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Short Communication

Development of health care and hygiene curative finishing on textile material using *Acalypha Indica*

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This present work deals with an eco-friendly natural antimicrobial finishing of cotton terry towel that has been prepared from the plant extracts of *Acalypha Indica*. Herbal extracts from *A. indica* (kuppai meni) have been applied to the cotton fabric by the method of direct application along with citric acid is act as a cross-linking agent using the pad-dry-cure method. The treated samples were antimicrobial activities were evaluated through qualitative methods (zone of inhibition in mm) and quantitative methods (bacterial reduction %), from the results the finished cotton bath towel shows better antibacterial activity against both bacterial strains *Klebsiella pneumonia* and *Staphylococcus aureus*, wash durability of the samples also good because the samples along with the extracts treated with citric acid act as a cross-linking agent so these cross-linking agents to form a bridge between herbal media and fibre assembly. After 10 washes the extract-treated samples show good antimicrobial properties for the fabrics.

Keywords: *Acalypha indica*, Antibacterial, Cross-linking, Herbal, Wash durability.

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Introduction

The current textile market has shown that apparel consumers all over the world are demanding different functionalities in the product. Some of the best examples of functionality are product characteristics such as soil release, wrinkle resistance, water repellency, flame retardancy, fade resistance and resistance to microbial invasion. Among these, the antimicrobial property of a fabric is being considered to be an important and inevitable parameter for garments that are in direct contact with the human body. Cotton textiles in contact with the human body offer an ideal environment for microbial growth[1-4]. Microbial infestations possess a danger to both living and non-living matter. The obnoxious smell from the inner garment (such as socks, the spread of diseases, staining and degradation of textiles are some of the detrimental effects of bad microbes. Consumers are now increasingly aware of the hygienic of a wide range of textile products finished with antimicrobial properties. Many commercial products are currently available in the market with a range of antimicrobial properties under different trade names for the textile industry. The majority of such products are synthetic based and may not be environment friendly. Many natural/herbal products show antimicrobial properties. Extracts from different parts of the diverse species of plants like root, flower, leaves, seeds, etc., exhibit antimicrobial properties. Many of the plants contain compounds like phenolic, terpenoids, flavonoids, alkaloids, polypeptide, polyacetylenes, etc. which are acting as antibacterial. Some of them act as bactericides (which kills bacteria) and some act as bacteriostatic (interfere with the multiplication, growth or activity of bacteria)[4-8].

India has a rich heritage of knowledge on plant-based drugs both for use in preventive and curative medicine. A country like India is very much suited for the development of drugs from a medicinal plant. Because of its vase and wide variations in soil and climate, the Indian subcontinent is suitable for the cultivation of a large number of the medicinal and aromatic plant which can be used as raw materials for pharmaceutical, perfumery, cosmetics, flavour, food and agrochemical industries. A large number of these plants grow wild and exploited especially for use in indigenous pharmaceutical houses. Some of these plants produce valuable drugs which have high export potential. There are many aspects of research associated with the medicinal plants' sector. The significant contribution to society, traditional medicine has experienced very little attention in modern research and development and less effort has been done to upgrade the practice[9-13]. The antimicrobial properties of plants have been investigated by many researchers worldwide. In the past few decades, antibiotics of microbial origin and other chemotherapeutic agents have been used for the control of bacterial disease. In this work to develop health and hygiene towels using *A. indica.* The

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chemical constituent of the *A. indica* aerial parts contain a cyanogenic glycoside called acalyphin (a 3-cyanopyridone derivative) as well as flavonoids, such as kaempferol glycosides mauritianin, clitorin, nicotiflorin, and biorobin. Tannins, β-sitosterol, acalyphamide, aurantiamide, succinimide, and flindersin (a pyranoquinolinone alkaloid) have also been isolated from this plant.

The present work aims to develop a natural antibacterial finish from the extract of traditional medicinal plant *A. indica* for textile bath towel application, form this finish through evaluating their antibacterial activities.

Materials and Methods

Naturally scoured, bleached 100% Cotton terry fabric (150 g per square meter (GSM)) Ends per inch (EPI) of 82 and Picks per inch (PPI) of 74 was used for the application of curative finish. Fresh *A. Indica* leaves were used for the herbal dyeing process, these herbs were sourced from the organic farms of Tamil Nadu and Kerala. The herbs are chosen according to the nature of the curative effects. The extraction process of *A. indica* using a Soxhlet extractor, the clear extracted solution was present in the collector. The herbs were washed, shadow dried, then powdered. About 50 g of ground *A. Indica* leaf powder was extracted successively with 250 mL of Methanol at 45–50 °C in a Soxhlet extractor until the *A. indica* leaf powder turned grey. The extracts were evaporated to dryness and the resulting paste from extracts were stored in a refrigerator at 4 °C for further use[4-7].

Application method

Methanol extracts of the herbs were directly applied on a 100% cotton terry bath towel by the pad-dry-cure method. A 4% concentration of the herbal extracts were applied to the cotton material along with 6% citric acid as a cross-linking agent by the pad-dry-cure method. Padding was carried out in a pneumatic padding mangle at a pressure of 3 Pressure per square inch (PSI) to get a pickup of 100% on the weight of the fabric. Drying was carried out in Hot air oven at 80 °C for 5 minutes and curing was carried out in a commercial curing machine at 140 °C for 3 minutes[5-8].

Wash durability

Wash durability is one of the important factors for any functional finished or value-added fabrics. The finished samples were subjected to several wash cycles with standard detergent (3%) at 35 °C in an automatic washing machine. The washed samples were also included for antibacterial activity assessment for evaluating the finishing durability of the bath towel.

Antimicrobial susceptibility testing

Disc diffusion method

Muller Hinton agar plates were inoculated with test organisms by spreading the bacterial inoculum on the surface of the media. Fabrics (8 mm in diameter) were punched in the agar. The plates were incubated at 37 °C for 24 hours. The antibacterial activity was assessed by measuring the diameter of the zone of inhibition (in mm).

The Kirby-Bauer and Stokes' methods are usually used for antimicrobial susceptibility testing, with the Kirby-Bauer method being recommended by the NCCLS. It promotes accurate antimicrobial susceptibility testing (AST) and appropriate reporting by developing standard reference methods, interpretative criteria for the results of standard AST methods, establishing quality control parameters for standard test methods, provides testing and reporting strategies that are clinically relevant and cost-effective. Table 1 shows the sample details for testing of antibacterial activity of the treated and control samples against the gram-positive and gram-negative bacterial strains like *Staphylococcus aureus* and *Klebsiella pneumonia.*

Result and Discussions

Fig. 1 shows the treated samples with 4% herbal extract of *A. indica* along with the 6% citric acid is a cross-linking agent, the treated sample colour was changed to green colour because the *A. indica* extract contains a chemical composition of a cyanogenic

Table 1 — Control and treated sample reference code

Sample ref. code	Sample details
A	100% cotton terry fabric - Unfinished
B	100% cotton terry fabric finished with 4% herbal extract of *A. indica*
C	100% cotton terry fabric finished with 4% herbal extract of *A. indica* 25% of moisture
D	100% cotton terry fabric finished with 4% herbal extract of *A. indica* after 5 washes
E	100% cotton terry fabric finished with 4% herbal extract of *A. indica* after 10 washes

Fig. 1 — a) Control and b) *Acalypha Indica* treated samples.

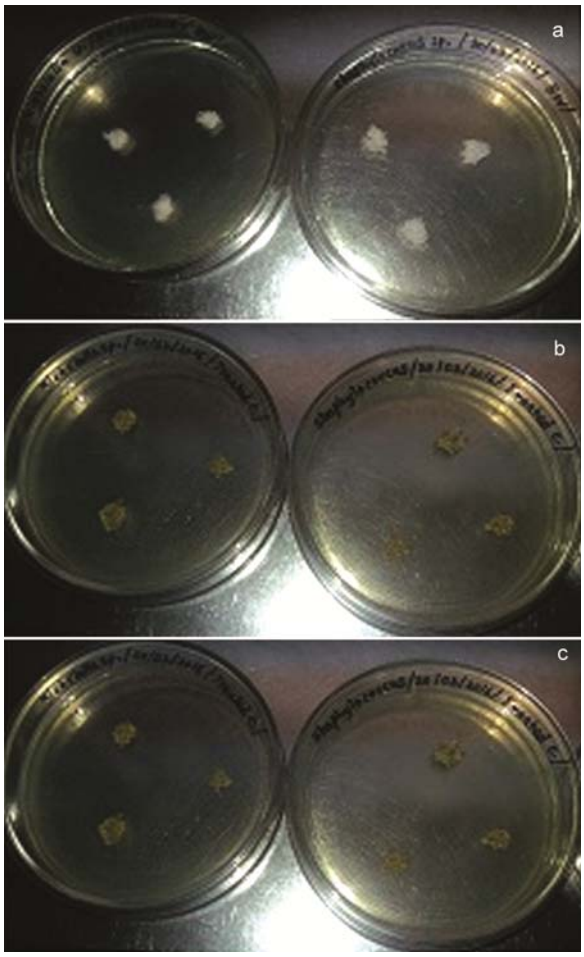

Fig. 2 — Antimicrobial efficacy of control and treated fabrics Qualitative method. a) Control sample, b) Herbal extract of *Acalypha indica* treated fabric sample, and c) Herbal extract of Acalypha indica treated fabric sample with 25% moisture.

Table 2 — Antibacterial activity of treated samples (Qualitative study zone of inhibition mm and quantitative study bacterial reduction in %)

Sample	Growth under fabric	Qualitative studyzone of inhibition in mm		Quantitative studybacterial reduction in %	
		S. aureus	*K. pneumonia*	*S. aureus*	*K. pneumonia*
A	Present	Nil	Nil	Nil	Nil
B	Absent	9	10	98.9	99.9
C	Absent	9	10	98.9	99.9
D	Absent	9	9	80.7	88.7
E	Absent	8	Nil	71.2	73.6

glycoside called acalyphin (a 3-cyanopyridone derivative) as well as flavonoids, such as kaempferol glycosides mauritianin, clitorin, nicotiflorin, and biorobin[3-6].

Evaluation of antibacterial activities

The Antibacterial activities of the samples were evaluated by both qualitative and quantitative methods. Table 2 and Fig. 2 show the antimicrobial efficacy of treated fabrics. The results indicate the presence of a clear zone of inhibition of 8-9 mm diameter for methanol extract treated fabric against the selected micro-organisms namely *S. aureus* and *K. pneumonia*[4-9]. The untreated fabric (control) shows bacterial growth under the test specimen. It is observed that all the 4% herbal extract of *A. indica* treated samples show higher antibacterial activity against *K. pneumonia* compared with *S. aureus*. In a quantitative method, the same trend showed higher antibacterial activity against *K. pneumonia* compared

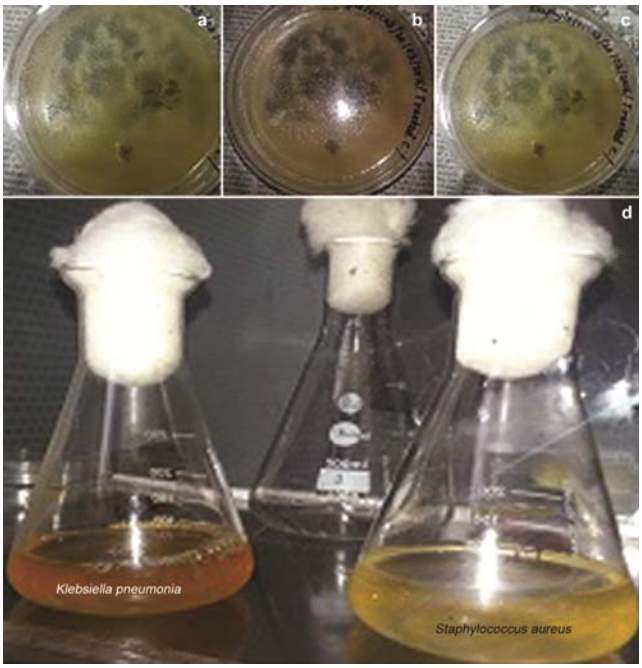

Fig. 3 — a,b,c) Antimicrobial efficacy of control and treated fabrics Quantitaive method, and d) Quantitative assesment Inoculation.

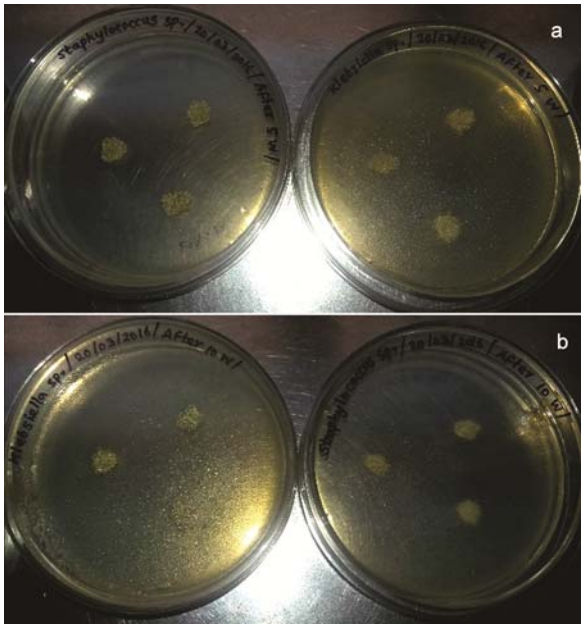

Fig. 4 — Antimicrobial activity of washed sample. a) Treated fabric sample after 5 wash, and b) Treated fabric sample after 10 wash.

with *S. aureus*[5,6]. Table 2 and Fig. 3 show both quantitative evaluation of the antimicrobial efficacy of treated and control fabrics. All the treated samples have a formation of a zone and to get more resistivity against both the strains i.e., *S. aureus* and *K. pneumonia*[4-9,14].

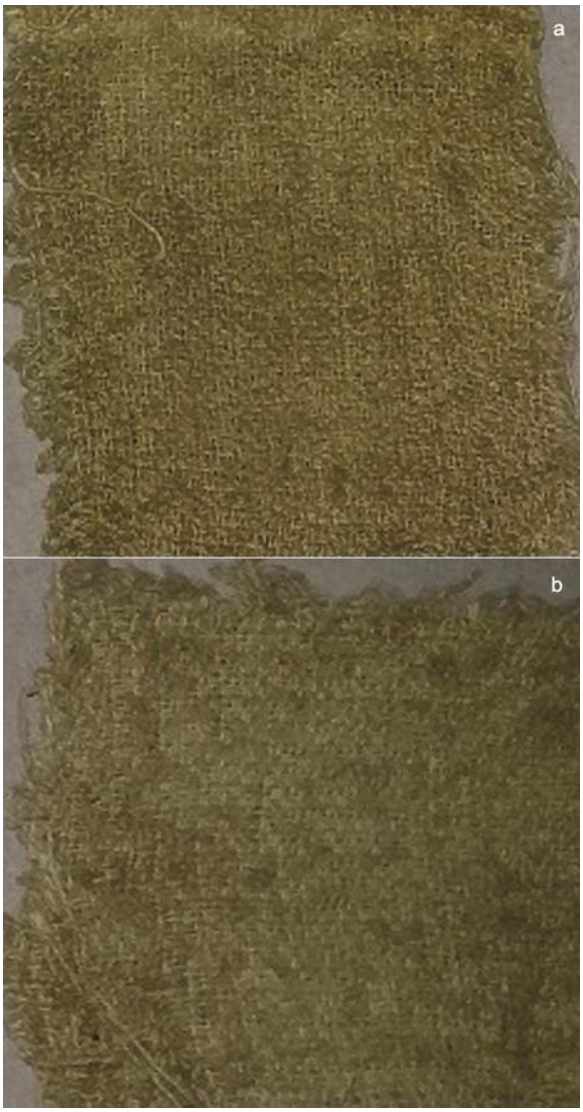

Fig. 5 — a) Fresh extract treated sample and b) *Acalypha Indica* treated samples after 5 and 10 washes.

Wash durability of the herbal treated sample

The samples underwent wash durability evaluation for analysis of the durability nature of the herbal extract on the samples by using launder-o- meter. After the washed samples were subjected to evaluation of the antimicrobial process, from the results shows the better in the nature of the antimicrobial test for both the strains, the Table 2 and Fig. 4 shows the antimicrobial activity of washed samples and Fig. 5 show the treated fabric performance of after 5 washes and 10 washes. It is observed that the wash durability of *A. indica* treated fabrics were showed better activity after 10 washes. This is because the herbal extracts were treated with citric acid as a cross-linking agent so the

binding and the cross-linking agent act as a bridge and provide firm bonding between extract and fibre assembly[6,8]. The fabric material finished with *A. indica* extract has shown the presence of antibacterial activity and it was found that the antibacterial activity of both dry and with moisture (25%) was the same after the washing process[9,14].

Conclusion

The *A. indica* extract was prepared using the soxhlet extractor method by methanol act as a solvent. *A. indica* methanol extracts of the herbs were directly applied to the cotton terry bath towel by using the pad-dry-cure method on 4% concentration of the herbal extract along with 6% of the cross-linking agent such as citric acid. The treated samples were evaluated for their antimicrobial activities through qualitative methods (Zone of inhibition in mm) and quantitative methods (bacterial reduction %). Based on the observation from the results, the finished cotton bath towel showed better antibacterial activity against both bacterial strains *K. pneumonia* and *S. aureus*. The samples underwent wash durability evaluation for analysing the durability nature of the herbal extract on the samples by using launder-o- meter. The washed samples were subjected to evaluation of the antimicrobial process. The antimicrobial test results show the better in nature of both the strains, because of the samples were treated with citric acid is act as a cross-linking agent so these cross-linking agents to form a bridge between herbal media and fibre assembly.

Conflict of interest

There is no conflict of interest

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