"A Review on the Natural Air Purification Properties of Eucalyptus globulus and Chrysopogon zizanioides in Fabric-Based Air Purifier Bag "

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ABSTRACT

The increasing concern over indoor air pollution has accelerated the development of sustainable and eco-friendly air purification systems. In this context, the integration of plant- based bioactive compounds into textile substrates offers a promising approach for functional air purification applications. The present study investigates the comparative performance of *Eucalyptus globulus* and *Chrysopogon zizanioides* treated cotton fabrics for use in fabric-based air purifier bags. The plant extracts were prepared using ethanol extraction and applied through a dip-and-dry method to ensure uniform deposition on the fabric surface. Both treated samples exhibited satisfactory anti-odor performance, while differences in moisture content and airflow characteristics highlight their distinct functional advantages. The comparative analysis indicates that *Eucalyptus globulus* provides strong antimicrobial activity, whereas *Chrysopogon zizanioides* enhances odor absorption and air circulation. The study establishes the potential of herbal-treated cotton fabrics as effective, sustainable, and reusable air purification materials, contributing to the advancement of eco-friendly textile-based air filtration systems.

Keywords: Natural air purifier bags, Eucalyptus globulus, *Chrysopogon zizanioides*, Ethanol extraction, Indoor air purification, Herbal textile finishing.

1. INTRODUCTION

The clean air is essential for human health and well-being. However, increasing urbanization, industrial activities, and the extensive use of chemical products have significantly contributed to indoor air pollution. Conventional air fresheners and air purification products commonly available in the market are mostly made using synthetic chemicals. Although these products may effectively mask odors, they may also release harmful chemical compounds into the environment. Natural plant-based materials are widely recognized for their ability to improve air quality through their antimicrobial, deodorizing, and aromatic properties.

Eucalyptus globulus is well known for its medicinal and antimicrobial properties. The leaves of eucalyptus contain essential oils rich in compounds such as eucalyptol, which possess antibacterial, and deodorizing activities. Another important aromatic plant used in natural air purification is *Chrysopogon zizanioides*, commonly known as vetiver. Vetiver roots are widely valued for their pleasant, earthy fragrance and cooling properties

The powdered plant materials were mixed with ethanol and water to allow the active compounds to dissolve and form concentrated extracts suitable for application. Cotton fabric is widely preferred for such applications because of its high absorbency, breathability, and compatibility with natural substances. Air purifier bags are simple and eco-friendly products designed to improve indoor air quality by absorbing odors and releasing natural fragrances.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1. Cotton (*Gossypium)*

Fig :1 Cotton (*Gossypium)*

Cotton is one of the most important natural fibers used in the textile industry worldwide. It is obtained from the seed hairs of plants belonging to the genus *Gossypium*. Cotton is widely valued for its softness, breathability, and high absorbency, making it ideal for producing clothing, bed linens, and various textile products.

Cotton has been cultivated for thousands of years, with early evidence found in regions such as India, Egypt, and the Americas. Today, it is primarily grown in warm climates, with major producers including India, China, the United States, and Brazil. Cotton production plays a significant role in the global economy, particularly in developing countries where it provides employment and income for millions of people.

However, cotton cultivation is also associated with environmental challenges, including high water consumption and the extensive use of pesticides. As a result, there has been increasing interest in sustainable alternatives, such as organic cotton and improved agricultural practices. The study was conducted using 100% cotton fabric as the base material due to its high absorbency, and suitability for functional finishing.

2.1.2. Eucalyptus leaves (*Eucalyptus Globulus)*

Fig:2 ***Eucalyptus Globulus***

Eucalyptus globulus, commonly known as the blue gum tree, is a fast-growing evergreen species belonging to the family Myrtaceae. It is native to Australia, particularly in regions such as Tasmania and southeastern parts of the mainland, but is now widely cultivated across tropical and subtropical regions of the world for its economic and medicinal importance. The plant is well recognized for its tall stature, smooth bark, and aromatic leaves, which contain a high concentration of essential oils.

The leaves of *Eucalyptus globulus* are rich in bioactive compounds, especially eucalyptol (1,8- cineole), which contributes to its strong antimicrobial, antifungal, and anti-inflammatory properties . Due to these characteristics, eucalyptus extracts have been extensively used in pharmaceutical products, cosmetics, and natural air purification systems. In textile applications, particularly in herbal-finished cotton fabrics, eucalyptus extracts are gaining attention for their ability to inhibit microbial growth and improve indoor air quality.

Eucalyptus globulus plays a significant role in environmental sustainability. Its essential oil vapors can help reduce airborne pathogens and unpleasant odors, making it suitable for eco- friendly air fresheners and purifier bags. The increasing demand for natural and biodegradable materials has encouraged researchers to explore eucalyptus-based treatments in textiles, especially for developing functional fabrics with antimicrobial and air-purifying properties.

2.1.3. Vetiver root (*Chrysopogon zizanioides)*

Fig: 3 ***chrysopogon zizanioides***

Chrysopogon zizanioides commonly known as vetiver, is a perennial grass belonging to the family Poaceae. It is native to India and is widely cultivated in tropical and subtropical regions around the world due to its ecological, medicinal, and industrial importance. The plant is characterized by its dense root system, which grows vertically deep into the soil, making it highly resistant to drought and effective in soil conservation.

The roots of *Chrysopogon zizanioides* are the most valuable part of the plant, as they contain a fragrant essential oil known as vetiver oil. This oil is rich in bioactive compounds such as vetiverol, vetivone, and khusimol, which exhibit antimicrobial, antioxidant, and anti- inflammatory properties. Because of its pleasant and long-lasting aroma, vetiver oil is extensively used in perfumery, cosmetics, and traditional medicine. In recent years, it has also gained attention in eco-friendly textile applications, particularly in herbal finishing of cotton fabrics for antimicrobial and air-purifying purposes.

In addition to its medicinal and aromatic uses, *Chrysopogon zizanioides* plays a crucial role in environmental protection. Its roots are capable of absorbing toxins, reducing odors, and improving air quality, making it suitable for natural air purification systems such as herbal air purifier bags. The growing interest in sustainable and biodegradable materials has further promoted the use of vetiver in developing functional textiles and green technologies.

2.2 Preparation of Plant Materials

The collected plant materials were thoroughly washed with distilled water to remove dust and impurities. They were then shade-dried for several days to preserve the bioactive compounds. After drying, the materials were ground into fine powder using a mechanical grinder to increase the surface area for efficient extraction.

Fig:4 Preparation of Plant Materials

2.3 Extraction of Plant Extracts

The powdered plant materials were subjected to ethanol extraction using the maceration method. A 20g of powder was soaked in ethanol in 1;10 ratio and kept under continuous shaking for 24–48 hours. The mixture was then filtered using muslin fabric, and the filtrate was collected and concentrated to obtain the plant extracts rich in active compounds.

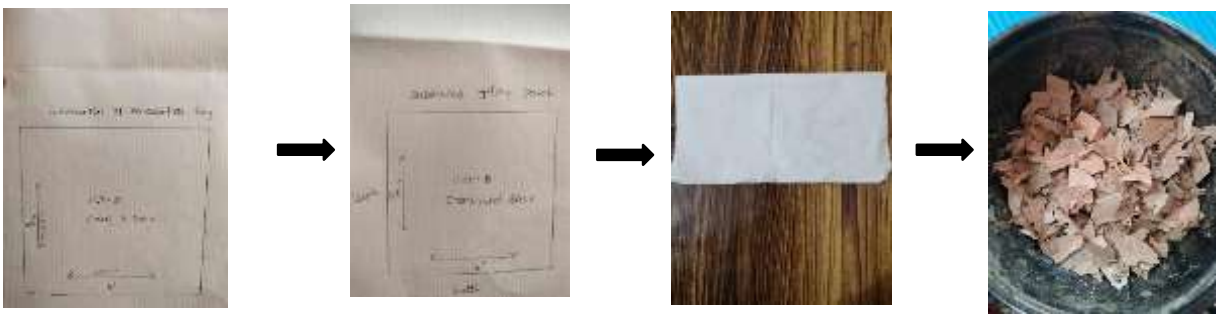
2.4 Fabric Treatment (Dip-and-Dry Method)

The cotton fabric samples were pre-washed to remove impurities and dried. The cleaned fabric was immersed in the prepared plant extract solutions to allow proper absorption of the active compounds. After sufficient soaking, the fabric was padded to remove excess solution and then dried at a controlled temperature. This dip-and-dry method ensured uniform coating of herbal extracts on the fabric surface.

Fig-4: Finish Application of Dip and Dry Method to cotton fabric

3. PRODUCT DEVELOPMENT

From the herbal extract finished fabrics, one product, an air purifier bag, was developed from herbal extract finished fabrics. These product is used for performance study. One fabric representing the extract treated fabric was selected for product development. Air purifier bags for indoor sectors, laundry. wardrobes, gym, shoes, pet animal places, and cars were developed from eucalyptus extract -finished cotton(100%). Developed air purifier bags were subjected to tests for functional parameters like air quality testing for the developed air filter bags finished with eucalyptus extract against bacteria and fungi.



1 2 3 4

5 6 7

1.Pattern construction for Air purifier bag , 2. Pattern construction of substance filling bag ,3. Treated fabric, 4. Crushed substance (Eucalyptus globulus) ,5. Filling the substance to the bag, 6. Finishing of filled bag, 7. Finishing of air purifier bag

Fig: 5 Construction of air purifier bag

4. FUTURE SCOPE

The present research opens up several opportunities for further development and innovation in the field of sustainable air purification. Future studies can focus on combining multiple plant extracts to achieve synergistic effects for enhanced antimicrobial and

deodorizing performance. Advanced finishing techniques such as microencapsulation and nano-finishing can be explored to improve the durability and controlled release of active compounds on the fabric surface. Additionally, long-term performance evaluation, including repeated washing and real-time air quality monitoring in different environments, can provide deeper insights into practical applicability. The development of smart textile-based air purification systems integrated with sensors for air quality detection is another promising area. Furthermore, scaling up the production of herbal air purifier bags and exploring their commercial feasibility can contribute to the growing demand for eco-friendly and sustainable products in the market.

5. CONCLUSION

The present study successfully demonstrates the potential of natural plant extracts in developing eco-friendly and effective air purification systems using textile materials. Cotton fabric treated with Eucalyptus globulus and *Chrysopogon zizanioides* through the dip-and-dry method exhibited excellent functional properties suitable for air purifier bag applications. The fabrics also maintained good air permeability, durability, and moisture characteristics, ensuring proper airflow and usability. While Eucalyptus globulus showed relatively better antibacterial performance and strength, *Chrysopogon zizanioides* contributed effectively to odor control and air circulation. Overall, the study highlights that herbal-treated cotton fabrics can serve as sustainable, reusable, and cost-effective alternatives to synthetic air purification systems, thereby improving indoor air quality in an environmentally friendly manner.

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