



# EXIT- posters

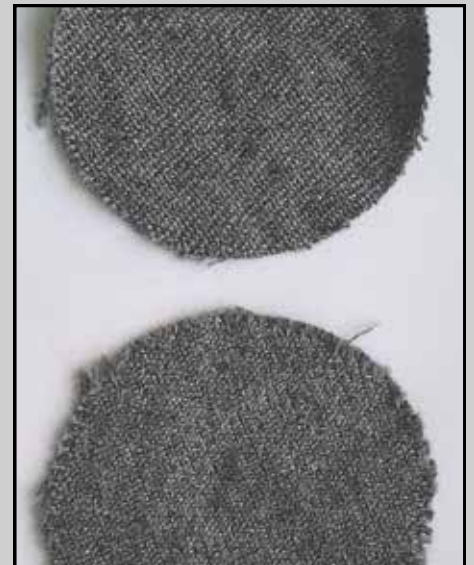
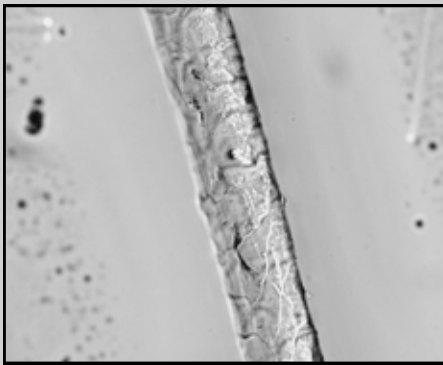
Graduates 2025

*Master's programmes in  
Textile Technology  
and Innovation*

# Water and wind resistant wool fabric

## - Weaving with Gotlandic Swedish semi-worsted yarns

Moa Ekvall, MSc Technical Textile Innovation



### Aim:

- Developing a fabric for outer layers that offers light to medium protection against rain and wind.
- Increase the utilisation of female Gotlandic sheep wool, a fibre that is available in large quantities and need to be put to usage.

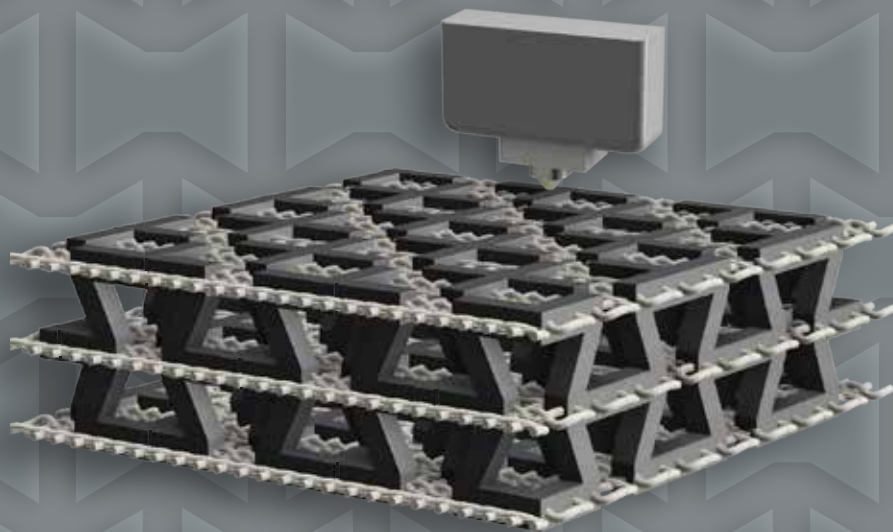


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# 3D-PRINTED AUXETIC STRUCTURES WITH TEXTILE INTEGRATION

*- DESIGN TOWARDS ADAPTIVE  
TEXTILE HYBRID SYSTEMS*



**AN EXPERIMENTAL STUDY ON HOW TEXTILE INTEGRATIONS  
AFFECT THE AUXETIC PROPERTIES OF RE-ENTRANT  
METAMATERIAL.**



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# THE ROLE OF EGGSHELL-DERIVED BIOCERAMIC COATINGS ON TEXTILE SCAFFOLDS FOR BONE TISSUE ENGINEERING

*How might textile engineering and eggshells advance the circular economy and healing of broken bones?*

## THE NEED

*Eggshells are underutilized—but they're a promising renewable calcium source*

*Conventional metal implants don't support natural healing and remain in the body*

*Textile engineering offers a biocompatible, biodegradable alternative—designed to heal*

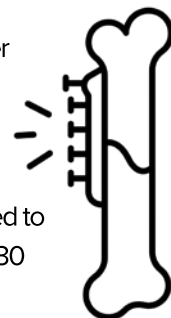


1/3

patients experience chronic pain after bone graft harvesting, a common treatment for bone fractures

2.7

million tons of eggshells are expected to be wasted globally each year by 2030



## OBJECTIVES

### Turn waste into value

Instead of discarding eggshells, show how they can be turned into useful material for medical applications.

### Engineer an improved implant

Develop a biodegradable scaffold that supports the body's natural healing process.

### Evaluate scaffolds

Study how human cells interact with the scaffolds in the lab to see if they are safe and can support the cells towards healing the bone.

## THE METHOD

1 PHA filaments fabricated through braiding

Biodegradable Textile Scaffold

2 Bioceramics produced from eggshells

Hydroxyapatite (HA)

Carbonated Hydroxyapatite (CHA)

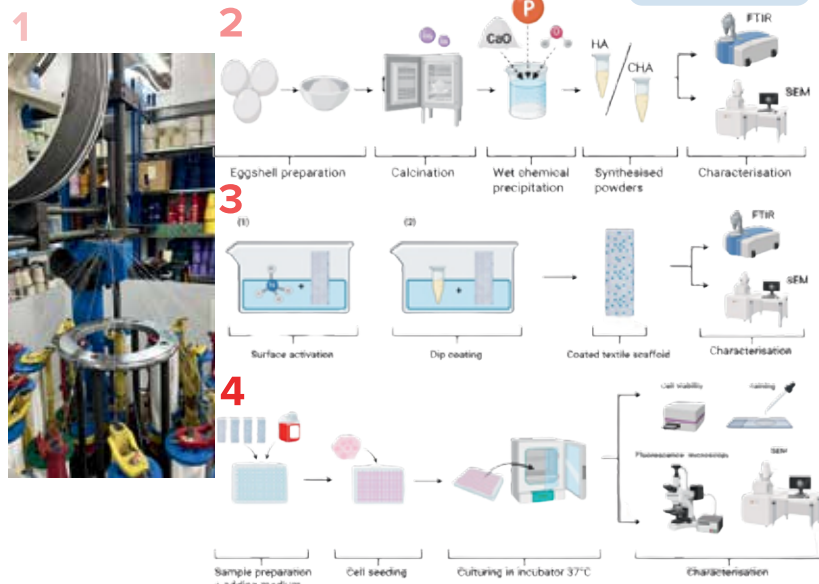
3 Bioceramic coatings applied on the textile scaffolds

100% HA

100% CHA

4 Bioceramics coated scaffolds tested for biocompatibility and bone-forming potential

50/50% HA/CHA



## THE FINDINGS

### Eggshells → bioceramics:

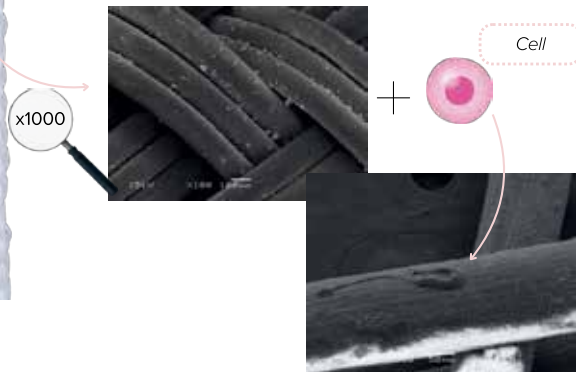
- HA and CHA were successfully turned into bone-like inorganic materials (HA and CHA) from eggshells, with yields of 47% and 49%, respectively.

### Application of coating:

- Bioceramic particles were clearly observed on the surface of the textile scaffold using a specialized microscope.

### Cells response:

- All scaffold types, coated and uncoated, were biocompatible.
- Coated scaffolds improved early cell attachment and spreading compared to uncoated.
- HA-coated scaffolds supported the stem cells to turn into bone-like cells.



## WHAT IT ALL MEANS

- Eggshells can be recycled into useful bioceramics for medical use.
- The process was simple, low-cost, low-temperature and is promising for scalability.
- All materials were safe for stem cells without showing any toxic responses.

→ Cells survived on biodegradable textile scaffolds with bioceramic coatings: a way towards sustainable and effective bone healing treatments.

## FUTURE IMPACT

**Circular Economy** Turning food waste (eggshells) into high-value biomedical materials.

**Medical Innovation** A less invasive, more natural solution for patients needing bone healing treatments

**New Avenues for Textile Engineering** Demonstrating how textile technology can power healthcare solutions.



# Cellulose Isolation and Wet Spinning of Protein Extracted Clover Grass

- Material and Process Development of Non-Wood Regenerated Cellulose Fibres

**Julia Ronkainen**  
Master Student in Textile Technology  
University of Borås

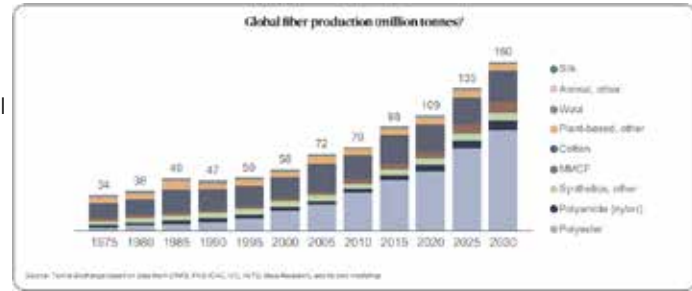


## BACKGROUND:

- There is a globally increasing demand for textiles
- A cellulose gap has been identified, a larger demand than supply
- Non-wood regenerated cellulose fibres have sustainable growth potential

This thesis is part of the EU project Green Valleys 2.0, where **green biorefineries** are explored to process grass and clover into different fractions:

- Primary product:** Protein for animal feed to replace imported soy
- Bioproduct:** Fibre-rich protein extracted clover grass (press cake)



## Growing grass and clover is beneficial for:

- Biodiversity
- Increased soil carbon storage
- Reduced nutrient leakage
- Positive crop rotation effects, e.g. minimised weed



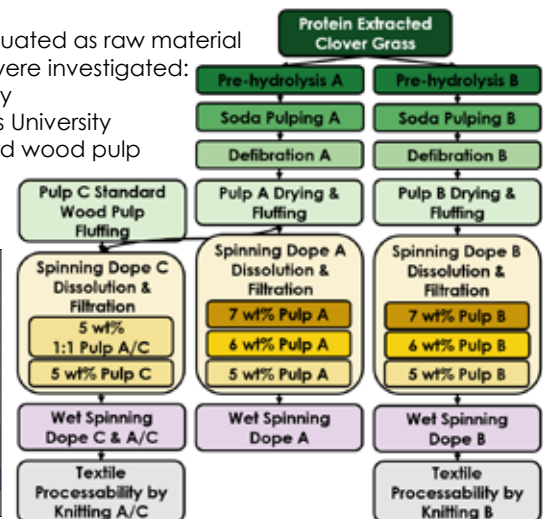
**Hypothesis:** Compared to a conventional regenerated cellulose fibre, the regenerated cellulose fibre from protein extracted clover grass will have equal performance.

## THESIS SCOPE:

Protein extracted clover grass was evaluated as raw material for textile production. Three scenarios were investigated:

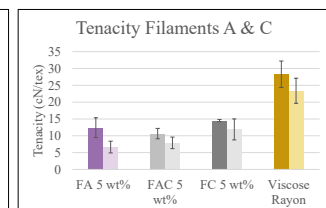
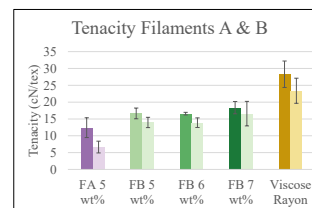
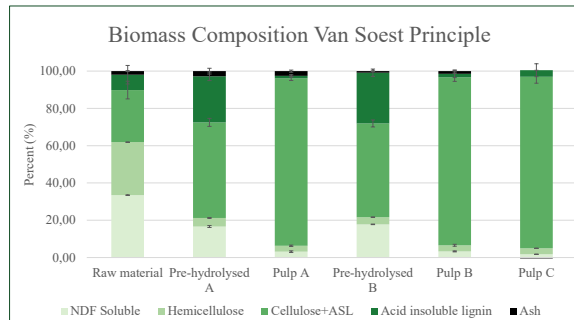
- A:** Pulp produced at Chalmers University
- B:** Pulp process refinement at Aarhus University
- C:** Blending 50/50% pulp A with standard wood pulp

Analysation Method/Material	Protein Extracted Clover Grass	Pre-hydrolysed Biomass	Pulp	Spin Dope	Filament Yarn
Van Soest Principle*	X	X	X		
CHN(O)S		X	X		
FTIR			X		
Crossover Point				X	
Polarised Microscope				X	
Lightness*					X
Linear Density, Elongation at Break*, Tenacity* & Initial Modulus*					X
Cross-Section Shape					X
Textile Processability by Knitting					X



## RESULTS & CONCLUSION:

- Protein extracted clover grass is suitable for textile production!**
- Cellulose isolation of protein extracted clover grass is possible with high purity
- Process refinement (scenario B) resulted in filaments more similar to viscose
- Textile processability was achieved by both process refinement (scenario B) and blending with 50% wood pulp (scenario C)



I'm forever grateful to everyone who has been involved.  
Thank you!

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AARHUS  
UNIVERSITY  
DEPARTMENT OF BIOLOGICAL AND CHEMICAL ENGINEERING



WARGON  
INNOVATION

GREEN  
VALLEYS



# SUSTAINABLE WOOD FIBERS FOR AUTOMOTIVE TEXTILE APPLICATIONS



**Authors** Kashif Munir (1), Sumit Sharma (1), David Maibach (2), Anneli Wörn (3)

**Affiliations** (1) University of Borås; (2) Polestar; (3) Borgstena

## ABSTRACT

With rising demand for sustainable alternatives in the automotive textile sector, this study explores a hybrid method for extracting wood-based fibres using mechanical drafting and ultrasonic vibration. Initial tests analysed fibre properties using FTIR and single fibre testing. Ultrasonic treatment, applied post-drafting, improved fibre looseness and separation efficiency. Cavitation forces aided lignin and pectin removal, reducing the elastic modulus from 8 GPa to 3.4 GPa, indicating 58% decrease and enhancing flexibility and spinnability. This eco-friendly approach offers a scalable solution for sustainable fibre production.

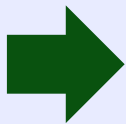


Figure 1: Replacing Chemical Treatments with Mechanical Methods

## RESULTS

The hybrid method significantly improved fibre separation. Mechanical drafting at a 45° angle led to better fibre opening compared to axial feeding. When followed by ultrasonic treatment at 360 W and 100% amplitude, separation efficiency increased markedly, particularly in pre-drafted samples. The elastic modulus dropped from 8.0 GPa to 3.4 GPa—a 58% reduction—enhancing flexibility and spinnability. Post-treatment fibres also showed improved elongation and cleaner filtrates, validating the effectiveness of combining mechanical and ultrasonic methods for sustainable fibre processing.

## CONCLUSION

This study demonstrates that combining mechanical drafting with ultrasonic vibration offers an effective, chemical-free method for separating wood-based fibres. The hybrid approach improved fibre flexibility, separation efficiency, and spinnability, making it a promising solution for sustainable textile applications, particularly in the automotive sector.

## REFERENCES

- [1] Patil, S.V., Rane, A.V., and Kanny, K. (2022). Ultrasonic Cavitation: An Effective Cleaner and Greener Intensification Technology.
- [2] Majeed, K., Khan, S., and Nasir, A. (2023). Innovative Design of a Continuous Ultrasound Bath for Effective Pretreatment of Lignocellulosic Biomass.
- [3] Singh, J., Kumar, A. and Sharma, S. (2022). Hydrodynamic Cavitation for Lignocellulosic Biomass Pretreatment: A Review. Bioresources and Bioprocessing.

## OBJECTIVE

The objective of this thesis is to develop a sustainable hybrid method for efficient separation and improved spinnability of wood-based fibres using mechanical and ultrasonic treatments without the use of any chemicals.

## METHODOLOGY

The following methods were used to investigate and optimise the fibre separation process:

- Mechanical Characterization
- Chemical Characterization
- Mechanical Drafting
- Ultrasonic Treatments
- Fiber Characterization



Figure 2: Results from Drafting. (a) Initial Sample with increased water content of 400% after passed through the drawing frame along the fiber axis (b) Initial Sample with increased water content of 400% after passed through the drawing frame at 45° orientation

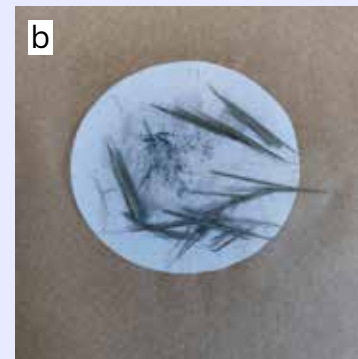
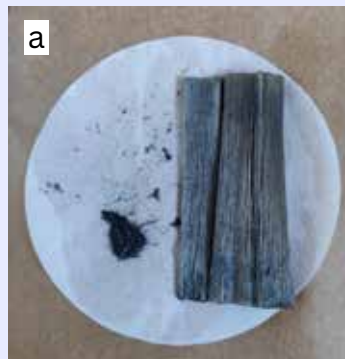


Figure 3: Results from ultrasonic treatments. (a) Filtrate obtained from the Ultrasonic treatment of untreated pulp (b) Filtrate obtained after the ultrasonic treatment of the sample passed through the drawing frame

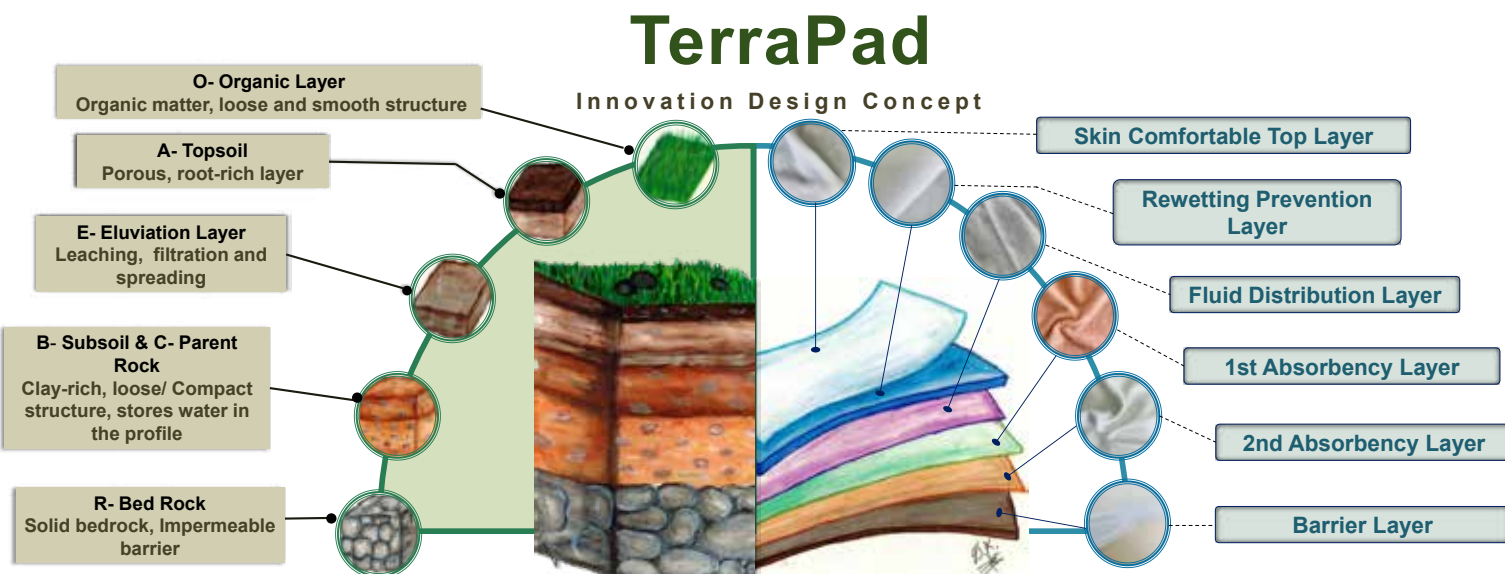
# Biomimicry- Inspired Reusable Incontinence Pad Development

Presented by Dilma Kulasena



### Abstract

The project aims to explore effective product development by evaluating biomimicry innovation theory to create a lightweight product with maximum performance. The purpose is to enhance the quality of life for users and promote environmental sustainability by reducing waste from disposable products.



### Problem Description

- Approximately 40% of women and 11% of men experience light urinary incontinence<sup>1</sup>.
- Disposable product pads produce over 6,600 tons of solid waste daily<sup>1</sup>

### Results

#### Prototype design and testing

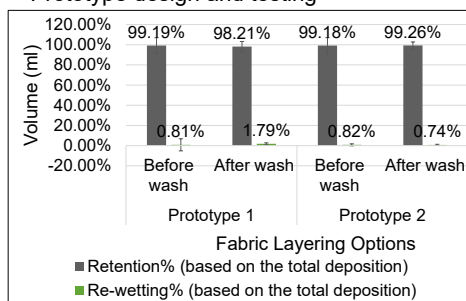


Figure 4. Prototype testing before and after 10 wash tests.

	Absorption Capacity (ml)	Average Weight (g)
Prototype 1	199.25	33
Prototype 2	136.7	25

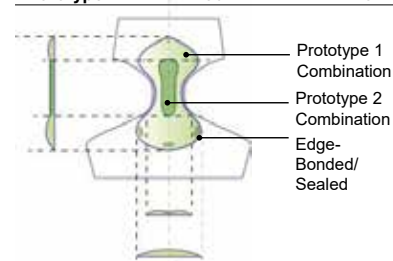


Figure 5. Prototype test results and performance

### Material & Method

#### Material structure analysis

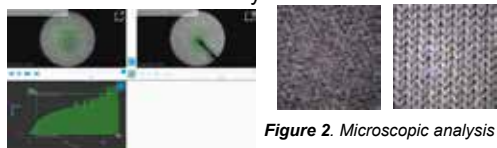


Figure 2. Microscopic analysis

#### Fluid spreading analysis

- Fluid absorption, rewetting, leakage, retention capacity, vertical spreading and horizontal spreading analysis

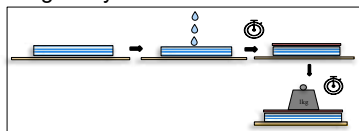


Figure 3. Retention, leakage and rewetting test procedure

#### Prototype design and testing

### Conclusion

The biomimicry of soil horizon theory aligns well with human fluid absorption and retention-related developments in textile-based products.

Examples: Advanced wound dressing (provides moisture control, fluid absorption and bacterial filtration), Bioactive components (healing while oxygen permeability), menstrual pad, Smart bandages for burns (natural healing)

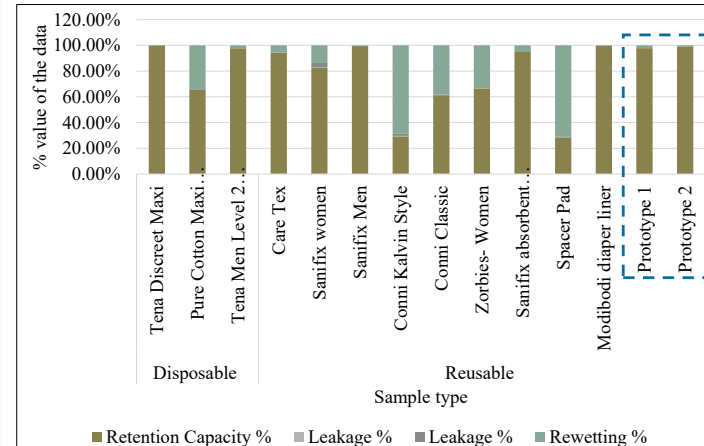


Figure 6. Prototype functionality comparison with the other reusable and disposable incontinence

### Acknowledgement

All the lecturers and academic staff of the University of Borås

### References

<sup>1</sup> Minassian, V.A., Bazi, T. & Stewart, W.F. (2017). Clinical epidemiological insights into urinary incontinence. *International Urogynecology Journal*, [online] 28(5), pp.687-696. doi:https://doi.org/10.1007/s00192-017-3314-7.

Video Introduction



Kulasena, 28.05.2025

# SMART TEXTILES FOR STROKE REHABILITATION

A STUDY WITH A HUMAN CENTRED DESIGN APPROACH TO EXPLORE THE USABILITY OF A SMART TEXTILE BIOFEEDBACK SYSTEM WITH SEMG FOR HOME-BASED AND CLINICAL STROKE REHABILITATION		
<b>AUTHOR</b> Saga Ingerholt. Master student in Technical Textile Innovation (TAMTI23)		<b>AFFILIATIONS</b> Swedish School of Textiles
<b>INTRODUCTION</b>  STROKE IS ONE OF THE LARGEST REASONS FOR ADULT DISABILITY AND AMONG THE MOST COMMON POST STROKE CONDITIONS IS MOTOR DISABILITIES IN UPPER LIMB. THIS EFFECTS THE EVERYDAY LIFE AND INDEPENDENCE OF STROKE SURVIVORS. SMART TEXTILES THAT CAN MEASURE AND COMMUNICATE THE MUSCLE ACTIVITY USING TEXTILE ELECTRODES COULD HELP WITH AN ENGAGING REHABILITATION THAT COULD BE PERFORM IN HOME ENVIRONMENTS. THIS COULD SAVE RESOURCES IN THE HEALTHCARE AS WELL AS INCREASE THE LIFE QUALITY FOR INDIVIDUALS.	<b>AIM</b>  The aim of this study is to explore how smart textiles with biofeedback can support upper limb stroke rehabilitation by identifying user needs and evaluate these from a Human Centred Design approach	<div>Previous research developed at The Swedish School of textiles which is the foundation for this study. A knitted sleeve with sEMG electrodes and biofeedback.</div> 
	<b>METHODOLOGY</b>  Thie methodology used fror this study was <b>Human Centred Design</b> using a qualitative approach: <ul style="list-style-type: none"><li>Semi structured Interviews - analysis <b>FITT-framework</b>.</li><li>Focus group discussion (evaluation)</li><li>Low, mid and high fidelity prototyping</li></ul> Participant were professionals working with stroke rehabilitation and included physiotherapist and occupational therapists.	
	<b>RESULTS/FINDINGS</b>  The semi-structured interviews resultet in three main user needs: <ul style="list-style-type: none"><li>The technolugu should be easy to understand and use</li><li>The technology should motivate the patient to perform training</li><li>The technology should include functional movements</li></ul> These needs were used to evaluate low-mid fidelity prototypes in a Focus group discussion which then resulted in two final high fidelity prototypes. <ul style="list-style-type: none"><li>Prototype 1: Targets muscles in hand and forearm</li><li>Prototype 2: A full sleeve that targets muscles in both forearm and upper arm</li></ul>	
	 <div>BIOFEEDBACK ENABLE REAL TIME COMMUNICATION OF THE MUSCLE ACTIVITY MEASURED BY THE SEMG ELECTRODES. THE ACTIVITY IS SHOWN IN AN APP AND ENABLES REHABILITATION.</div> <div>SUGGESTED LAYOUT DESIGN OF THE APP CONNECTED TO THE TEXTILE SLEEVE WERE CREATED. THE APP CAN HELP THE USER TO CHECK THE POSITION OF THE ELECTRODE TO ENSURE THAT THE SEMG ELECTRODES WILL CAPTURE THE MUSCLE ACTIVITY.</div> <div>THE APP CAN SEND MOTIVATING MESSAGES DURING TRAINING TO HELP THE USER REACH THEIR GOALS. A PROTOTYPE OF THE APP WAS OUTSIDE THE SCOPE OF THIS STUDY, ONLY SUGGESTED DESIGN LAYOUT WAS PRESENTED.</div>	
	<b>DISCUSSION</b>  The most significant finding was that the technology must be simple for a successful integration. This means few design features and few steps to operate.  Furthermore, lack of motivation and not being able to see the progress are challenges that many stroke survivors face. This is connected to usability and that the technology must be simple to understand, otherwise the technology might be opted out. This supports the Human Centred Design approach where the users are involved in the design process to always stay focus on the needs of the user.	<b>CONCLUSION</b>  Home based rehabilitation using a smart textile biofeedback system could contribute to less resources needed in the healthcare when looking at time and money. An effective rehabilitation would not only lead to less care needed for stroke related injuries but also an increased life quality for stroke survivors.

# Supercritical carbon dioxide dyeing of cellulosic woven textiles using madder dye and gallnut mordant.

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## Introduction

Supercritical carbon dioxide (scCO<sub>2</sub>) dyeing technology is identified as a greener dyeing technology for synthetic materials. But the usage of scCO<sub>2</sub> dyeing for cellulose is challenging due to the inability to make the reactive dyes solvable in scCO<sub>2</sub> and the inability of non-polar scCO<sub>2</sub> to weaken the strong hydrogen bonds and swell the cellulosic fibers to facilitate the reach of dyestuff into the inner fiber structure. This research explores the ability of madder (*Rubia Tinctorum* L.) as a natural dye and gallnut (*Quercus Infectoria*) as a natural mordant in scCO<sub>2</sub> dyeing with the collaboration between the university and the industry (Mission 0 House) aiming at omitting emissions in the industry. The experimental work is conducted in laboratory settings and only cotton and modal are examined as cellulosic fibers.

## Materials & Methods

### Experimental planning

- A four-factor full factorial design is utilised.
- High-level parameters are color-coded with white and low-level parameters are color-coded with yellow.

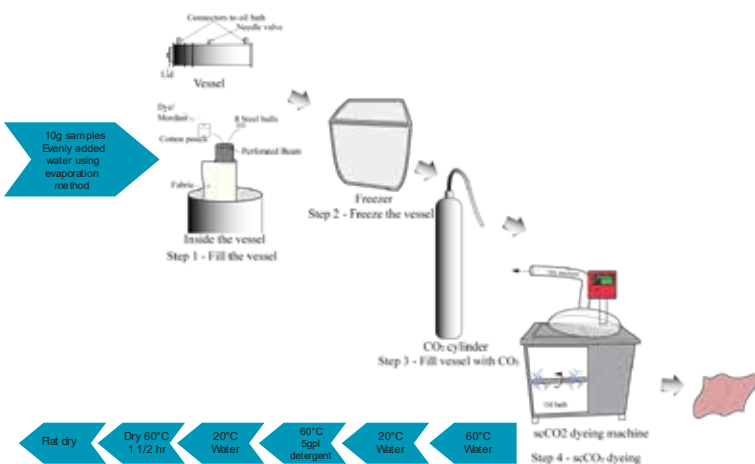
Factor	Level (H) - 1	Level (L) - 2
Mordant concentration (wt%) - m	1	0
System temp (°C) - t	150	120
Dyeing time at max temp (Same ramping speeds) - d	60	90
Auxiliary addition - Water (wt%) - w	50	0

### Main materials used

- 50/50 cotton/modal woven fabric
- Madder Rich Extract powder
- Finely ground Gallnut
- De-mineralized water

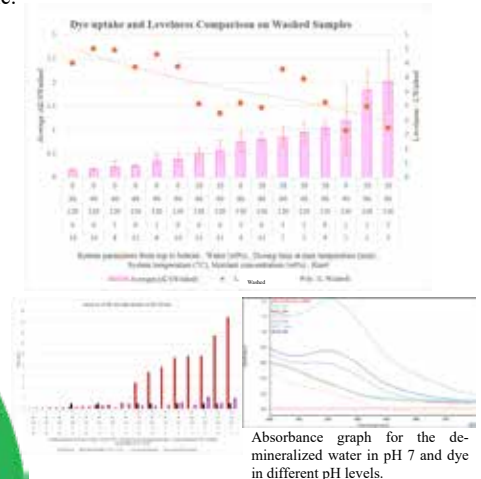
### Dyeing and Finishing

- Dyeing was performed in LABCOM – RAPID COLOR CF/SF TYPE LA2002 machine



## Results

- Dye uptake -  $\hat{Y} = 0.48855m + 0.00401t - 0.00403d + 0.01174w$   
;  $0 \leq m \leq 1, 120 \leq t \leq 150, 60 \leq d \leq 90, 0 \leq w \leq 1$
- Cotton showed significant dye uptake than modal.
- Color levelness is negatively influenced by the presence of water and initial creases of the raw fabric.



## Sustainability and Innovation

### Advantages;

Safe materials, waste as input, creating agriculture & processing related jobs, circular technology, reduced water consumption

### Challenges;

Obsoleting existing industry by a disruptive innovation, water and land consuming, risk of damaging current ecosystems, consistency related problems with plant-based material, inability to omit water consumption

## Conclusion

- Madder shows the possibility to use in scCO<sub>2</sub> dyeing for cellulose.
- Dye uptake is positively influenced by the presence of mordant, water, and the increment of temperature while duration affects negatively.
- The presence of water in the fabric highly affects the color levelness in a negative way. Water added to the system should be optimized to achieve both dye uptake and levelness.
- Madder dye is highly sensitive to pH changing color. So, measuring fixation using color data would not be a suitable method.

## Future Research

- Observe effect of pressure and find optimum water to achieve both uptake and levelness.
- Explore the possibility of scCO<sub>2</sub> dyeing focusing on cotton.
- Observe effect of an alkali on final color.
- Explore the possibility using pH sensitivity of Madder for a textile sensor.
- Find other ways to measure fixation.

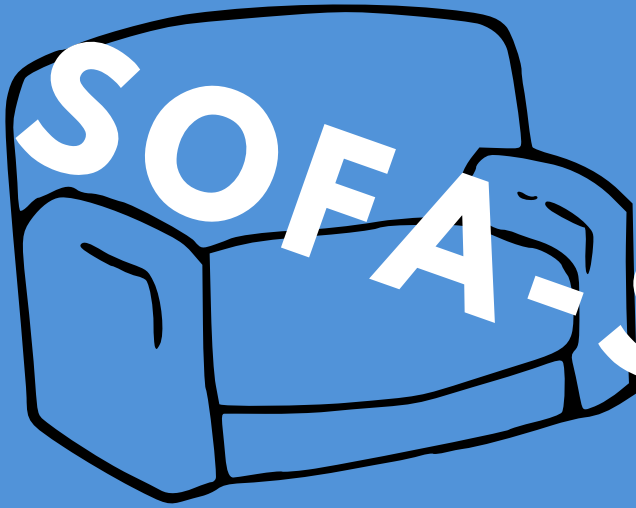
## Acknowledgment

Special thanks to University of Borås, Veronica Malm, Anneli Wärn, David Rehnlund Maibach





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# STICATED DRAPE



BY

AUGUSTA JERKERSSON, SELMA SVENSSON

## EVALUATING THE INFLUENCE OF FABRIC PROPERTIES ON DRAPE BEHAVIOUR IN UPHOLSTERY FABRICS INTENDED FOR THE USE OF SOFAS

### AIM

The purpose of this thesis is to investigate fabric attributes, evaluate and conduct appropriate testing methods, and propose a value-ranking grid relating to the drape quality of fabric.

### METHODS

Crease recover, air permeability, shear stiffness, fabric thickness and drape were measured. Data received from IKEA was also evaluated on bending stiffness and thread density in warp and weft direction, fiber composition, weave structure, backing, elasticity in warp and weft direction and weight. Statistical analysis were done using Pearson's product-moment correlation coefficient. P-values below 0.3 considered statistically insignificant.

### RESULTS

Upon analysing the factors, it was found that the thickness, thread density and elasticity in the weft direction, shear angle and crease recovery in warp direction with the back side upwards had most influence on the fabric drape quality. However, only one of these properties reached a value of strong linear correlation, with a r-value of negative 0.617.

Factor	r-value
Elasticity Weft	-0.612
Shearing	-0.434
Thickness	-0.370
Thread density Weft	0.336
Crease recovery angle, back side, warp	-0.336

### CONCLUSIONS

Creating a value-ranking grid based on correlations between the drape coefficient and other fabric attributes was possible, however further studies on the subject is necessary due to the many factors differing between the specimen.