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# From Biowaste to Biobased Products: Life Cycle Assessment of VALUEWASTE Solution

**Authors :** Andrés Lara Guillén, José M. Soriano Disla, Gemma Castejón Martínez, David Fernández-Gutiérrez

**Abstract :** The worldwide population is exponentially increasing, which causes a rising demand for food, energy and non-renewable resources. These demands must be attended to from a circular economy point of view. Under this approach, the obtention of strategic products from biowaste is crucial for the society to keep the current lifestyle reducing the environmental and social issues linked to the lineal economy. This is the main objective of the VALUEWASTE project. VALUEWASTE is about valorizing urban biowaste into proteins for food and feed and biofertilizers, closing the loop of this waste stream. In order to achieve this objective, the project validates three value chains, which begin with the anaerobic digestion of the biowaste. From the anaerobic digestion, three by-products are obtained: i) methane that is used by microorganisms, which will be transformed into microbial proteins; ii) digestate that is used by black soldier fly, producing insect proteins; and iii) a nutrient-rich effluent, which will be transformed into biofertilizers. VALUEWASTE is an innovative solution, which combines different technologies to valorize entirely the biowaste. However, it is also required to demonstrate that the solution is greener than other traditional technologies (baseline systems). On one hand, the proteins from microorganisms and insects will be compared with other reference protein production systems (gluten, whey and soybean). On the other hand, the biofertilizers will be compared to the production of mineral fertilizers (ammonium sulphate and synthetic struvite). Therefore, the aim of this study is to provide that biowaste valorization can reduce the environmental impacts linked to both traditional proteins manufacturing processes and mineral fertilizers, not only at a pilot-scale but also at an industrial one. In the present study, both baseline system and VALUEWASTE solution are evaluated through the Environmental Life Cycle Assessment (E-LCA). The E-LCA is based on the standards ISO 14040 and 14044. The Environmental Footprint methodology was the one used in this study to evaluate the environmental impacts. The results for the baseline cases show that the food proteins coming from whey have the highest environmental impact on ecosystems compared to the other proteins sources: 7.5 and 15.9 folds higher than soybean and gluten, respectively. Comparing feed soybean and gluten, soybean has an environmental impact on human health 195.1 folds higher. In the case of biofertilizers, synthetic struvite has higher impacts than ammonium sulfate: 15.3 (ecosystems) and 11.8 (human health) fold, respectively. The results shown in the present study will be used as a reference to demonstrate the better environmental performance of the bio-based products obtained through the VALUEWASTE solution. Other originalities that the E-LCA performed in the VALUEWASTE project provides are the diverse direct implications on investment and policies. On one hand, better environmental performance will serve to remove the barriers linked to these kinds of technologies, boosting the investment that is backed by the E-LCA. On the other hand, it will be a germ to design new policies fostering these types of solutions to achieve two of the key targets of the European Community: being self-sustainable and carbon neutral.

**Keywords :** anaerobic digestion, biofertilizers, circular economy, nutrients recovery
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