

MUSHNOMICS - Unlocking data-driven innovation for improving productivity and data sharing in mushroom value chain

MUSHNOMICS objective is to demonstrate the feasibility of dynamic data-driven analytics for multi-domain mushroom production environments in order to optimize yield, lower costs and improve the economic viability of this agri-food sector. It takes a full-chain systems-based approach, from producer to consumer and beyond (valorisation). Consequently, MUSHNOMICS mobilizes a balanced and meaningful research-practice partnership (50-50 research-business split), including research-intensive academics with strong industry involvement from Denmark, Hungary, Ireland and Romania.



Commercial edible mushroom cultivation is a 'big business' world-wide with a total production exceeding 27 million tons, a 25-fold increase during the last 35 years, which is combined with a high increase in the respective per capita consumption. Among them, several species of the genus *Pleurotus* are of particular interest because:

- their production amounts to ca. 30% of the total, corresponding to the fastest growing and most profitable section of the mushroom market during the last two decades;
- they are commonly grown on pasteurized wheat straw, however, they can also be cultivated on a wide variety of agro-industrial residues whose disposal is otherwise problematic.

The composition of mushroom substrates is anticipated to exert an effect on mushroom yield, thus optimization of relevant bioprocesses to maximize yields is absolutely essential. This can be achieved by quantifying the effects of environmental factors such as temperature, humidity, oxygen, carbon dioxide and light throughout the mushroom production process from substrate preparation and mushroom cultivation right through to the consumer including valorisation.

MUSHNOMICS is a highly ambitious project, deeply rooted in industry stakeholders and EU citizenry, and with the expertise and resources to deliver its objectives. The vision of MUSHNOMICS is to start something irreversible in relation to the wider use of ICT and digital technology solutions for the optimization of resource use efficiency as well as for the reduction, recycling and reuse of agro industrial waste in the European food supply chains. As its starting point, through the work that will be performed in the beginning of the project will gain invaluable insights into mushroom value chain, lifestyle preferences, retail strategies and more, to deliver a protocol enabling the whole industry to address the food production challenge in a business-focused manner. It is about understanding the food chain dynamics and delivering commercially viable agri-food chains that meet the aspirations of the consumer while also delivering reduced food waste and better waste utilization pathways to industry.



Figure 1 Oyster mushroom production

From the industry perspective, the components of the targeted supply chain will be studied (e.g. the key players within the supply chain, the geographical location of constituents, logistical issues, the volume and variety of materials moving through the supply chain); the relevance of inter-supply chain relationships (e.g. the interactions between different supply chains), the regulatory and institutional issues affecting each constituent of the supply chain. This research will bring new insights to better understand the pathways of food products from sources to the consumers to enable further exploration of the different aspects of the supply chain in relation to resource use efficiency and waste generation.

MUSHNOMICS will create a database of agro-industrial wastes that can be valorised to produce edible mushrooms, a highly nutritious food, providing an enormous enabler for innovation in the European food industries.

MUSHNOMICS will leverage an innovative, bottom-up and co-creative approach to optimize mushroom production using the 'MUSHNOMICS Module', an IoT-based and environment-controlled modular container farm unit, with the aim to provide real-time data analysis and maximize resource use efficiency throughout the production process.

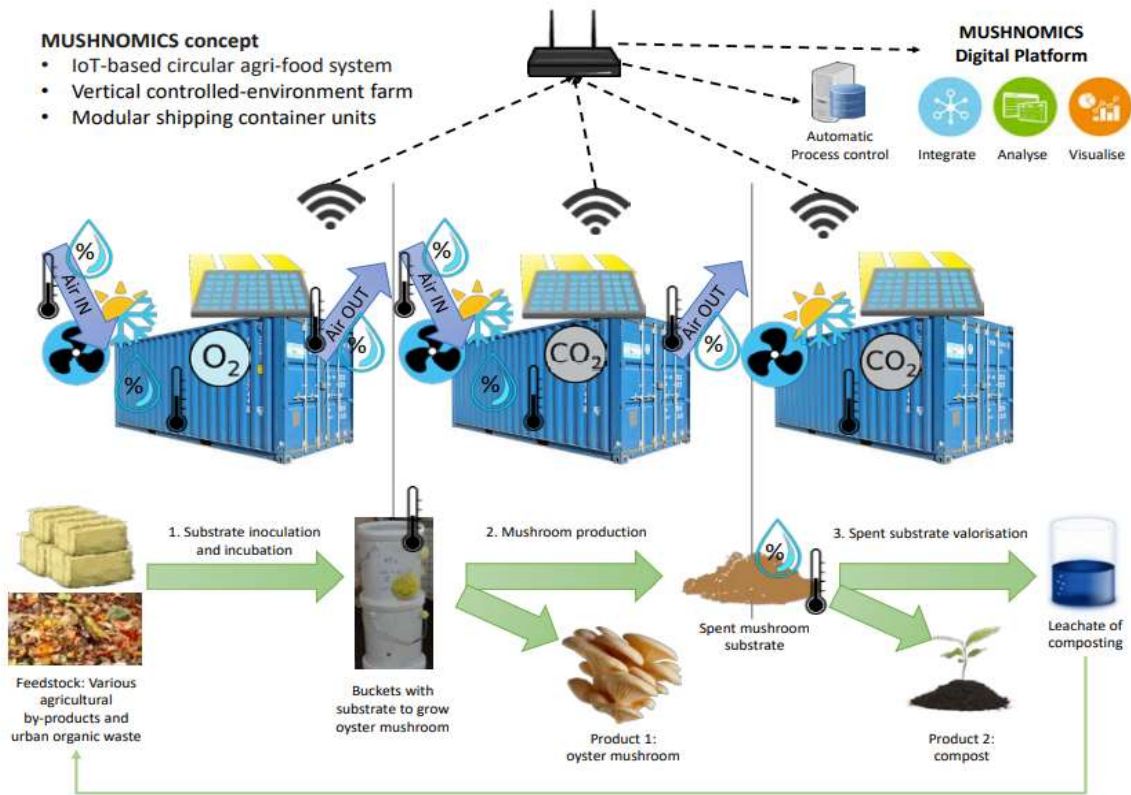


Figure 2 IoT-based MUSHNOMICS Module: concept and approach

The urban proximate MUSHNOMICS Module prototype will consist of three shipping containers; all of them will be retrofitted with necessary smart sensors and Internet of Things (IoT) devices to monitor the mushroom production process with the necessary threshold notifications and feedback loops.

Three containers are required because of the different environmental schedules for each step of the process:

- 1st container is the mushroom substrate preparation unit (pasteurization, inoculation with mushroom spawn) for the utilisation of the agro-industrial and urban wastes as feedstock for mushroom cultivation.

- 2nd container is the mushroom cultivation unit for incubation and fruiting:
 - Incubation: the buckets with the substrate are then placed in a container under warmer conditions to incubate and begin the first phase of growth.
 - Fruiting: Once the growing medium is fully colonised by the spawn, it is time for the mushrooms to start fruiting. The bags will be exposed to autumn-like conditions with fresh oxygen, high humidity, and low level light and often cooler temperatures.
- 3rd container is the spent mushroom substrate valorisation unit for the treatment of the soil-like, high in organic matter, material remaining after harvesting of mushrooms.

The prototype MUSHNOMICS Module will be located in Hungary at PILZE premises that it will implement across their commercial operations and that meet the demands of the consumer and legislators. Each unit will enable remote control and optimization of the environmental schedules by the use of smart sensors, IoT and artificial intelligence driven algorithms. Data will be collected along the entire production process from mushroom substrate preparation right through to mushroom cultivation, postharvest processing and spent mushroom substrate valorisation.

Technology will be applied for gathering data from vast networks in real-time (e.g. relative humidity, carbon dioxide concentration, temperature, air circulation and light) transmit these data to central storage (MUSHNOMICS Cloud), develop large data banks, undertake data analytics to deliver mined and collated data to the relevant stakeholders in real-time. This will be enabled through the MUSHNOMICS Digital Platform, a portal to the global community.

Relevant link(s)

Website: <https://mushnomics.org/>

Social media:

<https://twitter.com/mushnomics>

<https://www.linkedin.com/company/mushnomics-project>

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