Chitohusk Yarn

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Explorations in Bioyarn Materials and applications of felting properties.

Overview

Inspiration

Experimentation and Process

Results

Research

Final Samples

Findings

Inspiration

Drawing inspiration from Hannah Rempel's herbivorous reef fishes research, which highlights how Earth creates pathways for self-healing through evolution and animal adaptations that ultimately benefit human life, this biotextile project will aim to capture these natural processes in its final texture. The final product's surface will mimic the texture of algae and overgrowth, inspired by the eutrophication of coastal regions along with a color palette targeting shades of yellow (based on coral) and algae green.

Visual Inspiration

Naturally occuring textures & shapes

Concept

Developing a bioyarn with enhanced strength, durability, and potential for felting The goal is to create a sustainable, high-performance bioyarn for textile applications while addressing challenges like fragility and scalability.

Process

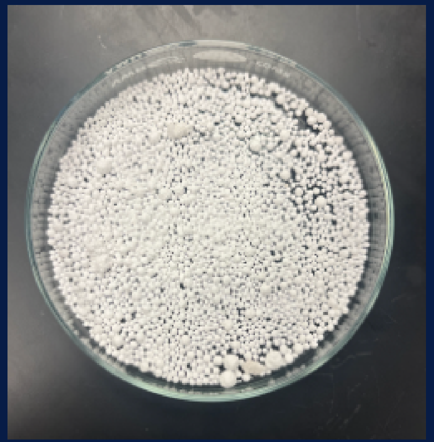
1. Mix Solutions

2. Extrude “Yarn”

3. Scaling Bath

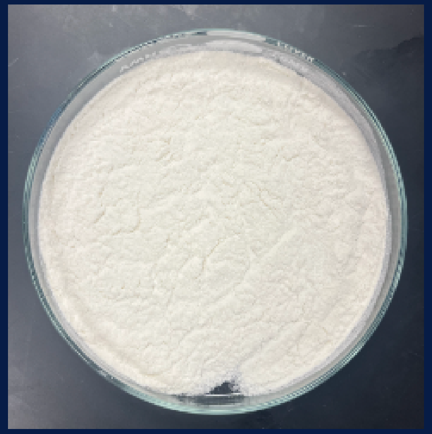
4. Drying and Assembly

Curing Solution

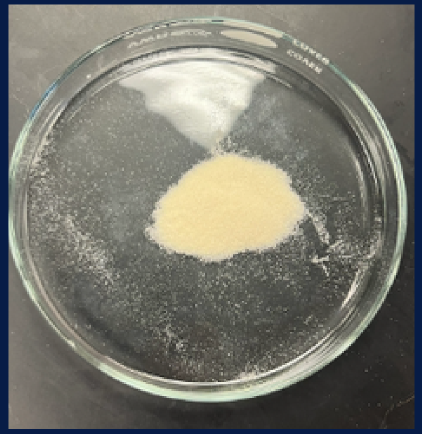

Calcium Chloride

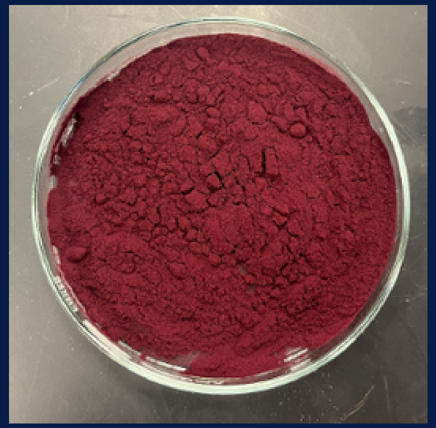

Water

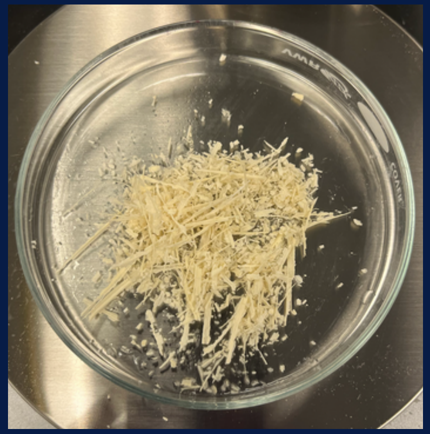
Yarn Solution


Sodium Alginate


Water


Chitosan


Red Cabbage Powder


Corn Husk Fibers

Scaling Solution

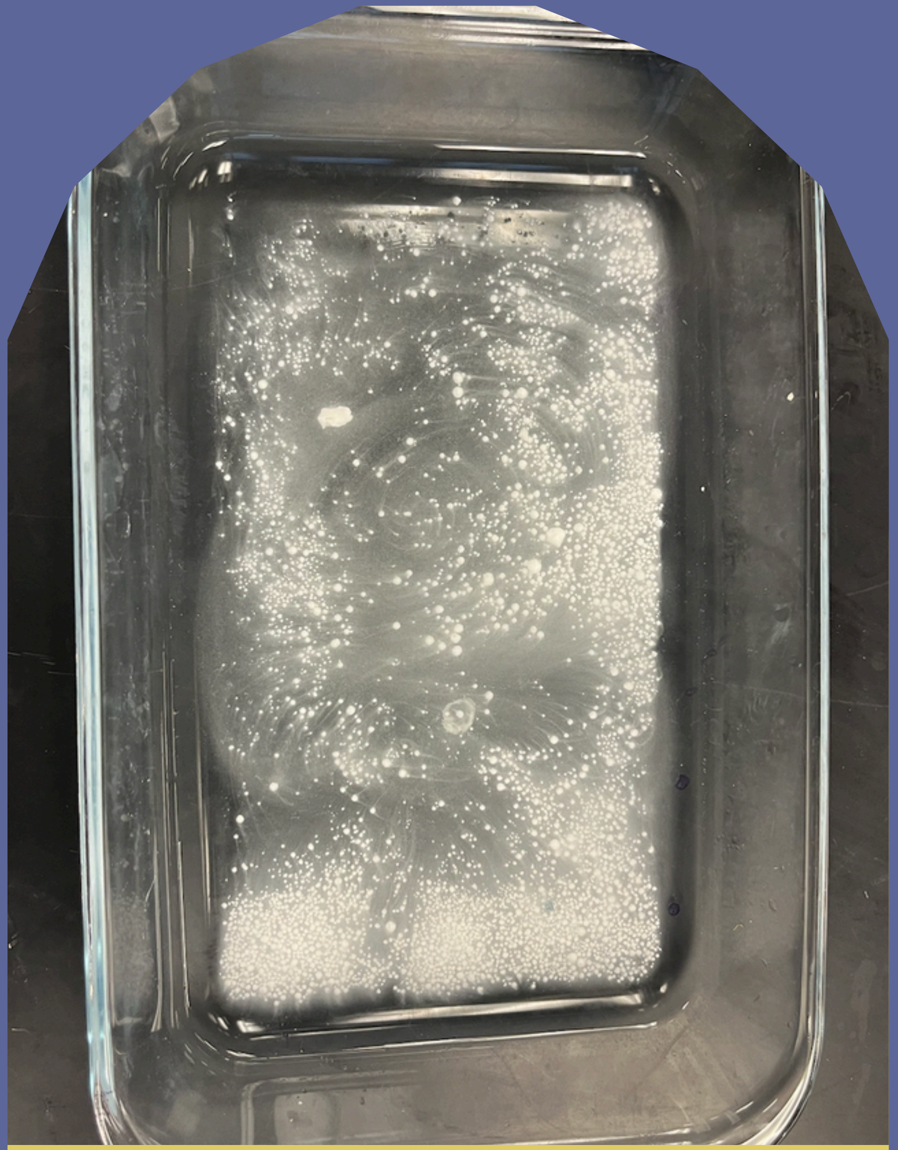

Water


Tannic Acid


Calcium Carbonate

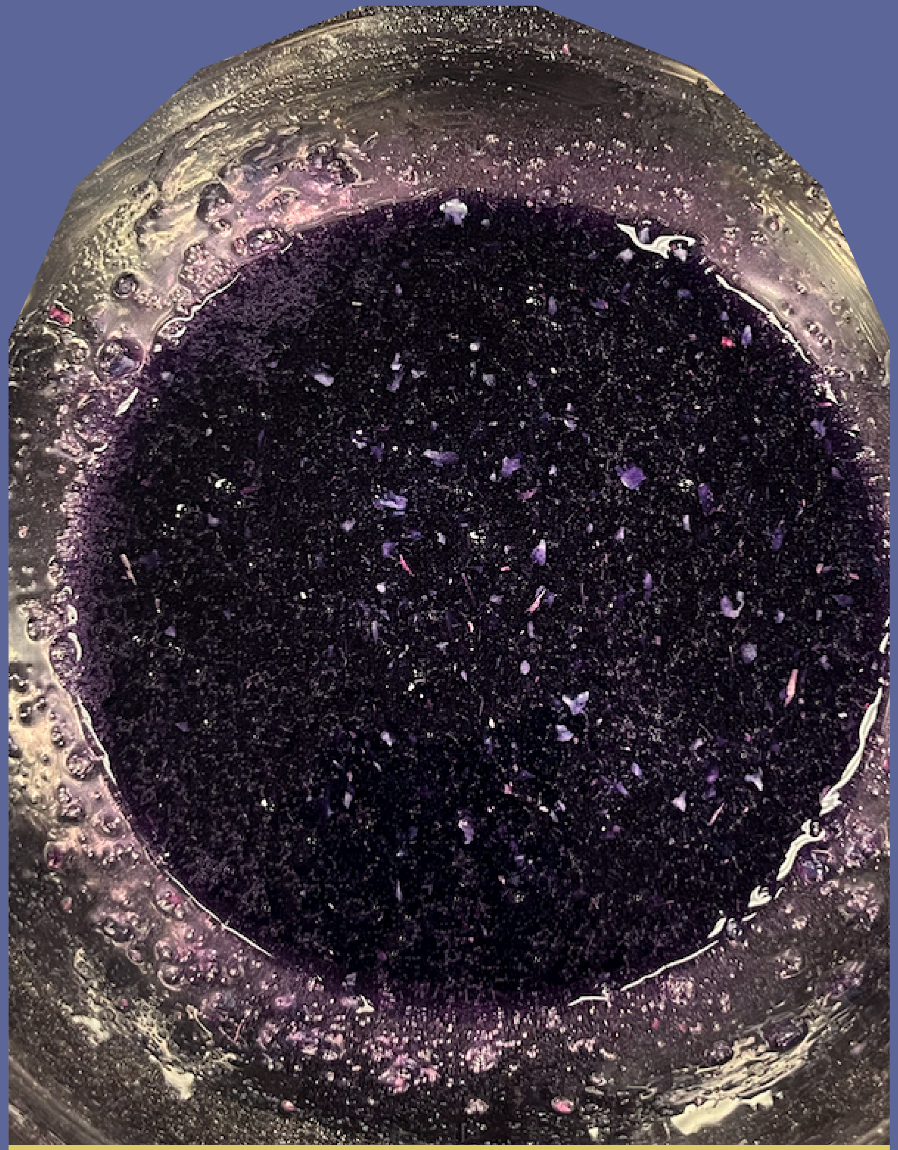
Materials

Process : Mix Solutions



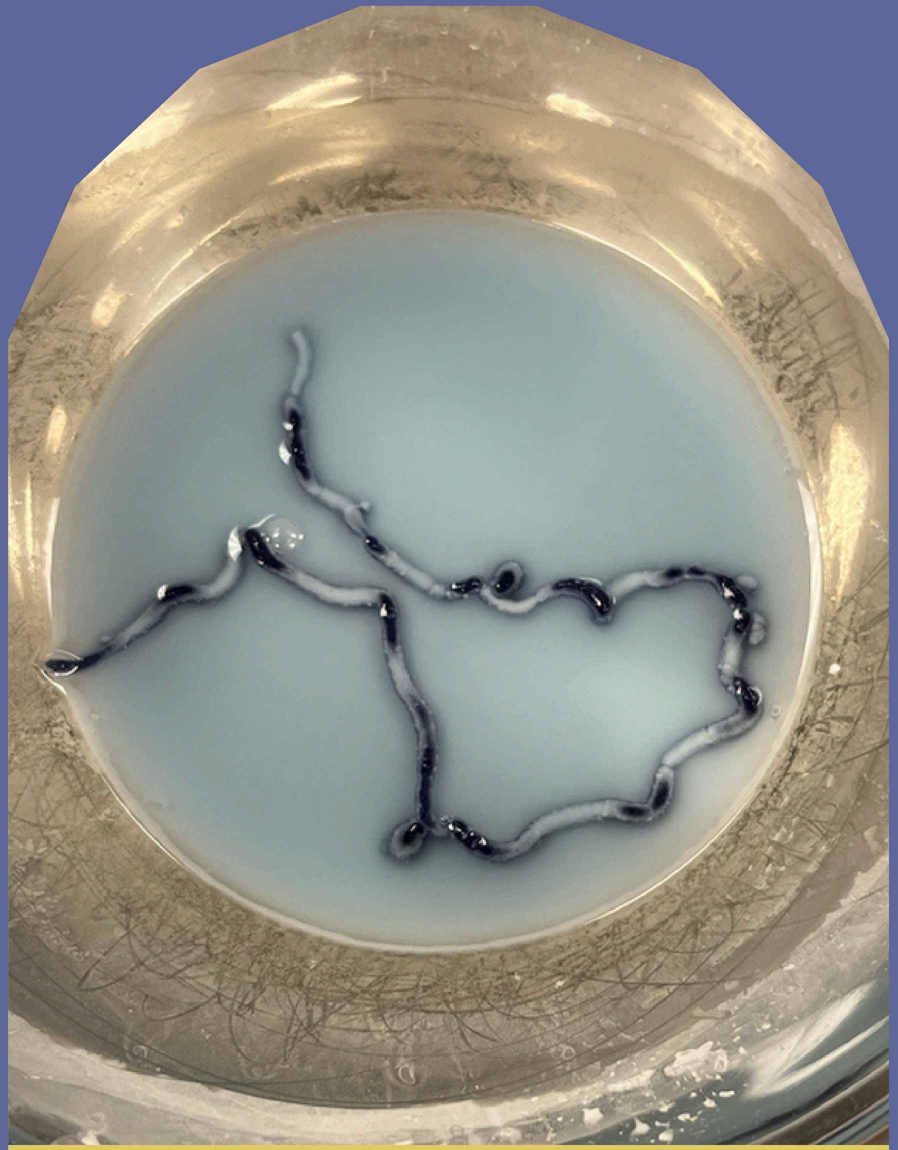
Curing

Water + Calcium Carbonate



Yarn

Water + Sodium Alginate + Chitosan + Red Cabbage Powder + Corn Husk Fibers



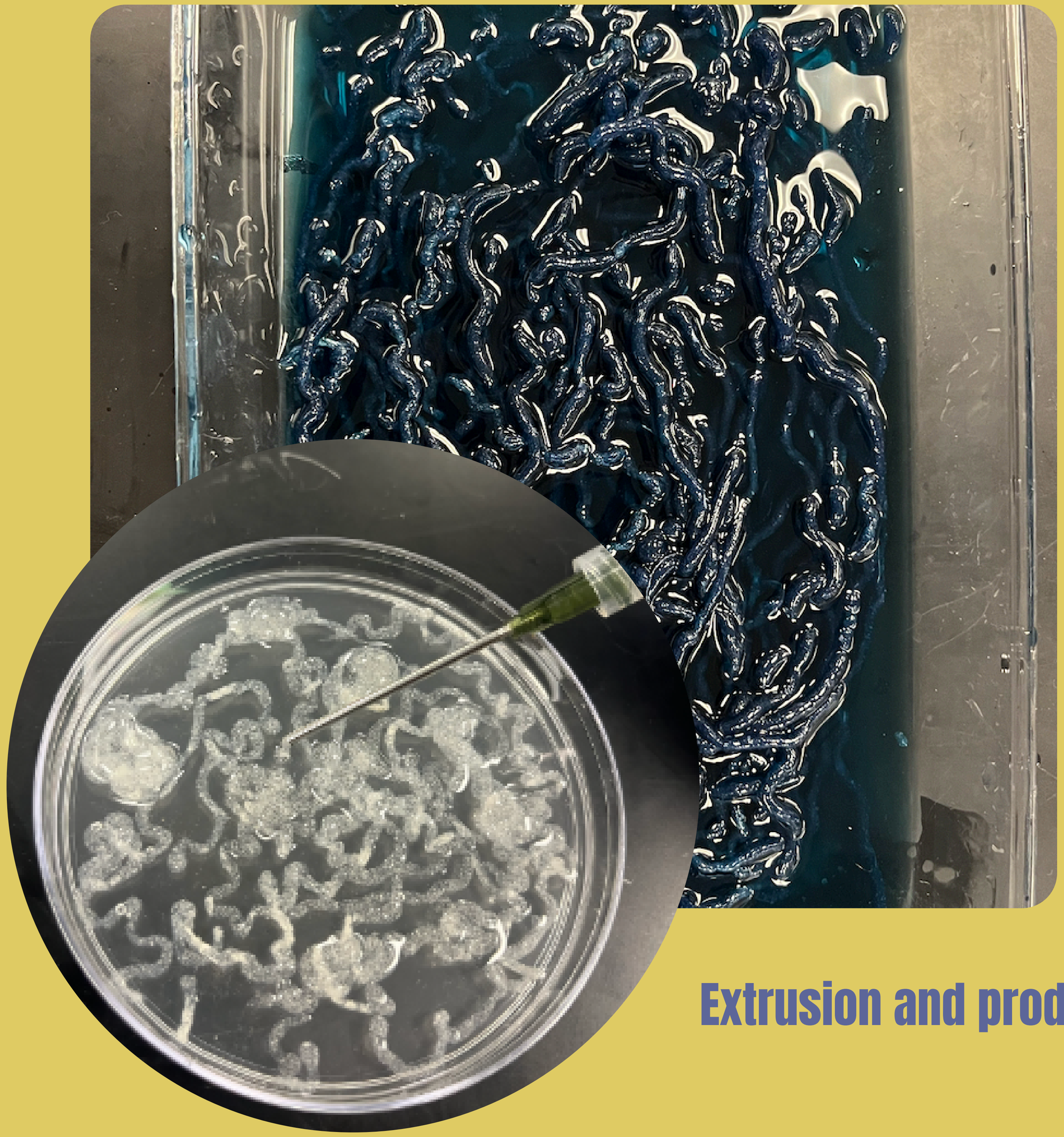
Scaling

Water + Tannic Acid + $CaCO_3$

Process : Extrude Yarn

2. <u>Extrude Yarn Solution into Curing Bath</u>

Fill a 80 mL syringe with the yarn solution. With controlled pressure, extrude the yarn solution into the curing bath. Once one filament is extruded allow it to sit in the curing solution for ~ 1 minute. Remove this piece and repeat the process. After all the yarn solution has extruded return the filaments to the curing solution to allow it curing for 24 hours.

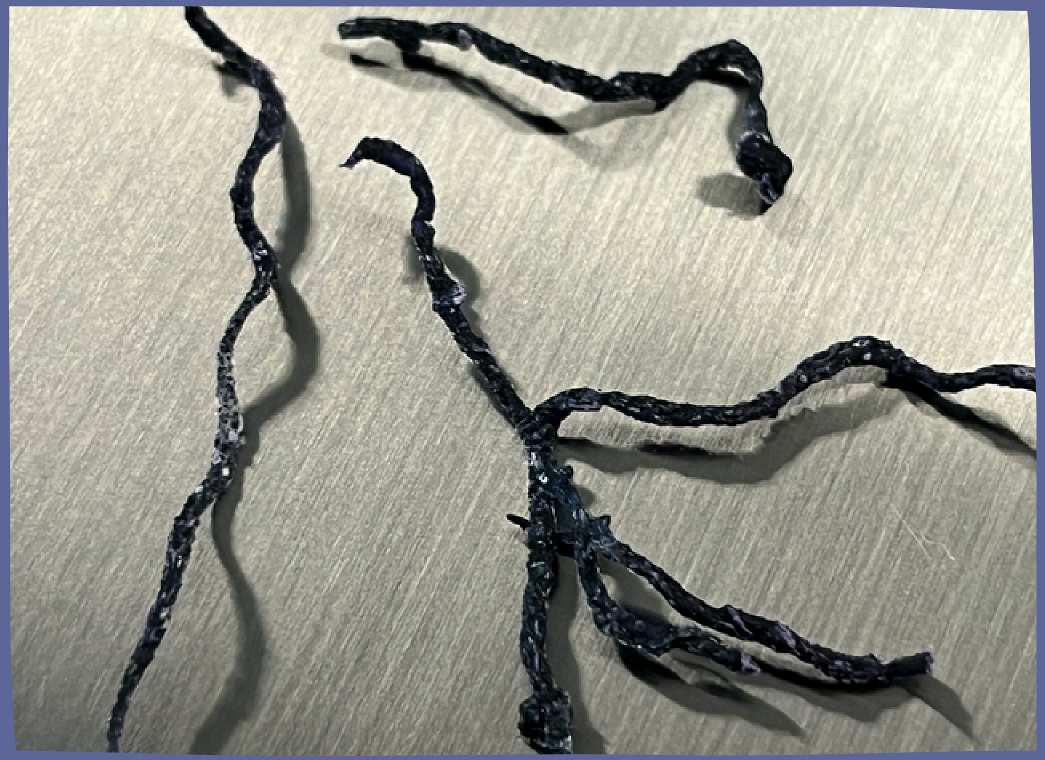


Extrusion and product!

Process: Scaling Bath

Before

After



Composition :

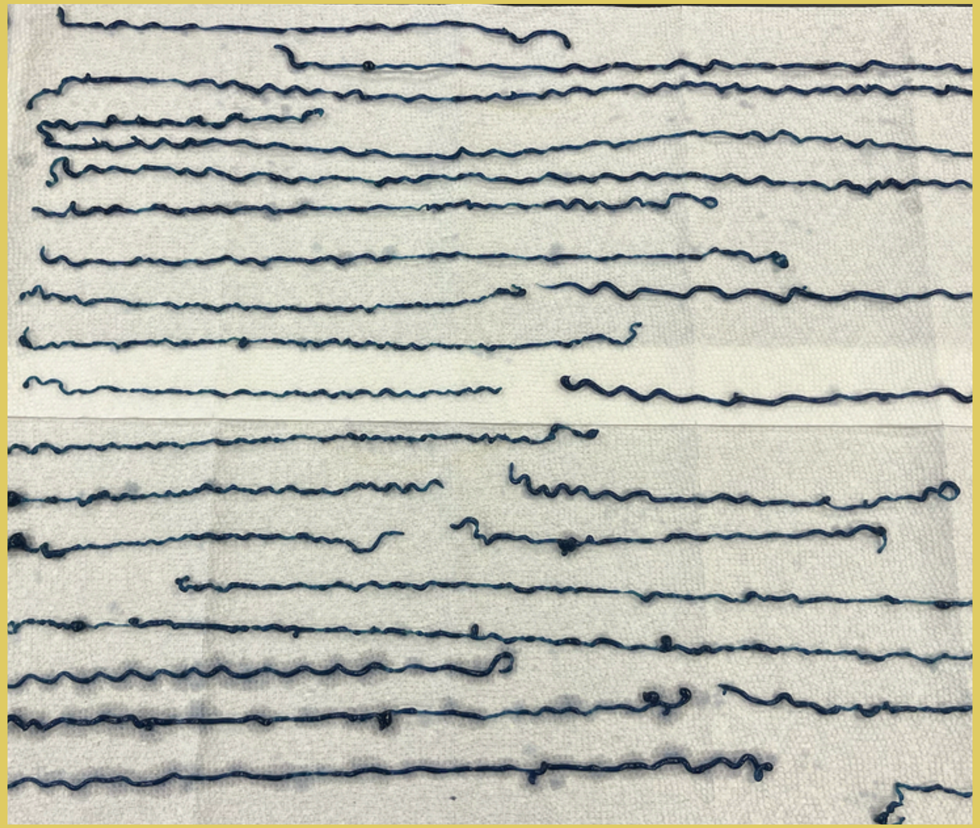
Water + Tanic Acid + Calcium Carbonate

5% Solution (equal parts tanic acid and carbonate)

Process:

Mix warm water, Tanic Acid, and Calcium carbonate in a bowl. Agitate the mixture to ensure an even mix of the ingredients.Allow yarn to sit in the bath for 20 minutes. Rinse the yarn and allow it to dry.

Process: Drying & Assembly



Results + Final Samples

After undergoing the scaling baths, the yarn became too brittle to test its felting abilities. Visual and tactile examinations confirmed the formation of scales on the yarn surface. Future adaptations of this experiment should explore alternative methods for implementing scaling to preserve the yarn's integrity.

Stress tests were performed on the strengthened bio-yarn and the improved recipe yields:

- *20% increase* in tensile strength compared to previous formulations
- While the yarn is susceptible to breaking under stress, it can withstand pressures of up to *65* psi
- Remains stable in both hot and cold water environments for up to *five* hours.

Hand Knitted Sample

4" X 4"
Purl & Knit Stitch
Long Tail Cast On

Inteded Product

Future Fibers: Strengthening Bio-yarn through Felting and Enhanced Textile Techniques

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Introduction

The development of sustainable textiles is a pressing priority in the effort to reduce the environmental impact of the fashion and design industries. This research focuses on strengthening plant-based bio-yarns through felting techniques to improve their structural integrity and versatility. By incorporating materials such as sodium alginate, calcium chloride, corn husk fibers, and chitosan, this project explores innovative methods to enhance the performance and durability of bio-yarns.

The aim is to bridge the gap between experimental bio-textiles and practical applications, creating materials that are not only environmentally friendly but also functional for diverse design contexts. This work contributes to the growing field of biomaterials by refining processes and expanding the possibilities for plant-based alternatives to conventional textiles, demonstrating their potential to meet modern demands for sustainability and creativity.

Research Goal

The goal of this research is to develop a plant-based bio-yarn that diverges from traditional keratin-based yarns, utilizing natural, sustainable sources to create a stronger alternative to existing bio-yarn recipes.

By developing alternative material compositions, the research aims to produce a bio-yarn capable of being felted, expanding its versatility and potential applications in textile design while maintaining a commitment to environmental sustainability.

Methods

To create the bio-yarn, two solutions were prepared:

Yarn Solution: A mixture of sodium alginate, chitosan, red cabbage powder, corn husk fibers and water was combined to serve as the base material for the yarn. The sodium alginate provides a gel-like structure, chitosan enhances durability, and red cabbage powder introduces natural pigmentation and elasticity. The corn husk fibers provide a solid structure for the solution to cure around.

Curing Solution: A bath was prepared using calcium chloride dissolved in water. This solution acts as a crosslinking agent, enabling the solidification of the yarn upon immersion. The yarn solution was extruded into the curing solution using a syringe to create uniform strands. After the yarn is formed, filaments will be submerged in a solution of Tannic Acid and Calcium Carbonate. Once submerged, the calcium ions from the curing bath interact with the sodium alginate in the yarn solution, forming crosslinked scales on the yarn surface. This scale formation is critical for enabling felting, as it mimics the structural properties found in keratin-based fibers.

After sufficient curing time, the bio-yarn was removed, rinsed, and dried. The resulting material was tested for its ability to felt, structural integrity, and potential applications in sustainable textile development.


Fig.1 Bio-yarn Representation

Figures and Results

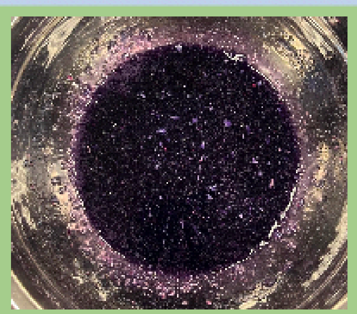
Fig.2 Bio-yarn solution

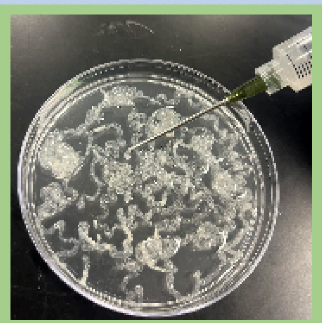
Fig.3 Bio-yarn extruded into curing solution


Fig.4 Bio yarn after scaling chemical bath

Increased Strength:
The bioyarn demonstrated a 20% increase in tensile strength compared to preexisting bio-yarn recipes. Tensile strength tests showed that the yarn can withstand stretching and weights up to 1lb.

Scale Formation:
Submersion in the tannic acid and calcium carbonate scaling bath successfully resulted in the development of crosslinked scales on the yarn surface. The yarn showed visible texture and the hand of the yarn was more textured than the control bio-yarn.

Brittleness Challenge:
While the scaling bath enhanced structural properties, it introduced brittleness to the yarn. The treated yarn could no longer be stored in the curing solution, posing limitations for prolonged handling and storage. This suggests that adjustments in the scaling process or composition may be necessary to balance durability and flexibility.

Conclusion


Fig.5 Final Knitted Sample

The bio-yarn developed in this study demonstrated significant advancements in strength and durability, achieving a 20% increase in tensile strength compared to previous formulations. This improvement is attributed to the synergistic contributions of red cabbage powder, chitosan, and corn husk fibers, which enhanced the yarn's elasticity, durability, and structural integrity. While the yarn is susceptible to breaking under stress, it can withstand pressures of up to 65 psi and remains stable in both hot and cold water environments for up to five hours.
The scaling baths successfully introduced crosslinked scales on the yarn surface, a crucial feature for potential felting applications. However, the chemical bath process increased the yarn's fragility, preventing further testing to confirm its felting capabilities. Future research will focus on optimizing the scaling process to reduce brittleness while preserving the yarn's enhanced properties, enabling its application in sustainable textile development.

Acknowledgments

I would like to express my gratitude to Professor Jessica Ciarla for her guidance, support, and mentorship throughout this project. Her expertise and encouragement were instrumental in bringing this research to fruition. I would also like to extend my thanks to the other lab members, whose collaboration and mutual support created an inspiring and uplifting environment. This project would not have been possible without the collective effort and dedication of everyone involved. Special thanks to the Stengyl Wyer Researchers for their guidance and support.

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