



Development and Analysis of Sustainable Sock

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ABSTRACT

The textile industry's environmental impact, particularly regarding high water consumption and pesticide usage in cotton production, necessitates sustainable alternatives. This research addresses this gap by investigating the development and analysis of sustainable socks utilizing a blend of hemp and cotton. Existing technologies fall short in providing eco-friendly solutions for textile manufacturing, highlighting the need for this study. The aim of this research is to determine the optimal blend ratio of hemp and cotton for producing sustainable socks that balance environmental benefits with user comfort. The problem statement lies in the lack of sustainable options in the textile industry, especially in the domain of sock manufacturing. Methods employed include material selection, blending, spinning, weaving, and rigorous testing of hemp-cotton blend samples to assess mechanical properties, moisture management capabilities, and odor resistance. Key findings of the study include the identification of an optimal blend ratio between hemp and cotton that maximizes sustainability without compromising comfort and functionality. Results indicate superior moisture-wicking properties and durability of sustainable socks compared to conventional cotton socks. The discussion interprets these results in the context of environmental impact and consumer satisfaction. Overall, the development and analysis of sustainable socks offer a promising solution to the textile industry's sustainability challenges.

Keywords: Sustainable textiles, hemp-cotton blend, sock development, environmental impact, consumer satisfaction, durability.

1. INTRODUCTION

The fashion sector is under rising pressure to implement sustainable practices in an era characterized by growing environmental concerns. This need covers every facet of the clothing manufacturing process, even the frequently disregarded field of socks. This study employs the combination of hemp and cotton fibers to create and analyze sustainable socks in response to this demand. Despite their small size, socks are an essential part of our daily life since they keep our feet warm, comfortable, and safe. But the traditional manufacturing methods used to make socks frequently have negative effects on the environment, including significant water and chemical usage as well as carbon emissions. On the other hand, combining hemp and cotton fibers offers a potentially effective way to lessen these negative effects on the environment. Because of its durability and sustainability, hemp is becoming more and more popular as an environmentally beneficial substitute for conventional textile materials. The characteristics of hemp are complemented by cotton, a popular natural textile, which increases breathability and comfort. Our goal in mixing these two fibers is to produce a sock that adheres to sustainability principles while also satisfying comfort and durability requirements. This paper explores the design, production, and material selection processes involved in the creation of hemp-cotton socks. In addition, a thorough examination of the environmental impact of producing these socks will be carried out, with particular focus paid to variables like energy and water consumption as well as carbon emissions. We hope that our research will add to the current conversation about sustainable fashion by offering useful information on the possibilities of hemp-cotton mixes in the production of socks. The objective of this study is to stimulate additional research and implementation of environmentally friendly substitutes in fashion design and production by highlighting the significance of sustainable practices in the apparel industry and providing a concrete illustration of innovation in sock production.

Nomenclature

Title: Development and Analysis of sustainable sock

1.1 Background of the Work

Globally, the textile industry is one of the main causes of resource depletion and environmental damage. There has been a noticeable shift in several industries, including fashion, toward the creation of eco-friendly alternatives as concerns over sustainability and environmental effect have grown. The idea of sustainable fashion has gained traction in response to this demand, focusing on the significance of utilizing components as well as manufacturing techniques that minimize environmental impact. Using hemp-cotton mixes is one of the many attempts in sustainable fashion that seems like a viable answer. Because of its adaptability and little requirement for fertilizer or pesticides, hemp is a sustainable crop that is also good for the environment. Hemp reduces the ecological imprint of the cloth while improving its durability and breathability when combined with cotton, another popular textile

ingredient. The creation and evaluation of sustainable socks made of a hemp-cotton blend is the main goal of this research. Everyday necessities like socks provide a useful platform for bringing eco-friendly materials into the mainstream fashion industry. Our goal in using hemp-cotton blends in sock manufacture is to show the viability and advantages of sustainable solutions in an area of clothing that is often disregarded. This study examines the entire process of making sustainable socks, from design and material selection to production and analysis. We want to offer important insights into the possibilities of hemp-cotton socks as a feasible and environmentally beneficial solution in the textile industry by looking at a variety of factors, including comfort, durability, and environmental impact. We believe that this project will further the continuous efforts to produce clothes in a more responsible and sustainable manner. We hope to lessen the textile industry's environmental impact and increase customer awareness of the value of choosing conscientious products by encouraging the use of hemp-cotton mixes in sock production

1.2 Objectives of the Proposed Work

The development and analysis of sustainable socks using hemp-cotton blends involve several sequential steps, as depicted in the flow diagram below:

1. Material Selection:

Selection of high-quality hemp and cotton fibers meeting sustainable sourcing criteria. Evaluation of the properties of individual fibers, including strength, durability, and environmental impact.

2. Blending Process:

Blending of hemp and cotton fibers in predetermined ratios to achieve the desired balance of sustainability and performance. Optimization of blend ratios through experimental testing to enhance fabric properties.

3. Spinning and Yarn Formation:

Spinning of the blended fibers into yarns suitable for knitting or weaving processes. Quality control measures to ensure consistency and uniformity of yarns.

4. Knitting/Weaving:

Knitting or weaving of the yarns into fabric panels for sock production. Consideration of design aspects such as texture, thickness, and elasticity to optimize sock performance.

5. Sock Manufacturing:

Cutting and sewing of fabric panels to create sock components, including the body, toe, and heel. Implementation of sustainable manufacturing practices to minimize waste and energy consumption.

6. Testing and Analysis:

Comprehensive testing of the sustainable socks to evaluate performance characteristics such as durability, breathability, and moisture management. Conducting environmental impact assessments, including life cycle analysis, to quantify the sustainability benefits compared to conventional socks.

7. Feedback and Iteration:

Solicitation of feedback from consumers and stakeholders to identify areas for improvement. Iterative refinement of the sock design and manufacturing process based on feedback and test results.

1.3 Proposed work

In the development and analysis of sustainable socks utilizing hemp-cotton blends, several key modules are proposed to facilitate the process effectively. These modules encompass various stages of research, development, and evaluation, each contributing to the overarching goal of creating environmentally friendly and high-quality socks. The proposed modules include:

Material Selection and Sourcing: In the Material Selection and Sourcing module, meticulous attention is paid to the careful curation of materials essential for the development of sustainable socks utilizing hemp-cotton blends. This process begins with an in-depth evaluation of available hemp and cotton fibers, considering factors such as their sustainability credentials, quality attributes, and compatibility with sock manufacturing processes. Sustainable sourcing practices are paramount, with a focus on partnering with suppliers who adhere to ethical and environmentally responsible practices throughout the production chain. Additionally, the module involves assessing the availability and consistency of the selected materials to ensure a reliable and uninterrupted supply chain. Through rigorous material selection and sourcing practices, this module lays the foundation for the creation of eco-friendly socks that meet stringent quality and sustainability standards, ultimately contributing to a more environmentally conscious textile industry.

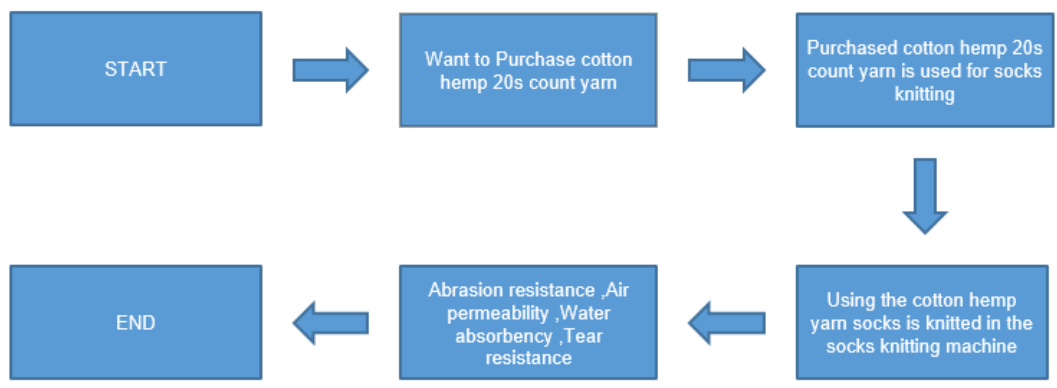
Blend Ratio Optimization: Blend Ratio Optimization is a critical aspect of the development and analysis of sustainable socks utilizing hemp-cotton blends. This module focuses on determining the ideal proportion of hemp and cotton fibers to achieve the desired balance of sustainability, durability, and comfort in the final product. The optimization process involves a systematic exploration of various blend ratios through experimentation and analysis. Initially, a range of blend ratios is selected based on literature reviews, industry standards, and preliminary testing. These ratios are then subjected to rigorous testing

and evaluation to assess their impact on key performance indicators such as tensile strength, abrasion resistance, moisture-wicking properties, and overall comfort. Through iterative testing and refinement, the optimal blend ratio is identified, maximizing the benefits of both hemp and cotton fibers while minimizing any potential drawbacks. This optimization process is essential to ensure that the sustainable socks meet the necessary quality standards and performance requirements, ultimately enhancing their market viability and environmental sustainability.

Manufacturing Process Development: The Manufacturing Process Development module focuses on refining the processes involved in blending, spinning, weaving, and finishing hemp-cotton fibers into socks. This entails optimizing machinery, techniques, and procedures to ensure efficient and high-quality production. Emphasis is placed on achieving consistency in fiber blending, yarn spinning, and weaving to produce socks that meet performance and sustainability standards. Additionally, this module involves exploring innovative manufacturing methods and technologies to enhance efficiency, reduce waste, and minimize environmental impact throughout the production process. Continuous iteration and refinement are key to achieving a streamlined and sustainable manufacturing process for the development of eco-friendly socks.

Testing: Testing play a pivotal role in ensuring the integrity, performance, and sustainability of the sustainable socks developed using hemp-cotton blends. This module encompasses a comprehensive array of testing protocols designed to assess various aspects of the socks' quality and functionality. Rigorous quality control measures are implemented throughout the manufacturing process to maintain consistency and adherence to standards. Tensile strength tests are conducted to evaluate the strength and durability of the socks, ensuring they can withstand everyday wear and tear. Abrasion resistance tests are employed to assess the socks' ability to resist damage from friction, prolonging their lifespan. Additionally, moisture-wicking tests are performed to measure the socks' ability to effectively manage moisture, enhancing comfort and reducing the risk of odor and bacterial growth. Comfort assessments, including sensory evaluations and fit testing, are conducted to ensure that the socks provide a comfortable and ergonomic wearing experience. Furthermore, adherence to established standards and specifications for textile manufacturing and sustainability is verified through rigorous testing procedures. By meticulously scrutinizing the quality and performance of the sustainable socks at every stage, from raw materials to finished products, this module ensures that they meet the highest standards of excellence and contribute positively to environmental sustainability efforts in the textile industry. By implementing these proposed modules, we aim to systematically advance the development and analysis of sustainable socks using hemp-cotton blends, ultimately contributing to a more sustainable and environmentally conscious textile industry.

1.4 FLOW CHART



1.5 Result and Discussion

TABLE: WALES PER INCH

SAMPLE	180 GSM FABRIC	200 GSM FABRIC
1	32	43
2	36	46
3	30	44
4	32	46
5	38	43
AVERAGE	33	44

TABLE : COURSE PER INCH

SAMPLE	180 GSM FABRIC	200 GSM FABRIC
1	34	46
2	36	45
3	32	47
4	33	44
5	36	47
AVERAGE	36	47

TABLE : GRAMS PER SQUARE METER

SAMPLE	GSM OF THE FABRIC	GSM OF THE FABRIC
1	180	200
2	179	210
3	177	190
4	180	194
5	184	206
AVERAGE	180	200

TABLE : DRAPE TEST

SAMPLE	180 GSM FABRIC	200 GSM FABRIC
1	1.5cm	2.0cm
2	1.7cm	2.1cm
3	1.6cm	1.9cm
4	1.5cm	1.8cm
5	1.8cm	2.0cm
AVERAGE	1.6cm	2.0cm

TABLE : ABRASION RESISTANCE

SAMPLE	NO OF REVOLUTION	180 GSM FABRIC	200 GSM FABRIC
1	800	DURABLE	DURABLE
2	600	DURABLE	HIGHLY DURABLE
3	400	HIGHLY DURABLE	HIGHLY DURABLE
4	200	HIGHLY DURABLE	HIGHLY DURABLE

TABLE : AIR PERMEABILITY

SAMPLE	180 GSM FABRIC	200 GSM FABRIC
1	250cm ³	205cm ³
2	245cm ³	200cm ³
3	240cm ³	210cm ³

4	255cm ³	200cm ³
5	250cm ³	220cm ³

TABLE : WATER ABSORBENCY

SAMPLE	180 GSM FABRIC	200 GSM FABRIC
1	3 Secs	2 Secs
2	2 Secs	3 Secs
3	4 Secs	3 Secs
4	2 Secs	2 Secs
5	3 Secs	1 Secs

1.5 DISCUSSIONS

1. In Drape test 180 GSM fabric has less drapeability compared to 200 GSM fabric.
2. In Abrasion Resistance test both fabrics got damage in 800 revolution soon, whereas in 600 revolution 180 GSM fabric got damage fast than 200 GSM fabric, but in 400 and 200 revolution both fabrics withstand the abrasion for long time.
3. It is found that one fabric has 180 GSM and another fabric has 200 GSM.
4. In Air Permeability test 200 GSM fabric has less air penetration than 180 GSM fabric.
5. In WPI and CPI both the fabrics has similar amount of yarns in one inch.
6. In Water Absorbency test 200 GSM fabric has fast water absorbency than the 180 GSM fabric

2. Output Product

To sum up, the creation and examination of eco-friendly hemp-cotton socks offer a bright future for the manufacturing of sustainable textiles. We have shown via our study and testing that using a hemp and cotton blend in the production of socks is feasible and provides a sustainable substitute for conventional materials like synthetic fibers or pure cotton. Hemp-cotton socks are superior to traditional choices in a number of ways, as demonstrated by our investigation. In the first place, using hemp lessens the environmental damage caused by growing cotton since it needs less water, fertilizer, and pesticides. Hemp is also a crop that grows quickly and generates a lot of grain per acre, which makes it a more sustainable use of land. Additionally, the blend of cotton and hemp fibers produces socks that are moisture-wicking, breathable, and long-lasting, improving the wearer's comfort and performance. Because of these qualities, hemp-cotton socks can be used for daily use as well as for a variety of sports and outdoor activities. Furthermore, compared to traditional sock manufacturing methods, the creation of hemp-cotton socks produces fewer greenhouse gas emissions and uses less energy and water, according to our sustainability study. Customers can help the textile sector adopt eco-friendly techniques and lessen their carbon footprint by selecting hemp-cotton socks.



Fig. 1 Heemp-cotton sock

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