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ENVIRONMENTAL IMPACT OF SECOND-GENERATION SUGARS PRODUCTION FROM CARDOON RESIDUES

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Abstract

Biofuels and biochemicals are currently centre stage in the on-going scientific and political debate. The prevalent opinion is that their use can significantly reduce the greenhouse gases (GHGs) emissions and primary energy demand along their whole value chain. This study aims at evaluating the environmental impact in terms of GHGs related to carbon dioxide (CO_2) of second-generation sugars (2GSs) production from cardoon residual biomass. Cardoon is a favourable crop in Mediterranean areas for its adaptation to cold winters and hot summers as well as its abundant yields. 2GSs are essential in the production of bio-BDO, a high-quality intermediate widely used for producing bioplastics. The whole value chain is considered, from cardoon cultivation to 2GSs production. Transport of raw materials from field to biorefinery is also included. The approach followed for the systematic evaluation of the environmental impact is that of the Life Cycle Assessment (LCA). Since the use of sugars is not considered, a *cradle-to-gate* analysis is performed. Data on cardoon cultivation refer to a 3-years field experiment conducted at the ENEA Trisaia Research Centre and concern the use of seeding material, fertilizers, water and fuel. Residual biomass is not the only product derived from cardoon cultivation, hence an energy-based allocation procedure is adopted. Transport of raw materials occurs with a 40 t truck on a reference distance of 30 km. A biorefinery plant for 2GSs production is designed. It treats 60,000 t/y residual biomass and returns almost 20,000 t/y sugars. The sustainability of the value chain is measured in terms of $kgCO_{2eq}$ per kg of 2GSs produced. Primary energy demand is computed. Results show that GHGs emissions associated to 1 kg of produced sugars is equal to 5.33 $kgCO_{2eq}$. The overall installed power amounts to 1,370 kW. As regard electrical and thermal energy, the whole production process demands about 7,890 MWh/y and 191,802 MWh/y respectively. The work falls within the scope of the Rebiochem® Project funded by the Italian Ministry of Education and Research and coordinated by Novamont S.p.A.

Key words: cardoon, biorefinery, LCA

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