All the bio-based products developed within the project, including **highly efficient enzymes for sugar recovery, biopesticides and biodegradable nanocapsules**, can either be reused directly in the mushroom production process or circulated to other industries. This flexible biorefinery concept can also be **replicated in other agricultural industries** that generate large amounts of biomass waste.

The process is thus entirely open to other feedstocks with interesting compositions in terms of bioactive compounds, lignin, or cellulose. In this way, BIOrescue is supporting the development of a circular economy while creating new business opportunities for rural communities.

OUR PARTNERS

CENER
NATIONAL RENEWABLE ENERGY CENTRE
ADItech

MONAGHAN MUSHROOMS

Celignis Analytical

Università degli Studi di Napoli Federico II

METGEN

Imperial College London

C-Tech INNOVATION

zabala innovation consulting

Greenovate! EUROPE

Max-Planck-Institut für Polymerforschung
Max Planck Institute for Polymer Research

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BIO-BASED INDUSTRIES Public-Private Partnership

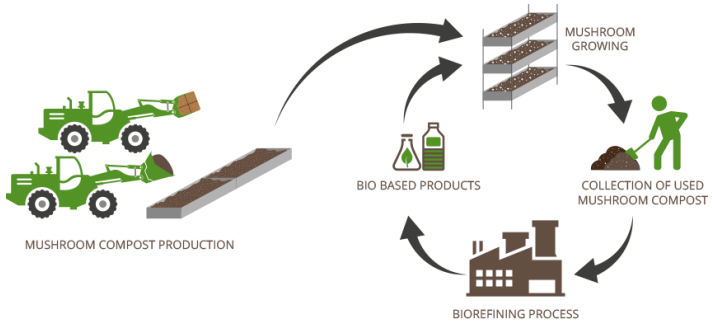
Bio-based Industries Consortium

Horizon 2020 European Union Funding for Research & Innovation

BIOrescue: a new circular biorefinery concept for agricultural waste

BIO RESCUE

Better known for shiitakes and baby buttons, the mushroom industry is now getting ready to implement a truly circular bioeconomy. Born from an encounter between one of the world's largest mushroom producers – Monaghan Mushrooms - and Europe's bioeconomy research community, the BIOrescue project aims to show that all waste is a business opportunity.



To help make this a reality, industrial, research and academic partners from eight countries, coordinated by CENER, Spain's National Renewable Energy Centre, are developing a **novel biorefinery concept** to transform used mushroom compost into sustainable bio-based products. During the last two years, the full process has been successfully tested and is expected to have promising applications in different sectors.

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Highly efficient enzymes for sugar recovery

For cellulose, the second conversion step consists of **enzymatic hydrolysis**. To maximise the efficiency of the process, the Finnish company MetGen carefully selected the best in-house produced enzyme components, created tailor-made MetZyme® SUNO™ enzymatic solutions and determined optimal conditions to break down the cellulose obtained from pretreated mushroom compost into cellulosic monosugars. In addition, the University of Naples developed **new enzymes** using genetic evolution to further increase process performance. Both the sugars obtained and the newly developed and highly efficient enzymes have multiple applications in the bio-based industries.

Within BIOrescue, sugars recovered through the enzymatic hydrolysis process are currently being fermented in view of producing **biopesticides** with naturally occurring bioactive compounds, that are less toxic than conventional pesticides and more efficient on targeted pests.

Biomass analysis in less than 5 minutes

Using conventional methods, the analysis of biomass samples can take several weeks and costs hundreds of euro. Within the BIOrescue project, Celignis Analyticals, a spin-out company based in Ireland, is developing **customised mathematical models** to determine biomass composition before and after the biorefinery process. These new models are applied directly after scanning the samples with near infrared spectrophotometers, making results available in a few minutes.

In view of implementing the BIOrescue biorefinery concept – within which mushroom compost is mixed with other agricultural residues - experts analysed the composition of mushroom compost and determined which feedstocks would be complementary and aid the efficient extraction of all valuable components. Residues from **wheat, oats and barley straw** proved to be the most suitable.

New bio-based nanocapsules for enhanced drug delivery

Using the lignin extracted through the organosolv process, the Max Planck Institute for Polymer Research is developing natural polymer membranes to create **biodegradable nanocapsules** that enable the progressive and controlled release of bioactive compounds. These capsules have a myriad of potential applications, from a targeted drug release tool in agriculture to food enhancement and pharmaceutical products.

Innovative methods for lignin and cellulose extraction

The biorefinery concept itself includes a **two-step extraction** process conducted by CENER. Once combined with other agricultural residues, mushroom compost is submitted to an **organosolv process** using solvents to extract the lignin. In addition, a **thermochemical pretreatment** is applied to the mixture to recover cellulose. The remaining bioactive compounds and nutrients are recycled to be used as **soil fertiliser**, while the lignin and cellulose are further transformed into different bio-based products.