NC STATE UNIVERSITY

College of Textiles, NC State University

JTATM Journal of Textile and Apparel, Technology and Management

Volume 7, Issue 3, Spring2012

Preparation and Characterization of Medicinal Herb *Glycyrrhiza Glabra* and a Study of the Anti-Microbial and Thermal Properties on Cotton Fabrics for Eye Syndrome

Krishna Veni
Assistant Professor, Department of Fashion Technology,
Kumaraguru College of Technology
Coimbatore, India

Amsa Mani
Associate professor, Avinashilingam University
Department of Textiles and Clothing
Coimbatore, India

ABSTRACT

Technical textile is an emerging area representing a multi-disciplinary field with numerous end uses. Technical textile products are produced from high performance textile materials that are manufactured primarily for their functional and performance properties rather than their aesthetic or decorative properties. In the recent years, comfort has become a mandatory requirement in medical textiles. Textiles with multifunctional finishes – coolant and antimicrobial finishes are employed in order to provide comfort to the wearers. Studies have been carried out in the present work to fine-tune the properties of thermal comfort and resistance to microbial attack particularly to human eye. The development of eye pillow with coolant and antimicrobial effects of finishes is achieved by using a selected eco-friendly medicinal herb -Glycyrrhiza glabra (Yashtimadhu) roots. The extraction of the herb is done by direct extraction method by using distilled water as the selected solvent among the other solvents like methanol, ethanol, chloroform, acetone and distilled water and it is applied on to the cotton fabric by pad – dry – cure method in an optimized process conditions. The treated and untreated samples are tested using such test methods as ISO 11092- Thermal Resistance, Wettability, Wickability, SEM, FTIR and Antimicrobial tests – AATCC 100, AATCC 147, AATCC 30 Agar Diffusion and Broth Dilution tests. The results indicate that the treated fabric with 50% concentration of Glycyrrhiza glabra have high thermal resistance coolant and antimicrobial activity and it showed good resistance to washing up to 12-18 cycles.

Keywords: Glycyrrhiza glabra herb, Antimicrobial, Thermal resistance, Cotton treated fabric, Eye Syndrome, S.aureas, Natural herbal finishing

1. Introduction

The environmental threats loom large on almost every nation in the world today while health is the greatest possession. Textile has always been a part of healthcare. Combination of textile technology and

medical sciences has resulted into medical textiles. *Medical Textiles* is one of the fast growing sectors of the global technical textile industry and one of the dynamically expanding sectors. As medical procedures continue and transform, the demand for textile materials is bound to grow and grow. The inherent properties of textile fibers provide room for the growth of microorganisms (Rattanawaleedirojn et al 2008).

Microbes include a variety of microorganisms like bacteria, fungi, algae and viruses, stain the fabric and Detroit the performance properties of fabrics. Comfort is a pleasant state of physiological, psychological and physical harmony between a human being and the environment. The Thermo-physiological comfort for eyes is very important because every part of body has one source to reduce the heat except eyes, which is more important organ of the body. The human eye is the organ which gives us the sense of sight, allowing us to observe and learn more about the surrounding world than we do with any of the other four senses. The heat produced in the eyes due to continuous usage has to be absorbed. The heat is not transferred then it may cause problems like cataract, coloboma, corneal Disease, diabetic eye disease and dry eye. To avoid the above problems we can go for eye exercise, soothing of eye massaging and can be cured by appropriate medicines (Usha sayed et al 2006). According to the old saying "Prevention is better than cure", controlling of diseases before humans get affected is important. So controlling can be done through the second skin of human-clothing. The controlling of microorganisms is tedious process; washing can only arrest the microorganisms and does not destroy them. Therefore it is necessity of the manufacture to provide comfort with antimicrobial finished clothing to protect human beings against microbes (Thilagavathi *et al*, 2008).

With this threat gaining its stature day by day, there are a wide variety of commercial anti-microbial agents but it gives toxic effect to the environment and the wearers (Sathiyanarayanan et al 2010). The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with eco-friendly antimicrobial properties. Eco Textiles gain utmost importance as one of the most useful resources that help promote new innovations, in an eco-friendly manner. The use of herbal medicated products helps to reduce the opportunity for contamination by biological toxins and infectious pathogens and therefore reduce the spread of diseases to other patients (Massey et al 2008). The purpose of this study is to examine the antibacterial activity of cotton fabric treated with Glycyrrhiza glabra herbal solution against eye disease causing bacteria Staphylococcus aureus and Aspergillu's nigar and identify the thermal resistance effect of herbs on the cotton fabrics for controlling the eye syndrome in medical application.

2. Materials and Methods

2.1 Material

The Cotton fabric with the following specification of Yarn count: 60 x 60,Fabric count: 80 x 80, GSM: 180 was scoured with a solution containing 5g/l of sodium carbonate and 3g/l nonionic detergent under the boiling condition for v 4 hr , after which time it was thoroughly rinsed and air dried at room temperature.

2.1.1 Antimicrobial herb

Yashtimadhu (Glycyrrhiza glabra) is the plant species chosen for the study. The roots of Yashtimadhu were shadow dried and made into a fine powder.

Figure 1. Glycyrrhiza Glabra Herb

2.2 Methods

2.2.1. Extraction of Herb

The solvents are selected based on their polarity ranging from low polar to high polar. The active compounds in the herbal powder that has affinity to those polar particles present in the solvents get separated. Based on the type of Extraction method and Agar Diffusion method (AATCC 147) the suitable solvent selected is distilled water (Usha Sayed & Laxmikant, S.Jawale, 2006).

2.2.2. Finish Application

The temperature, time, pH, Concentration and the M:L ratio was optimized using the Box and Benkhen method. The optimized conditions are Temperature - 37°c, Time – 4 hrs., pH – 7 and Concentration – 50%.The extracts of herb were applied to cotton fabric by dipping in bath at M:L ratio 1:10.The mordant alum was used as a binding agent to fix the herbal extract on to fabric. The fabric was then dried at 80^0C for 10 minutes to remove the moisture. Finally the fabric samples were tested for antimicrobial activity as per the standard test methods.

2.3. Measurements and analysis

The standard test methods for the products include the thermal resistance testing (ISO 11092) and anti-microbial testing (AATCC 147, AATCC 100, AATCC 30) and objective evaluation tests.

2.3.1. Thermal Resistance Testing (ISO 11092)

The fabric sample was held over the measuring plate (artificial skin), which was maintained as standard temperature (35 °C). The continuous exposure of the fabric over the heated surface helps to absorb the heat. The heat was absorbed due to the property of the fabric; the temperature of the measuring unit decreases thus the watts increases. The experiment was repeated for every 15 min up to 120 minutes and the mean was found. Standard R.H. 65% +/- 2% and Temp.21 Degree C +/- Degree C was maintained. Temperature difference between the two faces of material divided by the resultant heat flux per unit area in the direction of the gradient. The following formula was used for calculating the thermal resistance in the fabric samples.

$R_{ct} = (T_m - T_a)A / H - \Delta H_c - R_{ct0}$ (R_{ct0} apparatus constant).

2.3.2 Antimicrobial Tests

2.3.2.1 AATCC-100-1998 (USA): Quantitative Assessment of Antibacterial finishes on textiles-measures the degree of antibacterial activity- Broth Dilution Test

The 2"x 2" Samples were prepared from the Glycyrrhiza Glabra (untreated, 50%, 75% and 100% treated). 500ml Erlenmeyer conical flasks containing 50ml of nutrients broth were prepared and sterilized at 121^0C for 15 minutes. It was then allowed to cool (10). The fabric samples were then transferred aseptically into the conical flasks respectively. These were incubated at 37^0C for 24 hours in shaker at 121rpm. After incubation their absorbance were measured at 600nm.

2.3.2.2. AATCC-147-1998 (USA): Qualitative Antibacterial Assessment of diffusible antibacterial agents ("quick method")-Agar diffusion Test

The 50ml of nutrient agar was prepared and sterilized at 121^0C for 15 minutes. Petri plates were autoclaved in hot air oven at121^0C for 30 minutes. 20ml of Nutrient agar was poured into each of these plates and were allowed to solidify. A series of 8 test tubes containing 4.5ml of sterile water was taken. 0.5ml of culture from nutrient broth containing the 100% treated samples was transferred aseptically into the first test tube. Serial dilution was carried out until its reduced dilution was 10^ (-8). 100 micro liters of 10 (-8) diluted culture was taken aseptically and poured onto the petri plates. This was spread by using L rod. The plates were incubated at 37^0C for 16-18 hours. Similar procedure was carried out for untreated sample; sample treated with 50% and 75% concentrations.

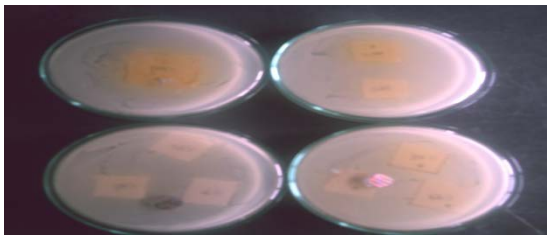

Figure 2. AATCC-147-1998-Agar diffusion Test

2.3.2.3. AATCC 30-1993: Antifungal activity, Assessment of textile material: mildew and rot resistance of textile material-Broth Dilution Test

500ml Erlenmeyer conical flask containing 50ml of PD broth was prepared and sterilized at 121^0C for 15 minutes. It was then allowed to cool. The fabric samples were transferred aseptically into the conical flasks respectively. These were kept at room temperature for 3 days. Then the growth of fungi in the conical flask was observed after 3 days.

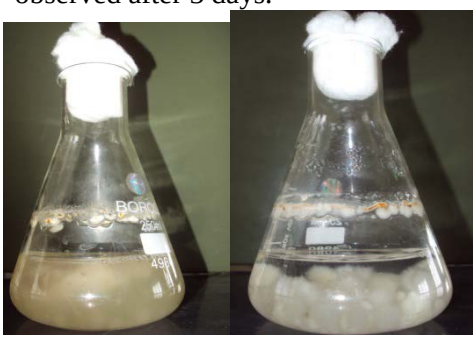

Figure 3. AATCC 30- Broth Dilution Test

2.3.3. Antimicrobial Compound Identification Method (FTIR Test)

A method for measuring all of the infrared frequencies simultaneously, rather than individually, was needed. The signal can be measured very quickly, usually on the order of one second or so. Thus the time element per sample is reduced to a matter of a few seconds rather than several minutes. Most interferometers employ a beam splitter which takes the incoming infrared beam and divides it into two optical beams. This means that as the interferogram was measured; all frequencies were being measured simultaneously. Thus, the use of the interferometer results in extremely fast measurements.

2.3.4. Characterization of Glycyrrhiza Glabra Herb

The treated fabric was observed with a scanning electron microscope (SEM) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons in a raster scan pattern with various frequencies. The herbal treated fabric was compared with unfinished fabric which served as the control fabric.

2.3.5. Objective Evaluation Tests

2.3.5.1. Fabric Stiffness

The five samples of size 6 ×1 inch from both the warp and the weft way were prepared. The sample was then transferred to the platform of the tester and the edge of the sample is in line with the edge of the platform. The strip of the fabric will commence to drop over the edge of the platform and the movement of the scale is continued until the tip of the specimen is viewed in the mirror cuts the datum line. The bending length was measured from the scale mark and the flexural rigidity, bending modulus were calculated.

2.3.5.2. Fabric Strength

The five samples of size 12" ×3" from both the warp and the weft way were prepared. Then the samples were placed in the jaws of the equipment. Tensile load was applied to the fabric on the principle of constant rate of loading. The readings were note from the dial when the fabric breaks.

2.3.5.3. Wicking Test

The water transport rate was measured according to a vertical strip wicking test. One end of a strip (25mm wide X 170 mm long) was clamped vertically with the dangling end immersed to about 3 mm in distilled water at 21˚C. The height to which the water was transported along the strip was measured at 1, 5 and 10 minute intervals and reported in centimeters (cm). Higher wicking values show greater liquid water transport ability.

2.3.5.4. Wettability Test

The absorbency rate of water by the fabric was measured by capillary drop

method. The fabric of 5x5 cm was clamped horizontally in the frame. Then water was dropped on to fabric surface and time taken for the absorbency was measured.

2.3.5.5. Wash Durability Test

The wash durability of the treated fabric was conducted for 6 sample of size 4x4cm. The sample chosen for the test was washed for 5-25 cycles in standard temperature 37 ^{o}c and with standard detergent.

3.1. Thermal Resistance Testing (ISO 11092)

Lower the thermal resistance values higher the coolness. The thermal resistance of untreated fabric is 0.0153 (Squ.m k/watt). The thermal resistance of Yastimadhu treated fabric is 0.0080 (Squ.m k/watt).The result, we can conclude that (Yastimadhu) Glycyrrhiza Glabra has higher Coolness values when compared to the untreated fabric, since it has the lowest value **0.0080** (Squ.m k/watt) in the Table -1.

3. Results and Discussions

Table1. Thermal Resistance of Untreated and (Yastimadhu) Glycyrrhiza Glabra Treated Fabric

A			THERMAL RESISTANCE TEST				
Temp Air Set							
s. No	Time	Temp Mu	Temp Grid	Temp Air	R/H	Rct- Untreated Fabric	Rct- Yestimathu Treated Fabric
1	0-15	35.0	35.0	19.9	65.0	.0161	0.0081
2	15-30	34.9	34.9	20.0	64.9	.0146	0.0093
3	30-45	34.9	34.9	19.9	64.9	.0149	0.0093
4	45-60	35.0	35.0	19.9	64.9	.0152	0.0081
5	60-75	35.0	35.0	19.9	64.9	.0147	0.0074
6	75-90	35.0	35.0	20.0	64.9	.0151	0.0079
7	90-105	35.0	35.0	19.9	65.0	.0155	0.0080
8	105-120	34.9	35.0	19.9	64.9	.0153	0.0081
AVERAGE						***.0153***	***0.0080***

3.2. Anti-Microbial Tests

3.2.1. AATCC-100-1998 (USA): Quantitative Assessment of Antibacterial finishes on textiles-measures the degree of antibacterial activity- Broth Dilution Test

Absorbance of the sample is directly proportional to the concentration of the cells in the sample. The absorbance values of the samples are compared. It is found that the fabric finished with 50% conc. gives low absorbance values when compared to the untreated fabric. This indicates that 50%conc. treated fabric does not support the growth of bacteria, the antibacterial property in the table-2.

Table 2. AATCC -100 Absorbance tests at 670 nm

Sample	Reduction values (at 670nm)
	Staphylococcus aureus
Untreated fabric	1.02
50% concentration Sample(1 hour)	0.94
50% concentration Sample(2 hour)	0.77

3.2.2. AATCC-147-1998 (USA): Qualitative Antibacterial Assessment of diffusible antibacterial agents ("quick method")-Agar diffusion Test

After incubation, the plates were observed for bacterial growth. Then the numbers of colonies were counted for each plate. The antibacterial activity of Glycyrrhiza Glabra at the optimized condition .The zone of inhibition is more when compared to the untreated fabric. This means that the fabric does not support the growth of bacteria in table 3.

Table3. Zone of inhibition for Glycyrrhiza Glabra with Agar Diffusion Method

Sample	Anti-bacterial activity (Zone of inhibition in mm)
	Staphylococcus Aureus
Glycyrrhiza Glabra extract finished fabric (50%)	19
Untreated fabric	0

3.2.3. AATCC-30-1993: Anti-fungal activity, Assessment of textile material: mildew and rot resistance of textile material (Broth Dilution Test)

It was found that there was less growth of fungi in the conical flask containing 50% concentration sample when compared to the untreated sample from the picture. This indicates that the 50% treated fabric has better anti-fungal property.

Table 4. AATCC-30 Absorbance Tests at 670 Nm Broth Dilution Test

Sample	Absorbance values (at 670nm)
	Aspergillus niger
Untreated fabric	1.02
50% concentration Sample	0.84

3.3. Antimicrobial Compound Identification Method (FTIR Test)

The result of FTIR state that the treated fabric of absorption bands occur at 3417 cm^{-1}.and 1055 cm^{-1} which confirms the corresponding bands to the compounds responsibility for antimicrobial phytochemicals are present. A high concentration strong broad around 3360-3417 cm^{-1} found in the sample may be due to the presence of O-H bond, characteristics of alcohols and phenols (Hirano et al 1998).The absorption bands 1052-1570 cm^{-1} are due to the stretching vibration of C-O group of phenols (Valchos et al 2006). The antimicrobial compounds of photochemical like alkaloids, flavonoids, tannins etc. were present the herbal solution showed in Figure 4.

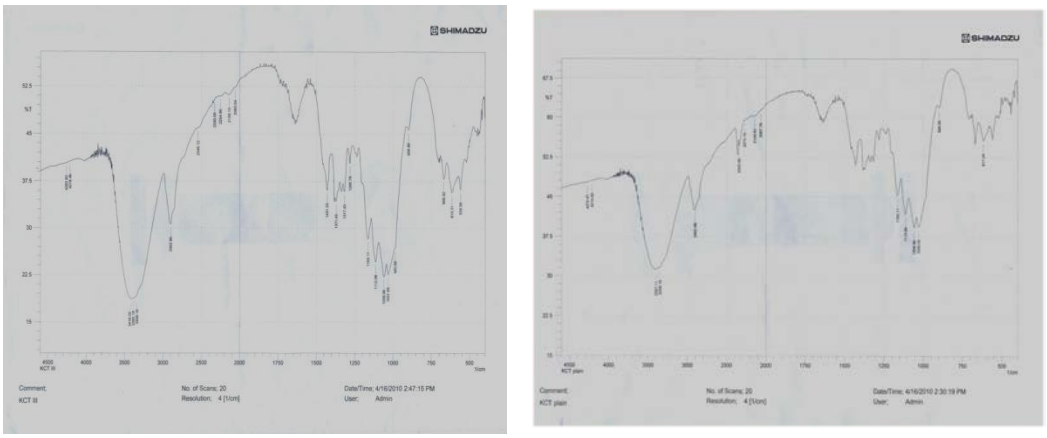

Figure 4. Untreated Sample and Herbal treated Sample

3.4. Characterization of Glycyrrhiza Glabra Herb (SEM study)

The surface of fabric was photographed. The extracted molecules of herb has fixed into the yarns of the fabric to a maximum amount. The SEM photo graph of X3,000 resolution power shows the bonded molecules of the herb with clarity. The untreated and treated fabric bonded molecules were analyzed.

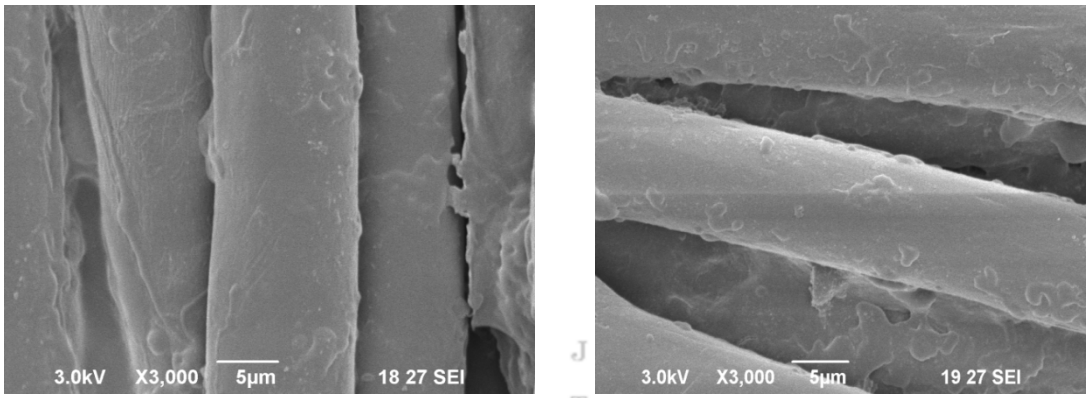

Figure 5. Untreated fabric and treated fabric

3.5. Objective Evaluation tests

3.5.1. Fabric Tensile Strength Testing

The results were observed that the herbal finish has increased the tensile strength of the fabrics both warp and weft way when compared to the untreated sample.

Table 5. Fabric Tensile Strength Testing- Weft

Sample Number	UNTREATED SAMPLE			50%CONC TREATED SAMPLE		
	Br. Force	Elongation (mm)	T.Break (s)	Br. Force	Elongation (mm)	T.Break (s)
1	14.40	19.50	3.8	15.40	17.30	3.4
2	11.80	16.90	3.3	15.20	16.30	3.3
3	13.00	17.70	3.6	16.90	19.20	3.8
4	12.20	17.40	3.5	14.40	16	3.2
Mean	12.80	18.10	3.5	15.40	17.20	3.4

3.5.2. Fabric Stiffness Testing

The results we have observed that the herbal finish has increased the stiffness of the

treated fabrics both warp and weft way, when compared to the untreated sample.

Table 6. Fabric Stiffness Test

Sample Number	WARP		WEFT	
	Untreated samples(cm)	50%conc treated sample(cm)	Untreated samples(cm)	50%conc treated sample(cm)
1	4.3	4.5	3.5	3.7
2	4.3	4.6	3.3	3.8
3	4.2	4.6	3.5	3.7
4	4.5	4.7	3.4	3.8
Mean	4.3	4.6	3.4	3.7

3.5.3. Wetting Test

The wetting process calculates the amount of fiber- air interface replaced with a fiber- liquid interface was calculated. From the test results the wet ability of the treated fabric has been increased in a considerable amount when compared to the untreated fabric showed in the figure-6.The wicking test method also determines the liquid absorbent capacity of protective and functional fabrics using gravimetric principles. From the test results, the wick ability of the treated fabric has been increased in a considerable amount when compared to the untreated fabric.

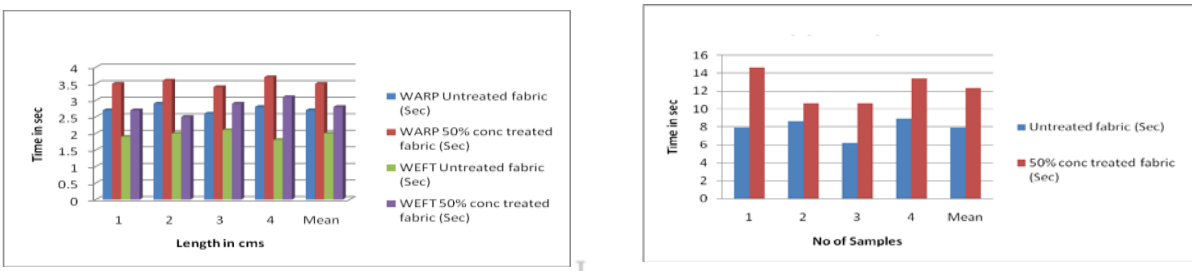

Figure 6. Wetting Test and Wicking Test

3.5.4. Wash Durability Test From the obtained absorbance value, it can be concluded that the herbal finished product can withstand up to 15- 18 washes.

Table. 8 Wash Durability Test

Wash durability		Absorbance Value (at 670 nm)
Untreated fabric	Before wash	1.09
Treated fabric	Before wash	0.77
	After 5 wash	0.89
	After 10 wash	0.94
	After 15 wash	0.99
	After 20 wash	1.24
	After 25 wash	1.37

4. Conclusion

In conclusion, it may be stated that the application of glycyrrhiza glabra herbal solution to cotton fabric imparts to it the functional properties of antimicrobial and thermal resistance. The 50% conc. treated fabric was proved to possess best anti-microbial property and coolant property. The treated fabric is found to be very

hygienic with less fungi and bacteria as well as making the cloth much softer than before. The SEM and FTIR analysis reveals that the herbal solution has the high antimicrobial compounds. The objective evaluation tests also states that the fabric strength, wickability and wettability of the herbal treated fabrics also have increased when compared to untreated control samples. The glycyrrhiza glabra herb gives the better coolant properties than the other products. This duel finish was very much cost effective and eco-friendly. The wash durability tests also revealed that the finish was able to withstand 12-18 washes. This herbal treated cotton fabrics will give better coolant effect and reduce the heat on the human eyes. So, In future, this study will surely helpful and enhance the computer engineers and software professionals to prevent the computer work eye irritations and also export quality of cotton eye pillow product especially when Indian exporters face tough competition after globalization. In a nutshell this study has open doors for production better eco-friendly medically treated cotton fabrics.

References

1. Rattananwaleedirojn, P., Saengkiettiyut, K and Sangsuk,S.(2008). Antibactrial efficacy of nano silver finished fabric on staphylococcus aureus and preliminary test on its safety, J.Nat.Sci. Special issue on nanotechnology, 7, 75-79.
2. Usha Sayed khan, and Laxmikant, Jawale.S.(2006), Application of Herbs on Fabric,Supplement to Colourage, Vol .LIII, No-4, 65-68.
3. Thilagavathi,G., Kannan,T and Rajendran,R (2010). Combined antimicrobial and aroma finishing treatment for cotton, using micro encapsulated genarium leaves extrat, Indian journal of natural products and resources, vol,1(3), 348-352.
4. Sathiyanarayanan,M.P., Bhat,N.V., Kokate,S.S and Walunj,V.E., (2010). Antibacterial finish for cotton fabric from herbal products, Indian Journal of Fibre & Textile Research, Vol. 35, 3, 50.
5. Massey, D.,Geol,P and Swerev, M.(2008) Antimicrobial Finishes and Modification, Melliand Internationl, Auguest., 151.
6. Brojeswari Das, A.,Kothari, V.K.,Frangueiro, R., and Araujo**,** M.D., (2007),Moisture transmission through textiles, AUTEX Research Journal, Vol 7 ,No3,98 -103.
7. Amandeep Kaur and Chakraborty, J. N,(2009),Essence of Healthy and Motivative Clothing, Asian Textile Journal, 37-39.
8. Hirano,S.,Okawara,N., Narazaki,S., (1998),Near Infra-Red Detection of Internally Moldy Nuts, Bioscience,Biotechnology and Bio chemistry, 62, 919-928.
9. Valchos, N., Akopelitia, Y., Psaroudaki, M., Konstantinidou,v., Chatzilazarou,A., Tegou,E.,(2006), Applications of Fourier Transform-Infra Red (Ftir)Spectroscopy to Edible Oils, Analytica Chemica Acta, 573/574,459-465.