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Green biocatalysis: chemo-enzymatic valorisation of industrial hemp waste from essential oil production

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PURPOSE OF THE ABSTRACT

Waste from the agri-food industry is gaining increasing value in the modern economy, and exploiting the potential of these resources requires a systemic change: the use of renewable organic residues as starting material for a sustainable value creation. In this work, the valorization of the organic waste connected with the production of Cannabis sativa essential oil has been considered as a potential source of valuable chemicals.[1] The essential oil is produced by steam distillation of the apical part of industrial hemp plant, which removes all the volatile components. The spent distillation residue, in the form of wet biomass, constitutes more than 90% of the original material loaded and is normally disposed of as agricultural waste or returned to the fields. However, many potentially useful natural products are still present in the matrix and would be discarded. The broad family of cannabinoids, in particular, are not sufficiently volatile to be removed by distillation, and remain in the solid wet residue. The naturally occurring cannabinoids (>100 molecules), as well as their synthetic or functionalised analogues, have been studied for many years due to their extremely interesting combination of bioactivities and pharmacological properties.[2]

Although some of the cannabinoids, most notably tetrahydrocannabinol (THC), have psychoactive properties and are considered illegal substances in most countries, industrial hemp crops have been specifically selected for their lower content of psychotropic cannabinoids. Industrial hemp can be cultivated without special authorisations for multiple industrial applications, including the production of fiber, seeds and essential oil, and still contains non-psychoactive cannabinoids which are very valuable for the consumer market and the pharmaceutical industry. The possibility to recover cannabinoids has been investigated in this work, analysing selective extraction techniques from the distillation waste of the industrial hemp C. sativa Futura 75, leading to an optimised protocol for the recovery of pure cannabidiol (CBD) from the spent waste with a yield of approximately 10-20 g/kg, depending on the variety and quality of the crop (Figure 1). The CBD recovered can be used in a range of consumer products for its antioxidant, anti-inflammatory and neuroprotective properties, as well as a natural food supplement. In the perspective of maximising the value of the material recovered, a procedure for the chemo-enzymatic functionalisation has been studied to convert the recovered CBD into other valuable cannabinoid derivatives. Exploiting an optimised lipase-mediated perhydrolysis in the presence of ethyl acetate, CBD has been converted into epoxy-cannabidiol (CBO) and further into cannabielsoin (CBE), cannabinoids with reported activity for pain management and as neuroprotective agents. [3,4] Overall, the method (Figure 1) is sustainable and environmentally friendly, involving only an immobilised enzyme, a benign solvent and hydrogen peroxide as the oxidant, to afford a high-value product starting from agricultural waste, complying with the highly prized principles of green chemistry and circular economy.

FIGURES

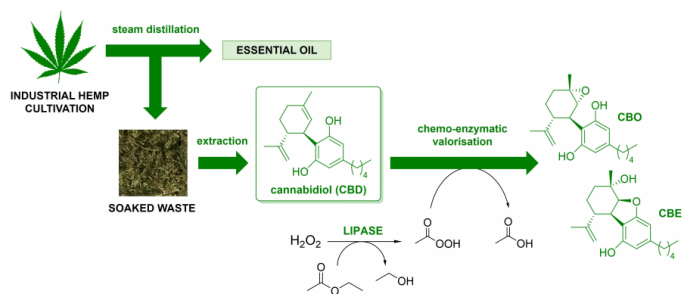


FIGURE 1

Figure 1.

Recovery and chemo-enzymatic transformations of CBD from hemp distillation waste

FIGURE 2

KEYWORDS

agri-food waste | lipase | cannabinoids | chemo-enzymatic synthesis

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