Title: The Life Cycle Inventory of an Innovative Biorefinery for Polyhydroxyalkanoates Production

ABSTRACT:

Petroleum-based plastics carry undoubted environmental burdens, thus, alternatives to fossil feedstock are sought. Biobased and biodegradable polymers, such as polyhydroxyalkanoates (PHAs), appear as a valuable substitute for conventional plastic. However, their environmental preferability over fossil plastics is greatly conditioned by the production process, whose high cost also hinders their market penetration. To be viable, solutions must consider both the cost and the environmental aspects. To overcome these challenges, an innovative PHA production process is proposed by the Horizon Europe-funded BioLaMer project, based on the valorization of food waste, through the food-eating black soldier fly larvae (BSFL, *Hermetia illucens*). The invariable chemical composition of the larvae constitutes a novel high-impact feedstock for the cost-effective production of PHAs and chitosan biopolymers. Life Cycle Assessment (LCA) is conducted from the very beginning of the proof of principle stage, to ensure the environmental sustainability of this innovative biorefinery and to provide a final product which is safe and sustainable by design. The project started in April 2023, and after the goal and scope definition, the Life Cycle Inventory (LCI) is now under development. Firstly, the main steps of PHA production will be here illustrated. The manufacturing process starts with the food waste to BSFL conversion, in a self-supporting larvae cultivation plant. Then, the BSFL exoskeleton is separated - for chitin extraction - from the protein and lipids fractions. These will be converted into PHAs through biorefinery. At the moment, various biopolymer synthesis pathways are trialed, comprehending both pure and mixed media cultures. As an accurate LCI is of primary importance to obtain reliable and strong conclusions, our first aim is to obtain a complete qualitative LCI comprising data on single-operation unit processes to the greatest extent, while minimizing black box unit processes. This not only allows easier reviews but also avoids multifunctionality problems as much as possible. Furthermore, while the quantitative data will vary as the production process is optimized, a detailed qualitative LCI is already relevant at this stage, to verify if available datasets exist for background processes. Moreover, it is also an essential base for the upscaling process, where lab-scale processes will have to be converted to pilot-scale plants.