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BoostCrop: from biomass to molecular heaters for plant protection using green chemistry

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PURPOSE OF THE ABSTRACT

The BoostCrop project revolves around a consortium of nine European research teams and aims to design molecular heaters that, after being sprayed on crops, will be able to increase the temperature of the latter in order to (1) protect them from the stress caused by the frost, (2) boost the mass yield, and (3) allow crops growth in "cold" areas.

The work carried out at URD ABI deals with the synthesis, according to the green chemistry principles, and the characterization of the innovative molecular heaters. First, it involves upgrading local biomass through the use of lignin-derived platform molecules. Indeed, lignin and related naturally occurring phenolics appear as a valuable source of sustainable aromatic building blocks. Moreover, the synthetic procedures that have been devised and optimized use bio-based and environmentally friendly reagents and solvents only.

For example, p-hydroxycinnamic acids and their derivatives can be readily extracted from different biomass and be further (chemo-)enzymatically modified1 to provide them with physico-chemical and biological properties of interest such as antioxidant and anti-UV activities2-3. However, these molecules are usually present in relatively small quantities in biomass, thus limiting greatly their uses at the industrial scale. To overcome this limitation, many synthetic methods have been designed to access p-hydroxycinnamic acids and derivatives in high yield and at large scale from commercially available reagents. Among them, the main synthetic route consists in the condensation of malonic acid with phenolic aldehydes through Knoevenagel reaction. Usually, Knoevenagel reactions are performed with a large amount of pyridine as solvent and with aniline or piperidine as catalyst. With

the aim to obtain p-hydroxycinnamic acids and derivatives through the greenest synthetic pathway, URD ABI developed several ecofriendly Knoevenagel condensation-based synthetic procedures using EtOH or water as solvent and proline as catalyst 4-6.

Once produced, purified and fully characterized (NMR spectrometry, HRMS and UV spectroscopy), these molecular heaters are shipped to our partners to assess their heating properties and resistance to sunlight irradiation. In addition, they undergo a series of tests to determine their toxicity and persistence, such as assessment of liver toxicity, genotoxicity, carcinogenicity, endocrine toxicity, persistence in soil, sediment and water. At the end of these different screenings, these molecular heaters will be tested in vivo at different scales: in glass plants, in greenhouses and in micro-plots to test their efficiency in a real environment.

FIGURES

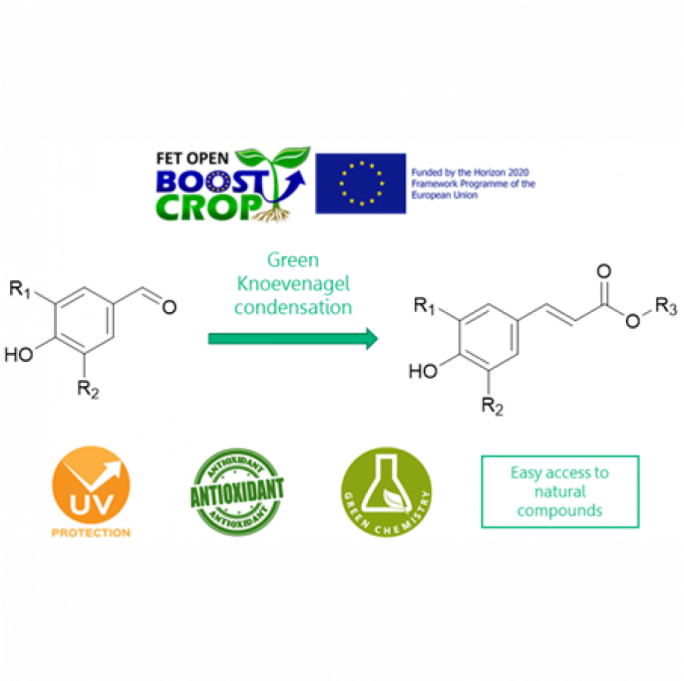

FIGURE 1

BoostCrop Graphical Abstract

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FIGURE 2

KEYWORDS

GreenChemsitry | Knoevenagel | p-HydroxycinnamicAcids | MolecularHeaters

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