Biomaterials and their Applications in Subarctic Food Systems

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Abstract

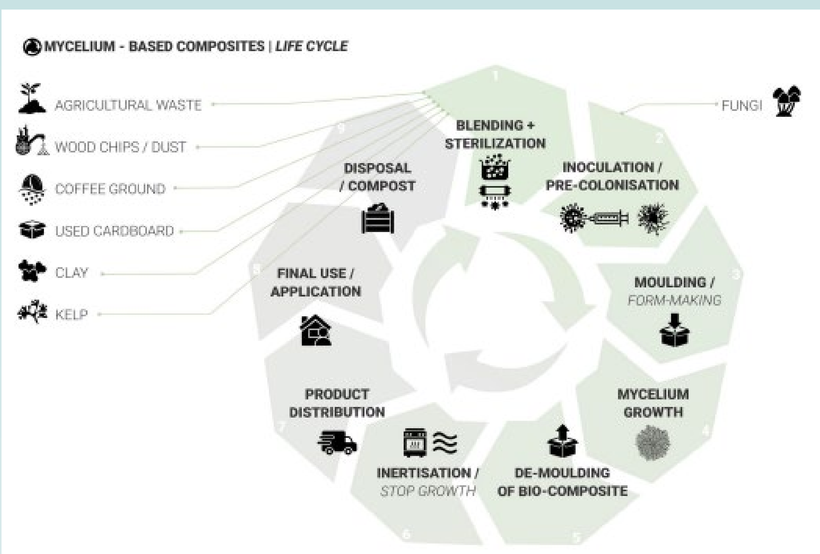


Diagram depicting the life cycle of fungal mycelium bio composites, *poster: Material Computation with Myco-materials (Gough et al 2022)*

Biomaterial research involves the development of materials used in medical and biological applications. These materials can be synthetic, natural or a combination of both (Gentry 2015).

Understanding fungal taxonomy is essential in biomaterial research because of the wide range of applications being discovered..

Fungi can produce a wide range of biomolecules, including enzymes, pigments, and polysaccharides, that can be used to create new materials (Aleksanyan 2023; Girometta, et al 2019; Raman et al 2022). Microbial DNA extraction in localized soil samples can further support this research by looking at genetic markers among species (Wang et al 2022).

The past 20 years have been an expansive movement for researchers and citizen scientists studying interactions of microorganisms as co-creators of materials both in the field and laboratories. Biogenic materials are being studied now more than ever for applications in building science, textiles, manufacturing, biofuel production, as well as medicine (Aleksanyan 2023; Srubar III et al 2022; Raman et al 2022).

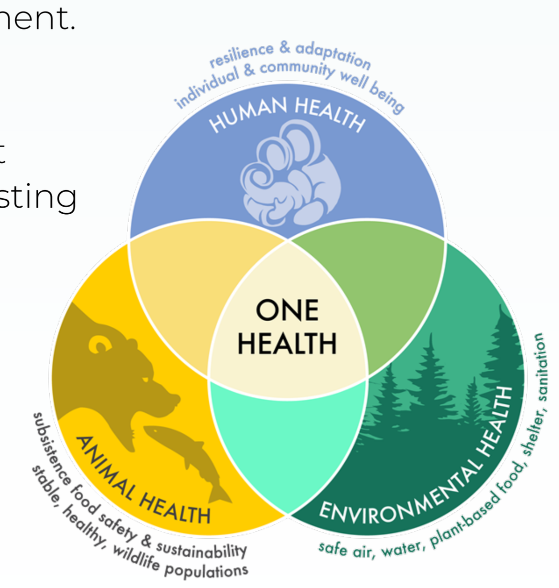
As a result of human activity, there is now more accumulated microplastics in farmable soil than in the ocean. Microplastics causes serious harm to human, animal, and environmental health. Certain species of microorganisms have been found to digest certain plastics and are being further tested for bioremediation (Wang et al 2022).

The phenomenon of biomaterials research is the opportunity to develop regenerative self-growing systems that may replace and eventually out-perform petroleum-derived and synthetic materials such as plastics, foams, textiles, and cements while enriching soil as the end-user of design and production.

By understanding the role of microorganisms like fungi in the environment, scientists can work with community members to implement sustainable practices for local development.

Food security continues to be an ongoing issue In the rapidly changing subarctic environment that traditionally values foraging and subsistence harvesting Methods (Fazzino, et al 2009).

Integrating indigenous wisdom with scientific methods will continue to shape processes and practical applications for the subarctic with biomaterials research. This can be seen through the One Health framework which considers human health, animal health, and environmental Health to be interconnected.



Introduction

Fungal taxonomy is an important component in understanding the properties of different microorganisms.

With the emerging field of biomaterials research, only 3-8% of the world's fungi biodiversity remains known (Hawksworth et al 2017).

A local need identified in this study was to replace planter pots and seedling containers that are commonly made from plastics, especially those derived from petrochemicals.

F. Pinicola harvested for this project on the Troth Yedd'ha campus, September 2022

Understanding local fungal taxonomy can inform sustainable biomaterials design that can also be studied in comparison to other species in the natural environment where they are located.

One way to address ongoing extreme weather events caused by climate change is the through the management of sustainable practices in local food systems. One way to boost soil health is through increasing microorganism activity that stimulates interactions between plants, microbes, and soil (Wang et al. 2022). Subarctic boreal forests in Alaska have a wide variety of species of fungi and microorganisms that have mainly been studied taxonomically. Researchers in other parts of the state are testing biomaterials for packaging, as well as building applications such as insulation.

Polypore fungi basidiomycetes can be "brown rot" or "white rot" meaning they are found on different substrates of organic material, such as wood. White-rot fungi are known as lignocellulosic degrading. This means they break down cellulose and lignin, a durable polymer found primarily in wood. *Fomitopsis pinicola* is a "brown rot" bracket or shelf fungus, meaning that while it grows on wood, it is only able to break down cellulose, as they do not produce lignin-degrading enzymes (Li et al 2022).

Collecting wild fungi species to compare mycelial growth of samples in lab, September 2022, Troth Yedd'ha campus, UAF Trail System

Learning spore morphology and fungal taxonomy in BIO 195, Mushrooms and other Fungi course with Christin Swearingen. Knowledge from course was applied in URSA project work.

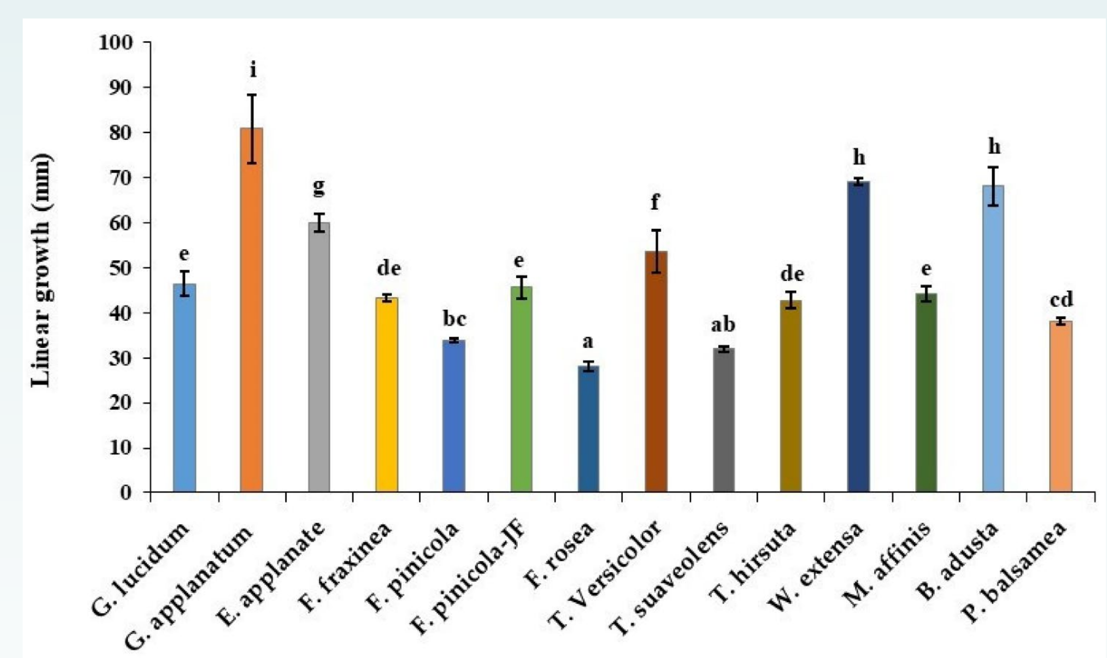
Results

This project examines properties of a local species of fungi, *Fomitopsis pinicola*, or red belted polypore, as a possible biomaterial for Alaskan food systems.

Researchers and staff at the UAF Agricultural and Forestry Experiment Station (AFES) expressed interest in water-repelling or hydrophobic organic containers as alternatives to methods such as soil blocking or the use of plastic seedling trays. Because of the lignin as well as chitin content of *Fomitopsis pinicola* (Li et al 2022; Erdogan el al 2017), a major question was how to create a regrowth of this species' mycelium, or fungal roots, when harvested. Researchers and farmers in Alaska were interested if it could be developed as a slow degrading hydrophobic container made of key local-sourced nutrients for subarctic soil health.

Over the course of this project, I observed that *Fomitopsis pinicola* was not only flexible when initially harvested, its mycelium was able to regrow in a lab using water as a biostimulator and agar as nutrient.

Researchers tested mycelium growth of polypore species for density and structure. (e) *Fomitopsis pinicola*-JF, (f) *F. pinicola*-KCTC, (Raman et al 2022)



Samples October 2022 of the harvested *Fomitopsis pinicola* suspended in liquid culture, indicate signs of fermentation.

[Graph, Left] Researchers tested F. Pinicola against other liquid cultures of harvested mycelia. The *F. pinicola* (fifth bar, bright blue) produced highly dense and flexible mycelium. The *Fomitopsis pinicola*-JF (sixth bar, bright green) produced high-density mycelia but was not as flexible and acted somewhat brittle (Raman et al, 2022).

[Below] Cold water flashing and immersion serves as a biostimulator for harvested F. pinicola, 4 weeks post-harvest

[Above, Right] Mycelial regrowth on F. pinicola agar nutrient 5 days post-cold water immersion

Conclusion

This research was exploratory and inconclusive. Future research should focus on substrates using waste materials in the local environment, such as from invasive species or agricultural by-product, that could provide structure and flexibility needed to replace plastics.

Additionally, further research is needed to understand the role of fermentation with the medicinal *Fomitopsis pinicola,* as it may improve or change applications where this fungi could be utilized, such as in soil health or human medicine.

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