



## **Studies of Medicinal Herb Extracts for Controlling the *Aspergillus niger* and *Trichoderma reesei* (Fungi) on Organic Cotton and Bamboo Knitted Fabric for Health Care Textiles**

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### **Authors' contributions**

This work was carried out in collaboration between all authors. Author SS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors AT, EGW managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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### **ABSTRACT**

**Aims:** This study investigates the antifungal activity of green tea, neem leaf and aloe root medicinal herbal extracts on organic cotton and bamboo knitted fabrics against *Aspergillus* and *Trichoderma reesei*.

**Study Design:** To evaluate the antifungal activity of treated fabric using AATCC test method. To develop an end products using the microencapsulated fabrics for health care textiles.

**Place and Duration of Study:** Research and development centre, Coimbatore, tamilnadu, india between august 2014 and January 2015.

**Methodology:** Agar well diffusion test, exhaust method, AATCC-30.

**Results:** The zone of inhibition of the herbal extracts of green tea, neem leaf and aloe root is 24, 26, 28 mm for *Aspergillus niger* (ATCC 6538) and 42, 41, 43 mm for *Trichoderma reesei* (ATCC

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8739) by well diffusion method. The antifungal assessment of finished organic cotton and bamboo fabric is 69, 67 mm for *A. niger* and 83, 80 mm for *T. reesei*. antifungal activity of the finished organic cotton fabric after 10<sup>th</sup> and 20<sup>th</sup> washes are 75, 71 mm for *A. niger* and 82, 80 mm for *T. reesei* and for bamboo fabric 68, 63 mm for *A. niger* and 80, 76 mm for *T. reesei*.

**Conclusion:** The results show promising use of these herbal extracts as source of antifungal finishing of organic cotton and bamboo natural fabric. Finished fabric shows excellent activity against *A. niger* and *T. reesei*. Durability of the herbal finishing is increased by microencapsulation methods. The outcome showed that maximum anti fungal effect even for the washed fabrics.

**Keywords:** Bio technology; anti fungal; *Aspergillus*; *Trichoderma reesei* organic cotton; bamboo fabric; microencapsulation and wash durability.

## 1. INTRODUCTION

Biotechnology is a frontier area in science and technology having significant commercial applications in health care, agriculture, process Industry and service sectors the world over. Today new processes and products are closely linked with bio-technology in many research and industrial fields. It also offers the potential for new industrial processes that require less energy and based on renewable raw materials. It is important to note that biotechnology is not just concerned with biology, but it is a truly interdisciplinary subject involving the integration of natural and engineering sciences. Biotechnology is like an enormous "factory" which not only provides other industries with innovative ideas but also supplies the appropriate know-how [1]. Current trend deals with the potential of biotechnology in the textile industry [2]. Now there is a good deal of demand for the fabric having functional / specialty finishes in general but antimicrobial finishes in particular to protect human being against microbes [3].

Textile goods, especially those made from natural fibers provide an excellent environment for microorganisms to grow, because of their large surface area and ability to retain moisture. [4]. Most textile materials currently used in hospitals and hotels are conducive to cross infection or transmission of disease caused by micro organisms. The application of antimicrobial finishes in textile finishes include a wide range of textile products for medicinal, technical, industrial, home furnishing and apparel sectors [5]. Microbes are small organisms that cannot be seen by the naked eye. They include a variety of micro-organisms like bacteria, algae, and fungi [6].

The use of plants and plant products could be traced as far back as the beginning of human civilization [7]. Medicinal plants as a source of

great economic value all over the world [8]. This situation force scientists to search for new antimicrobial substances. The present investigation aims at developing an eco-friendly antifungal finish from plant extracts for textile application. Based on this an attempt has been made to assess the antifungal activity with the following objectives. To collect and screen herbs based on antifungal activity. To prepare the herbal composites using the three selected herbs. To synthesize and encapsulate three selected herbs by microencapsulation process. To produce organic cotton and bamboo textile materials. To finish the herbal extracts on the selected fabrics using exhaust method. To determined the antifungal effectiveness of the treated and washed fabrics using AATCC 30-2003 test method.

## 2. MATERIALS AND METHODS

### 2.1 Materials

100% Organic cotton and Bamboo yarns were selected with expected quality requirements from the local market and were converted into the organic cotton and Bamboo fabric.

### 2.2 Selection of Herbs

For this research Green tea leaf (*Camellia sinensis*), Neam leaf (*Azadirachta indica*) & Aero root (*Maranta arundinacea*) herbs were selected for obtaining the antifungal herbal extract. The plants and their parts were collected in and around Coimbatore district. These herbs were selected because they exhibited antifungal activity properties.

### 2.3 Experimental Details

The extraction process was done in three stages, such as drying, grinding and extraction. Solvent extraction was done for all the selected herbs.

Extraction was carried out by dissolving 6 grams of the powder in 100 ml of 80% ethanol. The mixture was kept overnight under shaking condition. The extract was filtered using Whatmann no.1 filter paper. The filtrate was collected and evaporated at room temperature. The filtrate (extract) is transferred to a storage vessel and used for further studies.

### **2.3.1 Antifungal activity of herbal extracts by well diffusion method**

The antifungal activity of the selected plant extracts were evaluated by Agar well diffusion method. Sterile Potato dextrose agar plates were prepared. The plates were allowed to solidify for 5 minutes and wells of 6 mm were punctured using a well borer. 0.1% inoculum suspension of *Aspergillus niger* (ATCC 6538) and *Trichoderma reesei* (ATCC 8739) were swabbed uniformly over the surface of the agar. 100 µl of each herbal extract was loaded into the well and the plates were kept for incubation at 37°C for 72 hours. The antifungal activity was evaluated in terms of zone of inhibition, measured and recorded in millimeters.

### **2.3.2 Fabric finishing with herbal microcapsules by exhaust method**

Extraction was carried out by dissolving 6g of each herbal powders (Green tea, Neem, Aero root) in 100 ml of 80% ethanol. Herbal extracts were combined and then finished onto Organic cotton and bamboo fabric with the procedure as mentioned below. Herbal Microcapsules containing herbal extract were prepared employing Neem gum. About 3% Neem gum was prepared separately, and then 30ml of extract and 10 ml of Tween20 were added to the polymer solution and mixed thoroughly to form smooth viscous dispersion. This was sprayed into calcium chloride solution by means of a sprayer. The droplets were retained in calcium chloride for 15 min. The microcapsules were obtained by decantation and repeated washing with Iso propyl alcohol followed by drying at 45°C for 12 h. The microcapsules were then used for finishing the selected fabrics. The fabric samples (Organic Cotton and Bamboo) were finished with the prepared herbal microcapsules according to the following recipe. About 1L solution containing 700 g of microcapsules was used to finish one meter of fabric. The fabric was immersed in the binder solution (8% citric acid) for 30 min under

50°C in an oven. After 30 min, the fabric was removed and air dried in shade.

### **2.4 Antifungal Assessment by AATCC 30 - 2003 Test Method**

An inoculum of 1.0 ml was evenly distributed over the surface of the agar. Finished fabric (Organic Cotton and Bamboo) discs were pre wetted (not rubbed or squeezed) in water containing 0.05% of a non-ionic wetting agent (triton X- 100) and placed on the agar surface. Fabric samples were placed in intimate contact with potato dextrose agar, which has been previously inoculated (Mat culture) with broth suspension culture of test organisms (*Aspergillus niger* and *Trichoderma reesei*). After incubation, a clear area of uninterrupted growth underneath and along the side of the test material indicates antifungal effectiveness of the fabric.

### **2.5 Wash Durability Testing (AATCC 124-1996)**

The samples were washed with 5% neutral soap solution for 20 mins and dried. The washed samples (Organic Cotton and bamboo) were tested for the retention of antifungal activity for 10 and 20 laundry washes using standard procedure. The antifungal activity was assessed according to AATCC 30 test method. The above similar procedure was carried out for assessment.

## **3. RESULTS AND DISCUSSION**

Herbal extracts tested for its anti fungal activity by agar well diffusion method against standard cultures. The zone of inhibition for the herbals with solvent extracts of green tea, neem leaf and aero root is 24, 26, 28 mm for *A. niger* and 42, 41, 43 mm for *T. reesei*. Above results clearly showed that aero root herb having more antifungal activity against standard organisms. (Table 1). The treated fabrics were assessed for the anti fungal efficiency by AATCC 30 test method against *A. niger* and *T. reesei*.

The zone of inhibition for the antifungal activity of treated organic cotton fabric is 69 and 83 mm against *A. niger* and *T. reesei* respectively for Bamboo fabric 67 mm against *A. niger* and 80 mm against *T. reesei* when untreated organic cotton and bamboo fabrics shows nil activity in (Table 2).

**Table 1. Antifungal activity of herbal extract by well diffusion method**

S. no	Herbs		Zone of inhibition (mm)	
	Botanical name	Common name	<i>A. niger</i>	<i>T. reesei</i>
1.	<i>Camellia sinensis</i>	Green tea	24	42
2.	<i>Azadirachta indica</i>	Neem leaf	26	41
3.	<i>Maranta arundinacea</i>	Aero root	28	43

**Table 2. Antifungal assessment by AATCC 30-2003 test method**

S. no	Fabric samples		Zone of inhibition (mm)	
			<i>A. niger</i>	<i>T. reesei</i>
1.	Organic cotton	Untreated	0	0
		Treated	69	83
2.	Bamboo	Untreated	0	0
		Treated	67	80

**Table 3. Antifungal assessment of wash durability by AATCC 30-2003 test method**

S. no	Fabric samples	Washes	Zone of inhibition (mm)	
			<i>A. niger</i>	<i>T. reesei</i>
1.	Organic cotton	10 <sup>th</sup>	75	82
		20 <sup>th</sup>	71	80
2.	Bamboo	10 <sup>th</sup>	68	80
		20 <sup>th</sup>	63	76

The results show that combination of all three (Green tea, Neem leaf and Aero root) herbal extracts are found to be excellent activity when compared to the untreated fabrics. In order to increase the durability of the finished fabrics, the effective herbal combinations are microencapsulated by ionic gelatin method. The antifungal activity of the finished fabric after 10<sup>th</sup> and 20<sup>th</sup> washes have been tested and the results are presented in Table 3. The antifungal analysis shows that microencapsulation of the herbal extract for the samples (organic cotton fabric and bamboo) after 10 washes are 75 and 68mm against *A. niger* for *T. reesei* 82 and 80mm. antifungal activity shows after 20 washes are 71 and 63 mm against *A. niger* for *T. reesei* 80 and 76 mm respectively. From the above results it is observed that the microencapsulated herbal extracts possess a very good resistance for microbes (fungi) even after 20 washes.

#### 4. CONCLUSION

From the study conducted, combinations of herbal extracts (green tea, neem leaf and aero root) are found to contain the active substances that resist and control the *A. niger* and *T. reesei* (fungi). Herbal extract treated fabrics are found to be more suited for the health care textiles. The fabric will not be affected due to above finishing,

as it is natural, eco-friendly and cost effective. Also these herbs are available in abandon. This may lay a small founding for the medical textiles, where the research may extend over the application of herbal treated fabrics as a remedy for the skin infections and diseases and for eco-friendly medicated fabrics and apparels.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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