

REPORT ON NEW PRODUCTS BASED ON BIOMATERIALS CREATED BY THE INOCULATION OF MYCELIUM TO FOOD WASTE



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DEVELOPMENTS FROM MYCELIUM-BASED BIOMATERIALS

Technical, socio-economic and environmental feasibility study to foster the design and development of new products based on biomaterials created by inoculating mycelium into agri-food waste from crops in La Rioja.

BACKGROUND AND CONTEXT

The BIOMIS project has its origin in the European INTERREG POCTEFA 142/16 ORHI project "RESEARCH AND IDENTIFICATION OF NEW BUSINESS MODELS (Circular Economy) AND INNOVATIVE TECHNOLOGIES FOR ENVIRONMENTAL IMPROVEMENT TO THE AGRO-FOOD SECTOR IN THE POCTEFA TERRITORY". One of the objectives of the ORHI project is the synergy generation between companies and regional entities for the creation of new business models.

The Biomis project aims to study the potential of a new innovative ecosystem in the packaging sector in La Rioja, based on research focused on the creation of new biomaterials based on the growth of fungal mycelium on substrates of sub-products and organic waste from La Rioja, and the incorporation of circular economy practices and strategies.

The circular economy closes the loop in industrial manufacturing processes and minimises waste. A bio-based economy aims to replace fossil-based resources and processes with sustainable alternatives that exploit renewable biomass for the generation of new products used in our daily lives. This innovative mycological biotechnology approach - the production of fungal-based biomaterials - can contribute to this.

The key activities involved in this project are aimed at the study of new environmentally sustainable solutions and should include R&D&I activities in different areas: mycological biotechnology, new biomaterials, eco-design of new packaging, prototyping and definition of the needs for industrial-scale manufacturing of the proposed solutions, business models with start-up potential or marketing requirements for the products to be developed.

Spain is the fourth European producer of mushrooms, the first European producer of oyster mushrooms (*Pleurotus ostreatus*) and a significant producer of other exotic mushroom species.

La Rioja leads the national production of mushrooms and fungi, has a long tradition in the culture of edible mushrooms, and has an important agricultural and agri-food activity that generates a large amount of by-products and lignocellulosic organic waste.

MYCELIUM AND SUBSTRATE: APPLICATIONS

The mycelium of filamentous fungi (the set of hyphae that constitute the vegetative body of fungi) forms intertwined networks of hyphae that function as a natural binding agent for fibres from by-products or waste generated in agricultural, forestry and agro-industrial activities in La Rioja whose biomass is available in large quantities.

Unlike many plastic materials, this material is highly sustainable and completely biodegradable.

We can obtain numerous typologies of **fungal biomaterials** depending on the processing technologies for forming new products using the mycelium of different species of fungi combined with various types of substrates.

These fungal biomaterials have extremely interesting characteristics: they are **light, resistant, flexible, fireproof, and durable** and have very interesting properties as an **insulating and acoustic** material.

OPPORTUNITIES, APPLICATIONS AND POTENTIAL MARKET

The analysis of the projects and initiatives linked to the research, development and marketing of mycelium-based materials and their applications, as well as the associated business models, has allowed us to understand the situation of a market in clear growth.

Based on the establishment of a set of criteria agreed by the project's working and monitoring group, the Packaging sector has been selected as the one with the greatest potential for the development of applications configured with

these new materials, considering the local context and the characteristics of the productive and industrial network in La Rioja.

The interest in using these new materials in other sectors such as construction, automotive and artistic production has also been noted.

New containers and packaging based on biomaterials from mycelium can contribute to responding to a market that increasingly demands more environmentally friendly solutions that create regional value, contributing to an organised transition of the sector towards more sustainable solutions.

The technological advances that can be developed as a result of the project can also be incorporated into other sectors, such as textiles, footwear, construction and the automotive industry.



Textil



Construcción



Artículos domésticos



Packaging



Jardinería



Cuidado personal



Mobiliario urbano

There are opportunities for these materials in different areas, although the initial focus of development is on the packaging industry. An innovative proposal, feasible in the short term, is the use of these materials to protect and distribute wine or liquor bottles, an area that currently consumes large quantities of other, often less sustainable, materials.



Encaje estratégico



Viabilidad técnico productiva



Valores a transmitir



Sostenibilidad ambiental



Innovación



Funcionalidades



Experiencia de usuario



Requisitos logísticos, de distribución,
transporte y comercialización

Design and development parameters for new packaging

Taking advantage of this magnificent opportunity would help to place La Rioja as a European reference in the packaging sector with sustainability criteria, and would provide greater resilience to a region with an enormous agricultural tradition and to the regional productive network in the face of the paradigm shift accelerated by the COVID. This approach fits perfectly within the objectives of the future "Ciudad del Envase y Embalaje de La Rioja" and is fully in line with European strategies such as Green Deal and Circular Economy, as well as the Recovery and Resilience Mechanisms.

Fungal materials can be considered as an excellent renewable and biodegradable alternative, with a high degree of innovation and with the potential to inspire a new generation of products with their own characteristics as well as being able to replace a large part of the materials currently used from fossil sources.



Images taken from the testing of mycelium-based materials and proposals for their application (eco-design) in the food sector.

BUSINESS MODELS

Different business models with potential for implementation have been identified:

The analysis of the value chain by activities and stages needed to commercialise a product has allowed us to group the identified business models in a coherent way. A common objective and characteristic of the

different models is the development of products for different applications and production sectors depending on the formulations of the material to meet the different market requirements.

Regarding the circular business models identified, all of them are based on and share strategies including: the use of waste as a valuable resource, the detection of new market niches/segments, the development of new processing technologies and collaboration between companies.

Statement of models according to the range of activities developed:

Business Model A - Full development of activities

All processes are carried out by the same company, from research and development, through the production of materials, manufacturing and marketing.

Business Model B1+B2 - Marketing activities separate from the manufacturing and processing of materials

A cluster of companies that complement each other along the value chain. On the one hand, the first company (B1) is in charge of research and development, production of materials and manufacturing. Another company (B2) is responsible for marketing.

Business Model C1+C2 - Production activities of the materials separated from transformation and commercialisation

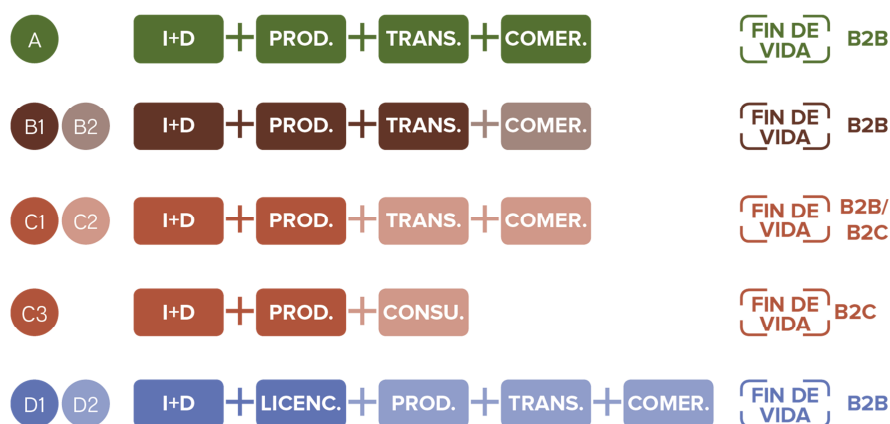
Several companies complement each other along the value chain. A first company is responsible for research, development and production of the material (C1). A second company (C2) is responsible for processing and marketing.

Business Model C3 - The company that produces the materials places them on the market unprocessed.

In this case, the first company carries out the same tasks as in the previous model (R&D and production), but as a complementary activity it incorporates the direct sale of biomaterials to the consumer/processor.

Business Model D1+D2 - Company that develops R&D activities and signs agreements with other companies that complete the value chain.

Several companies complement each other. A first company is in charge of R&D and licenses its patents and/or products. Agreements are signed with other companies (D2) so that they can develop the rest of the processes and commercialise the products.



Business models identified diagram

The different business model approaches can be developed depending on the entrepreneurial strategies adopted, the market positions chosen and the level of resources available for implementation.

A clear competitive advantage to be incorporated into the different viable business models outlined above is the incorporation of activities, initiatives or services that ensure the correct management of the end-of-life of the products and applications placed on the market.

The correct management of materials at the end of their life cycle will minimise environmental impacts and reinforce good "circular" practice.

ECOSYSTEM - EXPECTED BENEFITS

The success of this initiative will require the direct and decisive involvement of a series of economic and social agents that give the structure and solidity to the project, creating a rooted ecosystem that generates added value for the entire La Rioja region.

Some of the benefits associated with the development of the different possible applications for these materials are framed in their environmental and socio-economic aspects:

Economic - Social - Environmental Benefits

- Development of activities in the field of eco-innovation, circular economy and eco-design.
- Use of local materials, resources and waste.
- Minimisation of the environmental impacts associated with the new value chain.
- Driving and developing the commercialisation of more sustainable eco-designed products.
- Significant social benefits (creation of green jobs).
- Progressive development of business models associated with the initiative.
- Development of new biomaterials processing technologies.
- High degree of innovation incorporated.
- Promotion of local industrial development by integrating different value chains.
- Promotion of entrepreneurship, creation and development of companies that implement the achievements reached in the different stages of the project and links in the value chain.
- Economic benefits from the estimated sales potential for these innovative products with high added value. Significant growth in the implementation markets is foreseen.

TECHNICAL SHEET

Promotor:

ECONOMIC DEVELOPMENT AGENCY OF LA RIOJA (ADER)

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