BIOICEP: INNOVATION FOR THE CIRCULAR ECONOMY OF PLASTICS

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AIMPLAS is participating in the BioICEP project, which seeks to develop biotechnology-based solutions for the transformation of plastic waste into high-added-value bioproducts, such as bioplastics, thus fostering the circular economy within the plastics sector.

For decades, the socioeconomic model has been based on a linear concept of production and consumption, leading to the production of large quantities of waste, which is finally disposed of in landfills, as can be seen in Figure 1. However, in recent years, the circular economy has emerged as a model that seeks to promote sustainable development. This model proposes different strategies throughout the value chain of products and services. The circular economy approach seeks to minimise the quantities of virgin raw materials used in products, whilst also minimising waste production. To achieve this, interconnections must be established between waste generated and the production chain to enable the material and economic loops of resources to be closed, as shown in Figure 1.

In the plastics sector, the flow of materials from the waste generated to the plastics production chain must be created and established. The BioICEP project, in which AIMPLAS is participating as a partner, is working to achieve this. The main goal of the BioICEP project is to develop an effective and efficient route, in terms of cost, energy consumption and carbon emissions, for the biotransformation of plastic waste into bioproducts and bioplastics for which there is a high demand in the marketplace. In order to achieve this general objective, four specific objectives have been set. The first is to develop highly- efficient accelerated biodegradation through the incorporation of microorganisms that express new and improved enzymes to enable the degradation of mixed plastics. The second objective is to achieve sustainable degradation of at least 20% of plastic mixes. The third objective is to valorise waste plastic mixes by transforming them into high-added-value products through bioprocessing. And the final objective is to develop a sustainable prototype and pave the way to bring the solution to the marketplace, meeting current needs and future expectations.

A key element in terms of achieving the aforementioned objectives is pretreatment prior to the deployment of enzymes and microorganisms. This pretreatment enables chemical modification of the polymers of which the plastics are composed, which facilitates the subsequent enzymatic and microbial attack, thereby increasing the efficiency of the biological process. AMPLAS will lead tasks associated with the development and assessment of the functioning of different pretreatment methods for the purpose of enhancing the biodegradability of individual and mixed plastics. One of these pretreatments will be based on partial thermal degradation, implementing high-efficiency technologies such as microwave technology. This technology enables heat

generation inside the reactor, thereby doing away with the need for stages, such as heat or energy transfer stages, which can be limiting factors. Another pretreatment developed as part of the project will be based on reactive extrusion technologies and the use of supercritical CO_2. These technologies have the advantage of being easy to upscale, thus enabling the pretreatment of large quantities of materials. Supercritical CO_2 also has the advantage of spreading throughout the material, resulting in more homogenous pretreatment. Moreover, these pretreatments will be optimised and fine-tuned for each of the plastic materials used and the different mixes to be tested. The materials to be tested individually are: PET, polystyrene, polyethylene, Polyurethane, PLA, PHA and starch. The behaviour with three different polymer mixes will also be studied. One of the mixes will be composed exclusively of non-biodegradable polymers, another will contain only biodegradable polymers and the third mix will contain both biodegradable and non-biodegradable polymers. AIMPLAS will also participate in other technical aspects of the project, such as the characterisation of the biomaterials and bioproducts obtained, in addition to providing advice on different aspects of the use of the biopolymers and bioproducts obtained for applications such as pharmaceutical sector packaging and products.

AIMPLAS's participation in this project is in line with its firm commitment to environmental sustainability. Thanks to the project, companies in the sector will be able to introduce circular economy criteria into their business models and convert the legislative changes affecting them into opportunities to improve efficiency, reduce environmental impact and increase profitability. In this respect, AIMPLAS also carries out research in areas such as biodegradable materials and products, the use of biomass and CO_2.