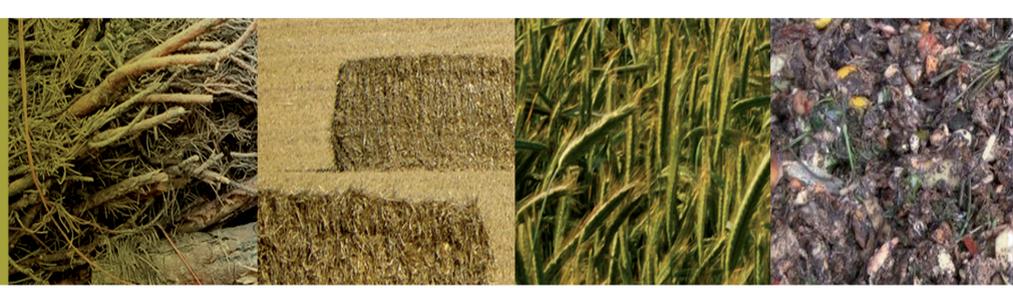




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A NOVEL BIOREFINERY CONCEPT FROM MUSHROOM COMPOST

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THE CHALLENGE

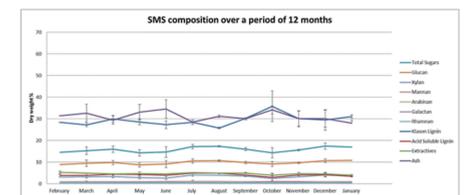
- Spent mushroom compost (SMS) is the residual compost waste generated by the mushroom production industry.
- Annually 3 million tons of this residue are generated in Europe resulting in disposal costs of 150 million Euro.
- The BIOrescue project aims to develop an innovative biorefinery concept to valorise spent mushroom compost together with other underutilised lignocellulosic feedstocks as cereal straw and pruning residues.



FEEDSTOCK SUPPLY, CULTIVATION & ASSESSMENT

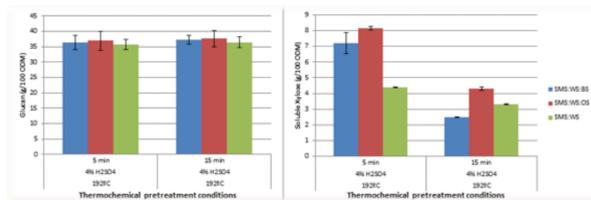
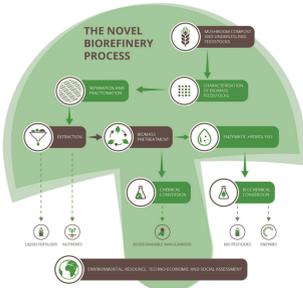
- A wide variety of underutilised feedstocks from different European regions have been analysed to select the best combinations with mushroom compost.
- Optimal feedstock mixture of compost, wheat, oat and barley straw has been proposed for a mushroom-farm-based biorefinery located in the Western region of Europe.
- Compost and straw have been collected and analysed over a one-year period in order to determine the variability in their composition. Rapid analysis models, based on the near infrared (NIR) spectra of samples, have been developed to predict the composition of compost and straw.

These models are accurate, even when the spectra of wet unprocessed samples have been used, and allow for the time for analysis to be reduced from weeks (using standard chemical analysis methods) to seconds.



SEPARATION & FRACTIONATION

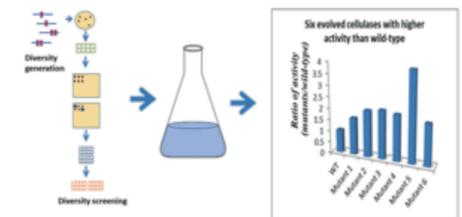
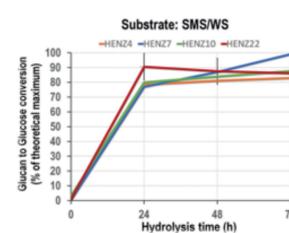
- CENER has conducted preliminary extraction assays on mushroom compost and show the release of a high amount of soluble compounds.
- A set of thermochemical pretreatment tests have been carried out on SMS alone and in combination with wheat straw (WS) and other underutilised feedstocks such as barley (BS) and oat straw (OS) using different catalysts and process conditions. These alternative feedstocks have been blended with SMS making out binary (SMS & WS) at a 40:60 wet basis ratio respectively; and ternary (SMS, WS and OS or BS) blends at 40:30:30 wet basis ratio. Considering different thermochemical pretreatment conditions tested, binary and ternary blend slurries composition showed.



- Similar glucan content but high variable soluble xylose.
- Ternary blends shows higher variability regarding soluble acetic acid compared to binary mixture.

ENZYMATIC HYDROLYSIS

- MetGen has conducted an extensive screening of tailored enzyme solutions (MetZyme® SUNO™) together with hydrolysis conditions for the optimal saccharification efficiency of pre-treated biomasses.
- Best enzyme formulations showed high reducing sugar yields and 80-100% glucan to glucose conversion ratios already within the first 24 h of hydrolysis.
- Aspects like processability and production cost of the enzyme cocktails have been considered, which will enable the selection of the most techno-economical feasible solution for the subsequent pilot-scale hydrolysis assays UNINA has expressed two new cellulases in recombinant forms and characterized them to select the best enzyme in terms of catalytic and stability properties. This selected enzyme was subjected to directed evolution experiments aimed at developing a series of mutated variants with improved properties.



CHEMICAL CONVERSION

NANOCARRIER PREPARATION

The liquid fraction obtained after the thermochemical pretreatment has been used as feedstock to produce two different types of biodegradable, enzyme-responsive lignin nanocarriers by miniemulsion polymerization for drug delivery. Even more the recalcitrant fraction that remains after enzymatic hydrolysis, is also currently being used for nanocarriers production whilst reducing biorefining wastes.

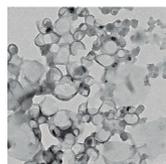
Nanocarrier Preparation:



Microfluidizer used for scale-up



TEM image of nanocarriers



SUSTAINABILITY ASSESSMENTS

- Initial definition of the system boundaries and settings for the environmental, techno-economic and social impact assessments of the future biorefinery.
- Technical assessment of selected sustainable feedstocks to be used in combination with SMS for different EU regions.
- Analysis of data on the environmental, techno-economic and social dimensions of SMS production and the proposed refinery, using a range of sources and techniques (biorefinery processes, EUROSTAT, HSDB, LCA, LC-EIA, sLCA, SWOT).
- Analysis of secondary sources on policies relating to biorefineries (EU and national level).
- Assessment of the socio-economic, environmental and policy issues relating to the underutilised feedstocks that will be used with SMS in BIOrescue refineries in mushroom-producing regions in the EU.

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