

# Antibacterial Treatment on Cotton Fabric from Aloe Vera

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## Abstract

The development of antibacterial treatment on cotton fabric using Aloe Vera extract with different finishing methods is a well-researched topic. Aloe Vera because of its rich constituents has been used in medical as well as cosmetic since ancient time. It was proved that the active ingredients of Aloe Vera are attached with the hydroxyl groups of cotton fabric via carboxylic acid cross linking agent through infrared spectra system. The objective of this study was to review previous research done by using Aloe Vera as an ingredient to improve antibacterial properties of textile material. Aloe Vera [Aloe Barbadensis Miller] was processed through hand filtered or whole leaf procedure to prepare Aloe Vera extract. Aloe Vera extract was applied on Cotton fabrics by pad-dry-cure method in different concentrations from 60% -100% for 35-60 mins at 60-80 Degree Centigrade. The antibacterial activity of Aloe Vera finished cotton fabric were qualitatively evaluated by AATCC [Agar diffusion] method and quantitative analysis test methods by most authors. The Aloe Vera extract treated cotton fabric exhibited antimicrobial activity against *E. coli* and *S. aureus*. It also found that it improves some other properties like odor control, softness and comfort. Even the washing durability showed the good results.

**Keywords** Aloe Vera, Eco-friendly, Gram Positive, Gram Negative, Natural textile finish.

## I. INTRODUCTION

The worldwide increasing awareness of hygienic life style has made it essential for the textile industries to develop textile products with antibacterial finishes using natural products and in eco-friendly manner [18]. In today's world there is a good deal of demand for the fabrics having functional/special finishes in general, but antimicrobial finishes in particular to protect human being against microbes.

Natural products such as Chitosan and natural dyes are widely used as antimicrobial finishing for textile materials. Other natural products such as Neem, Tea tree oil, Eucalyptus oil, Tulsi can also be used for this purpose. Since ancient times, Aloe Vera is used in medicinal and cosmetic purposes because of its natural antifungal and antibacterial properties. Aloe Vera is used in various medical textile applications such as wound dressing, suture, bioactive textiles, etc. [17].

The antimicrobial finishes protect not only to the wearer but also to the fabric itself. Infestation by microbes causes cross infection by pathogens and odours when the fabric is worn next to skin. Aloe Vera is a natural plant that has antimicrobial activity against various micro-organisms and therefore, it is used in various medicinal and cosmetic preparations [11]. The skin absorbency of Aloe Vera gel is four times faster than water. Aloe Vera leaf extracts consist of 75 nutrients and 200 active compounds including 20 minerals, 18 amino acids and 12 vitamins [8]. Neem and Aloe Vera are majorly used as eco-friendly antimicrobial finishes for textiles. Nanotechnology is used not only to provide plant-based finishes to combat infectious pathogens but also to give advance characteristics to textiles [2].

## Objective

To review the Antibacterial efficacy of Aloe Vera as a natural finishing agent and the methods that are widely used for the same.

## II. METHODS AND MATERIALS

### Natural Antibacterial Finishing Agent used:

Aloe Vera.

The other natural antimicrobial agents that can be applied to textiles are Aloe Vera, Tea tree oil, Neem, Eucalyptus oil and Tulsi.

**Material / Fabric** : Plain weave 100% cotton fabric.

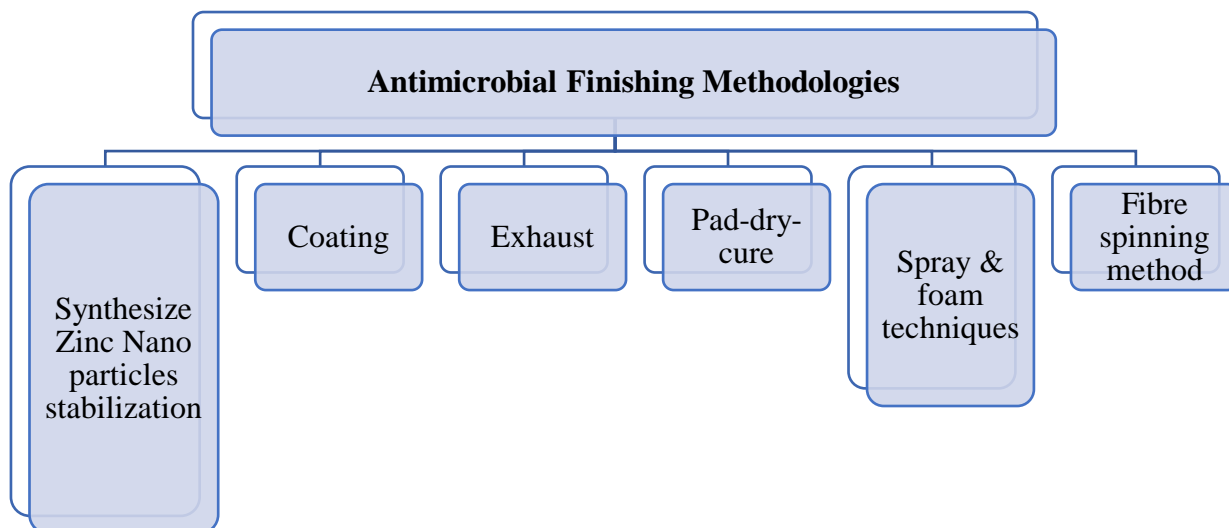


Fig. 1. Antimicrobial Finishing method

As seen in Fig. 1. the most commonly used method in Antimicrobial Finishing Method is by Pad-dry-cure method.

**Chemicals :** Citric acid and Methonal.

**Equipments :** Padding Mangle, Laundro meter, SS Extractor and Curing chamber.

**Treatment Temperature :** 80<sup>0</sup> C

**pH :** 5.5

**Extraction and Processing of Aloe Vera:**

Aloe Vera is processed using hand filleted or whole leaf procedure.

Chitosan and Methanol was used as solvent for extraction of gel from Aloe Vera plant.

**Microorganisms used :**

Gram Negative Organisms- Escherichia Coil

Gram Positive Organisms- Staphylococcus Aureus

Fungi- Aspergillus species, Penicillium species, Cryptococcus species, Candida albicans

**Methods for improving the durability of the finish include:**

- Treating the fibre with resin, condensates or cross-linking agents.
- In-solubilisation of the active substance in/on the fibre.

- Coating the fibre surface.
- Micro encapsulation of the antimicrobial agents with the fibre matrix.
- Use of graft polymers, homo polymers and/ or co-polymerization on the fibre.
- Chemical modification of the fibre by covalent bond formation [11].

**Standard Test Methods:**

AATCC-100-1998 Quantitative Assessment of Antibacterial Finishes on Textiles – measures the degree of antibacterial activity – Agar Diffusion Test.

AATCC-147-1998 Qualitative Antibacterial Assessment of Diffusible Antibacterial Agents- Agar Diffusion Test.

AATCC-30-1993 Antifungal Activity, Assessment of Textile Material – mildew and rot resistance of textile material- Agar Diffusion Test.

AATCC 6358 Quantitative Evaluation of Antimicrobial Activity, The shake flask method.

AATCC-124-2001 Test for Washing durability of the finish

**RESULTS AND DISCUSSION**

The Cotton fabric treated Aloe Vera finish showed higher antibacterial efficacy as compared to non treated fabric [1]. It was observed that the treated cotton fabric also had higher antibacterial property as

against untreated one. The number of Colony reduction in Aloe Vera treated cotton fabric at the absorbance value at 600 nm, showed as untreated 1.02, 75% gel treated 0.93, 100% gel treated 0.89, 75% leaf treated 0.94, Commercial gel treated 0.97 [16]. Sample treated with 100% gel showed maximum antibacterial and antifungal activity as compared to untreated, treated with 75% concentration, leaf extract and commercial gel. Samples treated with 75% concentration, leaf extract and commercial gel showed good antibacterial and antifungal activity as compared to untreated sample [18].

Methods of application

Two methods were used, that is Pad-dry and coating to apply Aloe Vera antibacterial finish. Pad dry method was the best way to give greater antibacterial properties which also made the fabric soft but affected its whiteness property [5]. Various types of organic

and inorganic antimicrobial agents and their limitations were identified and studied. Neem and Aloe Vera were majorly used as eco-friendly antimicrobial finishes for textiles. Plant based Bamboo material was known for antimicrobial ability [2].

The active ingredient of Aloe Vera not only acts as bactericidal agent but also inhibits the growth of both S. aureus and E. coli. 3% Aloe Vera gel treated fabric showed more than 90% where as 7% Aloe Vera gel treated fabric showed up to 99% antibacterial activity against both types of bacteria [9].

An eco-friendly natural antimicrobial finish from plant extract was applied to Cotton, Bamboo and Soyabean fabrics and tested through standard test methods [6]. The results are seen in Table I as follows:

**Table I**  
**Antibacterial Activity of Cotton, Bamboo and Soya Fabrics**

Fabrics	Kadukai	Tulsi	Aloe Vera	Lemon Grass Oil	Karpuravalli	Vettukaya Thalai	Untreated Fabric
<b>Cotton</b>							
Zone of Inhibition [mm] S. aureus	30	27	27	60	25	0	0
Zone of Inhibition [mm] E. Coli	29	27	27	60	25	0	0
<b>Bamboo</b>							
Zone of Inhibition [mm] S. aureus	30	45	25	25	25	0	0
Zone of Inhibition [mm] E. Coli	27	29	26	0	25	0	0
<b>Soya</b>							
Zone of Inhibition [mm] S. aureus	30	26	25	25	25	25	0
Zone of Inhibition [mm] E. Coli	25	26	27	25	25	26	0

Source: [6]

Both Aloe Vera [AG] and Neem extracts [NE] contain multiple substances that have antifungal and antibacterial activity. HCAN, a hybrid combination of AG and NE for their activity against microbes. The zone of inhabitation for S. aureus [Gram positive bacteria] was greater than for E. coli [Gram negative bacteria] for all, the concentration of AG, NE and HCAN due to the difference in the thickness of the cell

wall of S. aureus 80 nm as compared to 10 nm of E. coli. Even the inhibition zone of HCAN treated sample was higher than that of singly treated sample. Also, the washing durability was up to 20 wash cycles as compared to AG and NE finishes individually [8]. Through Agar well diffusion technique antibacterial activity was tested. The result showed that the Aloe vera gel can be used effectively for decontaminating

GP cones within a short duration and can be used in future as a medium for storage of GP points [13].

It showed the zone of inhibition ranging from 12 to 32 mm for gram negative bacteria, 21 to 31 mm for gram positive bacteria and 17 to 30 mm for fungal colonies. The percentage reduction test showed the reduction of less than 89%, 90% and 82% respectively. The antimicrobial activity was reduced at each wash cycle and at the end of 15<sup>th</sup> wash it is less than 30% in gram negative bacteria, less than 45% in gram positive bacteria and less than 25% in fungal colonies [15].

#### **Washing durability of Aloe Vera antibacterial finish**

The increase in concentration percent of Aloe Vera finish showed much more antibacterial activity. Even their washing durability showed good results for more washes. Huge and organized zone of antibacterial was formed through ZnO nano particles against E. coli and S. aureus before washing and after 5 washes it showed non organized shape but huge efficacy against S. aureus and less against E. coli. [1].

The result of Agar Diffusion Test proved that the reduction of S. aureus [gram positive] bacteria is 97% at concentration of 1gpl and it is highest i.e. 99.1% at 5 gpl. Even the wash fastness for fabric treated at 5 gpl. concentration is 98% till 50 Washes [17]. The washing fastness test showed that 100% and 75% gel treated fabric have antibacterial properties up to 20 washes while for commercial gel and leaf extract treated fabric up to 15 washes [18].

The ethanol herbal extract presented higher antibacterial activity against E. coli which last up to 25 washes. Nanotechnology is used not only to provide plant based finishes to combat infectious pathogens but also to give advance characteristics to textiles [2].

#### **Other properties**

Performance properties such as appearance, tensile strength, crease recovery angle, bending length, etc. were also evaluated. It was observed that due to present of BTCA cross-linking agent the Aloe Vera finished fabric has higher crease recovery angle and bending length. However, there was a decrease in the tensile strength and whiteness index of the fabric. [9]. Fragrance finished of Aloe Vera treated Cotton fabric was tested and it was found best for home textiles [4]. Other parameters such as whiteness index and absorbency were also studied [12].

The samples treated with Aloe Vera extracts at three different concentrations of 6%, 4% and 2% showed the reduction of both gram positive and gram negative bacteria at 90%, 78% and 50% before wash and 58.5%, 39% and 0% reduction after fourth wash respectively

[12]. From this study it is clear that this method of direct application does not have the wash durability and so it is suitable for one time use fabric only. In the development of sanitary napkins, a study compared the use of unbleached flax fibres and bleached flax fibres have greater absorbency of 20.797 g/g. The width of zone of inhibition was very effective for all the concentrations of 100%, 90%, 80% and 70% [7]. However, antifungal and the antibacterial efficacy against S. aureus for 100% conc. treated sample was higher than others. Through a grading system of 10 on comfort related features of the product, a group of the college going girls, working woman and housewives assessed the satisfaction and rated between 7 to 9. The finish could have other end use applications in the textile industry [7]. It is also possible to stabilize antimicrobial agent for about six months by using sodium benzoate [12].

The antibacterial efficacy against S. aureus and E-Coli and the odor retention property of treated samples were analysed. It was observed that samples treated with Aloe Vera alone have low antibacterial, but high odor resistance efficacy; while the sample treated with the Silver-nano alone have high antibacterial but low odor resistance efficacy. However, the sample treated with dual combination of 100% Aloe Vera and 7% Nano Silver concentration have higher antibacterial efficacy and good odor resistance [14].

The Aloe Vera finish as an antibacterial treatment can enhance the fabric by contributing to some physical properties such as crease recovery, softness apart from imparting other desirable properties such as odor resistance and comfort.

#### **CONCLUSION**

Aloe Vera has been used in medicinal and cosmetic purposes because of its natural antibacterial properties. Aloe Vera as a finish applied on cotton fabrics to impart antibacterial properties has been reviewed. Out of all the methods of application of Aloe Vera antibacterial finish to cotton textiles, Pad-dry-cure method is the most widely used method. It is most viable method to give antibacterial finishes to the textile materials in an eco friendly manner. Fabric treated with 100% concentration of Aloe Vera extract, processed for 60 mins at 80<sup>o</sup> C showed optimum antibacterial properties as compared to other concentrations. The washing durability was found to be good by this method. To increase the stability of antibacterial finish methanol and chitosan were used as binding agent in finishing. Although the availability of Aloe Vera is in bulk quantities, their extraction, isolation and purification to get standardised products are some of the challenges in their application. Also,

the durability, shelf life and antimicrobial efficacy are other issues which need to be considered. However, because of their eco-friendly nature and non-toxic properties, they are still promising candidates for niche applications in textile. It was observed that with the increase in the per cent of Aloe Vera gel concentration the bacterial reduction increases. The treated fabric retains antibacterial activity for may washes.

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