

Effect of imparting antimicrobial coating on organic cotton fabric using yashtimadhu for medical application

Abstract

Medical textiles are one of the most rapidly expanding sectors in the technical textile market. In the recent years, Comfort has become mandatory in medical textiles. Textiles with antimicrobial functional Finishes are given to provide comfort to the human beings. The development of antimicrobial coated fabric and effect of finish are achieved by using the herb-Yashtimadhu. The extraction of the herb is done by direct extraction method by using ethanol as the selected solvent among the other solvents like methanol, ethanol, chloroform, acetone and distilled water based on different polarity ranges and it is applied on to the cotton fabric by pad-dry-cure method in an optimized process conditions. The optimized conditions are Temperature-35°C, Time-3hrs, pH-6 and Concentration-20%. The coated and uncoated samples are tested in standard antimicrobial tests namely AATCC 100, AATCC 147, AATCC 30 Agar Diffusion and Broth Dilution tests.

Keywords: yashtimadhu, antimicrobial, box-behken design micro organisms, medical textiles

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Introduction

Medical Textiles are one of the fast growing sectors of the global Technical Textile industry and one of the dynamically expanding sectors. The inherent properties of textile fibers provide the opportunity for the growth of micro organisms.¹ Microbes include a variety of micro organisms like bacteria, fungi, algae and viruses, stain the fabric and Detroit the performance properties of fabrics. Comfort is a pleasant state of physiological, psychological and physical harmony between a human being and the environment.²⁻⁴

But according to the old saying "Prevention is better than Cure", controlling of diseases before humans get affected is important. So controlling can be done through the second skin of human-Clothing. The controlling of micro organisms is tedious process; washing can only arrest the micro organisms and does not destroy them. Comfort is more fortuitous for the common healthy people.⁵ Therefore it is necessity of the manufacture to provide comfort in all medical. With this threat gaining its stature day by day, there are a wide variety of commercial anti-microbial agents but it gives toxic effect to the environment and the wearers.⁶⁻⁸ Eco Textiles gain utmost importance as one of the most useful resources that help promote new innovations, in an eco-friendly manner. The natural plants are commonly used for curing the diseases. One of the natural plants Liquorice (Yashtimadhu) is one of the most popular medicinal herbs in India and also in abroad. The roots of Glycyrrhiza glabra contain a substance called glycyrrhizin that posse's anti-inflammatory property and also it's used for healing the wounds. Basically with a view of protecting the wearer and the textile substrate, the anti-microbial finish, is a recent innovation in finishes used for health care applications.

The present study investigation aims at developing natural antimicrobial finished fabrics from the herb Glycyrrhiza glabra (Yashtimadhu) plant extracts for controlling micro organism growth in medical application. The antimicrobial effect of the coated samples is tested and the results are discussed in this article.

Materials and methods

Selection of material

Organic cotton fabric with the following specification was desized, scoured and bleached prior to the application of finish.

Yarn count: 50×50

Fabric count: 80×80

Weave: Twill

Gsm: 170

Selection of antimicrobial plant

Yashtimadhu (*Glycyrrhiza glabra*) is the plant species chosen for the study. The roots of Yashtimadhu were shadow dried and made into a fine powder (Figure 1).⁹



Figure 1 *Glycyrrhiza Glabra* Root.

Preparation of extract

The active compounds in the herbal powder that has affinity to those polar particles present in the solvents get separated. Based on the type of Extraction method and Agar Diffusion method (AATCC 147) the suitable solvent selected was ethanol.

Method of finish application

The temperature, time, pH and the M: L ratio was optimized using the Box and Benhen method. The optimized conditions were namely Temperature-35°C, Time-3hrs, pH-6 and Concentration-20% The herbal extracts was applied on to cotton fabric at the material liquor ratio of 1:10 by pad-dry cure method using pneumatic padding mangle with standard conditions. The mordant alum was used as a binding agent to fix the herbal extract on to fabric. The treated fabric sample was then dried at 80°C for 10 minutes to remove the moisture. Finally the fabric samples were tested for antimicrobial activity as per the standard test methods.

Assessment of antibacterial activity in yashtimadhu extract coated fabric samples

AATCC-100-1998 (USA): Quantitative assessment of antibacterial finishes on textiles-measures the degree of antibacterial activity-broth dilution test: The 1”x1” Samples were prepared from the Yashtimadhu (untreated, 20%, 40% and 60% treated). 500ml Elenmeyer conical flasks containing 50ml of nutrients broth were prepared and sterilized at 121°C for 15 minutes. It was then allowed to cool. The fabric samples were then transferred aseptically into the conical flasks respectively. These were incubated at 37°C for 24 hours in shaker at 121rpm. After incubation their absorbance were measured at 600nm.

AATCC-147-1998 (USA): Qualitative antibacterial assessment of diffusible antibacterial agents (“quick method”)-agar diffusion Test: The 55ml of nutrient agar was prepared and sterilized at 121°C for 15 minutes. Petri plates were autoclaved in hot air oven at 121°C for 30 minutes. 20ml of Nutrient agar was poured into each of these plates and were allowed to solidify. A series of 8 test tubes containing 4.5ml of sterile water was taken. 0.5ml of culture from nutrient broth containing the 100% treated samples was transferred aseptically into the first test tube. Serial dilution was carried out until its reduced dilution was 10⁻⁸. 100 micro liters of 10⁻⁸ diluted culture was taken aseptically and poured onto the petri plates. The plates were incubated at 37°C for 16-18 hours. Similar procedure was carried out for untreated sample; sample treated with 40% and 60% concentrations.

Assessment of antifungal activity in yashtimadhu extract coated fabric samples

AATCC 30-1993: Antifungal activity, assessment of textile material: mildew and rot resistance of textile material-broth dilution test: 400ml Elenmeyer conical flask containing 50ml of PD broth was prepared and sterilized at 121°C for 15 minutes. It was then allowed to cool. The fabric samples were transferred aseptically into the conical flasks respectively. These were kept at room temperature for 3 days. Then the growth of fungi in the conical flask was observed after 3 days.

Finish wash durability test

The durability of the treated fabric was conducted for the sample of size 4x4cm. The sample chosen for the test was washed for 5-25 cycles in standard temperature 37°C and with standard detergent.

Results and discussion

AATCC-100-1998 (USA)

Quantitative assessment of antibacterial finishes on textiles-measures the degree of antibacterial activity-broth dilution test: The absorbance of the sample is directly proportional to the concentration of the cells in the sample. The absorbance values of the samples are compared. It is found that the fabric finished with 20% conc. gives low absorbance values when compared to the untreated fabric. This indicates that 20% conc. treated fabric does not support the growth of bacteria, the anti bacterial property (Table 1).

AATCC-147-1998 (USA)

Qualitative antibacterial assessment of diffusible antibacterial agents (“quick method”)-agar diffusion Test: After incubation, the plates were observed for bacterial growth. Then the numbers of colonies were counted for each plate (Figure 2). The antibacterial activity of Glycyrrhiza Glabra extract coated fabrics was analyzed. The zone of inhibition is more when compared to the untreated fabric. This means that the fabric does not support the growth of bacteria because of the absorbency of the extract on the fabric. The extract was highly absorbed by the fabric and the wet pickup ratio was appreciable more than 90% of original extract (Table 2).

Table 1 AATCC -100 Absorbance tests at 670nm

Sample	Reduction values (at 670nm)
	<i>Staphylococcus aureus</i>
Untreated fabric	1.01
20% concentration Sample(1 hour)	0.95
20% concentration Sample(2 hour)	0.74

Table 2 Zone of inhibition for Glycyrrhiza Glabra with Agar Diffusion Method

Sample	Anti-bacterial activity (Zone of inhibition in mm)
	<i>Staphylococcus aureus</i>
Yashtimadhu extract finished fabric (20%)	19
Yashtimadhu extract finished fabric (40%)	22
Yashtimadhu extract finished fabric (60%)	24
Untreated fabric	0

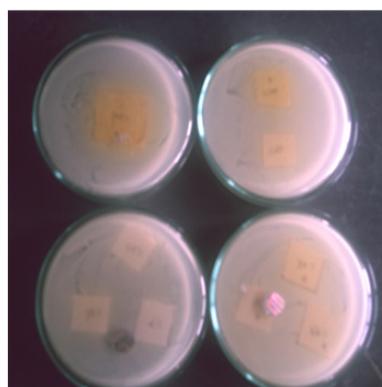


Figure 2 Zone of inhibition of yashtimadhu extract coated fabric samples.

AATCC-30-1993:Anti-fungal activity, assessment of textile material: mildew and rot resistance of textile material (broth dilution test)

It was found that there was less growth of fungi in the conical flask containing 50% concentration sample when compared to the untreated sample from the picture (Figure 3). This indicates that the 50% treated fabric has better anti fungal property (Tables 3).

Wash durability test

From the obtained absorbance value, it can be concluded that the herbal finished product can withstand up to 15-18 washes (Table 4).

Table 3 AATCC-30 Absorbance Tests at 670 Nm

Sample	Absorbance values (at 670nm)	
	Aspergillus niger	
Untreated fabric	1.02	
20% concentration Sample	0.84	

Table 4 Wash Durability Test

Wash durability		Absorbance value (at 670nm)
Untreated fabric	Before wash	1.07
	Before wash	0.76
	After 5 wash	0.89
Treated fabric	After 10 wash	0.94
	After 15 wash	0.99
	After 20 wash	1.24
	After 25 wash	1.37



Figure 3 Zone of inhibition of yashtimadhu extract coated fabric samples.

Conclusion

Multi functional products are more and more often projected and realized where even contrasting performances must coexist and cohabit. The 20% conc. treated fabric was proved to possess best anti-microbial property. The study reveals that the Glycyrrhiza Glabra herb coated fabric is found to be very hygienic with less fungi and bacteria as well as making the cloth much softer than before. This finish is very much cost effective and eco-friendly. The wash durability test revealed that the finish was able to withstand 12-18 washes and wet pickup ratio also found to be good. Now-a-days fabrics with comfort properties are more important in medical and other apparel categories. Hence this herbal yashtimadhu finish will help to resist microbes and also provide coolant effect to the eyes. In a nutshell this study has open doors for production better eco-friendly medically treated cotton fabrics.

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Conflict of interest

Author declares there is no conflict of interest in publishing the article.

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