Industrial symbiosis to valorise fleshing produced in tannery industry for different industrial applications

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Abstract

According to the European Fat Processors and Renderers Association (EFPRA), 17 million tonnes of animal by-products (ABPs) are managed annually in Europe, from which 2.85 million tonnes of animal fats and 3.65 million tonnes of processed animal proteins are produced, the rest is destined for landfill disposal or incineration. This poses a problem for both the climate and the environment since they can contain harmful substances. Therefore, ABPs (EC Regulation 1069/2009) plants require tuning up alternatives to minimise, recover and/or reduce the impact of their elimination. A promising viable alternative is transforming animal fat into biodiesel, as well as discarding protein fraction into protein-based products such as biostimulants, which would contribute both to fight climate change and achieve the 2030 European objectives.

Currently, only 5% of organic wastes are recycled and used as biofertilisers, although these organic wastes could replace up to 30% of inorganic fertilisers. In addition, fertilisers based on free amino acids (biostimulant) are able to improve soil structure, as well as soil biodiversity and soil carbon sink. Furthermore, the use of biostimulants based on amino acids contributes to simplifying the nitrogen life cycle (short-cut), as well as reducing the consumption of inorganic phosphorus.

The tanning industries have been an example of integration of the circular economy concept in their processes since their origin. In fact, their main raw material, i.e. raw hide, is a by-product of meat production. Moreover, these companies have endeavored to apply the best available technologies to minimise their impact on the environment.

With the aim of contributing to the circular bioeconomy and reducing the management of solid by-products in tannery facilities, two different bioprocesses have been developed to enable the integrated management of both lime and fresh fleshings, which are classified as CAT 3 ABPs. Fleshings have an average content of 15% fat, 20% protein and 65% water. For this reason, the fat fraction is separated from the protein and liquid protein fraction in order to process them independently.

The bioprocess developed to transform the protein and liquid fraction into a biostimulant based on free amino acids is developed by means of a resource-efficient bioprocess, contributing to a 35% reduction in CO_2 emissions into the atmosphere by reducing the consumption of chemical substances, energy consumption, water consumption by 96%, and the production of wastewater. In this way, a biostimulant is produced with a carbon and water footprint much lower than biostimulants obtained by chemical processes.

The bioprocess developed to transform fat fraction into an advanced biofuel consists of the catalytic transesterification of fat with heterogeneous catalysts made with methanol under supercritical conditions,

which allows transforming fats with high percentages of free fatty acids, without producing soaps, into an advanced biofuel that incorporates the modified glycerine, without producing by-products. This bioprocess is more efficient than traditional transesterification as it does not produce by-products such as glycerine and reduces the energy consumption of the process, which generates environmental and economic advantages over conventional process. In addition, it achieves a decarbonisation of fuels, which is expected to reduce the consumption of fossil raw materials for the manufacture of conventional diesel by 40%.

In this way, the LIFE SUPERBIODIESEL project contributes directly to the circular bioeconomy by recovering two bio-wastes (fat fraction and protein fraction) from the tanning industry into two bio-products that can be used in two very different industries, such as the biofuel industry and the phytosanitary industry, thus producing an industrial symbiosis.

The developed bioprocess has proved to allow the recovery up to 78% of mass yields as biostimulants and suitable properties for its implementation as a formulated product in the fertiliser market, so that the valorisation of these animal by-products to produce biostimulants could be replicated and implemented in other waste management plants.

Figure 1. Separating process of the fleshing into fat and protein fractions (images courtesy of Organovac).

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