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Application of Butea monosperma plant leaves (antimicrobial) on polyester and cotton/polyester fabrics

[1,]Shama Sadaf , [2*,]Nazia Erum , [3,]Naila Bashir , [4,]Zeeshan Ahmad, [2,]Sadia Sagar
[1]*Department of Home Economics, Lahore College for Women University, Lahore*
[2]*Department of Physics, University of Lahore, Lahore*
*(*Corresponding Author:Dr. Nazia Erum; email:nazia.erum114@gmail.com)*
[3]*Department of Statistics, Lahore College for Women University, Lahore.*
[4]*School of Systems and Technology, University of Management and Technology, Lahore*

A B S T R A C T : Butea monosperma have antimicrobial property and used in medicines but until now it is not apply on fabrics. The purpose of this study is to apply Butea monosperma plant laves extract on 100% and 50/50 cotton/polyester woven fabric. The leaves' extract of Butea monosperma used as an eco-friendly antimicrobial finish. The fabric was first desized; scoured, bleached and washed then antimicrobial finish was applied by using pad dry method. The antimicrobial property was checked before and after applying antimicrobial finish. Only those microorganisms were examined which were detected during the experiment. The ASTEM E2149 shake flask method was used for antimicrobial testing. The results showed that treated fabric with eco-friendly Butea monosperma leaves extract finish showed 100% microorganisms' reduction as compared to untreated fabrics, so the study reveals strong implications of fabric for the development of eco-friendly finish in Pakistan.

KEYWORDS: Antimicrobial finish, Butea Monosperma, Polyester, Cotton/Polyester

I. INTRODUCTION

In the modern era of emerging equipment, clients want fabrics which have both purpose hygiene as well as healthiness. Customers are also demanding clean and easy fabrics, in this situation the demand for antibacterial textiles have increased. In the previous some years the demand for germs free fabrics has two time more than any other demand. So, there is need to apply antimicrobial finish of on fabric [14]. Now a days client are demanding fabrics which have colour fade resistance, wrinkle, water and

microorganisms' resistance property. In all these properties the need of applying antibacterial finish is most vital and appropriate, because dresses are directly associated with human body [10].In the atmosphere all over the world microbes are present. According to report of NASA, microbes are present 11 km to deepness in the oceanic and 32 km at a height on ground. During the process of lubricant drilling, it was revealed that bacteria are also present even at 400m in the ground. There is an assessment that there are 25 times more microbes than all creatures in the world. The inorganic salts, water, nitrogen and carbon are the basic requirement for microbial development. In natural environment these components frequently exist. The fabric is the excellent medium for transfer and spread of bacterial infection because fabrics are closest to human beings [15].

Mostly review papers are on application of synthetic antimicrobial agents as compare to herbal antimicrobial agents. In herbal antibacterial agent's eucalyptus, aloe vera, chitosan, oil of tea tree, tulsi leaves and herbal dyes are commonly used on fabric. The new developments on herbal antimicrobial agents have opened up new opportunities in the area of textiles [6]. Previously there has been seen more awareness in the development of fiber. To apply antimicrobial finish usually metal and its salts, phenols, organometallics, quaternary ammonium combinations and triclosan are used as antibacterial agents. By nature, these antimicrobial agents are synthetic and effortlessly attain from marketplace. These synthetic agents revealed a good resistance against bacteria but on the other hand have harmful effect and as well effect on non-target microorganisms. So demand for herbal application of antimicrobial finish on fabric textiles have increased due to less side effect by the use of eco-friendly agents and also reduction in microorganism's contamination. Chitosan, curcumin and aloe-vera used individually in diverse recipes to divulge antibacterial finish on rabbit hair, cotton and wool substrate. Results showed that wool/rabbit hair treated with chemical formic acid and cotton treated with peroxide exhibited good antibacterial action than parallel integral ones [1].In current study antimicrobial finish, leaves extract Butea monosperma was applied on polyester/cotton 50/50 and 100% polyester. The antibacterial finish works in this way that it prevents the development of microbial inhabitants. The product which decreases the development of microorganisms known as Antimicrobial. This treatment was applied onto fabric to decrease the growth of

harmful bacteria, to reduce bad smell and degradation of fabrics which cause by the attack of these microorganisms. In the process of developing antibacterial textiles numerous biochemical and physical Possibilities need to be considered. These antibacterial agents usually applied in fiber, spinning and finishing stage [11]. The antimicrobial finish was applied by pigment printing on cotton/polyester (50/50 and 35/65) (15 g/kg) choline chloride, (20 g/kg) triclosan derivative, (10 g/kg) chitosan or zinc oxide nanoparticles (20 g/kg) was used. The observation showed that gram positive (*S. aureus*) more stopped the bacterial growth as compare to gram negative (*E. coli*) [4].The aim of current study is to make eco-friendly fabric by the application of extract of Butea monosperma leaves. The antimicrobial finish was smeared on polyester (100%) and cotton/polyester (50/50) blend.The standard test procedure was used to check the antimicrobial effectiveness of *B. monospermic* plant leaves extracts. The results of this study give important evidence on woven and reusable antimicrobial fabrics, which would be beneficial to medical industry as well as common people.In Pakistan and India plants have been used incessantly for the purpose of medicine. Globally all over the world people used herbal treatment to remain healthy and energetic, for the treatment of infections, lifelong anxiety and contamination. It is belief all over the world that the use of herbs as medicines are harmless and better as compare to synthetics agents [12.5].

Butea Monosperma : Butea monosperma (Lam.) Kuntze is used for cooking, medicine and other multi purposes. There are about 26 diverse uses of Butea monosperma, of which about 18 are reported in diverse portions of Pakistan and India. The fragments of tree are used in different ways such as in the form of gum, extract, combination and filtrate. For further studies these usages are very important to work on innovative technical means [8]. B. monosperma usually known as "dhak" and "forest flame". It has many remedial properties. It also has been used as energizer and astringent. Its flowers are widely used in the treatment of hepatic sicknesses, pathological hepatitis and diarrhoea. B. monosperma roots are helpful in the treatment of ulcer, lumps, piles, filariasis and night impaired vision. The antiulcer and antitumor properties are present in bark. The root is used for anthelmintic, pain-relieving and aphrodisiac. The leaves of *B. monosperma* have antimicrobial property. The flowers have butin, aurones, butrin, chalcones, coreipsin, butein, isocoreipsin, isobutrin and palasitrin. The gum of plant is useful in skin disease, haemorrhoids, diarrhoea, haepoptysis, leprosy, fungus and microbiological infections [7]. The revitalization of attention of researchers in the way of the herbal dying material on textiles is due to severe environmental standards which are enforced by many states, the reason is that by the use of man-made colours for textiles cause allergic and toxic effect [9]. The use of colours which are extracted from plants are ecologically friendly and also have tag of eco-labelling, these products have no harmful effect for human beings [2,13]. Conservatively, in various countries it was a rural tradition that they dye their fabrics with colour which they extracted from roots, flowers and leaves of plants, usually boiling was done to get preferred colour. One dying source is explora-tin which was inexpensive and easily accessible. Most recent eras work has been started on colourfastness enhancement approaches have achieved significant attention for scholars [3].

II. MATERIALS AND METHODS

This study was carried out in 2013 -15. In this study leaves of Butea monosperma were used as antimicrobial treatment. The extract of leaves was applied on polyester and cotton/polyester fabrics. The process of application of antimicrobial finish was carried out in National Textile University Faisalabad. Before and after applying the finish, antimicrobial testing was done in Centre of Excellence in Molecular Biology (CEMB). The extract from leaves of Butea monosperma was carried out in Botany Department of Government College University Lahore.The five-yard fabric sample of 100% polyester and 50/50 cotton/polyester were purchased from fabric trade of Faisalabad and it was approved by Dean Faculty of Engineering and Technology at National Textile University Faisalabad. The 100% polyester fabric consisted on 58 warps and 58 weft twill weaves. Its weight was 82 Gsm. The 50/50 cotton/polyester consisted of 70 warp and 55 weft plain weave. Its weight was 217 Gsm. After purchasing the cotton/polyester fabric it was desized by enzyme Bactasal HTN by using ratio of 1g/l. The fabric was dip for 45 minutes, 60-70 °C and pH was 5-6. Next step was scouring in which fabric was dip for one hour in NaOH 4g/l, soap was used in ratio of 1g/l, 2g/l wetting agent was used and 90°C temperature was maintained. Then bleaching was done H_2O_2 5g/l, NaOH 2g/l, ph. (10-10.5). The fabric was dip for one hour. The temperature of process was 90°C, 2g/l sequesting agent was used. For polyester fabric washing was done in 4g/l detergent at 90°C temperature and fabric were dip for one hour.

Leaves of Plants and Extraction : The leaves were collected in March 2014. These were collected from Botanical Garden of Government College University Lahore. After those leaves were identified and authenticated by one of the faculty members at Botany department Government College University Lahore. The

leaves of Butea monosperma were washed and shadow dry for two months. These were grinded in stainless-steel until crushed into very fine residue. After that autoclave air tight container and distilled water at 110°C. In Laminar flow hood the grinded leaves powder and purified water were taken as 100g crushed leaves and 250ml distilled water. The mixture was stirred thrice a day for seven days. First it was filtered by using muslin then filtered again by using Whatman filter paper. The extract was concentrated by the use of rotary film evaporator.

Microorganisms: The studies of microorganisms were carried out in CEMB Lahore in standard testing atmosphere. Only those microorganisms were examined which were observed during the experimentation. It consisted on Gram +ve small thick rods, caucus cluster, cluster, cocci Gram –ve such as thin short rods, dupo cocci short tail rounded coccus, coccus bacilli, coccus diploid and fungus (yeast).

Application of Antimicrobial Finish : To check antimicrobial activity, use pure extract of plant leaves. Take 200 ml plant leaves extract of B. monosperma which was obtained from rotary film evaporator in a baker. The length of fabric sample was one foot in width and in length. It was taken randomly from 100% polyester and 50/50 cotton/polyester blend fabric. Same fabric sample was also taken for untreated control group. Antimicrobial finish was applied by using pad dry method. After applying this finish microorganism's detection was checked against control group in CEMB.

Method of Antimicrobial Testing : To check presence of antimicrobial finish on fabrics ASTEM E2149 Shake Flask Method was used. It was a quantitative screening test. The 1.5" fabric sample was taken from polyester and cotton/polyester fabric. Dip it in 100% Butea monosperma solution for two hours. After two hours remove the samples and kept in incubators for dry. In laminar flow hood immersed these fabric samples individually in 50 ml PBS (phosphate buffer solution). The buffer solution was taken in sterilized petri dishes. These flasks had treated and untreated samples, label it. These samples were immersed for 1 hour along with continuous shaking. Prepare agar plates; adjust pipette men at 50 micro litres. In laminar flow hood took a spreader dip it in sprite and put on sprite lamp, cool don it. Dip pipette men in flask inject 50 micro litre solutions of plant leaves extracts (with sterilized nozzle, which was changed every time) and put a drop on agar plate's petri dish. Put this petri dish on rotator then with the help of spreader; spread the drop in clockwise direction. Cover it and put it incubator. First reading was taken after 22 hours and then counted the number of colonies in range of 20-200, 30-300, more than 2000, uncountable and lawn. After six days the readings were noted again. Number of colonies and colony characteristics were noted. Results were showed in table 1 given below.

Slides Preparation : In laminar flow hood put petri dishes, slides, sprite lamp, puppet men, wire stick and distilled water. Adjust level of puppet men at 10 micro litres. Took a slide, put a drop of distilled water. Then researcher took iron wire stick, dips it in sprite, heated it on sprite lamp until its colour was red, and cooled it down. Took a petri dish (on which microorganisms growth was showed), with the help of iron wire, took little bit microorganism sample from petri dish and spread it gently on glass slide until it was fully dissolve in distilled water. Then dried this glass slide on sprite lamp with the help of tweezers.

Staining Protocol : Put these glass slides on iron frame. Flood smear with methylene blue (inject methylene blue in the smear) and left it for one minute. Drain these slides with iodine solution and left it again for one minute. Washed these slides with distilled water, drained it with decolourizer. At the end overflowed with methylene red dye and left for one minute, wash it. When these slides were dried, microorganisms presence were observed under the microscope.

III. RESULTS AND DISCUSSION

Microorganisms Testing of Polyester Fabric : The polyester fabric was treated with three different plant leaves extracted in comparison to control group and microorganism's presences was evaluated by ASTM 2149 Shake Flask Method. To apply *B. monosperma* leaves extract as antimicrobial finish, three fabric samples were taken from untreated polyester fabric and three samples were taken from treated fabric on which antimicrobial finish was applied. The quantitative analysis of polyester fabric treated and untreated fabric samples are given in table below.

Table 1. Quantitative analysis test results of treated and untreated polyester sample

	Untreated	*B. monosperma*	Reduction %
reading after 22 hours			

1 st reading	0	0	100%
2nd reading	0	0	100%
3rd reading	0	0	100%
Reading after 6 days			
1 st reading	4	0	100%
2nd reading	5	0	100%
3rd reading	3	0	100%

Table 1 shows that readings of microorganisms reduction was taken at two intervals, first reading was taken after 22 hours as mentioned in ASTM 2149 Shake Flask Method and second reading was taken after six days to check the effectiveness of antimicrobial finish. After 22 hours there were no microorganisms ' growth shown while after six days microorganisms' growth has shown on untreated fabric. The polyester fabric treated with *B. monosperma* exhibited 100% reduction after 22 hours and even after six days interval.

Table 2: Effect of Antimicrobial finish on Microorganisms presences of polyester fabric

	Plant Name		Mean Difference (I-J)		Std. Error	Sig.[b]
Microorganisms presences	Control vs Experimental (*B. monosperma*)		2.000*		.658	.006
	Control Group		*B. monosperma*			
	Mean	SD	Mean	SD		
	2.00	2.28	.00	.00		

Table 2 shows that B. *monosperma* plant extracts have effect on microorganism's presence of polyester fabric as compared to control group. A one-way ANOVA showed that the difference in antimicrobial finish between control group (M=2.00, SD=2.28) and experimental group *B. monosperma* (M=.00, SD=.00) were statistically significant (F=4.615, p=0.013). Results revealed that control group scored significantly higher than the experimental groups. The significant difference between control group and the experimental group is also evident from the big difference in the mean values and remarkable difference in standard deviation (control=2.28, *B. monosperma*=.00).

Microorganisms testing of cotton/polyester : The cotton/polyester fabric was treated with B.monosperme plant leaves extracted in comparison to control group. The quantitative analysis of cotton/polyester fabric treated and untreated fabric samples are given in table below.

Table 3. Quantitative analysis test results of treated and untreated cotton/polyester sample

	Untreated	*B. monosperma*	Reduction %
Reading after 22 hours			
[`1 st reading	0	0	100%
2nd reading	0	0	100%
3rd reading	0	0	100%
Reading after 6 days			
1 st reading	2	0	100%
2nd reading	1	0	100%
3rd reading	2	0	100%

Table 3 shows that readings of microorganisms reduction was taken at two intervals, first reading was taken after 22 hours as mentioned in ASTM 2149 Shake Flask Method and second reading was taken after six days to check the effectiveness of antimicrobial finish. After 22 hours there were no microorganisms ' growth shown while after six days microorganisms growth has shown on untreated fabric. The cotton/polyester fabric treated with *B. monosperma* exhibited 100% reduction after 22 hours and even after six days interval. Table 4 shows that *B. monosperma* plant extracts have effect on microorganism's presence of cotton/polyester fabric as compared to control group. A one-way ANOVA showed that the difference in antimicrobial finish between control group (M=0.83, SD=0.98) and experimental group *B. monosperma* (M=.00, SD=.00) were statistically significant (F=3.33, p=0.04). Results revealed that control group scored significantly higher than the experimental groups. The significant difference between control group and the experimental group is also evident from the big difference in the mean values and remarkable difference in standard deviation (control=.983, *B. monosperma*=.008).

Ibrahim, et al [7] worked on cotton/polyester blends (50/50 and 35/65) and applied chitosan (10 g/kg), choline chloride (15 g/kg), triclosan derivative (20 g/kg), hyper branched poly amide-amine/silver or zinc oxide nanoparticles (HBPAA/Ag-NP's hybrid or HBPAA/ZnO-NP's hybrid – 20 g/kg) into a pigment print form. Only S. aureus as G+ve and E.coli as G-ve microorganisms were studied.

The antibacterial finish was applied on cotton/polyester and viscose/polyester fabrics. Nano-hybrid, i.e. silver nanoparticles/polyvinyl pyrrolidone), zinc oxide nanoparticles or chitosan were used as cross-linking agent. Neem and Lavender oil were also used [7].

Table 4: Effect of Antimicrobial finish on Microorganisms presences of cotton/polyester fabric

	Plant Name	Mean Difference (I-J)	Std. Error	Sig.[b]
Microorganisms presences	Control vs Experimental (*B. monosperma*)	.833*	.307	.013
	Control Group	*B. monosperma*		
	Mean SD	Mean SD		
	.83 .983	.00 .00		

Microscopy structure and Colony Characteristics : Antimicrobial finish *B. monosperma* was applied on polyester and cotton/polyester fabrics. Treated polyester fabric showed 100% reduction against microorganisms but on untreated fabric microorganisms presence was observed. Under the microscope the microscopy structure was observed while in colony characteristics, pigments, surface, elevation and margins were observed as shown in table below.

Table 5: Untreated Polyester and Cotton/polyester fabrics

Fabrics	Pigments	Microscopy Structure	Surface	Colony Form	Elevation	Margins
Polyester	Orange	Gram -ve short thin rods	Smooth	Circular	Raised	Entire
Polyester	Yellow	Gram –ve coccus	Rough	irregular	Flat	curled
Polyester	Yellow	Gram –ve Coccus bacilli	Rough	irregular	Flat	serrate
Polyester	Yellow	Gram –ve coccus	Rough	irregular	Flat	serrate
Polyester	Off white	Gram +ve Cocci cluster	Smooth	Circular	Flat	Entire
Polyester	Yellow	Gram –ve coccus	Rough	irregular	Flat	serrate
Polyester	Orange	Gram –ve coccus	Rough	irregular	Flat	serrate
Polyester	Yellow	Gram –ve coccus	Rough	irregular	Flat	serrate
cotton/polyester	Orange	Fungus	Rough	irregular	Flat	serrate
cotton/polyester	Yellow	Gram –ve coccus	Rough	irregular	Flat	curled
cotton/polyester	Yellow	Gram –ve coccus	Rough	irregular	Flat	serrate

Table 5 shows the microorganisms which present on untreated polyester and cotton/polyester fabrics. On untreated polyester fabric Gram –ve and Gram +ve microorganisms were observed which had yellow, orange and off white in colour. The surface of these microorganisms was rough and smooth. They had circular and irregular colony form with raised and flat elevation. The margins were entire, curled and serrated.
On untreated cotton/polyester fabric fungus and Gram –ve microorganisms were observed under the microscope which had orange and yellow in colour. The surface of these microorganisms was rough and irregular in colony form flat with elevation. The margins were serrated and curled.

IV. CONCLUSION

The antimicrobial finish is extracted from leaves of Butea monosperma and applies on 100% polyester and 50/50 cotton/polyester fabrics. The test result reveals that samples treated with extract of Butea monosperma leaves showed 100% reduction in number of colonies clear zone of microorganism's inhibition. The results of this study suggest that fabric treated with eco-friendly antimicrobial finish can be used for different textiles applications. The findings of this study have strong implication for the development of eco-friendly antimicrobial finish in Pakistan.

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