Turning waste into raw material, the LIFE byProtVal project

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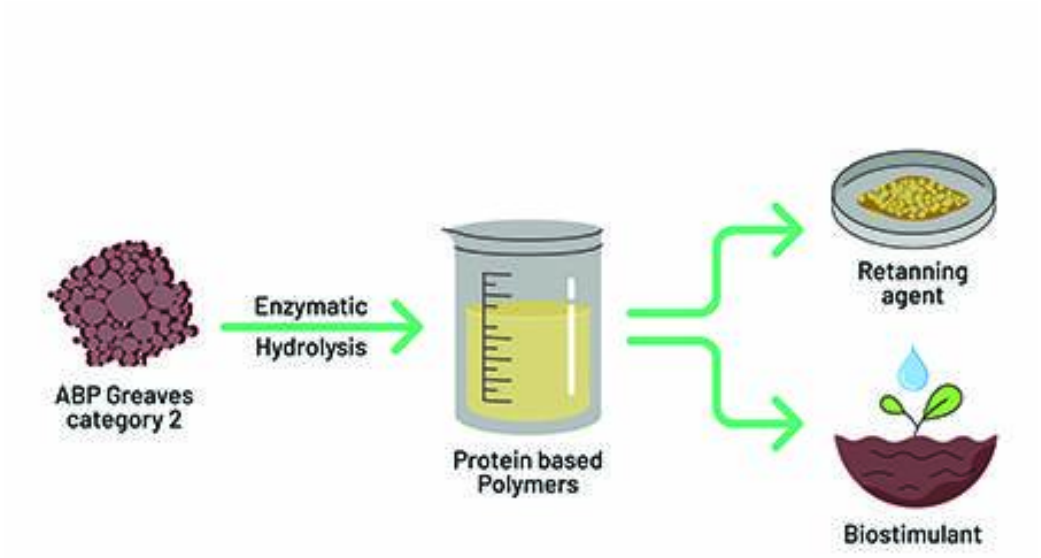

The Spanish footwear industry research centre INESCOP, under the framework of the LIFE ByProtVal project, has been working on the recovery of different protein-derived products from rendering residues (greaves) and wastewater produced in the treatment of Category 2 and 3 animal by-products (ABPs), respectively, for their subsequent recovery as raw material to produce retanning agents and fertilisers.

In 2017, INESCOP was joined by Trumpler Spain along with Energygreen Gas Almazan S.L. (EGA), a company dedicated to the management of non-hazardous waste through different technologies such as anaerobic digestion and rendering, and the ABP-rendering company Granja Otivar S.L., in the development of the byProtVal project. A multi-sectoral initiative to promote this circular economy model, it is a funded project by the European Union LIFE programme.

According to data from the European Fat Processors and Renderers Association (EFPRA), it is estimated that European slaughterhouses kill around 328 million head of cattle and 6 billion fowl annually, generating a large volume of low-risk Category 3 ABPs. In addition, many animals die on farms each year, producing around 2.5 million tonnes of Category 2 ABPs, unless they are high-risk disease carriers. As in the case of the circular economy, a key feature is that by-products return to the value chain to be integrated into the production of higher value goods and services. The management of these by-products generates more than 3.5 million tonnes of animal protein which could be used as raw material to generate products for the leather industry in the form of retanning bio-polymers and in the agrochemical sector for amino-acid based bio-stimulants.

Protein recovery

With the current practice of mainly using Category 3 ABPs for animal feed and Category 2 for energy recovery or disposal in landfill, the upcycling potential of this “waste” is clearly a viable alternative, being rich in proteins, carbohydrates, fatty acids, vitamins and minerals. In order to obtain the derivatives from the waste, usually this would entail thermal hydrolysis, essentially boiling under high pressure. This methodology, however, was found to have certain drawbacks for the project. Being highly energy- and water-intensive, the high environmental impact potential for this method, plus the degraded nature of the resultant protein bio-polymers, led to the development of a novel enzymatic hydrolysis process, a more sustainable process that benefits from a lower environmental impact plus a greater yield than from the thermal process. In addition, through the utilisation of different enzyme preparations, differing ranges of protein degradation can be achieved creating products of different molecular weight and differing amino acid profiles. Current trials have proved recovery of up to 85% of the protein, and with an adaptable technology that can be configured to work with other distinct types of ABPs.

Leather manufacture

Following the bio-polymer extraction, samples of conventionally tanned wet blue leather were subjected to an industry standard shoe upper retannage, after which numerous physical tests were carried out to validate the bio-polymer properties.

After validating that the bio-polymers obtained had the appropriate characteristics to be used as retanning agents, the comparative environmental impacts for both a synthetic retanning agent and a bio-based protein retanning agent were evaluated. The synthetic retanning agent such as polymeric acrylic syntan was found to have a carbon footprint value of 0.91–1.72kg CO_2eq/kg, while the bio-based protein retanning agent had a lower impact with a carbon footprint value around 0.43–0.61kg CO_2e/kg, contributing to an approximate three times reduction in the carbon footprint leather manufacturing. In addition, the use of a protein retanning agent not only improves the biodegradability of retanned leather compared to leather tanned with synthetic retanning agents but, additionally, the use of peptides recovered in the project as biobased functional chemicals in the tanning industry will support EU policies regarding sustainable and circular fashion.

Bio-stimulants

The future of modern agricultural practices is of current relevance and are faced with improving both quality and yield of crops to feed the growing population, whilst at the same time minimising the environmental impact and concerns with human health through the use of mineral fertilisers. The increased demand for organic foods and the rising awareness from consumers has shown that bio-stimulants have the potential to lessen these issues and provide a renewable option for improving crop quality and yield by simplifying the nitrogen life cycle in plants. Therefore, bio-stimulants from animal by-products by means of enzymatic hydrolysis contributes to a 35% reduction in CO2 emissions to the atmosphere, reduces energy consumption, and reduces water consumption by 96%, and the production of wastewater. In this way, a bio-stimulant is produced with a carbon and water footprint that is much lower than that of bio-stimulants produced from chemical processes.

Furthermore, with the aim of protecting the environment and human health by preventing the harmful effects of waste production and accumulation, the Waste Framework Directive 2008/98/EC proposes EU member states not only take measures to minimise waste production through the development of clean technologies, but also to encourage its recovery and valorisation, within the proposed measures related to the promotion of circular economy and sustainable use of resources. High added value protein recovery from ABPs Category 2 is also in line with EU policies on the circular bio-economy since it aims to convert wastes into the raw material for the manufacture of added value products. Besides, the substitution of mineral fertilisers by the organic fertilising products produced in the project will mean a reduction of nitrogen leaching to groundwater and GHG, (greenhouse gas), emissions due to agricultural activities. It will also support the implementation of EU policies on organic farming, as well as future Common Agricultural and other policies derived from the European Green Deal.

LIFE byProtVal is now in TRL 7 on the Technology Readiness Level scale, in a scaling-up production process stage, to recover protein derivatives from greaves and rendering plant wastewaters, as well as meat product processing plants. A pilot demonstration plant, with a recovery capacity of over 100 tons per year has been installed in Almazán, Soria, Spain for by-product treatment. The project now seeks to optimise processing parameters and running conditions, so that protein derivatives can be validated and produced in significant quantities as bio-stimulants for sustainable agricultural use.
(TRL is based on a scale from 1 to 9 with 9 being the most mature technology. The use of TRLs enables consistent, uniform, discussions of technical maturity across different types of technologies)

Category 2 ABPs

Category 2 ABPs are classed as high risk.
They include:
• animals rejected from abattoirs due to having infectious diseases
• carcasses containing residues from authorised treatments
• unhatched poultry that has died in its shell
• carcasses of animals killed for disease control purposes
• carcasses of dead livestock
• manure
• digestive tract content

Category 3 ABPs

Category 3 ABPs are classed as low risk.
They include:
• carcasses or body parts passed fit for humans to eat, at a slaughterhouse

- products or foods of animal origin originally meant for human consumption but withdrawn for commercial reasons, not because it is unfit to eat
- domestic catering waste
- shells from shellfish with soft tissue
- eggs, egg by-products, hatchery by-products and eggshells
- aquatic animals, aquatic and terrestrial invertebrates
- hides and skins from slaughterhouses
- animal hides, skins, hooves, feathers, wool, horns, and hair that had no signs of infectious disease at death
- processed animal proteins (PAP)