and its abundance. Nowadays, it is possible to find biofuels, binders in building systems or even platforms molecules deriving from this biomass. Among these platform molecules, two are particularly remarkable: (S)-hydroxymethyl-alpha,beta-butenolide (HBO) and (S)-hydroxymethyl-alpha,beta-butyrolactone (2H-HBO). The multifunctionnality and the chirality of these synthons, produced on the kilogram or even ton scale, made them versatile molecules.[1, 2, 3, 4, 5] They have already been used in many syntheses as intermediates for the production of numerous molecules with herbicidal, antiviral or even antibiotic properties. However, most of these pathways require harsh conditions (high temperature or pressure), hazardous solvents or other toxic compounds.[6, 7] Thus, the development of new synthetic methods, more environmentally friendly, represent a real challenge.

It is in this context that mechanochemistry operates. Initially applied to inorganic chemistry, it quickly seduced organist chemists, both for its implementation and its efficiency.[8] Mechanochemistry allows two or more chemicals to react under solvent-free conditions. Solvents, in addition to being often toxic to humans, have significant impact on pollution, energy use, air quality and climate change.[9] In addition, they are often used in large quantities and are rarely recycled at the end of reaction, ending up as waste. Their disposal represents a real advance in green chemistry.

By combining these two axes of green chemistry, biomass valorization and mechanochemistry, we recently developed an efficient mechanochemical transformation of 2H-HBO into new functionalized molecules. This reaction, never described in the literature, is a "one-pot sequential" reaction combining an aminolysis and a sulfation step. In other words, we avoid the work-up and purifications steps between the two reactions, thus limiting waste generation (Figure 1). We also compared the mechanochemical route to the conventional one (in solvent) and we noticed more than one advantage: considerable time saving, elimination of toxic solvent, higher yields. Moreover, this synthetic route is transposable to different types of reagents, thus allowing to obtain a large library of biosourced molecules. Some of them have shown interesting surface activities. To summarize, by applying mechanochemistry to 2H-HBO, we successfully accessed surface active molecules fully capable of competing with petroleum-based surfactants.

During this communication, after a quick introduction to mechanochemistry, we will describe in details the development of this "one-pot sequential" reaction. For that, we will present the different optimization phases to finish with the study of the surface activities of some molecules obtained through this sustainable synthetic pathway.

FIGURES

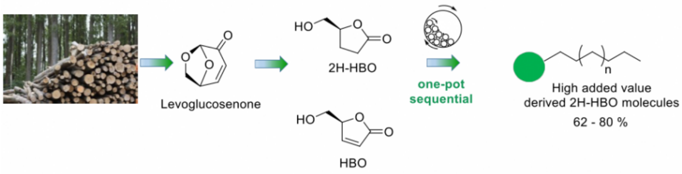

FIGURE 1

Figure 1

Valorization of lignocellulosic biomass into high added value molecules towards mechanochemistry

FIGURE 2

KEYWORDS

Mechanochemistry | One-pot sequential reaction | Lignocellulosic biomass | Biosourced molecules

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