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Antimicrobial activity of herbal treated cotton fabric

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Abstract - *The study focused on the development of bacterial resistant cotton fabric using Murraya Koengii (curry leave) and Zingiber Officinale (ginger) oil. It is also intended to produce Eco-friendly antimicrobial cotton fabric and to protect the consumer from microorganism's contamination. Herbal antimicrobial finish has been imparted to the cotton fabric by pad-dry-cure method. Finish was applied in two concentrations (40g/l and 80g/l) on grey cotton fabric. Weight add-on percent of extract on treated cotton fabric was determined to observe the quantity of extract absorbed by the fabric. The antibacterial activity of the finish was assessed quantitatively using AATCC-100 test method. Qualitative analysis is carried out to measure the antimicrobial activity against Gram-positive (S. aureus, B. subtilis, B. pumilus) and Gram-negative (Pseudo, Candida, E. coli) bacteria. Physical textile properties of treated and untreated cotton fabrics such as absorbency, fabric stiffness and strength are analysed***.**

***Key Words*: Antibacterial, Antifungal, Curry Leave oil, Cotton, Ginger oil, Gram positive, Gram negative.**

1. INTRODUCTION

Textiles and clothing are in permanent contact with microorganisms from the environment and the human skin [4]. Textile materials are good carriers of various types of microorganisms and can cause health related problems to the wearer. These micro-organisms create problems in textile, including discolouration, stains and fibre damage, unpleasant odour and a slick, slimy feel [7]. Hence to protect the wearer from infection, textile fabrics can be finished with antimicrobial agents. Antimicrobial textiles with improved functionality finds a variety of applications such as health and hygiene products, specially the garments worn close to the skin and several medical applications, such as infection control and barrier material[5]. Herbal antimicrobial finish is one of the special finishes which can be applied to the textile material to protect the skin of the wearer and the textile substrate itself [9].

There is a vast resource of natural antimicrobial agent/antimicrobial finish which can be used for imparting antimicrobial property to textile substrates [1, 10]. Some of mostly used natural antimicrobial agents are clove, cardamom, curry leaves, neem, tulsi stem, leave, aloevera, etc. [8]. But most of them are carcinogenic. Several studies have been done on antimicrobial activity of cotton fabric treated with aloe gel extract, effect of laundering on herbal finishes, antibacterial treatment on cotton fabric from neem oil, aloe vera &tulsi etc. [5, 8, 12]. Based on the literature review, it was decided to apply the Murraya Koengii (curry leave) and Zingiber Officinale (ginger) oil on cotton fabric by pad-dry-cure method in two concentrations for assessment of antibacterial and antifungal activity. Ginger is a natural antioxidant and anti-carcinogenic compound with antimicrobial properties whereas curry leaves are also naturally occurring antifungal agents which are non-carcinogenic. Some ginger compounds such as α-pinene, borneol, camphene and linalool are responsible for its antimicrobial activities [11]. Curry tree is a tropical tree with 2-4 cm long aromatic leaves. These leaves are often used in making dishes. The chemical components of curry leaves include linalool (32.83%), elemol (7.44%), geranylacetate (6.18%), mycrene (6.12%), allloocimene (5.02%), α-terpiene (4.9%), β-ocimene (3.68%) and nerylacetate (3.45%) [10].

2. MATERIALS AND METHODS

Pure cotton fabric with plain weave (126 EPI and 70 PPI) and fabric weight 182 g /m2 was used for antimicrobial finishing. To improve the exhaustion rate of oil, acid desizing and Scouring on grey cotton fabric was performed. The fabric was padded with acid solution (H 2SO 4 5-10 gpl) at 40^0C for 3-4 hours followed by hot water washing to remove maximum amount of starch. Conventional scouring was carried out by using 2%NaOH, 1% Na2CO3, and 1-3 gpl Non-ionic Emulsifier at 80◦C for 2 hrs.

2.1 Finish Application

Herbal antimicrobial finish was applied on fabric by pad-dry-cure method [fig. 1]. Ginger and curry leave oil were treated with carrier oil to form solution of 40 gpl and 80 gpl respectively. Four solutions were prepared as shown in table 1.

Table -1: Samples treated with different concentration

40 gpl	1. 50:50 curry leaves and ginger extract	Sample 1
	2. 100% pure curry leaves oil	Sample 3
80 gpl	3. 50:50 curry leaves and ginger extract	Sample 2
	4. 100% pure curry leaves oil	Sample 4
Untreated	5. Unfinished fabric	Sample 5

2.2 Parameters for padding

Fabric was dipped in solution for 30 minutes at a temp. of 130ºC, pressure: 1.5 bar, M:L= 1:30 followed by padding for other 30-40 seconds. The samples were dried at 80ºC for 5 minutes and cured at 200ºC for 1 minute in a curing chamber. Fabric was cold washed at 1-3 gpl concentration of soap to remove excess oil.


Fig -1: Pre treatment and Finish application by Pad dry cure method.

2.3 Quantitative Test Methods AATCC 147

Most of the antibacterial agents work under two main principles: inhibition of the growth of the cells (biostatic) and killing of the cell (biocidal) [2]. This is a Qualitative test used to detect bacteriostatic activity on textile materials. The test Method determines antibacterial activity of diffusible antimicrobial agents on treated textile materials [1].

Anti-Bacterial Assessment of the Finished Fabric by (AATCC 147)

The finished fabric samples with the diameter of 4.8 + 0.1 cm were taken for the analysis. Both the sides of samples were presterilized under steam flow for 15minutes. Sterile bacteriostasis agar was dispensed in sterile petridishes. Broth cultures (24 hours) of the test organisms were used as inoculum. Using sterile cotton swab the test organisms (Klebsiella pneumoniae ATCC 4352 Staphylococcus aureus ATCC 6538) were swabbed over the surface of the agar plate. Presterilized samples were placed over the pre-swabbed agar surface by using sterile spatula. After placing the samples all the plates were incubated at 37ºC for 24 to 48 hours. After incubation the plates were examined.

2.4 Anti Fungal assessment of the Finished Fabric by (AATCC 30)

The antifungal activity of finished Fabric is analysed by qualitative method AATCC. The two purposes of this test method are to determine the susceptibility of textile materials to mildew, rot and to evaluate the efficacy of fungicides on textile materials [13].

The fungus, Aspergillus niger, is grown on solid medium and a spore suspension is created after appropriate growth time. An inoculum of 1.0ml was evenly distributed over the surface of the agar.

The specimens were incubated at a temperature of 28ºC for seven days. A constant condition with respect to temperature was maintained throughout the length of the experiment procedure. The samples were evaluated visually after 7 days.

2.5 Measured properties

Wicking property

Prior to testing, the samples were conditioned in a standard atmosphere of 20±2ºC and 65±2% relative humidity for 24 hours. Sample of size 2.5cm x 20cm each were cut from the conditioned sample. The samples were then mounted on the pinned frame such that 3 cm of the sample length was kept in immersed condition in reservoir containing distilled water. A ruler was placed parallel to the sample strip to enhance the accuracy of the measurement. The wicking height of the advancing liquid front as a function of time was recorded by visual observation after 5 minutes. At least 10 samples were tested and the average value was taken.

Stiffness Test

A widely used method for determination of stiffness of fabric is cantilever test method. In this test, fabric specimen is allowed to bend under its own weight as the length of overhanging portion of specimen, is gradually increased. The free length which bends under its own weight is sufficient to make its leading edge intersect with a plane of 41.5◦ inclination and is taken as the measure of stiffness. By this value of length, bending modulus and flexural rigidity was calculated.

Tear Strength Test

Elmendorf tear tester was used to test tear strength of finished and unfinished fabric. A pendulum is used to measure the force required to propagate an existing slit a fixed distance to the edge of the test sample.

Thermal Conductivity Testing

Thermal conductivity is total heat transmitted through fabric per unit time with unit temperature difference. It is influenced by fabric/fibre properties, surface treatment, temperature and other factors [12]. Thermal properties were Guarded plate method was used to measure thermal conductivity.

3. RESULT AND DISCUSSION

Chart 1 shows vertical wicking test results for the specimens. It can be observed that samples with oil finish do have much better wicking property as compared to plain fabric i.e water molecules are showing better adhesion to the coated yarns than plain ones. It means fabric can easily hold water in the interstices of cloth and hence more absorbent spaces are formed. Capillary action occurs when the adhesion to the walls is stronger than the cohesive forces between water molecules. Reason of this phenomenon which has occurred in our testing is dependent on capillary action as well as on sticky nature of water molecules. As the surface tension of oil coated yarns is more, it attracts the water molecules to adhere to its surface which causes the meniscus to flow upward. Every liquid aspires to reach at Max. Surface tension to stabilize, similarly water gets more attracted towards the coated yarn than plain one and hence wicking property of oil coated samples is more.

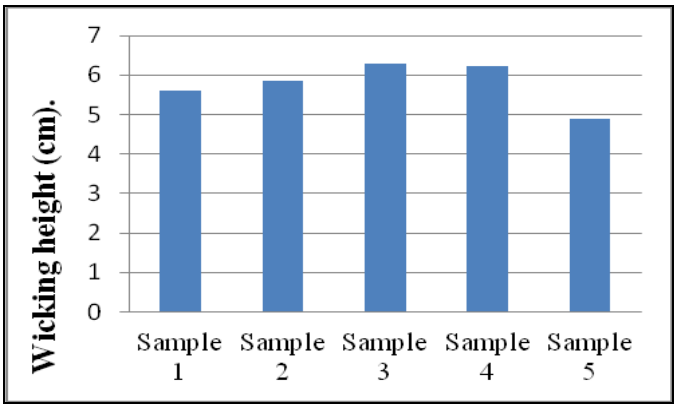

Chart -1: Vertical wicking test result

Chart 2 shows that, there is no significant variation in stiffness of fabric. Although, results show that stiffness of fabric is increased with a minimal amount but it is not significant to affect the handle of fabric when wore on human skin.

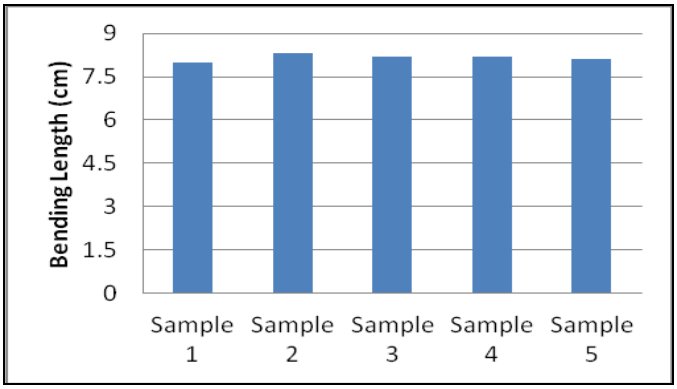

Chart -2: Bending Length test result

After analyzing results, we concluded that stiffness of fabric doesn't vary much in finished and unfinished fabric. Flexural rigidity and bending modulus of unfinished fabric is approximately similar to that of finished fabric.

The result in chart 3 shows tear strength of fabric increases after finishing. It took more force to tear the fabric samples in case of finished fabric than unfinished fabric. Tear strength of fabric increases as we increase the percent concentration of oil in fabric because, yarns slip over each other due to the presence of the oil on their surface and the force required to tear the fabric will be more.

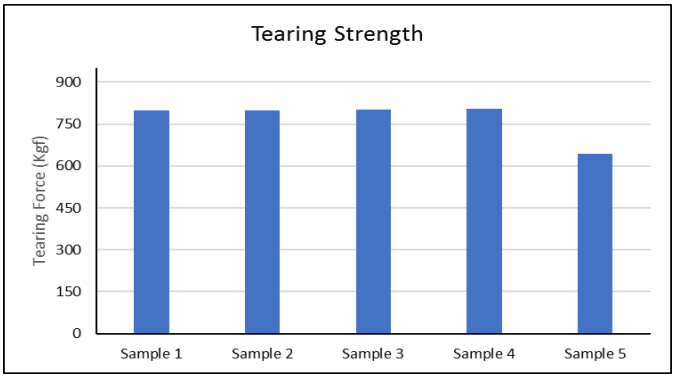

Chart -3: Tear Strength test result

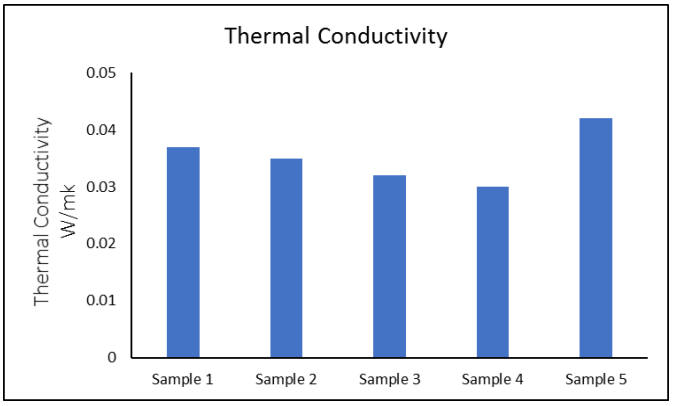

Chart -4: Thermal Conductivity test result

Thermal conductivity is an important factor in determining the fabric comfort properties [6]. Chart 4 shows that thermal conductivity of finished fabric is less as compared to unfinished fabric.

During finishing the presence of oil in the fabric hinders the path for the free ions to move forward and hence thermal conductivity decreases which is a positive change for fabric as textile fabric is required to be an insulator.

3.1 Test Results of Antimicrobial Activity

Here we compare the growth of S aureus and K pneumonia on untreated and treated sample with different concentration of the ginger oil and curry leave oil.

It can be seen from fig 2 that the growth of K pneumonia bacteria is more in all the samples as compared to S aureus. It is attributed that bacterial inhibition is due to the slow release of active substances from the fabric surface. Reduction in growth of bacteria can be seen in treated samples as compared to untreated sample 5. The fabric exhibited high antimicrobial property at 80 gpl concentration due to attachment of anti microbial agent to the substrate through bond formation on the surface. Better results can be observed in sample treated with 100% curry leave oil i.e sample 3 and 4.

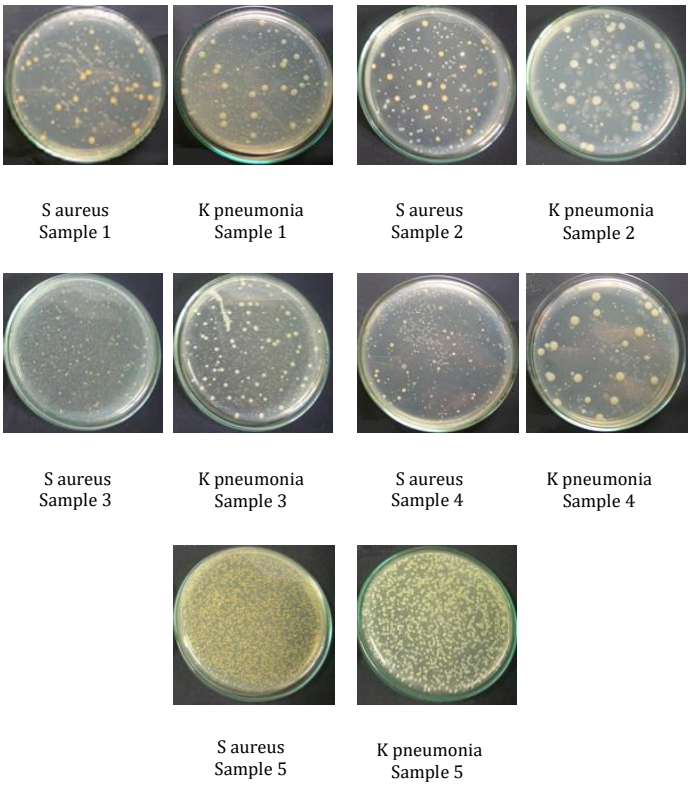

Fig -2: Antibacterial activity of treated and untreated specimen

Thus, after the entire study it can be conclude that, curry leaves have maximum antibacterial activity against S. aureus.

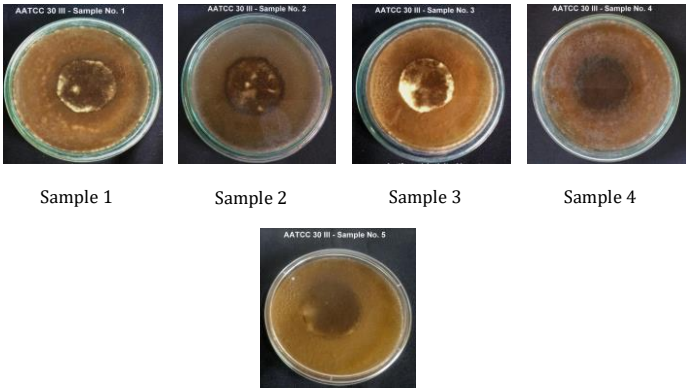

Fig -3: Antifungal activity of treated and untreated specimen
The results showed that compared to the untreated fabric, the treated fabric showed reduction of fungal growth. No significant difference between treated and untreated sample was observed in antifungal activity.

4. CONCLUSIONS

Ginger and curry leaf extracted essential oil application has been done successfully by pad-dry-cure method on cotton fabric as an antimicrobial finish. Finished fabric shows the very good antibacterial activity as compared to unfinished fabric. As the concentration of extract increased, its effectiveness against bacterial growth also increased. No negative effect was observed on physical properties of fabric after finish application. The effect of finish on antifungal activity was minimal, and other methods of finish application with different concentrations can be used for better results. There is a vast resource of natural antimicrobial agent, which can be used for imparting useful antimicrobial property to textile substrates.

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