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DEVELOPMENT OF PLASMA COATED MULTIFUNCTIONAL TEXTILE FOR WOUND AND HEALTH CARE APPLICATIONS

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ABSTRACT:

An inventive and environmentally friendly method of textile finishing is the production of silk fabric coated with orange and pomegranate peel extract and plasma coating. the development of a novel plasma-coated multifunctional textile for wound and healthcare applications using silk fabric, enriched with coatings derived from orange and pomegranate peel extracts. This innovative approach aims to harness the natural antimicrobial and antioxidant properties of these fruit peels to enhance the functionality and therapeutic potential of the textile. Through a meticulous process of plasma coating, we aim to imbue the silk fabric with a thin layer of orange and pomegranate peel extracts, thereby introducing antimicrobial agents and antioxidants into the textile matrix. This coating is designed to inhibit the growth of harmful microorganisms, preventing infections in wound care scenarios, while also promoting a conducive environment for wound healing through antioxidant activity. Our research encompasses a multidisciplinary approach, integrating expertise from materials science, textile engineering, and biochemistry. We will conduct comprehensive studies to optimize the plasma coating process, ensuring uniformity and durability of the coatings on the silk fabric. Furthermore, we will evaluate the antimicrobial efficacy and antioxidant capacity of the coated textiles through rigorous testing protocols, validating their suitability for healthcare applications. By leveraging the natural properties of orange and pomegranate peel extracts, our research aims to provide a sustainable and biocompatible solution for enhancing the functionality of silk textiles in wound care and healthcare settings. This work holds promise for addressing the growing need for effective, eco-friendly, and multifunctional materials in the field of medical textiles

Keywords: Environmentally friendly, wound care, sustainable, biocompatible, antimicrobial agents, antioxidants and healthcare applications

I INTRODUCTION:

The development of plasma-coated multifunctional silk textiles involves a multidisciplinary approach, blending expertise from materials science, biotechnology, and healthcare. At its core lies the careful selection and preparation of the silk substrate, which serves as the foundation for subsequent plasma deposition. Through a series of chemical treatments and surface modifications, researchers optimize the silk surface to enhance adhesion and functionality, ensuring the effectiveness of the plasma coatings. In the ever-evolving landscape of healthcare, advancements in materials science are continually reshaping the way we approach medical treatments and patient care. Among the latest breakthroughs lies the development of plasma-coated multifunctional textiles, poised to revolutionize wound management and health applications. In particular, the integration of these technologies into silk fabric holds immense promise, offering a blend of tradition and innovation that could transform the healthcare industry. Motivated by the pressing need for improved wound care solutions, researchers have embarked on a journey to harness the unique properties of silk and the versatility of plasma coatings. Chronic wounds, such as diabetic ulcers and pressure sores, present significant challenges, often leading to prolonged suffering and complications for patients. Traditional wound dressings, while effective to some extent, are limited in their ability to address the multifaceted nature of these wounds. The emergence of antibiotic resistance further exacerbates the urgency for novel approaches to infection control and tissue repair. In response to these challenges, the development of plasma-coated silk textiles represents a paradigm shift in wound care. By leveraging the inherent properties of silk – including its biocompatibility, strength, and antimicrobial potential – researchers aim to create a multifunctional platform capable of addressing the diverse needs of wound management. Through the precise deposition of plasma coatings, tailored to specific healthcare requirements, these textiles offer a holistic solution that combines antimicrobial activity, wound healing promotion, and enhanced patient comfort.

MATERIALS:

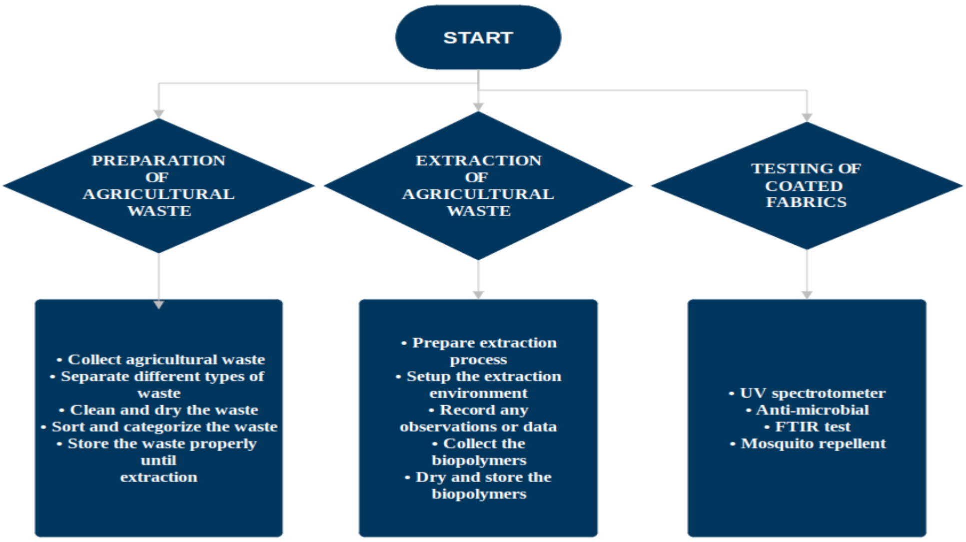
The orange and pomegranate peel were brought at local markets in Sathya Mangalam, Erode. Methanol can be used for the extraction process. All chemicals were used in this process for laboratory grade and were purchased from National Scientific Chemicals Private. Limited, Erode.

III OBJECTIVES AND METHODOLOGY

The objectives of the proposed work for developing a plasma-coated multifunctional textile for wound and healthcare applications in silk fabric encompass a range of goals aimed at addressing the complex needs of both patients and healthcare providers.

3.1 Objectives of the Proposed Work

- To extract the biopolymeric compounds from the orange peel and pomegranate peel using Soxhlet apparatus.
- To develop a coated textile material for the mosquito repellency property using dip coating method.
- To evaluate the performance of the coated textile substrate for antimicrobial activity and mosquito repellency property.
- Enhancement of Wound Healing Properties: A primary goal is to imbue the coated textile with properties that promote wound healing and facilitate better patient outcomes. This includes incorporating features such as antimicrobial activity to prevent infections, moisture management to maintain an ideal wound environment, and possibly even therapeutic agents to accelerate healing processes.
- Evaluation of Biocompatibility and Safety: Ensuring the safety and biocompatibility of the plasma-coated textile is essential. Rigorous testing will be conducted to assess any potential adverse effects on the skin, ensuring that the textile is suitable for prolonged contact with wounds and sensitive skin areas without causing irritation or allergic reactions
- Integration of Multiple Functionalities: The proposed work aims to develop a textile that serves multiple functions relevant to wound and healthcare applications. This involves integrating various functionalities, such as antimicrobial, moisture-wicking, and therapeutic properties, into a single textile substrate to provide comprehensive care and support for patients.
- Validation through In Vitro and In Vivo Studies: Validating the efficacy of the plasma-coated textile will involve both in vitro and in vivo studies. In vitro experiments will assess the performance of the textile in simulated wound environments, while in vivo studies will evaluate its effectiveness in real-world clinical settings, involving patient trials under the supervision of healthcare professionals.
- Scalability and Cost-Effectiveness: Another objective is to develop a manufacturing process that is scalable and cost-effective, enabling large-scale production of the plasma-coated textile at a reasonable cost. This will involve optimizing production techniques, sourcing affordable materials, and minimizing waste to make the product accessible to healthcare providers and patients.
- Environmental Sustainability: Finally, the proposed work aims to address environmental sustainability concerns associated with textile manufacturing and healthcare practices. Efforts will be made to minimize environmental impact throughout the product lifecycle, from raw material sourcing to end-of-life disposal, by exploring eco-friendly materials, production processes, and recycling options



Methodology of the Proposed Work

- **FABRIC PREPARATION:** Select high-quality silk fabric as the substrate for the coating process. Consider factors such as fabric weight, weave structure, and biocompatibility. Simultaneously, identify potential coating materials with desirable functionalities such as antimicrobial agents, moisture-wicking compounds, or therapeutic substances.

- **ORANGE AND POMEGRANATE PEEL EXTRACTION:** Gather an adequate quantity of orange and pomegranate peels. The amount will vary depending on the size of the fabric and how intense you want the colour to be. Pulverize the peels into a fine powder using a blender. In order to aid in the blending process.

- **SOXHLET EXTRACTION:** In this procedure, bioactive substances are extracted from fruit peels using the Soxhlet extraction method. A common method for separating natural chemicals from solid materials is Soxhlet extraction. In this instance, a thimble is filled with pulverized orange and pomegranate peels, and an organic solvent, like methanol, is repeatedly cycled through the system. The resultant extract is made up of bioactive substances that can be used to apply antibacterial, antioxidant, and scent qualities to textile.

- **DIP COATING:** An innovative and environmentally beneficial strategy in the textile industry is the production of cotton and polycotton fabrics coated with orange and pomegranate peel extracts using a dip coating technique. Utilizing the natural colouring and antibacterial qualities of orange and pomegranate peel extracts, this eco-friendly procedure entails soaking the fabric in a solution containing these peels. To assure the coating's adhesion, the cloth is dried and cured after the dip coating. The fabrics that are produced have brilliant, organic hues that come from the peels that are both aesthetically beautiful and eco-friendly. Additionally, the fruit peels' inherent antibacterial capabilities improve the materials' hygienic qualities and durability, making them suited for a range of uses, including clothes and household textiles.

- **ANTIMICROBIAL TESTING:** These tools can be used to assess the coated fabrics' antimicrobial activity. It offers a standardized method of evaluating the coating's effectiveness against bacteria.

- **UV SPECTROMETER;** This device can be used to assess the UV protection that coated fabrics offer. It gauges the quantity of UV light that the fabric absorbs, which is crucial for figuring out how effective the coating is UV spectroscopy or up visible spectrophotometer.

- **PLASMA COATING:** Experiment with different plasma coating techniques, including atmospheric pressure plasma, low-pressure plasma, and plasma-enhanced chemical vapor deposition (PECVD). Vary parameters such as gas composition, pressure, temperature, and treatment time to optimize coating adhesion, uniformity, and functionality while preserving the integrity of the silk fabric.

- **BIOCOMPATIBILITY:** Investigate the biocompatibility of the plasma-coated textile through cytotoxicity assays, skin irritation tests, and biodegradation studies. Ensure that the coated fabric poses no harm to human health and complies with regulatory standards for medical devices and textiles.

PROCESS OF THE PROJECT:

1. **FABRIC PREPARATION:** Select high-quality silk fabric as the substrate for the coating process. Consider factors such as fabric weight, weave structure, and biocompatibility. Simultaneously, identify potential coating materials with desirable functionalities such as antimicrobial agents, moisture-wicking compounds, or therapeutic substances.

2. **ORANGE AND POMEGRANATE PEEL EXTRACTION:** Gather an adequate quantity of orange and pomegranate peels. The amount will vary depending on the size of the fabric and how intense you want the colour to be. Pulverize the peels into a fine powder using a blender. In order to aid in the blending process.

1. (a)

2. (b)

1. **SOXHLET EXTRACTION:** In this procedure, bioactive substances are extracted from fruit peels using the Soxhlet extraction method. A common method for separating natural chemicals from solid materials is Soxhlet extraction. In this instance, a thimble is filled with pulverized orange and pomegranate peels, and an organic solvent, like methanol, is repeatedly cycled through the system. The resultant extract is made up of bioactive substances that can be used to apply antibacterial, antioxidant, and scent qualities to textile.

Fig 2: Soxhlet Extraction Method

2. **DIP COATING:** An innovative and environmentally beneficial strategy in the textile industry is the production of cotton and polycotton fabrics coated with orange and pomegranate peel extracts using a dip coating technique. Utilizing the natural colouring and antibacterial qualities of orange and pomegranate peel extracts, this eco-friendly procedure entails soaking the fabric in a solution containing these peels. To assure the coating's adhesion, the cloth is dried and cured after the dip coating. The fabrics that are produced have brilliant, organic hues that come from the peels that are both aesthetically beautiful and eco-friendly. Additionally, the fruit peels' inherent antibacterial capabilities improve the materials' hygienic qualities and durability, making them suited for a range of uses, including clothes and household textiles.

Fig 3: Dip Coating

3. PLASMA COATING: Experiment with different plasma coating techniques, including atmospheric pressure plasma, low-pressure plasma, and plasma-enhanced chemical vapor deposition (PECVD). Vary parameters such as gas composition, pressure, temperature, and treatment time to optimize coating adhesion, uniformity, and functionality while preserving the integrity of the silk fabric.

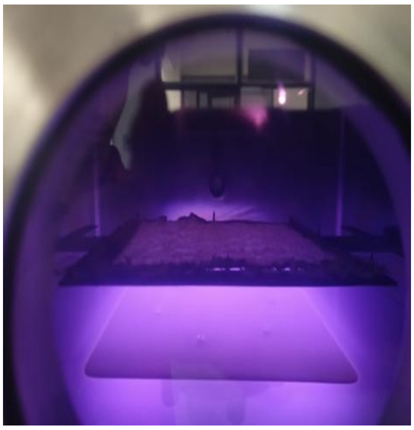


Fig 4: PLASMA COATING

4. ANTIMICROBIAL TESTING: These tools can be used to assess the coated fabrics' antimicrobial activity. It offers a standardized method of evaluating the coating's effectiveness against bacteria.

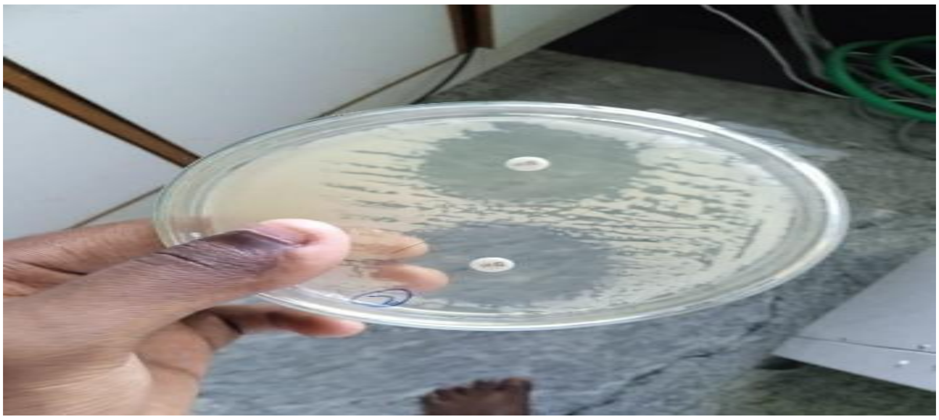
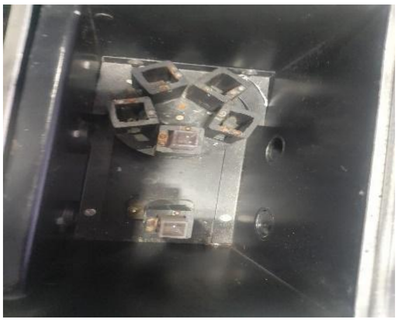


Fig 5: Antimicrobial Testing Tools

5. UV SPECTROMETER; This device can be used to assess the UV protection that coated fabrics offer. It gauges the quantity of UV light that



the fabric absorbs, which is crucial for figuring out how effective the coating is UV spectroscopy or up visible spectrophotometer.

Fig 6: UV spectrometer

1. **BIOCOMPATIBILITY:** Investigate the biocompatibility of the plasma-coated textile through cytotoxicity assays, skin irritation tests, and biodegradation studies. Ensure that the coated fabric poses no harm to human health and complies with regulatory standards for medical devices and textiles.

2. **MOSQUITO REPELLENT TESTING:** Take a mosquito cage, add a few mosquitoes, and then place a fabric with dye on it inside the cage. Watch the mosquitoes to see whether they avoid the fabric for 30 minutes.

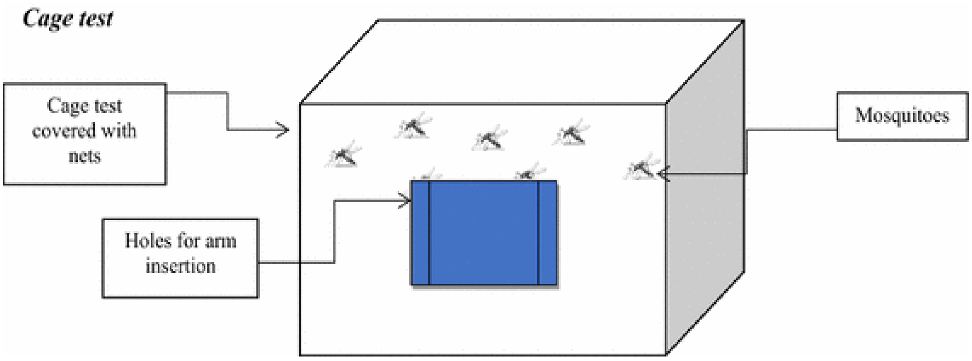


Fig 7: Mosquito repellent testing

3. **FOURIER COEFFICIENT FTIR SPECTROSCOPY: Fourier** Coefficient FTIR Spectroscopy sometimes referred to as **Infrared Spectroscopy Analysis**, is an analytical method for classifying materials as organic, polymeric, and occasionally inorganic. Infrared light is used in the FTIR analysis procedure to scan test materials and observe chemical characteristics.

4. When assessing industrially created material, FTIR spectroscopy is a well-established method for quality control that is frequently used as the initial step in the material examination process. A shift in the distinctive absorption band pattern unmistakably suggests that the material's composition has changed or that contamination is present. FTIR microanalysis is usually used to identify the source of a product's faults if they are detected through visual inspection. This method works effectively for examining bigger surface areas and tiny particles (usually 10–50 microns) to determine their chemical makeup.

With FTIR analysis;

1. Determine the identity and properties of unknown materials, such as liquids, solids, films, or powders.
2. Determine whether a substance is contaminated (e.g., by particles, fibres, powders, or liquids).
3. After being extracted from a polymer matrix, identify the additives.
4. Determine whether oxidation, breakdown, or uncured monomers are present in failure analysis inquiries.

Fig 7: FTIR TEST

RESULTS AND DISCUSSION:

Effect on physical properties

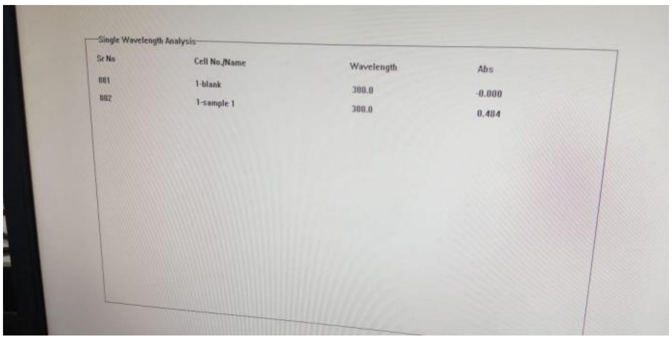
Table 1 discusses the results obtained after coating with extracted biopolymeric finishes obtained from orange peel and pomegranate peels. In case of fabric add-on, the all the treated samples show increase in the weight in the fabric. The maximum add-on % is seen in the cotton fabric sample treated with

Table: 1 Effect on physical properties

S. No	Physical properties	fruit peel extract		plasma treatment	
		Before	After	Before	After
1.	Add-on%	3.502g	4.010g	2.583g	3.008g
2.	Tensile strength (lbf)	170	160	170	153
3.	Stiffness (N/mm)	3.87	3.57	4.46	3.86

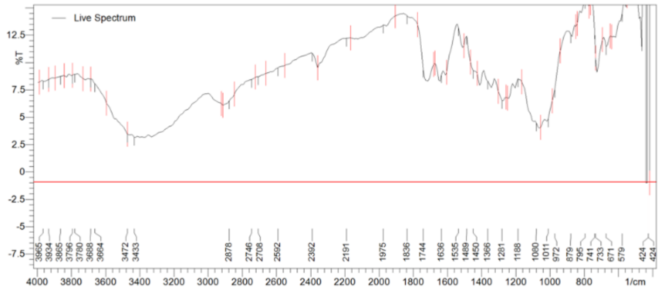
RESULT OF UV SPECTROMETER

- Visible in UV The basis of spectroscopy is the way that chemical compounds absorb ultraviolet or visible light, producing unique spectra in the process. Spectroscopy relies on the way light and matter interact. **(**In This Test, We Got a Positive Result. Pomegranate peel extraction have UV resistance**)**



1. **ANTIMICROBIAL TEST: (**In This Test, We Got a Positive Result. Both Pomegranate and Orange Coated Fabric Have Antimicrobial Properties**)**

2. **FTIR TEST:** The main component of fruit peel that keeps insects away is the essential oil, which includes limonene and other chemicals.

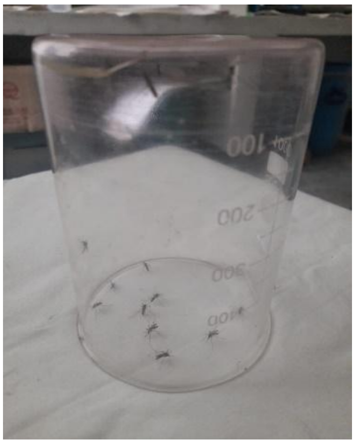


These substances have a potent citrus aroma that keeps a lot of insects away and antimicrobial and antifungal

3. **MOISTURE MANAGEMENT:** Before Plasma coating and after plasma coating

1.Before Plasma coating and after plasma coating

4. **INSECT REPELLENT TEST** Take a mosquito cage, add a few mosquitoes, and then place a fabric with dye on it inside the cage. Watch the mosquitoes to see whether they avoid the fabric for 30 minutes in the cage test.



1. Before finishing

2. After finishing

CONCLUSION:

The development of a plasma-coated multifunctional textile for wound and healthcare applications in silk fabric, featuring orange and pomegranate coatings, embodies a convergence of scientific innovation, medical necessity, and sustainable practice. By harnessing the unique properties of silk as a substrate and leveraging the antimicrobial and therapeutic benefits of orange and pomegranate, this endeavor holds promise for revolutionizing wound care and healthcare practices. Through meticulous research and collaboration across disciplines, we can pave the way for a new era of medical textiles that prioritize patient comfort, safety, and effectiveness. Moreover, by considering factors such as scalability, cost-effectiveness, user experience, and environmental sustainability, we can ensure that our innovation not only meets the needs of healthcare providers and patients but also contributes positively to our planet. Together, let us embark on this journey towards creating a brighter, healthier future through the fusion of nature-inspired textiles and cutting-edge technology**.**

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