Growing Fungi Structures in Space

Executive Summary

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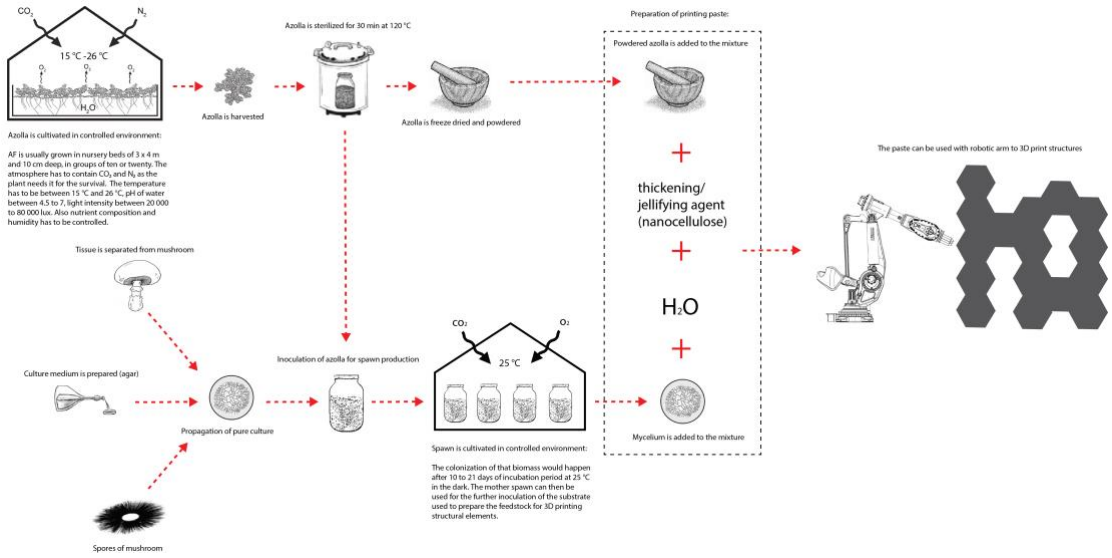
Picture



Motivation

In this project, we explored the concept of growing fungal based bio-composites in space for constructing architectural structures. A small amount of fungal mycelium brought from earth would be used to inoculate local organic material to grow the bio-composite in situ.

Methodology

The mushroom forming fungi *Pleurotus ostreatus* (PO), *Trametes versicolor* (TV) and *Schizophyllum commune* (SC) are known to effectively colonize organic material. These fungi were grown on the aquatic fern *Azolla filiculoides* (AF), the fastest growing plant on Earth and that can fix its own nitrogen. SC showed the best growth on AF. Therefore, growth of this fungus was determined under microgravity conditions and high radiation dosage (up to 200 Gy) and related to melanin production. To make fungal composite materials, freeze dried and ground AF was inoculated with the melanin producing SC strain 227. Additives were added to create a paste like structure that can be used for 3D printing fungal bio-composites in different shapes.

Results

- *Schizophyllum commune* is able to grow at microgravity conditions (it may even grow better at this condition) and is able to survive high doses of radiation (200 Gy, ± 30% survival). This is not associated with enhanced melanin formation.
- *Schizophyllum commune* is able to fully colonize *Azolla filiculoides* and panels of this biocomposite have been produced.
- Addition of 10% psyllium created a *Schizophyllum commune* / *Azolla filiculoides* paste that could be 3D printed. Computational design strategies have been implemented for controlling robotic devices and for consequent deposition of mycelium based pastes.
- Different shaped 3D printed prototypes consisting of mycelium biocomposites have been produced.
- *Schizophyllum commune* / *Azolla filiculoides* bio-composites grown as panels or in 3D printed shapes are still relatively brittle, though preliminary experiments have shown that a different *Azolla filiculoides* strain with reduced phenolic composition could improve these mechanical properties. Alternatively, scaffolds or fibres could

be used. Future studies should explore the inclusion of nutritious hydrogels, allowing for an effective deposition in layers, at architectural scale.

Publications

- Läkk, H., Krijgsheld, P., Montalti, M., Wösten, H. *Fungal Based Biocomposite for Habitat Structures on the Moon and Mars.* 69th International Astronautical Congress (IAC), Bremen, Germany, 1-5 October 2018.

Highlights

- First material samples containing *Azolla filiculoides* as a plant substrate in combination with fungus *Schizophyllum commune*
- First experiments with *Schizophyllum commune* in simulated microgravity conditions showing enhanced speed of growth compared to 1G
- First experiments with *Schizophyllum commune* in high doses of γ-radiation showing its survival in 200 Gy
- First 3D printing studies for manufacturing biocomposite structures using the developed paste without any scaffolding