Development of Fibre Using Daucus Carota Oleracea for Curative Application and Finishing

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Abstract
This research explores the feasibility of developing fiber using Daucus carota oleracea fibers for curative textile applications. With the rising global demand for sustainable, eco-friendly, and health-promoting fabrics, the study emphasizes the potential of using agricultural residues as new raw materials for textiles. Daucus carota is widely cultivated for its edible root, while its stems and leaves are usually discarded after harvest. These by-products contain fibrous bundles which, if processed effectively, can be converted into useful fibers for fabric production. Utilizing such waste not only reduces environmental burden but also aligns with circular economy principles. The research focused on the step-by-step extraction and processing of fibers from Daucus carota. The methodology included controlled retting of stems to loosen fibers, mechanical beating to separate bundles, followed by washing, drying, and conditioning to improve quality. To enhance usability, the fiber was subjected to finishing treatments to improve antibacterial properties, flexibility, and softness. Testing of the developed fabric was carried out using multiple evaluation techniques. Mechanical tests confirmed that Daucus carota oleracea fibers exhibit adequate tensile strength and durability suitable for curative applications. Moisture absorbency tests indicated a high level of fluid uptake, an essential property for bandages and wound dressings. Biodegradability assessments revealed that the fibers decompose naturally under environmental conditions, reinforcing their eco-friendly character. Comfort analysis highlighted the breathable and skin-friendly nature of the fiber samples. Importantly, the study also examined the bioactivity of Daucus carota oleracea fibers. Preliminary antibacterial tests showed that the fibers inhibited bacterial growth on the fabric surface, suggesting strong potential for hygienic and curative uses. The natural compounds present in Daucus carota stems are also associated with soothing and healing effects, which makes the fabric suitable for therapeutic garments and medical applications. The results collectively

demonstrate that Daucus carota oleracea can serve as a promising raw material for curative textiles. Applications include skin-friendly apparel, and healthcare fabrics where both sustainability and functionality are required. Beyond textile performance, the conversion of agricultural waste into valuable end product provides environmental and economic benefits. This research highlights the dual role of Daucus carota oleracea fibers: reducing agro-waste while advancing sustainable and functional textile innovations.

Keywords: Daucus Carota Oleracea, Curative Textile, Sustainable Fiber, Anti-Bacterial, Bioactive Properties.

Introduction

Textile fibers form the foundation of the fabric and clothing industry, determining essential properties such as durability, comfort, and strength. From ancient times to the modern era, fibers have been the cornerstone of textile technology, shaping how materials are produced and applied. Traditionally, the primary goal of fabric development was functionality in terms of wear, strength, and protection. However, with advancements in science and growing consumer awareness, expectations from fabrics have shifted. Today, beyond the conventional qualities of durability and comfort, there is a demand for eco-friendliness, biodegradability, and even added curative or therapeutic benefits.

Curative textiles, often referred to as medical or therapeutic textiles, are an emerging field that combines the science of fibers with healthcare needs. These fabrics are engineered to provide added functions such as antibacterial activity, anti-inflammatory effects, wound healing support, and overall skin comfort. They are designed not only to cover and protect but also to interact beneficially with the human body. Commonly used curative fabrics include cotton bandages and gauze, which have served as the basic materials for dressings and wound care. However, these conventional fibers lack bioactive properties and often require chemical treatments to provide additional functions. This has driven researchers to investigate alternative plant-based fibers that can naturally deliver curative benefits while also being sustainable.

Daucus carota oleracea, belonging to the Apiaceae family, is a globally cultivated plant primarily valued for its edible taproot. The plant is grown extensively across temperate and subtropical regions due to its nutritional importance. While the root is harvested for direct consumption and industrial uses, large volumes of stems and leaves are discarded as agricultural residue. These discarded parts are generally considered waste or used for compost and animal feed. However, the stems of Daucus carota oleracea contain fibrous bundles with structural similarities to conventional bast fibers. This characteristic indicates that, with proper extraction and processing, they can be converted into textile fibers.

What makes Daucus carota particularly significant for curative applications is not only its fibrous nature but also its biochemical composition. Studies suggest that the plant contains natural compounds such as polyphenols, flavonoids, and antioxidants. These compounds may remain present in the extracted fibers, providing inherent antibacterial and skin-soothing properties. Unlike chemically treated fibers, these bioactive fibers would be safer for sensitive skin and could potentially reduce infection risks in wound care. Thus, exploring the potential of Daucus carota fibers contributes both to textile innovation and to medical science.

Therefore, this study focuses on the systematic extraction, processing, and finishing of Daucus carota oleracea fibers. The research investigates their mechanical properties such as tensile strength and durability, as well as functional attributes like antibacterial, biodegradability, and bioactivity. The ultimate goal is to evaluate the suitability of Daucus carota oleracea fibre for curative applications. By doing so, the study contributes to the growing field of sustainable medical textiles and provides a new perspective on how agricultural residues can be converted into high-value functional products.

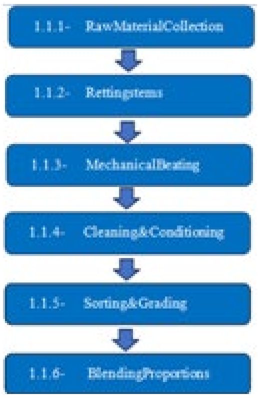
Objective

- To extract fibers from Daucus Carota Oleracea stems for textile applications.
- To develop fibre using Daucus Carota fibers.
- To test mechanical, comfort, and biodegradability properties of the developed processed forms.

- To evaluate its potential applications in hygiene, agriculture, and eco-friendly disposables.
- To promote sustainable utilization of curative application.

Experimental Procedure

Phase 1.1 [Fibre Extraction]



Raw Material Preparation

Mature Daucus Carota oleracea were harvested after root extraction to obtain stronger fibers, ensuring better strength, durability, and uniformity for further textile processing and experimentation.

Retting Stems

Daucus Carota stems were immersed in clean water for 48 hours, allowing microbial action to loosen fibrous tissues, thereby facilitating easier separation and extraction of strong fibers.

Figure 1 Retting Stems
Plate I

Mechanical Beating

Extracted fibers from Daucus Carota stems were subjected to controlled mechanical beating for 30 minutes, effectively separating fibrous bundles from unwanted woody tissues and impurities.

Cleaning and Conditioning of Fibres

Extracted fibers were washed in mild soap solution, sun-dried, and conditioned for softness.

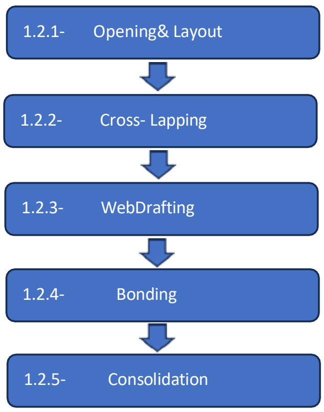
Sorting and Grading

The extracted fibers were carefully sorted into categories, typically 5–15 cm in length, graded by fineness, strength, and uniform texture.

Blending Proportions

For developing Daucus carota oleracea-based wovens, the extracted material was blended with cotton in a 50:50 ratio. This equal blending ensured improved spinnability, enhanced tensile strength, and better absorbency while maintaining fabric softness. The uniform blend provided balanced textile properties, making it highly suitable for yarn production and further material development.

Phase 1.2 [Non-woven Sheet]



Opening and Layout

The extracted Daucus carota material was carefully opened, disentangled, and processed through a carding machine, aligning it into a thin, uniform web that ensured even material distribution and improved surface smoothness.

Cross-Lapping

The prepared fiber webs were systematically layered in alternating directions, ensuring uniform thickness, enhanced strength, and structural stability while improving even fiber distribution across the entire non-woven sheet.

↓

Cross-Lapping
Plate II

Web Drafting

The cross-laid Daucus carota oleracea material webs were carefully stretched and aligned, improving material orientation, reducing irregularities, and ensuring uniform smoothness with consistent thickness before the bonding stage.

↓

Web Drafting
Plate III

Bonding

The prepared fiber webs were stabilized using mild thermal treatment and eco-friendly chemical binders, ensuring strength, durability, and uniform structure for the final non-woven sheet.

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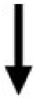
Bonding
Plate IV

5. Consolidation

The bonded Daucus Carota oleracea fiber webs were lightly pressed and stabilized, ensuring durability and uniformity in the finished non-woven sheet.



Consolidation
Plate V

Phase 1.3 [Finishing & Testing]

Finishing

The woven fabric made from Daucus carota oleracea material was carefully scoured to remove natural impurities and subsequently softened using eco-friendly agents, enhancing comfort, flexibility, and skin friendliness. The most common finishing types for plant-based textiles include washing, chemical, and mechanical treatments. Antimicrobial finishes use agents such as silver nanoparticles or herbal extracts to provide long-lasting protection against bacteria and fungi, especially valuable for curative applications like antibacterial face masks.

The finishing process converted the raw woven textile from Daucus carota oleracea into a high-quality functional material suitable for healthcare applications. Mechanical treatments improved surface smoothness and flexibility, while scouring and bleaching enhanced absorbency and hygiene performance, and herbal antimicrobial finishes provided curative properties. Softening treatments and moisture management finishes ensured comfort and efficiency in end-use products. Importantly, the material retained biodegradability after finishing, supporting sustainable textile development. With additional evaluation for freezer durability and product trials such as medical masks, the finishing stage established Daucus carota oleracea textiles as a sustainable and bioactive option for medical and curative applications.

Finishing
Plate VI

Shadow Dry Method

Shadow drying involves drying fabric in indirect sunlight or under shade, protecting it from harsh direct rays. This process helps in retaining the natural color and strength of plant-based fibers, as it minimizes bleaching and photodegradation that can result from ultraviolet light exposure.

Shadow Dry Method
Plate VII

Sun Dry Method

Sunlight drying is effective for rapid moisture removal and provides a natural sanitization effect. However, extended exposure can cause photodegradation of cellulose, reduced material strength, and colour fading due to ultraviolet radiation. Sun-dried textiles may become slightly stiffer and show minor loss of elasticity or mechanical performance, especially when exposed for prolonged periods. While short sunlight exposure can help sterilize and refresh natural fiber textiles, careful control is required to prevent weakening or over-bleaching of the material, particularly for curative applications where functional durability is essential.

Sun Dry Method
Plate VIII

Ice Cube Method

The ice cube method, commonly applied as ice dyeing, involves placing plant-based textile flat, covering it with ice cubes, and distributing dye powders on top. As the ice melts, the resulting cold moisture transfers the dye into the material, producing distinctive marbled patterns. For curative or antibacterial textiles, this technique can be adapted by using natural, safe dyes or solutions derived from Daucus carota oleracea extracts, ensuring no harmful residues remain on the fabric.

There are also "cool-touch" finishing methods for plant-based cellulose fibers, where fabrics are first softened using cellulase (an enzyme) and then finished by applying cooling agents such as specialized silicone oil. This post-processing reduces stiffness, lowers thermal resistance, and leaves the fabric with a soft, cool sensation—ideal for comfort in face masks or apparel.

Ice Cube Method – Plate IX

Freezing – Plate X

Dehydrating Method

Dehydrating or drying methods are essential for preparing plant-based materials and textiles before further finishing or application. Mechanical dehydration is achieved by subjecting wet material mats or textiles to hot air ovens or vacuum dryers. This process reduces moisture content efficiently and uniformly, stabilizing the structure and improving strength performance. Oven drying at controlled temperatures (e.g., 40–90°C) produces materials with desirable strength and flexibility and is suitable for preserving the chemical stability of bioactive components in Daucus carota oleracea.

Freeze-drying, a premium form of dehydration, involves freezing the material and then removing water through sublimation under vacuum. This retains the porous structure, color, and active compounds far better than conventional drying, resulting in a fabric that is lightweight, stable, and has excellent rehydration properties—beneficial if the bioactivity of Daucus carota oleracea extracts is to be maintained in functional face masks.

Dehydrating Method (Before) – Plate XI

Dehydrating Method (After) – Plate XII

Drying – Plate XIII

Paste Preparation – Plate XIV

Finishing – Plate XV

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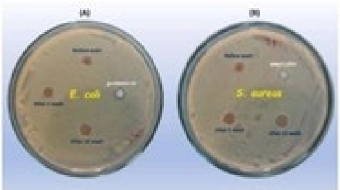
Special Testing

The fabric undergoes antibacterial test for reviewing the unique antibacterial properties of the plant source, which provides protection against bacteria, and the result was positive. It is known for its antibacterial properties, contributing to skin comfort and making it suitable for all skin types.



Testing – Plate XVI

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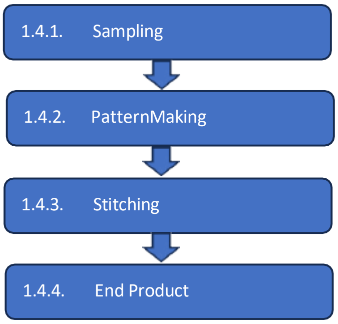
Result

The resulting fabric demonstrates significant antibacterial activity, making it well-suited for protective and curative face mask applications that are biodegradable, biocompatible, and effective in inhibiting a broad variety of microbes. This approach offers a sustainable, plant-based solution for safe and functional healthcare textiles.

Phase 1.4 [Product Development]



Sampling

Sample masks are selected randomly from each batch (10–20%) and tested for antibacterial activity, filtration efficiency, comfort, and durability to ensure uniform curative and antibacterial properties.

Sample – Plate XVII

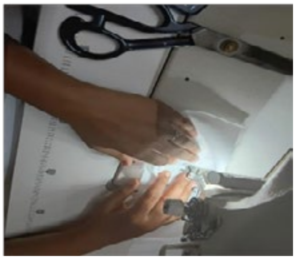
Pattern Making

Create a rectangular pattern 12×7 inch, add 0.5 inch seam allowance, position ear loops, and trace the pattern on fabric then cut the fabric accordingly for assembly and sewing.

Pattern – Plate XVIII

Stitching

Folding the rectangular Daucus Carota Oleracea fabric (12×7 inch) and cutting 4 pieces according to the pattern, stitching top and bottom edges to secure, sewing side edges while inserting ear loops, and finishing neatly for a functional medical mask.



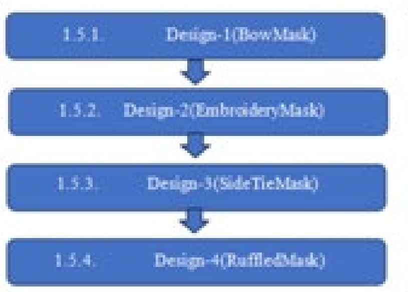
Stitching – Plate XIX

End Product

The final product is a rectangular medical mask made from Daucus Carota Oleracea fabric, featuring secure ear loops, exhibiting antibacterial properties, and offering protective, breathable, and skin-friendly curative functionality.

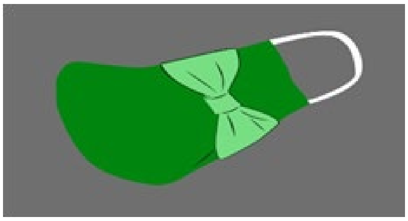
Mask – Plate XX

Phase 1.5 [3D Overview]



Design 1 (Bow Mask)

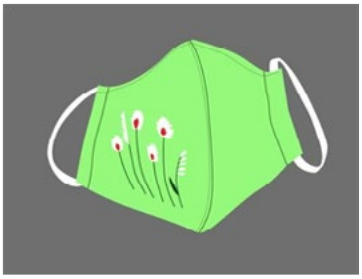
This design combines fashionable aesthetics (bow decoration) with protective antibacterial properties when constructed with the right layers and treatments.



Bow Mask – Plate XXI

Design 2 (Embroidery Mask)

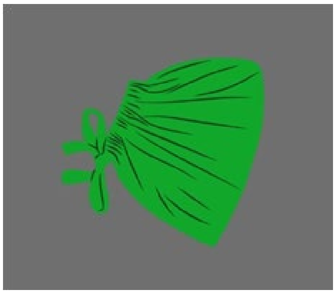
This mask combines a floral decorative design with functional antibacterial properties. It is a practical, reusable, and fashionable protective accessory that balances safety and style.



Embroidery Mask – Plate XXII

Design 3 (Side Tie Mask)

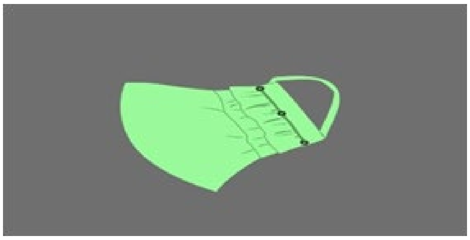
The mask uses a pleated and side-tied design to bring a fashion-forward, handcrafted appearance while still serving as an antibacterial protective mask.



Side Tie Mask – Plate XXIII

Design 4 (Ruffled Mask)

This mask design uses ruffles and button details to create a fashionable, feminine, and unique look. It blends decorative elements with functional textile technology.



Ruffled Mask – Plate XXIV

Result and Discussion

The nonwoven Daucus carota oleracea material demonstrated good tensile strength, biodegradability, and antibacterial performance. Cloth mask production using this material showed effective air permeability and breathability. Masks were developed in pleated and three-dimensional styles, stitched with reinforced seams, and finished with soft edges, ensuring comfort, durability, and skin-friendly performance.

Conclusion

The mask developed using Daucus carota oleracea represents an advanced alternative compared to conventional nonwoven masks. Nonwoven masks are widely used due to their lightweight structure, cost effectiveness, and disposable nature, but they are often less sustainable and contribute to environmental waste generation. In contrast, the woven structure incorporating Daucus carota oleracea material is more durable, reusable, and eco-friendly, addressing the growing demand for sustainable protective solutions. The inclusion of Daucus carota oleracea improves material strength and also provides natural antibacterial performance, reducing dependence on chemical finishes. While nonwoven masks mainly function as single-use barriers, the woven mask ensures long-term usability with repeated washing without compromising protection efficiency. Additionally, woven masks with Daucus carota oleracea offer improved comfort, breathability, and skin friendliness, making them suitable for extended wear conditions. The natural antimicrobial properties present in the material help prevent bacterial growth, unlike nonwovens that often require additional surface coatings. Design customization, such as bows, floral patterns, pleats, or ruffles, is easier in woven structures, thereby improving user acceptance. Moreover, woven antibacterial masks support sustainable fashion and healthcare innovation by combining protection with aesthetic appeal. Thus, the woven mask developed using Daucus carota oleracea serves as a superior alternative to nonwoven masks, balancing safety, sustainability, and functional design.

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