Proceedings of
National Conference on

# "Eco-Textiles: A Step towards Sustainability"
# (NCETS 2015)

Editors
Dr. K. Sangeetha
Ms. K. Amutha
Dr. Rupa Gunaseelan

Published by

Laser Park Publishing House
No.5, M.G. Colony, Vadavalli,
Coimbatore - 641 041
Email : lpphouse@gmail.com
Mobile: 9842232545

# Contents

ISBN 978-93-84234-43-0

# APPLICATION OF ANTIMICROBIAL FINISH ON KHADI FABRIC USING *ACORUS CALAMUS*

*S.Tharani[1] and Dr. R. Sunitha[2]*
[1]M.Sc. Student and [2]Assistant Professor,
Department of Textile and Clothing, Avinashilingam Institute for Home Science and Higher Eduction for Women, Coimbatore

## 1. Introduction

The textile industry is a diverse one, as much in the raw materials it uses as the technique it employs. At each stage of the textile industry, the negative impacts on the environment are as numerous as they are varied. The need for eco friendly textiles is being voiced soundly at present day times. So, the fibre, yarn, fabric, manufacturing process, finishes used, and treatment methods involved should not affect the environment, considering cradle to grave effect.

An attempt to apply antimicrobial finish on khadi cotton using a natural herb was intended as people are becoming more conscious about health and hygiene and Khadi cotton was selected for this as hd

Microbial infestations pose danger to both the living and non-living beings. Obnoxious smell, spread of diseases, staining and degradation of textile materials are some of the detrimental effects of bad microbes. For these reasons, it is highly desirable that the growth of microorganisms on textiles be minimized during their storage and use.

### Objectives

* to impart antimicrobial finish on khadi fabric
* to develop end products

## 2. Methodology

* Selection of fabric, finish and herb
* Extraction of finishing agent
* Pilot study and optimization
* Application of finish
* Evaluation

## 2.1 Selection of fabric, finish and herb

Khadi cotton was selected for the application of the finish. Antimicrobial finish can be applied to a fabric either by using chemicals or by using natural agents. Herbal antimicrobial finishes given to fabrics are gaining popularity and are proved to be effective and useful. [1] The rhizome of the herb *Acorus calamus* contains active ingredients possessing antibacterial and antifungal properties.[2] So, this herb was selected for the study.

## 2.2 Extraction of *Acorus calamus*

Extracts of the rhizome was prepared using two solvents namely water and ethanol.

### 2.2.1 Ethanolic extraction

Ethanolic extraction was done in an orbital shaker. An orbital shaker has a table board that shakes in a circular motion. The solutions to be stirred and extracted were taken in conical flasks. The number of rotations per minute was set as 230 and the temperature as 30°C for a period of 24 hours.[3] After the extraction process was over, the solutions were filtered and collected in a sterilized beaker and stored in refrigerator. The collected extracts were evaporated to remove the solvent. The evaporation process was done using Soxhlet apparatus. The concentrated extract was collected and stored in refrigerator.

### 2.2.2 Aqueous extraction

The aqueous extraction was carried out in water bath. About 10 grams of the herb was taken and soaked in 100 ml of distilled water. The mixture was allowed to boil in a beaker kept in water bath.

The temperature was set to 80°C and the process was carried out for 30 minutes.[4] Then the solution was filtered and stored.

### 2.3 Pilot study

A pilot study was conducted to check the antimicrobial activity of both extracts qualitatively by using the test method AATCC 147 (Agar plate test) It is a rapid qualitative method for determining antibacterial activity of treated textile materials against gram-positive and gram negative bacteria.

The zone of inhibition for both bacteria and fungi were measured using a metric scale. Ten readings were taken for each and the average was calculated. The average values ware taken as the zones of inhibition and were compared. The extract with the larger zone of inhibition was chosen for further study. After the zones were measured, the decontamination process was carried out.

#### 2.3.1 Optimization

The concentration of the extract was optimized based on the antimicrobial activity. *Acorus calamus* was extracted using ethanol in five concentrations namely 2 percent (4 g in 200 ml), 4 percent (8 g in 200 ml), 6 percent (12 g in 200 ml), 8 percent (16 g in 200 ml) and 10 percent (20 g in 200 ml). The qualitative test for antimicrobial activity of the solutions was carried out. The concentration that corresponds to the largest zone was decided as the optimized concentration.

#### 2.3.2 Preparation of fabric

The fabric was immersed in detergent solution prepared using soft water and was boiled for half an hour. Then the fabric was taken out, rinsed thoroughly and dried in shade. Thus the desized khadi fabric was obtained.

### 2.4 Application of finish

#### 2.4.1 Exhaustion method

For exhaustion method, the material liquor ratio was taken as 1:40. The fabric was immersed in the selected rhizome extracted solution and heated at 50°C - 55°C for 45 minutes. After treatment, the fabric was left to dry in shade. A water bath was utilized for the application process.

#### 2.4.2 Pad – dry – cure method

Pad – dry – cure method was executed using a padding mangle. The M:L ratio for the process was taken as 1:5.[5] A padding mangle offers continuous processing of the fabric in the concerned liquor. The fabric was passed into the solution of *Acorus calamus*, under a submerged roller and out of the bath. The fabric was then.squeezed to remove excess solution. The padding mangle was made to run at a speed of 15m/min. After padding, the fabric was air dried and then cured for 3 minutes at 140°C.[6]

#### 2.4.3 Plasma treatment

Plasma treatment was done using the plasma chamber which was operated in a vacuum. Vacuum evaporation is a Physical Vapour Deposition (PVD) process and is of the most commonly used methods for deposition of functional films on different substrates. The process allows vapor particles to deposit directly on the substrate where vapour particles condense back to a solid state, forming a functional coating. Vacuum is used to prevent the collision of the evaporated particles with unwanted particles.[7] Samples were immediately dipped in the *Acorus calamus* solution after plasma treatment.

### 2.5 Evaluation of the finished fabric

The original, desized and all the treated samples were subjected to evaluation. Both subjective and objective evaluation methods were used for the study. SEM (Scanning Electron Microscope) analysis was also done to interpret the structural changes and appearance of the samples.

Table 1 : *Nomenclature*

| S. No | Nomenclature | Sample |
|---|---|---|
| 1 | O | Original sample . |
| 2 | D | Desized sample |
| 3 | E | Sample treated by exhaustion method |
| 4 | P | Sample treated by pad-dry-cure method |
| 5 | PL | Sample treated by plasma treatment method |
| 6 | PLW1 | 1 time washed plasma treated sample |
| 7 | PLW2 | 2 times washed plasma treated sample |
| 8 | PLW3 | 3 times washed plasma treated sample |

The original, desized and treated samples were evaluated subjectively and objectively. The results of the desized sample were compared with the original sample and all the treated samples were compared with the desized sample, considering it to be the untreated sample.

## 3. Results and Discussion

### 3.1 Pilot study

The zones of inhibition formed for bacteria and fungus in aqueous extract and ethanolic extract are tabulated below.

Table 2 : *Pilot Study*

| S. No | Extract | Zone of Inhibition -Bacteria (mm) | | Zone of Inhibition - Fungus (mm) |
|---|---|---|---|---|
| | | Gram +ve | Gram -ve | |
| 1 | Aqueous | - | - | - |
| 2 | Ethanolic | 1.2 | 1.7 | 2 |

From the Table 2, it is obvious that there was antimicrobial activity in the ethanolic extraction of *Acorus calamus* from the pilot study.

### 3.2 Optimization

The zones of inhibition for the five different concentrations of the ethanolic extract are tabulated below.

Table 3: *Optimization*

| S. No | Concentration | Zone of Inhibition (Bacteria) (mm) | | Zone of Inhibition (Fungus) (mm) |
|---|---|---|---|---|
| | | Gram +ve | Gram –ve | |
| 1 | 2% | 1 | 1.5 | 1.9 |
| 2 | 4% | 1.5 | 1.5 | 2.1 |
| 3 | 6% | 1.7 | 1.9 | 2.3 |
| 4 | 8% | 2 | 2.2 | 2.5 |
| 5 | 10% | 1.5 | 1.7 | 2.1 |

From the Table 3, it could be concluded that 8 percent concentration of the ethanolic extract of *Acorus calamus* rhizome has the best antimicrobial activity.

### 3.3 Subjective evaluation

The treated samples were subjectively evaluated by a panel of 30 members

Maximum number of judges felt that the samples had a very good general appearance of which it was highest in sample PL with 93 percent, followed by the samples P and E with 70 and 67 percentages respectively. Samples P and PL were rated high in evenness of which it was highest in sample PL with 97 percent followed by sample P with 90 percent ratings. Sample E was rated to have medium evenness

with 83 percent ratings. Maximum numbers of judges feel that the samples had a good lustre of which it was highest in sample PL with 90 percent, followed by samples P and E with 87 and 67 percentages respectively.

All the judges felt that the sample P has a coarse texture. Samples E and PL were rated smooth in texture with 83 and 87 percentages of ratings. Also a maximum number of the judges feel that the samples have a moderate fragrance of which it is highest in sample PL with 90 percent ratings followed by samples P and E with 83 and 77 percentages respectively.

### 3.4 Objective Evaluation

### 3.4.1 Fabric Count

Table 4: *Fabric Count*

| S. No | Sample | Fabric count (Warp) | | Fabric count (Weft) | |
|---|---|---|---|---|---|
| | | Fabric count | Loss or gain percent | Fabric count | Loss or gain percent |
| 1 | O | 77 | - | 67 | |
| 2 | D | 86 | 12 | 78 | 16 |
| 3 | E | 97 | 13 | 83 | 6 |
| 4 | P | 99 | 15 | 84 | 8 |
| 5 | PL | 85 | 1 | 78 | - |

From the Table 4, we know that the treated samples showed an increase in fabric count of which it was the highest in sample P. It could also be concluded that in weft direction the fabric count increased on desizing which further increased on finishing treatment and the increase was higher in sample P.

### 3.4.2 Fabric Weight and thickness

Table 5 : *Fabric Weight & Thickness*

| S. No | Sample | Weight | | Thickness | |
|---|---|---|---|---|---|
| | | (GSM) | Loss or gain percent | Thickness (mm) | Loss or gain percent |
| 1 | O | 102 | - | 0.33 | - |
| 2 | D | 95 | 7 | 0.32 | 3 |
| 3 | E | 82 | 14 | 0.34 | 6 |
| 4 | P | 153 | 61 | 0.38 | 19 |
| 5 | PL | 96 | 1 | 0.32 | - |

From the Table 5, it is clear that the weight increased drastically in sample P where as only slight increase was observed in sample PL. It could also be seen that the increase in thickness was higher in sample P and no change was observed in sample PL.

### 3.4.3 Tensile Strength

Table 6 : *Tensile Strength*

| S. No | Sample | Strength (Warp) | | Strength (Weft) | |
|---|---|---|---|---|---|
| | | Strength (Kg) | Loss or gain % | Strength (Kg) | Loss or gain % |
| 1 | O | 27 | - | 26 | - |
| 2 | D | 28 | 4 | 27.5 | 6 |
| 3 | E | 26 | 7 | 21 | 24 |
| 4 | P | 22 | 21 | 19 | 31 |
| 5 | PL | 24 | 14 | 20 | 27 |

From the Table 6, it is obvious that the strength loss was highest in sample P in warp direction. And the greatest loss in strength was observed in the sample P over the desized sample.

### 3.4.4 Elongation

Table 7 : Elongation

| S. No | Sample | Elongation (Warp) | | Elongation (Weft) | |
|---|---|---|---|---|---|
| | | Elongation (%) | Loss or gain % | Elongation (%) | Loss or gain % |
| 1 | O | 8 | - | 5 | - |
| 2 | D | 11 | 38 | 9 | 80 |
| 3 | E | 7 | 36 | 2 | 78 |
| 4 | P | 4 | 64 | 1 | 89 |
| 5 | PL | 5 | 55 | 2 | 78 |

From the Table 7, it could be concluded that the elongation of the fabrics reduced on the application of finishing treatments.

### 3.4.5 Pilling

Table 8 : *Pilling*

| S. No | Sample | Grade |
|---|---|---|
| 1 | O | 1 |
| 2 | D | 1 |
| 3 | E | 2 |
| 4 | P | 2 |
| 5 | PL | 2 |

From the Table 8, it is obvious that slight pilling was observed in all the treated samples.

### 3.4.6 Fabric Stiffness

Table 9 : *Fabric Stiffness*

| S. No | Sample | Fabric stiffness (Warp) | | Fabric stiffness (Weft) | |
|---|---|---|---|---|---|
| | | Stiffness (cm) | Loss or gain percent | Stiffness (cm) | Loss or gain percent |
| 1 | O | 2.9 | - | 2.8 | - |
| 2 | D | 2.7 | 7 | 2.2 | 21 |
| 3 | E | 2.3 | 15 | 1.9 | 14 |
| 4 | P | 5 | 89 | 4.9 | 123 |
| 5 | PL | 2.1 | 22 | 1.55 | 29 |

From the Table 9, it could be concluded that the stiffness of the fabric in warp direction reduced in samples E and PL but increased in sample P. It is also obvious that the stiffness of the fabric in weft direction reduced in samples E and PL but increased in sample P.

### 3.4.7 Crease recovery

Table 10 : *Crease Recovery*

| S. No | Sample | Crease recovery (Warp) | | Crease recovery (Weft) | |
|---|---|---|---|---|---|
| | | Recovery angle | Loss or gain % | Recovery angle | Loss or gain % |
| 1 | O | 52 | - | 71 | - |
| 2 | D | 62 | 19 | 108 | 52 |
| 3 | E | 72 | 16 | 100 | 7 |
| 4 | P | 71 | 15 | 88.5 | 18 |
| 5 | PL | 75 | 21 | 102.5 | 8 |

From Table 10, it is obvious that the sample PL has the highest crease recovery angle in the warp

direction. It is also clear that the treated samples have a decrease in crease recovery angle over the desized sample D.

### 3.4.8 Drape

Table 11 : *Fabric Drape*

| S. No | Sample | Drape coefficient | Loss or gain % |
|---|---|---|---|
| 1 | O | 66.66 | - |
| 2 | D | 63.58 | 5 |
| 3 | E | 46.96 | 26 |
| 4 | P | 95.37 | 50 |
| 5 | PL | 47.06 | 26 |

From the Table 11, it could be concluded that the sample P has the lowest drape while sample samples E and PL have an increase in drape after treatment.

### 3.4.9 Drop test and sinking

Table 12: *Drop test & Sinking*

| S. No | Sample | Drop test | | Sinking | |
|---|---|---|---|---|---|
| | | Time (sec) | Loss or gain percent | Time (sec) | Loss or gain percent |
| 1 | O | 25 | - | 42 | - |
| 2 | D | 2 | 92 | 3 | 93 |
| 3 | E | 2 | - | 2 | 33 |
| 4 | P | 3 | 50 | 3 | - |
| 5 | PL | 1 | 50 | 1 | 67 |

From the Table XII, It can be seen clearly that there is 1% significance as per the F value. Hence, it could be concluded that the sample PL has the highest absorbency over the desized sample D after treatement. It is obvious that samples E and PL had increased in absorbency property after treatment.

### 3.4.10 Wicking

Table 13 : *Wicking*

| S. No | Sample | Wicking (cm) | Loss or gain % |
|---|---|---|---|
| 1 | O | 0.4 | - |
| 2 | D | 5.7 | 1325 |
| 3 | E | 4.35 | 69 |
| 4 | P | 2.6 | 54 |
| 5 | PL | 6.8 | 19 |

From the Table 13, it could be concluded that the treated samples have an increase in wicking ability than the original and the desized samples.

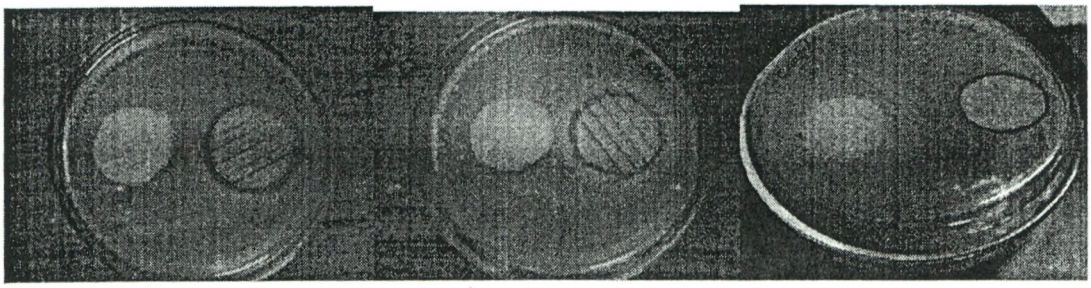
### 3.4.11 Antimicrobial test

Table 14 : *Antimicrobial Test*

| S. No | Sample | Zone of Inhibition (Bacteria) (mm) | | Zone of inhibition (fungus) (mm) |
|---|---|---|---|---|
| | | Gram +ve | Gram –ve | |
| 1 | E | 2.2 | 2.1 | 2.3 |
| 2 | P | 2.2 | 2.3 | 2.5 |
| 3 | PL | 2.3 | 2.3 | 2.5 |

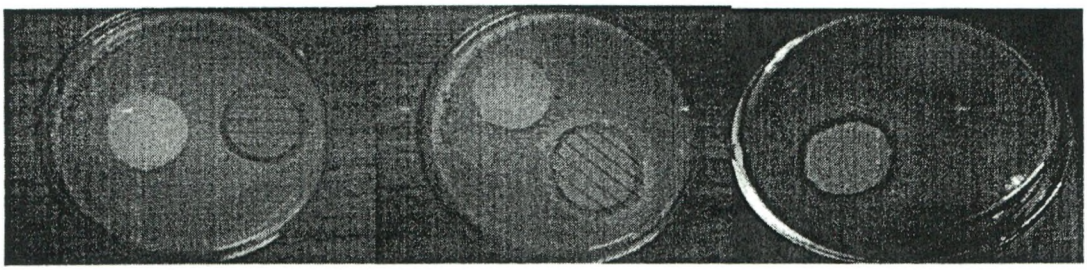
From the Table 14, it is evident that the highest zone of inhibition of gram +ve bacteria was observed in sample PL with 2.3 mm followed by samples E and P with 2.2 mm. As for the gram –ve

bacteria, the highest zone of inhibition was observed in samples P and PL with 2.3 mm followed by sample E with 2.1 mm. As far as fungus is concerned, the highest zone of inhibition was observed in samples P and PL with 2.5 mm followed by sample E with 2.3 mm.



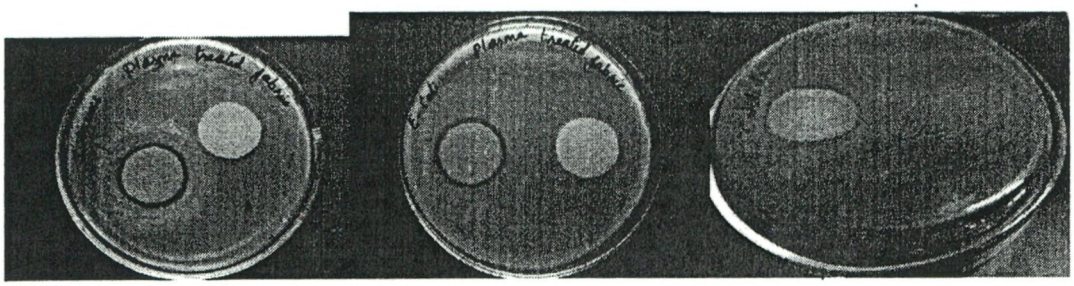
Gram +ve Bacteria Gram -ve Bacteria Fungus

Antimicrobial Activity of Sample E



Gram +ve Bacteria Gram -ve Bacteria Fungus

Antimicrobial Activity of Sample P

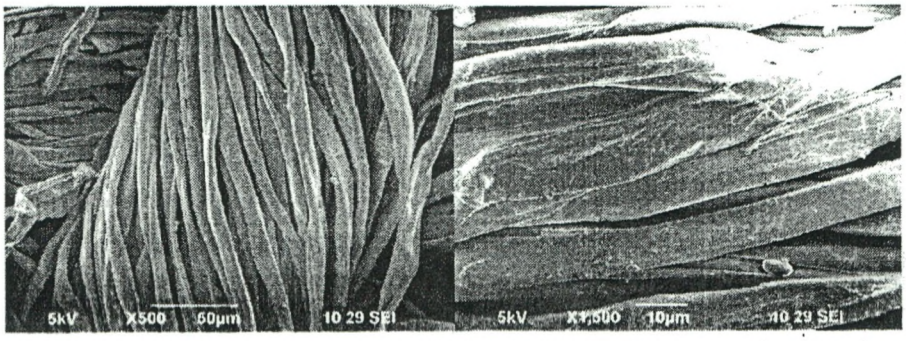


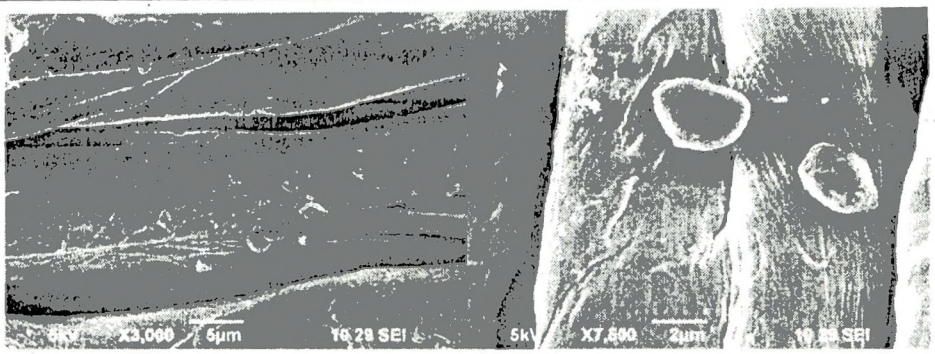
Gram+ve Bacteria Gram -ve Bacteria Fungus

Antimicrobial activity of Sample Pl

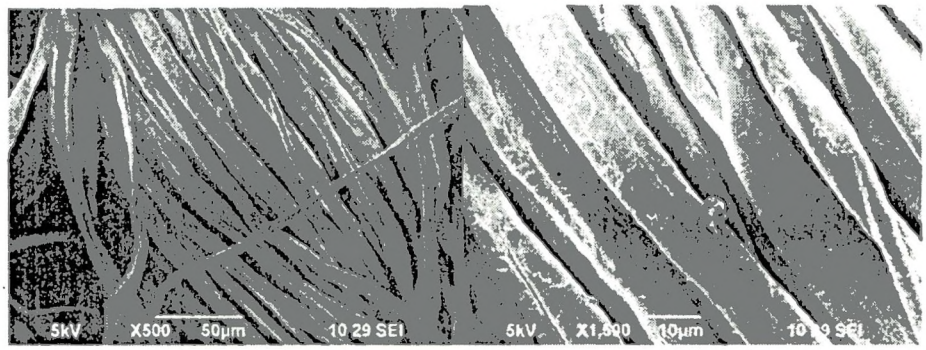
### 3.4.12 SEM analysis

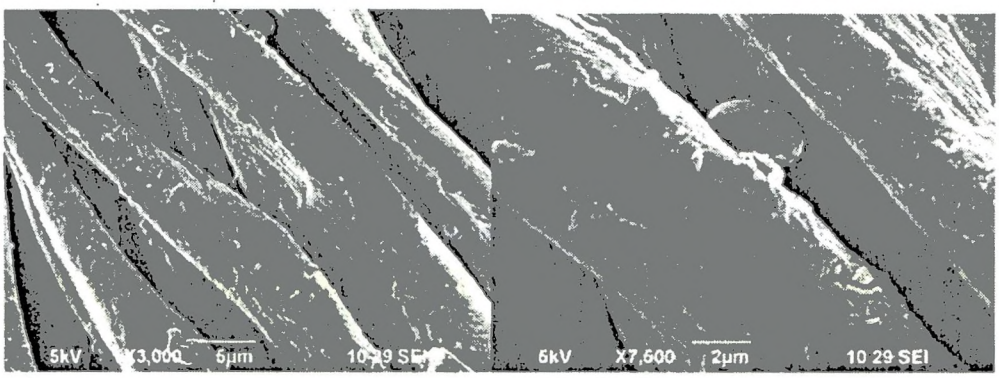
From the Scanning Electron Microscopic appearance at various magnifications, it is obvious that the appearance of sample P exhibited the adherence of *Acorus calamus* on the surface of the fibres. This adherence was noted to be more in the sample PL. This may be due to the treatment methods adopted for the study.



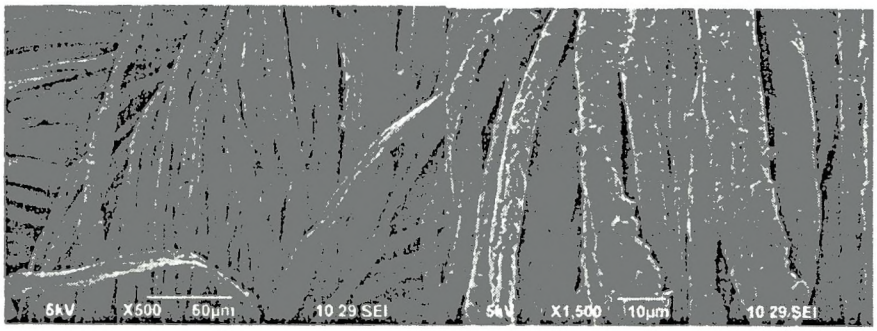


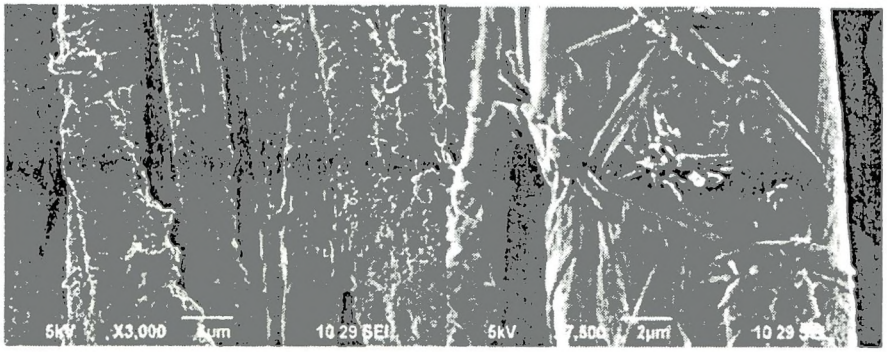

SEM appearance of Sample D



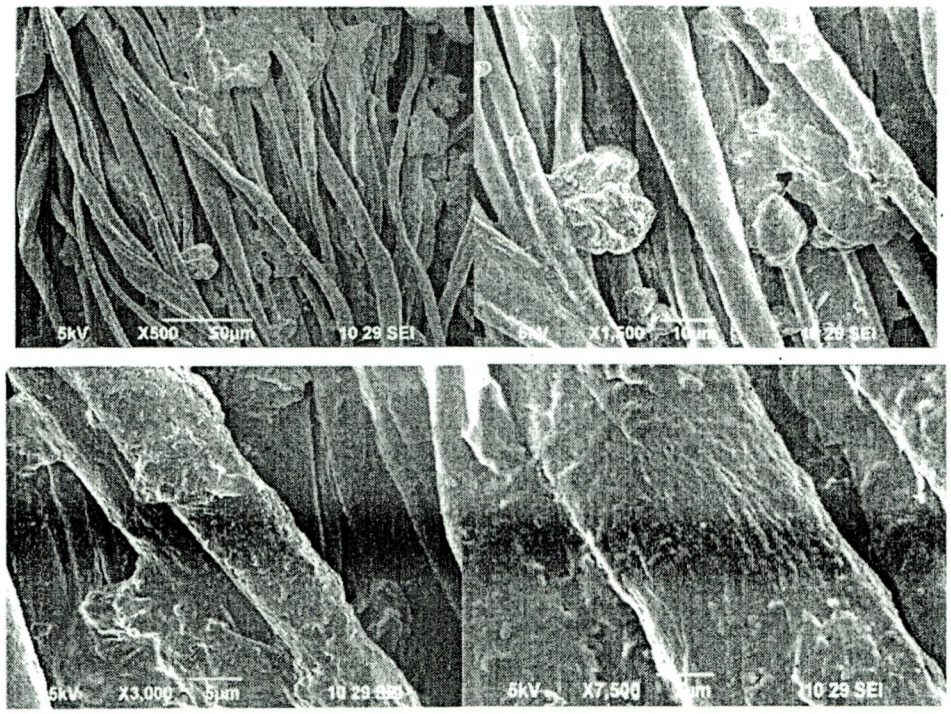




SEM appearance of sample E




SEM appearance of sample P




SEM appearance of sample PL

## References

[1] Hooda, S., Khambra, K., Yadav, N. & Sikka, V.K. (2013). "Antimicrobial Activity of Herbal Treated Wool Fabric", *American International Journal of Research in Formal, Applied & Natural Sciences*, 1(3), 66.

[2] Avadhani, M.M.N., Selvaraj, I.C., Rajasekharan, P.E. & Tharachand, C. (2013). "The Sweetness and Bitterness of Sweet Flag (Acorus calamus L.) – A Review", *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 4(2), 598.

[3] Behera, P., Raja, V.J. & Basavaraju, R. (2014). "Phytochemical and Antimicrobial Activity of Fruit Pulp of Aegle marmelos", *Journal of Chemical and Pharmaceutical Research*, 6(8), 320.

[4] Johnson, D.B., Shringi, B.N., Patidar, D.K., Chalichem, N.S.S. & Javvadi, A.K. (2011). "Screening of Antimicrobial Activity of Alcoholic & Aqueous Extract of Some Indigenous Plants", *Indo – Global Journal of Pharmaceutical Sciences*, 1(2), 187.

[5] Karolia, A. & Mendapara, S. (2007). "Imparrting Antimicrobial and Fragrance Finish On Cotton Using Chitosan With Silicon Softener", *Indian Journal of Fibre & Textile Research*, 32(1), 100.

[6] Yadav, A., Prasad, V., Kathe, A.A., Raj, S., Yadav, D., Sundaramoorthy, C. & Vigneshwaran, N. (2006). "Functional Finishing in Cotton Fabric Using Zinc Oxide Nano Particles", *Bulletin of Material Science*, 29(6), 642.

[7] Vihodceva, S. & SilvijaKukle, (2013). "Low - Pressure Air Plasma Influence on Cotton Textile Surface Morphology and Evaporated Cooper Coating Adhesion", *American Journal of Material Science and Technology*, 2(1), 1-9.