

Microencapsulation of copper enriched *Aloe* gel curative garment for atopic dermatitis

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A novel attempt has been made in this research work to develop medicinal herb *Aloe vera* (L.) Burm.f. gel extract treated garment using alternate medical concepts to cure atopic dermatitis. The present study focuses on curing the eczema by wearing the medicinal herb treated curative garment. Based on the copper content, the *Aloe vera* (L.) Burm.f. plant was applied on to the 100% cotton single jersey knitted fabric by microencapsulation method. Microcapsules are produced using *Aloe vera* gel as core and *Gum Acacia* as wall material. The presence and the density of microcapsules are analyzed by using scanning electron microscopy and different functional groups present in the samples by FT-IR infrared spectroscopic study. The antimicrobial efficacy of the treated fabrics has been evaluated by agar diffusion and broth dilution of qualitative and quantitative test methods. The antimicrobial assessments of the *Aloe vera* gel treated fabrics, SCORAD evaluation and clinical trials have commended the correlation between its curative performance and antimicrobial activity. The present study is an effective method of controlling the skin disease through medicated textiles.

Keywords: Cotton, *Aloe vera* (L.) Burm.f., Antimicrobial, Microencapsulation, Curative garment, Alternate medical concept

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Textile has always been a part of healthcare. The combination of Biotechnology and Textile Technology has birthed medical textiles. Medical Textile is one of the fast growing sectors of the Global Technical Textile industry and one of the most rapidly expanding sectors in the technical textile market¹. Biotechnology is a frontier area in science and technology having significant commercial applications in healthcare, technical textile, agriculture, process industry and in service sector the world over. It is important to note that Biotechnology is not just concerned with biology, but it is a truly interdisciplinary subject involving the integration of natural and engineering sciences².

Microbial infestation poses danger to both living and non-living matters. The inherent properties of textile fibers provide room for the growth of microorganisms. Microbes include a variety of micro organisms like bacteria, fungi, algae and viruses causing various diseases, stain the fabric and also destroy the performance properties of fabrics. Consumers are now increasingly aware of the benefits of a hygienic life style and there is a necessity and

expectation for a wide range of textile products finished with antimicrobial properties. Now, there is a good deal of demand for the fabrics having functional/specialty finishes in general but antimicrobial finishes in particular to protect human beings against microbes³.

Antimicrobial finishes using natural sources have been the current vogue and it promotes natural and eco-friendly life style. The relatively lower incidence of adverse reactions of herbal products as compared to modern synthetic pharmaceuticals, coupled with their reduced cost can be exploited as an attractive eco-friendly alternative to synthetic antimicrobial agents for textile applications. Recent studies on *Aloe vera* (L.) Burm.f. (a naturally occurring biopolymer) activity have opened up new avenues in this area of research⁴ and trying to keep pace by developing more and more effective and safe solutions. Substances derived from plants remain the basis for a large proportion of the commercial medications used today for the treatment of psoriasis, eczema, headache, joints pain, heart disease, sun burn from ultraviolet rays and other problems. Clinical evaluations have revealed that the active ingredients present in the gel and rind of *Aloe vera* leaves show analgesic,

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anti inflammatory, antimicrobial, anti viral, immune stimulatory, cell growth stimulatory , bacteriostatic, regenerate and promote suppleness of skin, soothes skin and beneficial for blood circulation⁵.

Aloe vera acts as a physiological carrier for many active biological agents. Therapeutic uses of *Aloe vera* have been reported in medicinal literature for over 50 yrs^{6,7}. *Aloe vera* extracts are a rich source of polyphenols, such as aloin and emodin and have shown a wide range of pharmacological properties including anti-inflammatory and anticancer properties. Many of the health benefits associated with *Aloe vera* have been attributed to the polysaccharides contained in the gel of the leaves. These biological activities include promotion of wound healing, antibacterial, antifungal, anti diabetic, anti inflammatory, anticancer and gastro protective properties. The cumulative evidence tends to support that *Aloe vera* might be an effective interventions used in the skin care and particularly beneficial in the treatment of skin conditions such as acne, eczema, psoriasis and burn wound healing for first to second degree burns⁸. The plant derived polyphenols that are also present in *Aloe vera* may exhibit pro-oxidant properties either alone or in the presence of transition metals, such as copper. *Aloe* gel contains phenolic anthraquinones, carbohydrates polymers and various other organic and inorganic compounds. The primary function of copper in the body is to serve as constituents of many biologically important enzymes, thus enzymes which contain copper in the active site, catalyze the oxidation of ferrous iron to ferric iron. Copper is required for absorption and transport of iron, and it plays a key role in hemoglobin synthesis and wound healing⁹.

In this research work, an attempt is made to impart medicinal property to cotton fabrics by using microencapsulation method and trying to produce curative garments by coating naturally available herb *Aloe vera* (L.) Burm.f.. Copper plays an important role in curing many diseases, gives energy to the body and balances the nervous system. So, on the basis of copper content, the *Aloe vera* (L.) Burm.f. herb is selected and the aloe gel extracts is coated on cotton fabric by using micro encapsulation technique. The microcapsules are produced using *Aloe* gel as core material and *Gum Acacia* as wall material. An extensive study also conducted to assess the antibacterial effectiveness of the herbs by employing standard test methods and the findings are discussed in this paper.

Methodology

Materials and methods

Cotton knitted fabric with the count of 40's with single jersey was selected for the manufacturing of curative garment. The fabric was desized and bleached prior to the application of finish. The medicinal herb, *Aloe vera* (L.) Burm.f.. was collected in and around Coimbatore, Tamil Nadu, India.

Aloe gel extraction process

Aloe vera (L.) Burm.f. leaves were collected and washed with fresh water. *Aloe vera* leaves were taken into a jacketed SS extractor and subjected to steam purging which helps in removal of volatile impurities such as pesticides. *Aloe vera* gel was processed using the hand filleted process. The inner gel was carefully removed avoiding the yellow sap (latex) found next to the rind as shown in Fig. 1. The latex contains aloin which was removed. Stabilizing the constituents within *Aloe vera* gel was essential to develop effective products. Therefore, the gel was cooled and processed within 4 hrs of harvesting then the gel was smashed and converted into a solvent form. The ethanol solvent was added in the ratio of 1:5 of aloe vera: solvent. Extraction was done for 2-4 hrs at temperatures of 40 °C. The solvents were allowed to evaporate for one hour and the extraction process was repeated twice.

Antimicrobial finish application method- Microencapsulation

Microencapsulation co-acervation spray drying method was selected and the selected percentage



Fig. 1—Extraction of aloe gel from *Aloe vera* plant

concentrations 20% and 40% of *Aloe vera* (L.) Burm.f. gel extracts as the core material and *Gum Acacia* as a wall material was used for finishing. Ten gm of wall material (*Acacia* powder) was allowed to swell for half an hour in 100 ml of hot water. Later this was mixed with 50 ml of hot water, stirred for 15 min maintaining the temperature at 50 °C. After the stipulated time, ten ml of core material (herbal extract) was added and stirred at 500 rpm for further 15 min followed by drop wise addition of ten ml of sodium sulphate (20%) solution and 6 gm of citric acid were added¹⁰. This process was completed within 10 min then the speed was reduced to 100 rpm. The stirrer was stopped and the mixture was freeze dried. The single jersey cotton knitted fabric was immersed in the microcapsule solution using padding mangle, squeezed and then the fabric was then dried at 80 °C for 3 min and cured at 110 °C for 2 min on a lab model curing chamber. Finally, the fabric samples were tested for antimicrobial activity and disease curing property as per the standard test methods.

Standard test methods

The SEM study is mainly used to identify the finished herbal molecules present in the fabric sample. The morphology of microcapsule finished fabric was analyzed using high resolution Scanning Electron Microscope JEOL M JSM-6360 with suitable accelerating voltage and magnification was used to conform the binding of microcapsules and alignment onto the fabric sample. The scanning was done for thirty minutes for each sample and the images were pictured and presented.

One of the important applications of the infrared spectroscopic study is the diagnostic value in establishing the presence of certain organic constituents in plants. The compounds responsible for the antimicrobial activity present in *Aloe* gel micro treated fabric and untreated fabric samples were analyzed using Infra red spectra of Nicolet 6700 FT-IR Spectrometer. The FT-IR Graph representing the corresponding peaks and wave lengths for different functional groups present in the samples were recorded and analyzed.

The antimicrobial activities of the micro herbal finished and unfinished samples were evaluated by both qualitative and quantitative test methods. The qualitative and quantitative test includes agar diffusion test (AATCC 147-1998) and broth dilution (AATCC TM 100-1998) test methods. The presumptive screenings of fabrics were carried out using agar diffusion method and the antimicrobial efficacy was

assessed by the zone of inhibition and further confirmed by calculating the percentage reduction of bacteria using broth dilution method¹¹.

The European standard SCORAD evaluation (Scoring of Atopic Dermatitis) method is used to assess the severity (i.e. extent, intensity) of atopic dermatitis and evaluate the disease improvements during and after treatment¹². The SCORAD identifies the intensity of 6 items namely erythema, oedema, excoriations, lichenification, oozing/crusts and dryness. The erythema evaluations were carried out on the *Aloe vera* micro-treated and untreated garments. The SCORAD ratings of erythema value were identified by SCORAD diagram to provide an interpretation of the percentage of affected areas.

Apart from the above tests, the standard wash fastness test (AATCC -61, 2003) was carried out to determine the antimicrobial efficacy after 5, 10, 15 and 20 home launderings. The finished samples were washed using a standard detergent (2% on weight of fabric) and sodium carbonate (1% on weight of fabric) at 60°C.

Development of curative garment

Using the developed aloe gel microcapsule medicated fabrics, the next to skin tight garments namely T-Shirt and Pyjama have been constructed and developed to cure atopic dermatitis (erythema) skin disease.

Clinical trials

The performance of the developed curative garments was evaluated by conducting Scored evaluation and clinical trial at Sri Nature Cure Centre by giving it to patients with atopic dermatitis. The patients were instructed to wear the *Aloe* gel curative garment next to the skin 10 hrs per day especially during the sleeping time to get better results. The patients were instructed to carry out the washing of curative garments with detergents and dry them in shade to retain the medicinal values. The performance of the curative garments was evaluated once in every week and the clinical trials were conducted for 8 weeks duration. The severity of the erythema were measured on the selected patient's skin by Scorad index rating values which was calculated by medical professional (doctor) to assess the percentage of atopic dermatitis and improvements in before and after wear study of treated garments. Detailed feedback from the patients and the doctor was collected every week regarding the healing effect and performance of the curative garments.

Results and discussion

Evaluation of microcapsules treated cotton knitted garment

The scanning microscope images clearly show the presence of herbal molecules, bondage between the fibre structures and penetration of herbal capsules into the surface of the micro finished samples. The unfinished sample shows maximum pore size and clear structure with a large number of protruding fibers. The morphology of 20% and 40% concentration of *Aloe vera gel* micro finished sample clearly shows the microcapsules were present in the interstices of the fibre assembly of fabric in the Figs. 2a b & c.

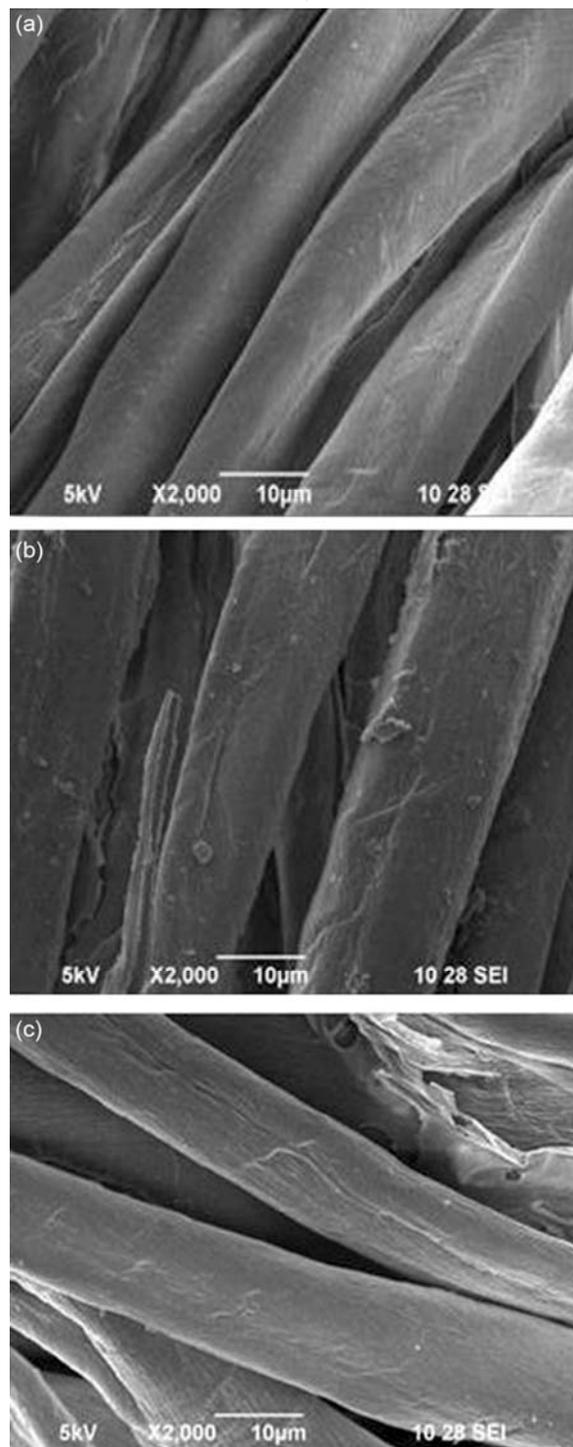
Evaluation of photochemical compounds in micro-treated cotton knitted garment

The FTIR graphs clearly representing the detected functional groups by corresponding peak values are the hydroxyl groups of aromatic ring structure. The C-H stretch of aldehyde, alkynes, alkanes and aromatic rings and the C-O stretch of alkyl substituted ether and alcohol. The differences in absorbance were observed between the micro treated and untreated cotton fabrics in the Figs. 3a & b. The peaks at 2916.37 cm^{-1} , 1427.32 cm^{-1} and 1639.49 cm^{-1} revealed the presence of stretch in bonds between C-H of aldehyde, C=C=C aromatic ring and C=O of amide group respectively. The strong absorption band of C=C stretch, indicates the presence of aloin compound¹³ because of the interaction with plant extract, shift in the absorbance pattern of N-H amine and C-H stretch of alkane groups were observed at 3296.56 cm^{-1} and 2303.01 cm^{-1} respectively. The formation of C-H stretch of aldehydes and stretching of C-N bond in amine group were identified in treated fabric due to plant extract functional group intervention. The shift in the absorbance due to C-O bond stretch also indicates the presence of plant extract. The shift of peak value of functional groups between treated and untreated specimens proved the interaction of plant extract with the base material. The presence of cotton functional groups revealed its nature is not altered by the addition of plant extract and it can be safely used as wound dressing material.

Evaluation of antimicrobial activity of *Aloe gel* treated curative fabrics

Agar diffusion is a preliminary qualitative test to detect the diffusive herbal molecules of the *Aloe gel* treated fabrics which are having antimicrobial

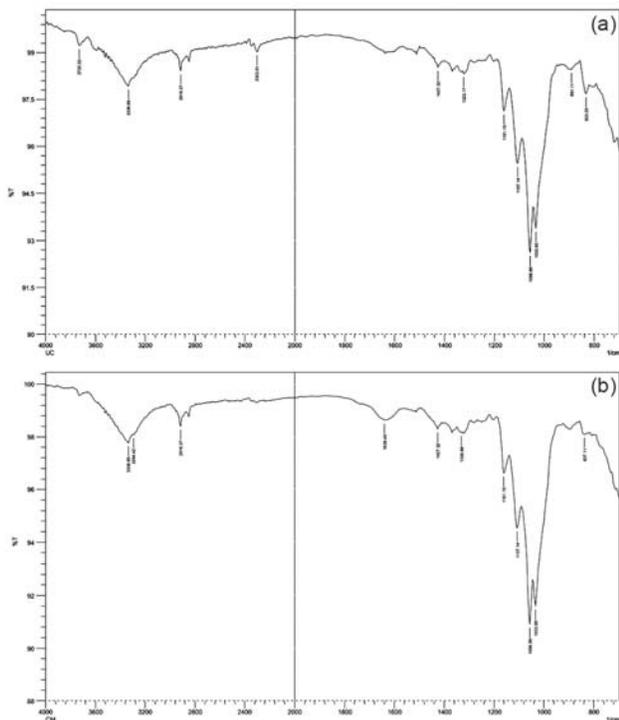
activity. In this test, a microbial culture is spread evenly on the top of an agar plate containing medium that will support its growth and the test results of agar diffusion test for antimicrobial effectiveness against standard test cultures namely *Staphylococcus aureus*



Figs. 2 (a)—SEM-untreated fabric; (b) SEM-20% *Aloe gel* treated fabric; (c) SEM-40% *Aloe gel* treated fabric

and *Escherichia coli* (gram positive and negative) organisms are given in the Table 1 and Figs. 4 a & b. The zone of bacterial inhibition is indicated by a halo around the specimen. After incubation, the plates were observed for bacterial growth. Then the numbers

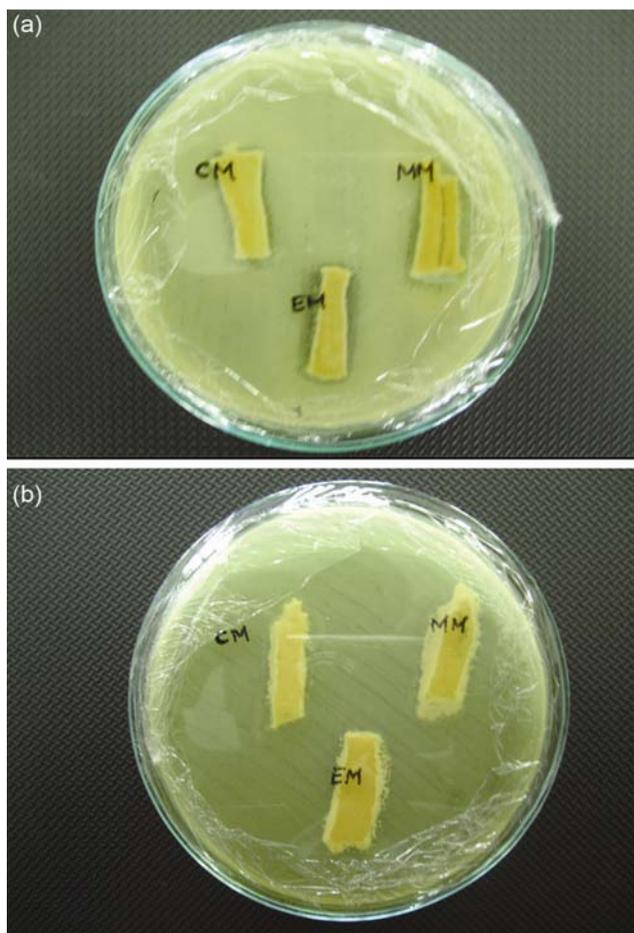
of colonies were identified and the zone of inhibition was observed for each plate. Samples treated with 40% gel concentration showed higher zone of inhibition of about 29 mm and 23 mm when compared to 20% gel treated (19 mm and 17 mm) and untreated samples. The zone results indicate that 40% gel treated fabric do not support the bacterial growth to larger extent against *Staphylococcus aureus* and *Escherichia coli*, where as 20% gel treated sample to a smaller extent when compared to untreated sample. It is attributed that bacterial inhibition is due to the slow release of active substances from the fabric surface. It can be seen from the test results, proved that the phenolic groups, amino groups and aloin compounds present in *Aloe* gel are responsible for its excellent antimicrobial activity. The imparted antibacterial activity on developed garments was only due to the presence of herbs and not the combined effect of herbal and



Figs. 3 (a)—The FTIR graph representing the absorbance peak values of untreated cotton fabric sample at 2916.37 cm^{-1} , 1427.32 cm^{-1} and 1639.49 cm^{-1} revealed the presence of stretch in bonds between C-H of aldehyde, C=C=C aromatic ring and C=O of amide groups; (b) The FTIR graph representing the absorbance peak values of aloe gel micro treated cotton fabric sample with strong absorption band of C=C stretch, indicates the presence of aloin compound and shift in the peak values of C-H stretch of aldehydes, C-N bond in amine group, C-O bond stretch also indicates the presence of plant extract

Table 1—Quantitative analysis of antimicrobial activity of zone of inhibition of untreated and aloe gel micro treated samples

Samples	Antibacterial activity (zone of inhibition in mm) against Gram positive bacteria <i>Staphylococcus aureus</i>	Antibacterial activity (zone of inhibition in mm) against Gram positive bacteria <i>Escherichia coli</i>
Untreated fabric	0	0
<i>Aloe</i> gel extract micro encapsulation finished fabric (20%).	19	17
<i>Aloe</i> gel extract micro encapsulation finished fabric (40%).	29	23



Figs. 4 (a)—Zone of inhibition of untreated, 20% and 40% *Aloe* gel micro treated samples against *Staphylococcus aureus* bacteria in agar plate; (b)—Zone of inhibition of untreated, 20% and 40% *Aloe* gel micro treated samples against *Escherichia coli* in agar plate

sodium sulphate solution. The 20% sodium sulphate solution was added during the micro encapsulation process in order to induce the co-acervation. Simple co-acervation can be effected either by mixing two colloidal dispersions, one having a high affinity for water or it can be induced by adding a strongly hydrophilic substance such as alcohol or sodium sulphate¹⁴. The sodium sulphate solution will only provoke the co-acervation of herbal microcapsules and does not exhibit any antibacterial activity and it's proved based on the test results and literature surveys.

Anti microbial efficiency of the untreated and treated fabric samples were performed by the quantitative (AATCC TM 100) broth dilution test method. This was to evaluate the effect of antimicrobial activity on different concentration of 20% and 40% treated fabrics, in which the difference between the actual bacterial count of treated and untreated control was assessed. The reduction rates in the number of colonies were found on finished samples at different concentrations are given in Table 2. It can be seen from the Table 2, the test results clearly indicated that by increasing the solution concentration, the reduction rates of bacteria colonies also progressively increased. Absorbance measurements (OD) are used for the determination of viable bacteria and give a rapid estimate of cell numbers. Absorbance measurements (turbidity) are commonly used for minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) tests. This variant of the broth dilution method is quicker to perform due to the use of absorbance measurements rather than conventional plating method. It gives an indication of bacterial efficiency within hours where as it takes at least 3 days to get the results by conventional plating methods¹⁵.

Absorbance of the sample is directly proportional to the concentration of the cells in the sample. The absorbance values (OD) for the 3 samples were compared. It was found that fabric treated with 40%

gel concentration gives low absorbance value against both positive and negative bacteria. This indicates that 40% gel treated fabric do not support the growth of bacteria compared to others. The treated fabric exhibited high antimicrobial property (84.11% & 77.57%) against *Staphylococcus aureus* when compared the *Escherichia coli* bacteria (72.81% & 66.02%) in 40% and 20% concentrations. This is because the antimicrobial agent gets attached to the substrate through bond formation. On the fabric surface, the results clearly show that the curative fabrics have got excellent antibacterial activity against the major disease causing bacteria such as *Staphylococcus aureus* and *Escherichia coli*. The attached antimicrobial agent disrupts the cell membrane of the microbes through the physical and ionic phenomenon. The finishing agent inhibits the growth of micro organisms by using an electrochemical mode of action to penetrate and disrupt their cell walls. As, the herbal concentration increases, the percentage of bacterial reduction also increases.

Wash durability evaluation

It can be seen from the test results in Table 3, the wash fastness properties of treated sample during 20 wear wash cycles. The treated fabrics showed good wash fastness as expected. Finishing agent does not

Table 3—Wash durability test for aloe gel micro treated samples

Wash durability Number of washes	Antibacterial activity (Bacterial reduction in %) against <i>Staphylococcus aureus</i>	
	40% Aloe gel treated sample	20% Aloe gel treated sample
Before wash	81	70
After 5 wash	66	60
After 10 wash	53	43
After 12 wash	28	17
After 15wash	18	12
After 20wash	15	06

Table 2—Qualitative analysis of antimicrobial activity of untreated and aloe gel micro treated samples

Samples	Antibacterial activity (OD at 600 nm)			
	<i>Staphylococcus aureus</i> positive bacteria		<i>Escherichia coli</i> negative bacteria	
	Absorbance (OD) Value	Reduction (%)	Absorbance (OD)Value	Reduction (%)
Untreated fabric	1.07	0	1.03	0
Aloe gel extract micro encapsulation finished fabric (20%).	0.28	72.81	0.35	66.02
Aloe gel extract micro encapsulation finished fabric (40%).	0.17	84.11	0.24	77.57

migrate off the treated sample and destroys the bacteria coming in contact with the surface of the treated cloth. The microbes do not consume the antimicrobials, which destroy them by acting on the cell membrane¹⁶. Hence, finishing agents do not lose their effectiveness and will remain functional throughout the life of the fabric, thus the finish effect will withstand more than 20 washes. The 20% and 40% *Aloe* gel treated samples showed good fastness property in all wash cycles. This is due to the antimicrobial agent, it does not leach out and it continuously inhibits the growth of bacteria in contact with the surface barrier or blocking action¹⁷. The efficiency of the antimicrobial activity was determined by comparing the reduction in bacterial concentration of the treated sample with that of control sample expressed as a percentage reduction in standard time. In the case of treated fabric, in each wash cycle the antibacterial activity decreases gradually and at the end of 20th wash cycle the percentage reduction of bacterial value reaches to 14 and 8 in 40% and 20% concentrations.

Evaluation of curative garments using clinical trials

Garments made from the microencapsulated fabric were given to the patients having atopic dermatitis skin disease. The clinical trial results are given in Tables 4 & 5. From the Table 4 and Figs. 5 a & b, the clinical evaluation study result shows the lesser SCORAD index rating value in both 20% and 40% *Aloe vera* gel micro treated samples. After the wear study, the 40% *Aloe vera* gel micro treated cotton (T-Shirt and Pyjama) garments showed a maximum reduction value (35.25% & 41.34%) when compared to untreated garment rating value (0). After the wear study and clinical evaluation, the 20% and 40% *Aloe vera* gel micro treated garments showed better results in reducing the erythema in the form of percentage reduction of Scorad value. The higher percentage reduction value is exhibiting the higher curing and controlling property of atopic dermatitis.

The scored evaluation and clinical trial test result shows that the performance of the curative fabrics and garments were found to be good as per doctor's evaluation.

In order to present the study in a scientific manner the statistical assessment was done for the results. The clinical severity of the eczema was evaluated by using the scoring atopic dermatitis (SCORAD) score. The mean \pm SE of each sign and symptom before treatment had been compared with mean \pm S.E. value of after treatment. Paired t-test was used for significance and the effectiveness of the finished sample and % of control samples were assessed through *P* value of $\leq .02$. The extent of the eczema decreased during active treatment through the *P* value ($P = .02$)¹⁸. Many studies have shown that herbal extracts and essential oils from plants can modify the activity of antimicrobial and thereby improve its performance effect of skin infections. *Aloe vera* has been used in traditional medicinal practices of many cultures for a host of curative purpose such as healing of wounds and burns and finds uses for medical and cosmetic purpose as well as for general health. *Aloe vera* gel contains nutrients, vitamins and antioxidants and it possess wound healing, immune modulating, antifungal, antibacterial and antiseptic properties which can be exploited for medical textile applications such as wound dressing, suture and bioactive textiles¹⁹. As the need to control increasing medical expenditures continues to mount, formal

Table 5—Curative performance of herbal treated garments in clinical trials

Disease	Curative garment	% of Improvement	Curative performance
Atopic dermatitis	20% Aloe gel micro treated T-shirt	78	Significant
	40% Aloe gel micro treated T-shirt	92	Significant
	20% Aloe gel micro treated Pyjama	82	Significant
	40% Aloe gel micro treated Pyjama	96	Significant

Table 4—SCORAD rating value of developed garments before and after wear study

S.no	Sample	SCORAD Rating (Before wear study)	SCORAD Rating (After wear study)	% of erythema reduction
1	Untreated garment	31.18	31.18	0
2	20% <i>Aloe</i> gel micro treated T-shirt	31.18	24.04	22.89
3	40% <i>Aloe</i> gel micro treated T-shirt	31.18	20.19	35.25
4	20% <i>Aloe</i> gel micro treated Pyjama	31.18	22.97	26.33
5	40% <i>Aloe</i> gel micro treated Pyjama	31.18	18.29	41.34



Figs. 5 (a)—The photographs represents the clinical evaluation SCORAD index rating of erythema on the human skin before aloe gel micro treated garment wear study; (b)—The photographs represents the clinical evaluation SCORAD index rating of percentage reduction of erythema on the human skin after aloe gel micro treated garment wear study.

economic evaluations are taking on a prominent role in assessing the value of new medical herbal therapies for atopic dermatitis by objective Scorad and can be used as a prescreening system for epidemiological studies^{20,21}. *Aloe* gel not only increased collagen content of the wound but also changed collagen composition and increased the degree of collagen cross linking. *Aloe* in combination and alone in wounds increased the breaking energy when compared to controls ($p < 0.05$). *Aloe* appears to expedite wound contraction and neutralize the wound retardant effect²².

Traditional significance of study to the farmers/researchers and some constructive recommendations

The significance of the study brings out the value of the aloe gel herbal coated textiles; and the

relevance of the result findings support the reported therapeutic use of *Aloe vera* (L.) Burm.f. plant extracts as a antibacterial agent in Ayurveda which will be useful to integrate for improving modern atopic dermatitis skin care treatment. Atopic Dermatitis is one of the most controversial and socially complex aspects in the medical field. The use of the traditional knowledge for this process has the aim to alleviate social inequalities by providing access to end products such as new herbal drugs or bio technologies. So countries rich in biodiversity can develop these resources to combat social and environmental problems. This is one of the most important roles of the studies of the folk medicine and the traditional knowledge.

Further experimental analyses of these plant parts are needed to obtain more detail mechanism of action for development of new herbal drug which may be useful in the treatment and/or prevention of atopic dermatitis which may be boon for the society. This study will also be useful to the other researchers to take forward the references for further scientific evaluation of antimicrobial and anticancer activity.

Conclusion

This research work has given a new idea in finishing of cotton with herbs for antimicrobial activity (*Aloe vera* (L.) Burm.f.). Microencapsulation of herbal extracts of *Aloe vera* (L.) Burm.f. has been done successfully by simple technique using herbal extracts as core material and gum *Acacia* as wall material followed by its simple application on to single jersey cotton knitted fabric using pad dry cure method. It is found in the test results, the specimens treated with the solution containing 40% concentration of *Aloe* gel showed excellent antimicrobial activity against both Gram positive *Staphylococcus aureus* and Gram negative *Escherichia coli* bacteria. The treated sample clearly indicated the high reduction rate in the number of colonies and a clear zone of bacterial inhibition against positive bacteria than negative bacteria. The SEM study reveals the better penetration of finish and bondage between the fibre molecules. The FT-IR study also exhibiting the phytochemical compounds responsible for the antibacterial activity in the *Aloe vera* gel. The antimicrobial property of the aloe gel micro-treated samples exhibited better durability even after 20 wash cycles. The Scorad evaluation results of before and after wear study and Field trials also reveals that the developed herbal treated garment cures the atopic

dermatitis to the maximum extent. This work can be helpful in the development of cost effective, user friendly healthcare fabrics/products for the people who are having eczema skin infections.

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