Testing waste kombucha as an organic fertiliser

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Introduction

Bacterial cellulose (BC) is a solid formed when water, sugar, tea and a starter culture are mixed together and left to ferment. The cellulose is being investigated by the Hub for Biotechnology in the Built Environment (HBBE) as a building material. The major waste product from this process is a liquid called 'kombucha', like the Kombucha that's soared in popularity in recent years. This research explores a potential use of the HBBE waste kombucha as a fertiliser, based on the notion that it can potentially enrich the bacterial colony of the soil, in turn providing nutrients to a plant. This has the potential to create a circular material economy for BC through its waste stream. The experiment was developed around growing wheatgrass, a quick growing microgreen suited to slightly acidic soil conditions. This was important as kombucha is an acidic solution.

Wheatgrass growth cycle

Seeds are soaked for 12 hours to begin the germination process

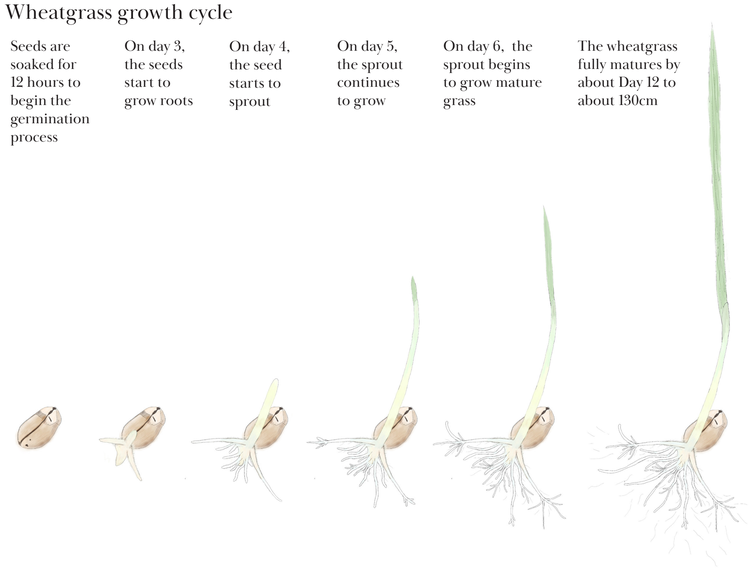
On day 3, the seeds start to grow roots

On day 4, the seed starts to sprout

On day 5, the sprout continues to grow

On day 6, the sprout begins to grow mature grass

The wheatgrass fully matures by about Day 12 to about 130cm



Aims

- Can we use waste kombucha as a fertiliser for growing wheatgrass?
- What is the optimum kombucha fertiliser mix in order to grow wheatgrass?

Method

An experiment was developed around growing wheatgrass in microgreen trays, shown in the process pictures below. 6 grows were determined in order to properly assess the viability of feeding waste kombucha as fertiliser. Fertiliser was introduced once the germination process had ended, on 12.8.22. The 6 grows were:

- 1 Control - fed daily with water,
- 2 Control - fed daily with water (changed to a 33% kombucha mix, fed from the top on 15.8.22)
- 3 Conventional - fed with conventional fertiliser and water
- 4 100% K - fed with 100% kombucha
- 5 67% K - fed with 67% kombucha and 33% water
- 6 33% K - fed with 33% kombucha and 67% water

Waste kombucha is prepared 2 weeks in advance of the wheatgrass experiment

The kombucha is measured to have a pH of 4

6.8.22 - The kombucha mix has fermented and is ready to be fed to the wheatgrass

6.8.22 - Germination process of the wheatgrass is begun by soaking the seeds overnight

8.8.22 - 6 trays are prepared on a low nutrient medium of peat moss and vermiculite

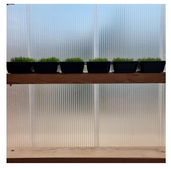
8.8.22 - The seeds are evenly spread into each tray

10.8.22 - The seedlings begin to sprout

12.8.22 - Once mature grass starts to grow, kombucha is fed to 3 of the grows

12.8.22 - Water being fed to the bottom of one of the control grow trays

12.8.22 - Kombucha being fed to the bottomg of one of the kombucha grow trays



The 6 grows are watered with 75ml of their different mixes daily

The 6 grows are observed daily

The 6 grows are measured daily

21.8.22 - '1 Control' has fully grown and matured

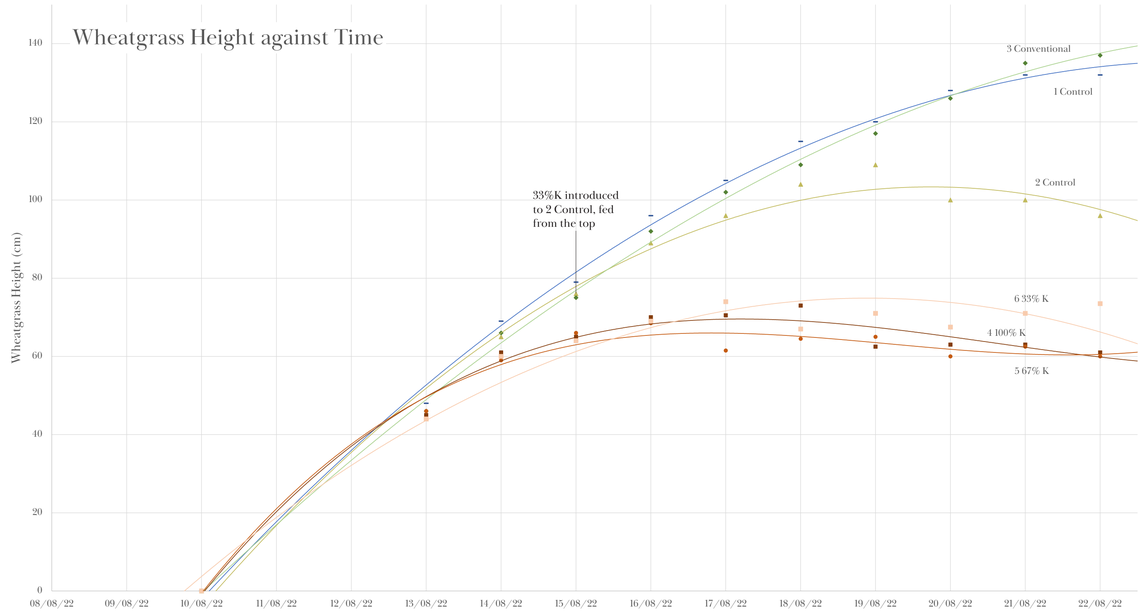
21.8.22 - An observation of Control 1's healthy roots

21.8.22 - '4 100% K' is patchy, yellow and dying

21.8.22 - The roots of '4 100% K', suffocated by the BC growing

22.8.22 - Final observations and comparison of the 6 grows

Results and Observations



- The samples fed with water and conventional fertiliser grew as expected.
- Upon feeding waste kombucha liquid to the 3 kombucha grows, BC immediately started to form around the roots.
- This led to me changing '2 Control' to feed it with a kombucha mix from the top of the grow, to test if it was the experimental method of feeding the kombucha to the roots that was causing the BC growth.
- '2 Control' also began growing BC on its roots after feed it with 33% K from the top.
- The 3 kombucha grows did not grow as quickly as the water conventional fertiliser grows.
- From 16.8.22, the kombucha grows began to grow patchy with yellowing of the grass showing.
- From 17.8.22, flies and maggots began nesting the in the kombucha grows seed bed. The fly infestation continued to grow for the rest of th experiment.
- From 19.8.22 the kombucha grows seemed to start dying.
- From 20.8.22, green mould started to grow on the surface of the kombucha grows.

Findings

- The samples fed with water and conventional fertiliser grew as expected.
- The method used seems to conclusively prove that the kombucha is not viable as a fertiliser for growing wheatgrass at these concentrations.
- Changing the concentration of the kombucha did not seem to effect the poor wheatgrass growth.
- It may be viable to use kombucha fertiliser in lesser concentrations.
- Using kombucha as a fertiliser creates a toxic environment that cultures invasive species.
- Feeding kombucha to wheatgrass forms a composite biostructure of Bacterial Cellulose and Wheatgrass Root.
- Feeding kombucha to wheatgrass from the top of the tray (in '2 Control') still forms BC at the roots. This indicates that the liquid, and its bacterial colony, is passing through the soil and the roots into the bottom of the tray.
- Whilst '2 Control' did not grow as well as '1 Control' and '3 Conventional', it did grow better than the other kombucha grows. This indicates that kombucha could be viable as a fertiliser through a different experimental method. Perhaps the soil filters some of the kombucha toxicity as it passes through.

Conclusion

The experiment successfully proved the objective aim of whether waste kombucha was viable as a fertiliser for growing wheatgrass. The kombucha mixes form a fascinating composite structure of Bacterial Cellulose and Wheatgrass Root. This finding could be used to generate a new research stream. Feeding kombucha from the top generated slightly better results than the other kombucha grows. This indicates that soil may filter the kombucha toxicity. As a follow-up experiment, kombucha could be tested to see whether it speeds up the process of compost creation. The experiment provided some fascinating observations and findings, which has inspired me to pursue an architectural project this year concerned with the symbiosis of non-human organisms.