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Application of a bio-extract mixture of *Rosmarinus officinalis* and *Psidium Guajava* plant leaves on textile fabric

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Abstract

Rosmarinus officinalis and *Psidium guajava* plant leaves are having phytochemical compounds those inhibit the growth of microorganism. Wound healing property was developed on organic cotton fabric using an equal ratio of *Rosmarinus officinalis* and *Psidium guajava* extract by following pad-dry-cure method. The antibacterial activity of the herbal extract and treated cotton fabric was evaluated using the agar well diffusion and parallel streak method. High zone of inhibition attained against *Escherichia coli* and *Staphylococcus aureus* indicates antibacterial potency of the extract. The thickness, stiffness, air permeability, vertical wicking length and water vapour permeability properties were marginally affected after treatment. The wound healing analysis of the treated fabrics was carried out using in vitro wound healing scratch assay.

Keywords : Rosmarinus Officinalis • Psidium Guajava • Phytochemicals • Zone of inhibition • Escherichia coli• Staphylococcus aureus

Introduction

In hospitals, hotels, homes and other places, healthcare and hygiene are required. Most of the medical products such as bandages, and wound dressing are affordable and made of synthetic agents such as phenols, quaternary ammonium salts and organo-silicons. Nowadays, in order to avoid the toxic substance from synthetic antibacterial agents, the natural extract was developed to apply the textile materials like fibres, yarns and fabrics for hygienic and health care applications. The phytochemical compounds present in rosemary are flavonoids, henolics, oleanolic acid, carnosol, ursolic acid and terpenoids. This herb has functional properties like, antibacterial, wound healing, anti-inflammatory, antioxidant, anti-cancer, and antiseptic properties. The phytochemical compounds present in Psidium Guajava are flavonoids, carotenoids, polyphenols, tannins, terpenoids, saponins, alkaloids, glycosides and anthraquinones. This herb has many functional properties like antibacterial, wound healing, anti-cancer, antioxidant, anti-inflammatory and anti-allergic properties. The antibacterial property of herbal extract and treated fabric were assessed using the Agar well diffusion method and parallel streak method. In view of the supra, an attempt has been made to characterise the phytochemical compounds present in the bio-extract prepared from an equal ratio of Rosmarinus officinalis and Psidium guajava bio-molecules, explore the antibacterial effectiveness and wound healing property while applied on organic cotton fabric [1].

Material and Methods

Collection of rosemary and guava leaves

The Rosmarinus officinalis plant leaves of 5 kg were collected from Nilgiri North Division, Medicinal Plant Development Area, Ooty, Tamilnadu. The Psidium guajava leaves of 1kg were collected from the local area, Poondurai, Tamilnadu. The herbal plant leaves were washed and cleaned thoroughly in tap water to eradicate unwanted microorganisms, dirt, and honeydews. The fresh leaves were shadow dried for 15 days at room temperature used for the extraction process.

Fabric

Organic plain-woven cotton fabric of EPI × PPI = 92 × 88, warp count = 40S Ne, weft count= 40S Ne and weight = 117 GSM was used in the study.

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Extraction process

In the soxhlet extraction method, finely grinded powder of the herbal leaves (Rosemary: Guava) with a ratio of 1:1was filled in the thimble chamber using non-woven bag. The bottom flask was filled with methanol as a solvent, which was heated and vapourized through the thimble. The condenser flask condenses the herbal plant powder using methanol solvent and drip back. The extraction process was carried out at boiling temperature of 40°C. The final concentrate present in the extraction chamber was kept at 4°C to become fine powder and it is dissolved in methanol for further process Identification of phytochemical compounds using Thin Layer Chromatographic Technique (TLC) The fraction and polarity of the compound was analyzed using column chromatography [2]. When the suitable spraying reagent based on phytochemical compounds are sprayed on the TLC chromate plate would results in compound spots. The phytochemical compounds are visualized in the chromate plate and marked in the form of individual spots. Each spot was measured using Rf value and it is computed by the formula

$$Rf = \frac{\text{Sample travelled distance (cm)}}{\text{Solvent travelled distance (cm)}} \quad \text{----------(1)}$$

S. No	Phytochemical constituents	Mobile Phase	Spraying Agent
1	Tannins	Methanol	10% Ferric chloride
2	Phenols	Ethyl acetate	10% Ferric chloride
3	Terpenoids	Ethyl acetate	11% Aluminium chloride
4	Flavanoids	Ethyl acetate	11% Aluminium chloride
5	Saponins	Methanol	10% Ferric chloride

Table 1: The phytochemical constituents, mobile phase and their corresponding spraying agents.

Fourier Transform Infrared Spectroscopy (FTIR)

The herbal plant extract containing functional group available in the phytochemical compounds is identified using FTIR spectroscopy. Chemical group available in the herbal plant extracts was revealed during this analysis.

Microencapsulation Process of Herbal Extract

Microencapsulation was done using Rosmarinus officinalis and Psidium guajava herbal extracts as core material and sodium alginate as wall materials. Ten grams of sodium alginate powder were added in 100ml of boiled water, allowed to swell for 15 min followed by the addition of 50 ml of boiled water in the swelling mixture. It was agitated by continuous magnetic stirring for 15min and the temperature was maintained at 50ºC. To this mixture, 240g of core material (Rosmarinus officinalis and Psidium guajava extracts) was slowly added under magnetic stirring and continued at 300-500 rpm. The process of stirring was continued for 15min and the resultant solution was poured in 2% calcium chloride solution. After repeated washing with isopropyl alcohol there was separation of microcapsules from calcium chloride bath followed by drying at 50°C for 10 hours.

Herbal extract application on cotton fabrics

The developed microencapsulate was applied onto the organic cotton fabric with material to liquor ratio of 1:20 at 40°C along with 8% citric acid for strong fixation of microcapsules and allowed to solidify for 50 minutes using three bowl padding mangle. Finally, the treated fabric was squeezed and dried at 120°C for 5 minutes and then cured at 110°C for 2 minutes.

Evaluation of Antibacterial Activity of Herbal Extracts and Treated Fabrics

Agar well diffusion method

An amount of 2g of dry powder from the given herbal extract powder was taken and mixed with 20ml of 90% methanol for screening the antibacterial activity of the herbal plants against two pathogens. When the liquid (solvent + herbal extract) was closed and kept overnight at room temperature for 12 hours in which proper dissolution of the antibacterial compounds into the solvent was achieved. The final concentrate of the extract obtained after overnight incubation were filtered using Whatman filter paper and the concentrated extracts were used for analyzing the antibacterial activity. The antibacterial property was assessed using the agar well diffusion method (NCCLS-1993). The well containing herbal extract, bacteria *(Escherichia coli and Staphylococcus aureus),* and solvent (DMSO) was kept at room temperature for 30 minutes and incubated overnight at 37°C for 18-24 hours. After incubation, the formation of a clear inhibition zone (mm) around the well was observed which indicates the antibacterial activity of the herbal plant extracts.

Parallel Streak Method

Two test microorganisms (Escherichia coli and Staphylococcus aureus) were prepared in a liquid culture medium. Test specimens (control and treated fabric) on the inoculated agar plates are incubated at 37°C for 24 hours. After incubation, the plates were removed from the incubator and observed the growth interruption of inoculum agar streaks on the underneath of the fabric. A clear zone of inhibition had occurred outside the fabric specimens were measured in mm and it indicates the antibacterial activity of the treated fabric.

Assessment of Surface Characteristics By Using Scanning Electron Microscope (SEM)

The surface morphology of the microcapsules treated fabric was analyzed by using high resolution scanning electron microscope JOEL-M-JSM 6360 with high energy electron beam. It gives detailed information about the surface morphology of samples. The image was formed by using signals produced from the electron beam. SEM is used for confirming the binding nature and alignment of the microcapsules present in treated fabric surface.

Assessment of fabric characteristics

The fabric thickness test was calculated using Shirley thickness tester according to the ASTM D1777-96 standard. The fabric stiffness test was done using Shirley stiffness tester according to the ASTM 1388-18 standard. The fabric tensile strength test was evaluated using Instron tensile strength tester according to the ASTM D5034-95 standard. The rubbing fastness of treated fabric was measured using Crockmeter according to the AATCC-TM8-96 standard. The wash fastness of treated fabric was performed using wash fastness tester according to the AATCC124 standard. The air permeability test of fabric was carried out using Shirley air permeability tester according to the ASTM 737-96 standard. The wicking behaviour of treated and untreated fabrics was assessed using fabric wicking apparatus according to the AATCC 197-11 standard. The water vapour permeability test of treated and untreated fabrics was evaluated using water vapour permeability tester according to the ASTM E96-95(B) standard (ASTM Test methods, 2019).

In vitro self wound healing scratch assay

In vitro wound scratch assay method was used for assessing migration, proliferation of cells and wound closure rate of the cells. The density of L929 mouse fibroblast cells around 2×105 cells/ml was growth in each well. Around 24-well plate was filled with L929 mouse fibroblast cells and growth of the cells was about 70–80%confluence as a monolayer. The well plate was incubated at 40°C for 24 hours and 7% CO2 gas was passed through the well plate. After incubation, the sterile P200 pipette tips were used to scratch the monolayer confluent cells in the horizontal direction. The waste present in the cell plate was removed by washing with Phosphate Buffered Saline (PBS). The methanolic extract of *Rosmarinus officinalis* and Psidium guajava with100 *µ*g/ml concentration was treated with well cell plates by diluting with serum-free Dulbecco's Modified Eagle's medium (DMEM). The proliferation of cells treated with herbal extract (100 *µ*g/ml) and treated with distilled water (50*µ*g/ml) was used as the positive control and control samples. The proliferation of cells was captured at three different time periods (0hr, 12hr and 24hr). The first set of migrated cells images for control and positive control samples was captured using phase contrast microscopy at 100×magnification for 0th hr. The second set of images of migrated cells of control and positive control samples was captured at 100× magnification after 12 hours of incubation. The third set of images of migrated cells of control and positive control samples was captured at 100×magnification after 24 hours of incubation. The migration cell rate, cell proliferation rate and percentage of the closed wound area of the images were evaluated using image processing software, and the percentage increase in the wound closure area indicated the higher cell proliferation with lower migration of cells.

Results and Discussion

Phytochemical analysis

Five types of phytochemical compounds were analyzed from the herbal plants extract using Thin Layer Chromatographic technique as shown in the Table 2.

S. No	Phytochemical Constituents	Mobile phase	Spraying agent	Rf value	Presence of compounds
1	Tannins	Methanol	10% Ferric chloride	0.76	++
2	Phenols	Ethyl acetate	10% Ferric chloride	0.81	++
3	Terpenoids	Ethyl acetate	11% Aluminium chloride	0.74	+
4	Flavanoids	Ethyl acetate	11% Aluminium chloride	0.56	+
5	Saponins	Methanol	10% Ferric chloride	0.62	+

Table 2: Thin layer chromatography analysis of binary bio-extract.

The mobile phase used for the identification of phenol is ethyl acetate along with ferric chloride as spraying agent. Green colour spots were observed.

The mobile phase used for tannin is methanol along with ferric chloride as spraying agent. Grey colour spots were observed. The mobile phase used for flavonoids is ethyl acetate along with aluminum chloride as spraying agent. A minute yellow-green spots were observed during the analysis.

The mobile phase used for saponins is methanol with ferric chloride as spraying agent. Light Orange colour spots were observed for saponins as shown in Figure 1. The Rf values were evaluated by comparing with the standards. The Rf value for tannin, phenol, terpenoids, flavonoids and saponins were calculated as 0.76, 0.81, 0.74, 0.56 and 0.62 respectively.

The phytochemical analysis of rosemary leaf extract by using Thin layer chromatography was done in earlier investigation and the presence of polyphenols, saponins, flavonoids, rosmarinic acid, diterpenes and triterpenes was reported. Earlier authors also studied the phytochemical analysis of guava leaf extract by using TLC and identified the presence of tannins, polyphenols, terpenoids, glycosides, carbohydrates, saponins and flavonoids.

Figure 1: Phytochemical analysis of binary bio-extract .

FTIR Analysis

The FTIR spectrum obtained for herbal extract is shown in Figure 2.The spectrum lines obtained from the herbal extract proved to be a prominent peak at 3734 cm-1 confirmed the presence of phenols and alcohols. The prominent peaks at 2345cm-1,1643cm-1,903cm-1and 849cm-1 represents the major functional groups such as phosphines, oximes, vinyl compounds and 1,3,5 Trisubst benzene functional groups. The prominent peak at 795cm-1, 741cm-1, 694 cm-1, 640cm-1and 447cm-1represents the major functional groups such as 1,2,3,4 tetrasubst benzenes, O-disubst benzenes, C-C-CHO aldehyde group,=CH2 vinyl compound group and C-O-C ethers as a functional groups are present in the herbal extract as shown in the Table 3.

S.No.	Wavelength (cm – 1)	Bond Stretching / Intensity	Functional Group
1	3734	O-H Stretch Medium	Phenols and Alcohol
2	2345	-PH Stretch Medium	Phosphines
3	1643	C=N Stretch Weak	Oximes
4	903	CH=CH2 (CH2 out of plane wag) Very strong	Vinyl compounds
5	849	CH out of plane deformation Very strong	1,3,5 Trisubst benzene
6	795	CH out of plane deformation Very strong	1,2,3,4 tetrasubst benzenes
7	741	CH out of plane deformation Strong	O-disubst benzenes
8	694	C-C-CHO bending Strong	C-C-CHO in aldehydes
9	447	C-O-C bend Medium strong	C-O-C in ethers

Table 3: FTIR Analysis for binary bio-extract with respect to wave length.

The functional groups such as phenols, alcohols, phosphines, oximes, vinyl compounds, 1,3,5 Trisubst benzene, 1,2,3,4 tetrasubst benzenes, O-disubst benzenes, C-C-CHO aldehyde group, =CH2 vinyl group, and C-O-C ether group are present in the rosemary and guava leaf extracts. Such functional groups are responsible for antibacterial activity and wound healing activity.

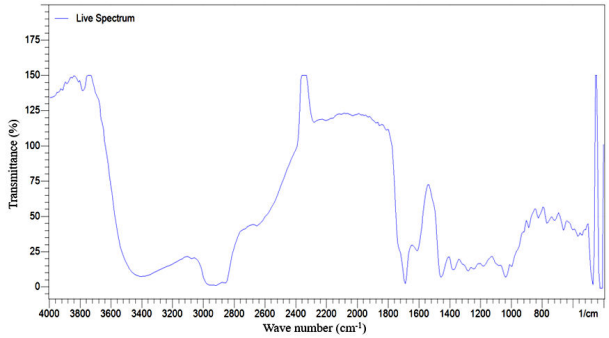


Figure 2: FTIR spectral lines for binary bio-extract with respect to wavelength.

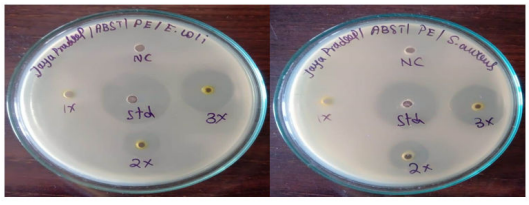
The functional groups present in the methanolic extract of *Rosmarinus officinalis* leaf by using FTIR spectroscopy were studied and identified the presence of Alkenes, Aliphatic fluoro compounds, Alcohols, Ethers, Carboxylic acids, Esters, Nitro compounds, Alkanes, Aldehydes, and Ketones compounds. The functional groups present in the *Psidium guajava* leaf extract by using FTIR spectroscopy and identified the presence of phenols, oximes, phosphines and alcohols compounds.

Antibacterial activity of treated fabric (Agar Well Diffusion method)

The antibacterial activity of the herbal plant extract against gram-positive and gram-negative test pathogens is presented in Table 4.

S. No.	Samples	Zone of inhibition (mm)	
		Escherichia coli	*Staphylococcus aureus*
1.	Negative control (DW)	-	-
2.	3(X) Methanol Extract	40	36
3.	2(X) Ethanol Extract	17	18
4.	1(X) Aqueous extract	10	15
5.	Std (Gentamicin)	28	28

Table 4: Antibacterial property of binary bio-extract using agar well diffusion method.



(a) *Escherichia coli* (b) *Staphylococcus aureus*

Figure 3: Antibacterial property of binary bio-extract using agar well diffusion method.

Figure 3 confirms that the treated fabrics have antibacterial activity against two test pathogens with an inhibition zone ranging from 10 mm to 40 mm using different solvents. Such inherent antibacterial properties were attained due to the essential oils present in phytochemical compounds of the bio-extract.

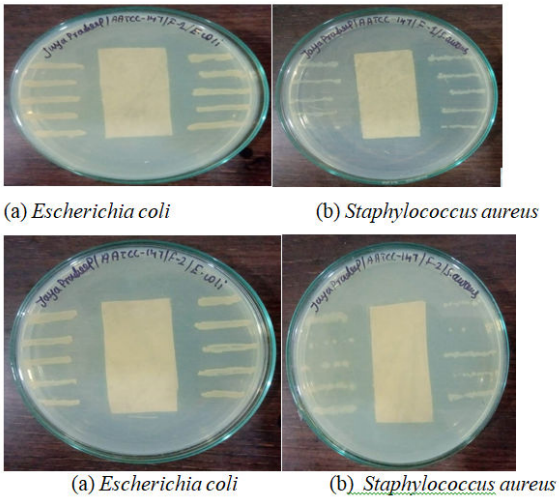
The antibacterial activity of *Rosmarinus officinalis* leaf extract was investigated by using agar well diffusion method and identified excellent zone of inhibition against different bacterial pathogens. The antibacterial activity of *Psidium guajava* leaf extract was studied by using agar well diffusion method and identified excellent zone of inhibition against bacterial pathogens.

Antibacterial activity of treated fabrics (Test Method 147-1988)

During the analysis, rosemary and guava leaves extract treated fabrics showed a significant zone of inhibition. The treated fabrics showed promising antibacterial activity against two test pathogens are presented in Tables 5 and Figure 4

Test samples	Zone of Inhibition (mm)	
	Escherichia coli	*Staphylococcus aureus*
Treated fabric before wash	34	33
Treated fabric after wash	31	30

Table 5: Antibacterial property of treated fabric using parallel streak technique.



(a) *Escherichia coli* (b) *Staphylococcus aureus*

(a) *Escherichia coli* (b) *Staphylococcus aureus*

Figure 4: Antibacterial activity of the treated fabric before and after washing.

During the parallel streak assay, the fabric treated with microcapsules of Rosmarinus officinalis and Psidium guajava leaves showed maximum inhibition zones of 34 mm against Escherichia coli and 33 mm against Staphylococcus aureus before washing. After washing, a slight reduction in the antibacterial activity against gram-negative (Escherichia coli) and gram-positive (Staphylococcus aureus) test pathogens with the zone of inhibition ranging from 30 mm to 31 mm. The antibacterial activity of Psidium guajava leaf extract on cotton fabrics by using parallel streak method was earlier studied and identified good antibacterial activity against Escherichia coli and Staphylococcus aureus. It is also reported that antibacterial activity of herbs is high due to presence of tannins, flavonoids and saponins in the leaf extract.

Assessment of surface characteristics

The surface morphology of the microcapsules treated fabric was analyzed using high resolution scanning electron microscope as shown in Figure 5. It was used to identify the particle size, shape and binding nature on the surface of the fabric.

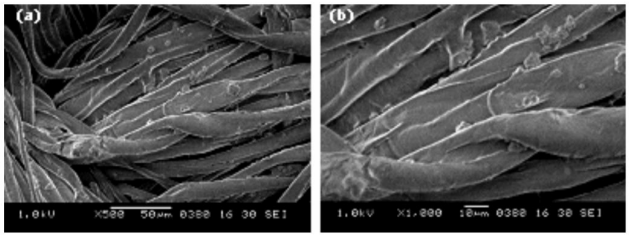


Figure 5. SEM photographs of microcapsules treated fabric a) × 500 and b) × 1000 magnification levels.

The binding and alignment of microcapsules on the treated fabric was observed at ×500 magnification and×1000 magnification levels with uniform size distribution of microencapsules on the fabric surface. The uniform size distribution of microencapsules present in the treated fabric was observed on the surface of the treated fabric. The surface morphology of fabrics treated with bio-extract was reported by using scanning electron microscope and the formation of granules like structure on fibre surface was observed.

Assessment of Fabric Characteristics

The thickness test of both treated and untreated fabrics was done using Shirley thickness tester according to ASTM D1777-96 standard. The results obtained from fabric thickness test are shown in the Table 6.

S.No.	Thickness of Fabric (mm)	
	Untreated fabric	Treated fabric
1	0.35	0.37
2	0.34	0.39
3	0.36	0.39
4	0.35	0.38
5	0.35	0.39
Mean	0.35	0.38

Table 6: Assessment of thickness test.

From the test results, higher thickness was achieved in treated fabric compared with untreated fabric was mainly due to the finishing of microencapsulated particles on the micropores of the fabric surface. Herbal treated fabrics was thicker than the untreated fabrics.

The reason of such increase in thickness caused by antibacterial treatment was investigated and reported.

Stiffness test

The stiffness test of both treated and untreated fabrics was performed on Shirley stiffness tester according to ASTM 1388-18 standard. The results obtained from fabric stiffness test are shown in the Table 7.

S.No.	Bending Length (cm)	
	Untreated fabric	Treated fabric
1	2.5	3.4
2	2.4	3.2
3	2.5	3.5
4	2.3	3.4
5	2.4	3.3
Mean	2.4	3.3

Table 7. Assessment of stiffness test.

Stiffness was higher in the treated fabric. The microencapsulated particles are absorbed in the interstices of the fabric will increase the stiffness, flexural rigidity and bending length of the fabrics. Increase in stiffness of the fabrics after herbal treatment was also observed in other study.

Air permeability test

The permeability of air for both treated and untreated fabrics was evaluated on Shirley Air permeability tester according to ASTM 737-96 standard. The results are shown in the Table 8.

S.No.	Air Permeability (cm3/cm2/sec)	
	Untreated fabric	Treated fabric
1	38	30
2	39	29
3	37	29
4	38	28
5	28	25
Mean	36	28.8

Table 8. Assessment of air permeability test.

The lower volume of air was passed through the treated fabric compared with untreated fabric. It was mainly due to the finishing of microencapsulated particle on the fabric surface. As a result, the fabric cover factor and pore size was decreased and there is increase the stiffness of the fabric. In case of untreated fabric, the pore size and cover factor remain the same without finishing and therefore the flexibility becomes higher and stiffness is reduced compared with treated fabric. The air permeability of treated fabrics decreased after the application of the herbal extracts compared to untreated fabrics was investigated by earlier authors. Higher fabrics thickness & more number of fibres per unit area offer more resistance to air flow leading to lower air permeability. Earlier authors also observed the loss in air permeability of *Calendula officinalis* and *Ricinuscommunis* treated cotton fabrics as compared to the untreated fabrics.

Vertical wicking test

The vertical wicking test of both treated and untreated fabrics was done according to AATCC 197-11 standard. The results obtained from the vertical wicking test are shown in the Table 9.

S.No.	Time (min)	Untreated fabric (cm)	Treated fabric (cm)
1	5	3.8	2
2	10	5.5	2.7
3	15	7.1	3.4
4	20	8.2	4.5
5	30	9	5

Table 9. Assessment of vertical wicking test.

Decrease in wicking length (cm) in the treated fabric was mainly due to microencapsulated extract bound the microcellular fibrils of cellulose molecule. There is reduction of the micropores of the treated cotton fibre. As a result there is crystalline structure formation by binding of microfibrils as compared with untreated fabric. It was observed that samples treated with herbal extract had much better wicking property as compared to plain fabrics since water molecules have better adhesion to the treated fabrics than untreated fabrics.

Water vapour permeability test

The water vapour permeability test of both treated and untreated fabrics was conducted according to ASTM E96-95 standard. The results obtained from the water vapour permeability test are shown in the Table 10.

S.No.	Untreated fabric	Treated fabric	WVP Index
1	43511450	39185750	90
2	43875859	38452874	87
3	42998005	39681321	92
4	43328637	39365892	90
5	42957028	38892585	90
Mean	43334195	39115684	90

Table 10. Assessment of water vapour permeability test (WVP).

The lower water vapour permeability of treated fabric was mainly due to the absorption of microencapsulated particle on the surface of the fabric which covers the micropores of the fabric. In case of untreated fabric, the pores remain unblocked resulting in better water vapour permeability compared with treated fabric. It is reported that untreated fabrics have greater water sorption ability than the treated fabrics because the water diffuses into the pore spaces of the untreated fabrics. This was also reported that water vapour permeability of the treated fabrics was decreased in comparison to untreated cotton fabrics. The hydrophobic nature of bio-extract, which

forms thin film on the fabric surface may be the probable cause for such decrease.

Tensile strength test

The tensile strength test of both treated and untreated fabrics was done according to ASTM D5034-95 standard. The results are shown in the Table 11.

S.No .	Untreated fabric				Treated fabric			
	Strength(kgf)		Elongation(mm)		Strength(kgf)		Elongation(mm)	
	Warp Way	Weft Way	Warp Way	Weft Way	Warp Way	Weft Way	Warp Way	Weft Way
1	24.2	22.9	12.1	14.2	39.4	41.6	13.9	13.3
2	25.1	23.4	12.7	14.5	38.2	40.1	13.2	12.5
3	24.5	23.1	12.4	14.3	39.1	41.2	13.8	13.1
4	24.8	22.8	12.6	14.5	38.4	40.5	13.5	12.7
5	25.1	23.2	12.3	14.3	39.1	40.6	13.3	12.9
Mean	24.7	23	12.4	14.3	38.8	40.8	13.5	12.9

Table 11. Assessment of tensile strength test.

The increase in tensile strength for the treated fabric in warp way and weft way was mainly due to cross link of microencapsules with the chain of cellulose polymer and bonding in the interstices of the fabrics. The similar trend was also observed by earlier authors. However, no significant change was observed for elongation behaviour for treated and untreated samples.

In vitro self-wound healing scratch assay

In vitro self-wound healing assay was used to measure the migration and proliferation of cells and also in response to cell wound closure as well as inspiration with specific agents. In this study, the phytochemical compounds present in the herbal extract have the ability to progress better wound healing property by directly acting on L929 mouse fibroblast cells are shown in the Figure 6.

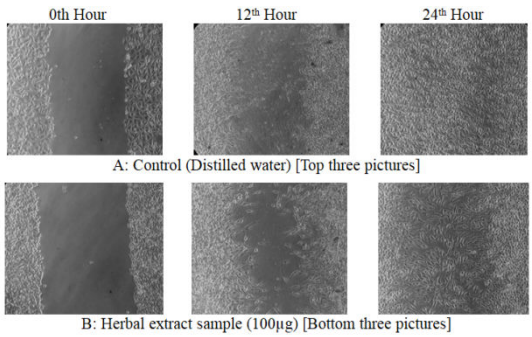


Figure 6. *Invitro* Wound healing scratch assay of treated fabrics.

When a linear scratch was created on L929 mouse fibroblast cell lines, the migration, proliferation and wound closure of cells were measured for the 100µg/ml concentration of herbal extract at three different time periods (0th hour, 12th hour and 24th hour). Figure 5 corresponding to self-wound healing ability of the herbal extract showed that, at the 0th hour, no cell migration and proliferation was observed for the 100µg concentrate including control (Distilled water). At the 12th hour, herbal extract showed positive cell migration and cell proliferation, when compared to the control sample. After 24thhours, more cell proliferation was evident and thus indicating the better wound healing ability of herbal extract. Earlier studies indicate the wound healing properties and identified rosemary extract is a good source of antioxidant. It plays a valuable role in the process of healing wounds which is due to its antioxidant activity. The wound healing properties of guava leaf extracts was also investigated and excellent wound healing properties were identified. Wound healing ability of the bio-extract may be due to saponins, flavonoids, alkaloids and tannins.

Conclusion

The result obtained from the test shows excellent zone of inhibition against *Escherichia coli* and *Staphylococcus aureus*. The physical and comfort properties of the treated fabric was slightly affected when compared with untreated fabric. The treated fabric shows excellent wound healing property using in vitro self-wound healing scratch assay test. Thus, *Rosmarinus officinalis* and *Psidium guajava* extract treated fabric may be preferred for making wound dressing, compression bandages, head cover, face mask, patient dress material, and surgical gowns for health care and hygienic applications.

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