BioTextiles: Kombucha Leather

Glen Mair, Samantha Mung, Matthew Mulia, Veronica Singh, Tony Yang, Anna Dinh, Caitlyn Cheong, Jenna Juma, Siwan Bang, Joelle Dewis, Katie Drobe

Background

20,000 million tonnes of textile waste is disposed in Metro Vancouver each year[1]

- **Synthetic polyurethane leathers** takes years to break down, filling landfills and polluting ecosystems with microplastics.[2]
- **Kombucha-based leather**, made from microbial cellulose, is a **sustainable alternative.** This material is produced through the fermentation of a **symbiotic culture of bacteria and yeast** (**SCOBY**), a living culture that produces a pellicle, a cellulose layer that forms at the surface of the culture.[3]
- Parameters such as light exposure, temperature, concentrations of tea, sugar, and bacterial and yeast culture can affect the pellicle growth rate.[3]

Benefits of Kombucha Leather:

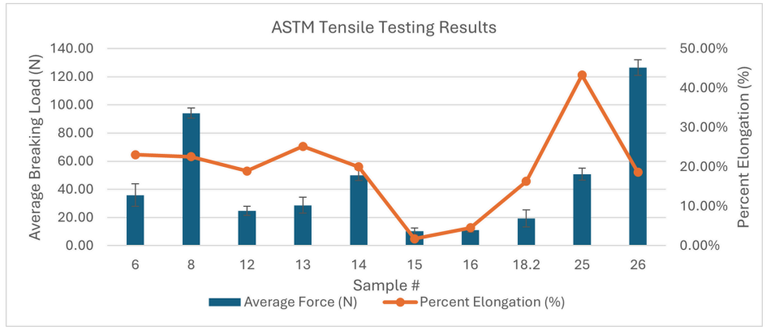
- **Compostable:** Breaks down in soil in by 96% in ~30 days.[3]
- **Circular economy:** Reduces waste and promotes resource efficiency.
- **Fashion and design applications:** Provides an alternative to synthetic and animal-based leathers used in various products, supporting sustainability in the textile industry

Project Objectives

- Testing pre-treatment parameters such as **brew time**, **aeration**, **sugar levels** to maximize growth
- Material testing via ASTM standards (ie. Tensile testing, burst strength)
- Post-treatment research such as waterproofing, dyeing, and strengthening

Results

Holds up to 126 N of load and has up to 43% elongation

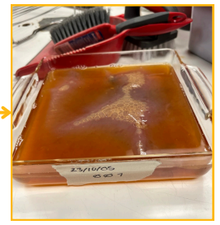


	breaking load [N]	% elongation	cost [$/ft2]	CO2e footprint [kg/ft2]
animal leather	153-494	15.8-66.4	10	10.22
synthetic (PU)	up to 420	3.9-31.5	2	1.47
Our kombucha leather	10 - 126	1.7-43.3	0.001	0.07

Kombucha Leather Making Process

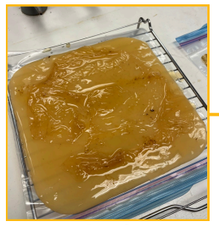
Kombucha Composition

- 0.034 g/mL Tea
- 0.422 g/mL Sugar
- 0.143 g/mL Bacterial/Yeast culture



Preparing the Fermentation Vessel

The Kombucha mixture is poured into a non-porous container.



Culturing

The thickness of the pellicle was measured every 7 days with calipers. Pellicle was fed with water-tea mixture to maintain liquid levels in the vessel.

Harvesting and Processing

The pellicle was harvested once it reached a desired thickness and dried at room temperature for 1-3 weeks.

Tensile Testing

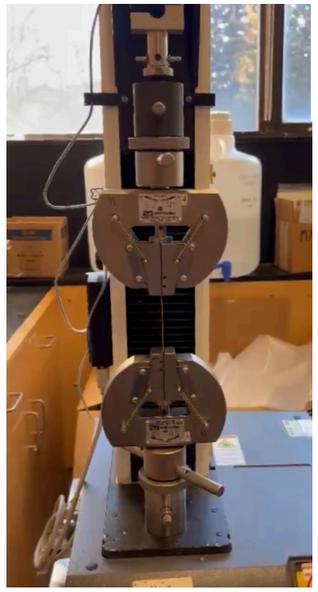


Figure 1. Kombucha sample clamped to a universal testing machine with strain rate applied at 100 mm/min

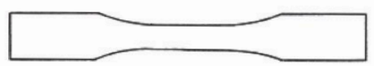


Figure 2. Dog bone layout of samples

Test Parameters

- Strain rate 100 mm/min
- Clamp Distance: 50 mm
- Sample:
  - Width: 20 mm
  - Centre Width: 5.3 mm
  - Length: 32 mm

- Tensile testing was conducted using a universal testing machine (UTM) to evaluate tensile strength of kombucha leather with different growth conditions.
- 18 samples of SCOBY from varying batches were tested for average elongation due to the force applied.

Next Steps

1. **Conducting a Life Cycle Assessment (LCA)**
   - Perform a LCA to evaluate the environmental impacts of kombucha leather compared to chrome-tanned leather and synthetic leather.
2. **Further Testing on Material Properties**[4]
   - **Burst Strength:** Use ASTM Standards to determine the burst strength.
   - **Wear resistance:** Test ability to withstand abrasion.
   - **Waterproofing:** Test water resistance.
3. **Further treatment to Kombucha leather**
   - **Oil Conditioning:** Evaluate effectiveness of oil conditioning using oils such as coconut, almond, and olive oil on the durability, texture and strength of the kombucha leather.[5]
   - **Starch Treatment:** Test different starch treatments by using starches such as corn, potato and wheat starch, on kombucha leather and assess its impact on the tensile strength and water resistance.[6]

References

1. Vancouver-Economy-Report-Spring-2022-Web.pdf. (n.d.). Retrieved December 5, 2024, from https://vancouvereconomic.com/wp-content/uploads/2022/03/Vancouver-Economy-Report-Spring-2022-Web.pdf
2. Shi, Y., Huang, H., Zheng, L., Tian, Y., Gong, Z., Wang, J., Li, W., & Gao, S. (2023). Releases of microplastics and chemicals from nonwoven polyester fabric-based polyurethane synthetic leather by photoaging. Science of The Total Environment, 902, 166584. https://doi.org/10.1016/j.scitotenv.2023.166584
3. SCOBY BREASTPLATE: SLOWLY GROWING A MICROBIAL INTERFACE | Proceedings of the Seventeenth International Conference on Tangible, Embedded, and Embodied Interaction. (n.d.). Retrieved December 5, 2024, from https://dl.acm.org/doi/10.1145/3569009.3572805
4. Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method. (n.d.). Retrieved December 5, 2024, from https://www.astm.org/d3786_d3786m-18r23.html
5. Vegan Leather from Kombucha Tea and Scoby. (2022). Medicon Engineering Themes. https://doi.org/10.55162/MCET.03.097
6. Wan, Y. Z., Luo, H., He, F., Liang, H., Huang, Y., & Li, X. L. (2009). Mechanical, moisture absorption, and biodegradation behaviours of bacterial cellulose fibre-reinforced starch biocomposites. Composites Science and Technology, 69(7), 1212–1217.

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Introduction

20,000 million tonnes **of textile waste is disposed in Metro Vancouver each year**

Much of the waste from Metro Vancouver's recycling facilities consists of flaking, **synthetic leathers,** primarily made of **polyurethane.** It is **non-biodegradable** and takes years to break down, filling landfills and polluting ecosystems. **Kombucha-based leather**, made from microbial cellulose, is a **sustainable alternative.** This material is produced through the fermentation of a **symbiotic culture of bacteria and yeast** (**SCOBY**), a living culture that transforms simple sugars into cellulose fibers.

Benefits of kombucha leather:

- **Biodegradable and renewable:** Breaks down naturally and uses renewable resources.
- **Circular economy:** Reduces waste and promotes resource efficiency.
- **Fashion and design applications:** Can replace synthetic and animal-based leathers in various products, supporting sustainability in these industries.

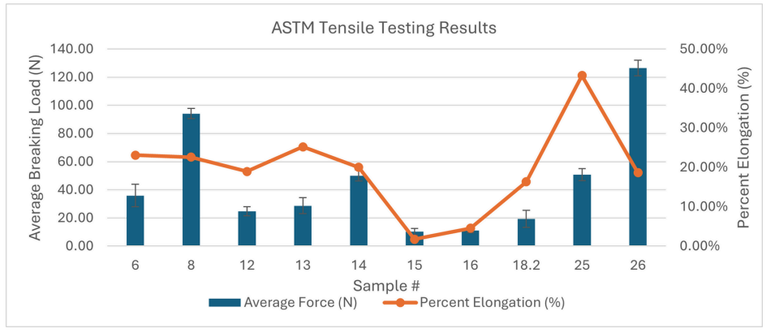
Project Objectives

We aim to create a kombucha-based substitute for current synthetic leathers by:

- Pre-treatment research:
  - Testing parameters such as **brew time**, **aeration**, **sugar levels** to maximize growth and
- Material testing via ASTM standards
- Post-treatment research:
  - Waterproofing, Dyeing, and Strengthening
  -

Project Findings

Holds up to 126 N of load and has up to 43% elongation



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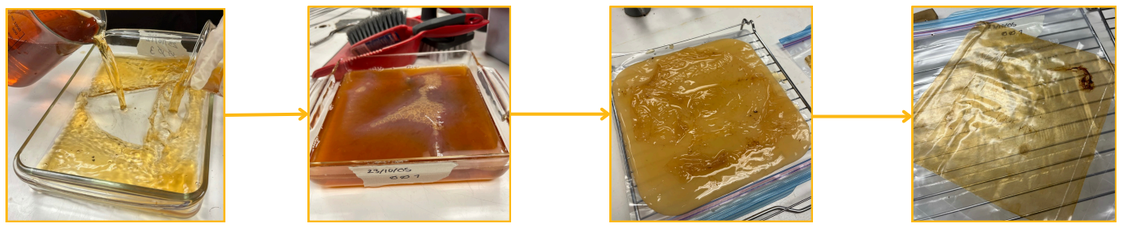
Kombucha Leather Making Process



Steeping Tea
Tea is steeped in a ratio of ___ for *time* at *temp*

Preparing the tea mixture
Sugar is added at a ratio of _____ to the brewed tea.

Preparing the Fermentation Vessel
The tea mixture is poured into a sterilized, non-porous container.

Inoculation
A SCOBY mother of *size* is added to the vessel under growing conditions.

Monitoring
The growth of the SCOBY was measured every *time* with sterilized equipment.
Additional brewed tea was added to maintain liquid levels in the vessel.

Harvesting and Processing the SCOBY
The SCOBY was harvested once it reached *dimensions.*
It was then dried through *drying process.*

Tensile testing was conducted using a universal testing machine (UTM) at a strain rate of 100 mm/min and a clamp distance of 50mm to evaluate the durability of kombucha leather of different growth conditions. 18 samples of SCOBY from varying batches were tested for average elongation due to the force applied. Each sample was prepared to a width of 20mm, centre width of 5.3mm, and a centre length of 32mm.

Next steps

1. **Conducting a Life Cycle Assessment (LCA)**
   - Perform a LCA to evaluate the environmental impacts of kombucha leather compared to chrome-tanned leather and synthetic leather.
2. **Further Testing on Material Properties**
   - **Burst Strength:** Use ASTM Standards to determine the burst strength
   - **Wear resistance:** Test ability to withstand abrasion.
   - **Waterproofing:** Test water resistance through humid environments.
3. **Further treatment to Kombucha leather**
   - **Oil Conditioning:** Evaluate how oil conditioning, using oils such as coconut, almond, and olive oil, affects the durability, texture and strength of the kombucha leather.
   - **Starch Treatment:** Test different starch treatments, using starches such as corn, potato and wheat starch, on kombucha leather and assess its impact on the tensile strength and water resistance.

References

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