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EFFECT OF LAUNDERING ON HERBAL FINISH OF COTTON

S. HOODA[1], K. KHAMBRA[2], N. YADAV[3] & V. K. SIKKA[4]

[1]Department of Home Science, BPS Women University, Khanpur Kalan, Sonepat, Haryana, India

[2,3]Department of Textile and Apparel Designing, COHS, CCS HAU, Hisar, Haryana, India

[4]Department of Biotechnology, College of Basic Sciences and Humanities, CCS Haryana Agricultural University, Hisar, Haryana, India

ABSTRACT

The study focused on the development of bacterial resistant cotton fabric using *Aloe vera* extract. Methanolic extract from *Aloe vera* leaves was prepared by Maceration method. Herbal antimicrobial finish has been imparted to the cotton fabric using methanolic *Aloe vera* extract by pad-dry-cure method. Finish was applied in two concentrations (3g/l and 5g/l) on grey as well as enzymatically scoured cotton fabric and compared. Weight add-on percent of extract on treated cotton fabric was determined to observe the quantity of extract absorbed by the fabric. The antibacterial activity of the finish was assessed quantitatively using AATCC-100 test method. To assess the effect of laundering of *Aloe vera* finished fabric samples were washed with 5, 10, 15 and 20 washing cycles using standard ISO: 6330-1984E and bacterial count of treated samples again tested. From the results it was observed that weight add-on percent increased in *Aloe vera* treated scoured (10.21%) sample as compared to *Aloe vera* treated grey (9.94%) sample. *Aloe vera* treated scoured cotton fabric (96.70%) showed very good antibacterial activity than *Aloe vera* treated grey (68.50%) cotton fabric. As the concentration of extract increased bacterial reduction was also increased. Finished samples have been found effective against bacterial growth (77.37%) even after 20 washing cycles. Since the *Aloe vera* extract as an antimicrobial agent can serve as appropriate alternative for herbal antimicrobial finish to conventional harmful chemicals in present use.

KEYWORDS: *Aloe vera*, Cotton, Enzymatic Scouring, Antimicrobial and Laundering

INTRODUCTION

Textiles are excellent substrate for bacterial growth and microbial proliferation under appropriate moisture, nutrients and temperature conditions. In the ample of various finishes, importance is given to herbal antimicrobial finish since people take much care about health and hygiene. The herbal antimicrobial agent for textile material is an agent that destroys or inhibits the growth of micro-organism like bacteria, fungi, yeast and algae (Cho and Cho 1997). Natural fibres are more liable to bacterial attack than synthetic fibres due to their porous and hydrophilic nature. The structure of natural fibers retains water and oxygen along with nutrients, in that way offering optimal environment for microbial growth. On the other hand, direct contact with human body supplies warmth, humidity and nutrients, i.e. provides a perfect environment and optimal conditions for bacterial growth. Micro-organism proliferation can cause malodours, stains and damage of mechanical properties of the component fibres that could cause a product to be less effective in its intended use. Additionally, may promote skin contamination, inflammation in sensitive people (Haug, 2006). As a result, the number of bio-functional textiles with an antimicrobial activity has increased considerably over the last few years.

Some of the herbal compounds obtained from plants are well known for their antibacterial and anti fungal activity. These natural products are abundantly available in nature and are widely distributed. These plant products are non irritant to skin and non toxic. *Aloe vera* (*Aloe barbadensis, Miller*) belongs to the family *Liliaceae* and is known as "Lily of the

Desert". Research has shown that *Aloe* leaf contains over 75 nutrients and 200 active compounds, including 20 minerals, 18 amino acids and 12 vitamins. Botanical research shows that *Aloe vera* exhibit antibacterial, antiviral and antifungal properties. The activity of *Aloe vera* inner gel against both Gram-positive and Gram-negative bacteria has been demonstrated by several different methods (Habeeb, *et al.* 2007). Antibacterial and antifungal properties of *Aloe vera* can be exploited in applications for medical textiles such as bandages, sutures, bioactive textiles, etc. (Joshi *et.al* 2009). Different attempt have been made to impart antibacterial finishing on textile using *Aloe vera* extract (Wasif *et al.* 2007).

The present research work is aimed at developing an eco-friendly herbal antimicrobial finish from *Aloe vera* leaves for textile application. The *Aloe vera* leaves extract was applied on cotton fabric and a study was conducted to assess the antimicrobial activity of the finished samples.

MATERIALS AND METHODS

Material Used

The material with the following specifications was taken for this study.

100 % cotton fabric (unbleached and unfinished)

Fabric count	-	56 x 44
GSM	-	286
Chemicals	-	Citric acid, acetic acid and methanol

Preparation of *Aloe vera* Extract

Aloe vera (*Aloe barbadensis*, *Miller*) belonging to family Lilyaceae is known as "Lily of the desert". Fresh flashy mature green leaves were collected from the CCS HAU campus Hisar washed, weighted and allowed to dry in hot air oven at 40^{o}C temperature.

After complete drying they were made into a fine powder by grinding. Dry powder was weighted and subjected to organic solvent (methanol) to get the concentrated extract. *Aloe vera* extract was carried out by Maceration method as per standard described by Mukherjee (2002).

Maceration Process

In this process, the powdered raw material was placed in a closed vessel containing methanol for seven days. During this period shaking was done occasionally. After seven days, the liquid was strained and then filtered to make a clear liquid. This filtered solvent was transferred to the beaker on the water bath in order to evaporate the solvent. At last the solidify mass of the methanolic extract of *Aloe vera* was obtained. The extract obtained was weighted and percentage yield was calculated in terms of air dried powder weight of the plant material.

Figure 1

Pre-Treatment of Fabric

Cellulase enzymatic scouring as pre-treatment was carried out by following the optimised standard conditions which were already standardized through research studies in the department (Kholiya, 2007). The standard conditioned were concentration 0.5g/l, temperature 60^{o}C, pH 5 for 30 minutes and material to liquor ratio 1:30. Acetate buffer was used for maintaining the pH 5. After giving the enzyme treatment the samples were taken out and given a hot wash followed by cold-water wash to neutralize the enzymatic effect. Objective of enzymatic scouring was to remove impurities from the grey cotton fabric and enhance the absorbency of *Aloe vera* extract by the cotton fabric.

Application of Finish

Finish was applied on cotton fabric with methanolic *Aloe vera* leaf extract by pad-dry-cure Method. On the basis of weight of fabric, quantities of Aloe vera extract and cross linking agent were calculated. The sample was immersed in 3 g/l and 5 g/l concentration of methanolic extract of *Aloe vera* for thirty minutes. The material to liquor ratio was taken as 1:20 and acetic acid was used to maintain 5-6 pH. After this sample was taken out and padded on a two-bowl pneumatic padding mangle at a pressure of 2.5 psi with two dips and nips to give a maximum pick up by the fabric. The fabric was then dried at 80ºC for 3 minutes and cured at 120ºC for 2 minutes on a lab model curing chamber. Citric acid (8% owf) was used as across linking agent. A post treatment was given with citric acid (fixing agent) at room temperature for 30 minutes. The sample was then again padded on a two-bowl pneumatic padding mangle at a pressure of 2.5 psi, dried at 80 °C and cured at 120 °C.

Determination of Add-on (%)

To estimate the actual amount of extract absorbed by the fabric, the total weight add-on % of the treated fabric was calculated. The total weight add-on of the treated fabric reflects the amount of extract absorbed. The fabric was oven-dried at 110 ^{o}C and dried weight of samples was determined before and after antimicrobial treatment and add-on value was calculated using the following formula.

$$\text{Add-on (\%)} = [(W_2 - W_1)/W_1] \times 100$$

Where **W_1:** Weight of fabric before treatment (g)

W_2: Weight of fabric after treatment (g)

Determination of Bacterial Population of Controlled and Treated Fabrics

The bacterial population (total colony forming units) of controlled and finished samples was determined quantitatively using AATCC-100 test method. Sample size taken for determination of bacterial population was 2"×2". Luria bertani's (LB) medium was prepared for bacterial growth. The media was poured in the sterilized petri dishes and allowed to solidify under the laminar flow. The dishes were marked for identification. A series of 3 test tubes containing 5ml sterilized water was taken. To assess the bacterial load of treated and untreated samples, the samples were placed in a sterilized flask containing the sterilized water and incubated at 37 ^{o}C for 24 hours. Serial dilutions (10^{-1}, 10^{-2} and 10^{-3}) were carried out to determine bacterial counts.

From each of prepared dilutions, 0.1 ml was transferred onto the prepared petri dish and spread with the help of spreader under laminar flow. The work was done in duplicates. The petri dishes were placed in the incubator and set at 30^{o}C for the growth of bacteria. After 24 hours the colonies of bacteria were counted manually and percent reduction was calculated on mean bases.

Assessment of Durability of Finish to Washing

The durability of the finish to washing was analyzed by washing all finished samples in the 'Launder-o-meter' by using standard ISO: 6330-1984E. Fabric samples were subjected to a controlled and predetermined number of washing cycles. Soap solution was prepared by taking the following materials-

Standard soap (powder form) - 4 g/l

Sodium carbonate (Na_2CO_3) - 2 g/l

After washing samples were again subjected to bacterial test and the bacterial growth was analyzed.

RESULTS AND DISCUSSIONS

Table 1: Weight Add-on (%) of *Aloe vera* Treatment on Treated Cotton Fabric

Application Method	Conc. (g/l)	Weight/Unit Area of Cotton (g/m^2)			
		Aloe vera Application			
		Grey Fabric(AS_2)		Scoured Fabric(AS_3)	
		g/m^2	%	g/m^2	%
Pad- dry -cure method	3	309.66	6.17	308.33	6.64
	5	320.66	9.94	318.66	10.21
C.D. 2.22	2.22	5.67			

At 5.0 % level of significance
* Control grey sample = 291.66 g/m^2, Control scoured sample = 281.12 g/m^2
AS_2 =*Aloe vera* treated grey sample, AS_3 =*Aloe vera* treated scoured sample

With the perusal of data depicted in table 1 that when the *Aloe vera* treatment was given by pad dry cure method on grey cotton fabric, add on weight was 6.17 % with 3g/l concentration which increased to 9.94 % with 5g/l concentration. Whereas add on weight was obtained 6.64 % when *Aloe vera* treatment was given to enzymatically scoured cotton fabric with 3 g/l extract and became 10.21 % with 5 g/l concentration.

Thus, from the above findings it was concluded that as the extract concentration increased weight add on percentage on the fabric was also increased. This may be due to the reason that more amount of extract was attached in more concentrated solution. These findings are in accordance with Purwar (2005), reported that weight add percentage increases with increase in concentration of neem bark extract. Weight add-on percentage increased when treatment was given on enzymatically scoured cotton fabric as compared to grey fabric. This may due to reason that pre-treatment removes impurities and leads to improvement in adhesion, spreading and exhaustion of herbal antimicrobial ingredient into the fibrous substrates. Enzymatic scouring also increases the absorbency of the fabric. It was supported by the findings of Ammayappan and Jeyakodi Moses (2007), in which they reported that pre-treatment increases wettability, critical surface tension as well as accessible regions and decreases the diffusion barrier of the fibrous substrate.

Table 2: Bacterial Reduction of *Aloe vera* Treated Grey and Scoured Cotton Fabric by Quantitative Method

Application Method	Conc. (g/l)	Bacterial Reduction in *Aloe vera* Treated Cotton Fabric									
		Grey Fabric (AS_2)					Scoured Fabric (AS_3)				
Dilutions		10^{-2}	10^{-3}	10^{-4}	Mean (10^3)	Percent Reduction	10^{-2}	10^{-3}	10^{-4}	Mean (10^1)	Percent Reduction
Pad dry cure	3	> 300	98	19	14.4	52.00	19	Nil	Nil	6.3	96.69
	5	> 300	69	12	9.5	68.50	13	Nil	Nil	4.3	96.70
Control (S_1)	Confluent lawn of growth										

AS_2 =*Aloe vera* treated grey sample
AS_3 =*Aloe vera* treated scoured sample

It is evident from the table 2 that there was confluent lawn of growth in controlled sample. Data also revealed that percentage reduction was 52.00 % with 3g/l *Aloe vera* treated grey cotton fabric which increased to 68.50% with 5g/l *Aloe vera* treated grey cotton fabric. The percentage reduction value was found to be increased (96.69 % and 96.70% with 3g/l and 5g/l extract concentration), when *Aloe vera* extract was applied on scoured cotton fabric as compared to the *Aloe vera* treated grey samples.

It can be concluded from the above results that as the concentration of extract increased percentage of bacterial reduction of *Aloe vera* treated grey cotton samples also increased. This may be due to reason that more extract attached to the textile substrate in more concentrated solution through bond formation. The attached *Aloe vera* extract disturbs the cell membrane of the microbes through the physical and ionic phenomena (Sarkar *et al*., 2003). It is also attributed that bacterial inhibition is due to the slow release of the herbal extract from the fabric surface. These results are in accordance with Wasif and Ruble (2007), they reported that increase in concentration found to have better zone of inhibition to bacterial presence as compared to lower concentration. Jothi (2009) also reported that percentage bacterial reduction is 99.10 % with 5g/l concentration whereas, 97.90 % and 98.10 % with 2g/l and 3g/l concentration respectively for *S. aureus*. Vyas *et al.*, (2011) reported that 5 % concentration of neem and *Aloe vera* extract shows the low absorbance value that is better antimicrobial activity as compared to 3 % concentration.

Further, it was also concluded that *Aloe vera* treated scoured cotton fabric showed very good percentage of bacterial reduction as compared to *Aloe vera* treated grey cotton fabric. It may be due to reason that enzymatic scouring removes the natural impurities and increase the absorption rate of antimicrobial agents. These findings are in line with the findings of Ammayappan and Jeyakodi Moses (2007), where they reported that as pre-treated cotton with hydrogen peroxide prior to *Aloe vera* and turmeric application shows better antimicrobial activity as compared to untreated cotton (without pre-treatment), as pre-treatment leads to increase in hydrophilic nature of the fibre surface and antimicrobial activity. Ash Demir, *et al.* (2010) also reported that enzymatic treatment remove the fatty bonded layer of wool fibre and promote the absorption rate, hence antimicrobial activity.

Table 3: Wash Durability of Finish in Terms of % Bacterial Reduction of *Aloe vera* Treated Cotton Fabric

		Percentage of Bacterial Reduction in *Aloe vera* Treated Cotton Fabric (%)									
Methods of Application		**Pad-Dry-Cure Method**									
		***Aloe vera* Treated**					**Scoured *Aloe vera* Treated**				
Dilutions →		**10^{-2}**	**10^{-3}**	**10^{-4}**	**Mean (10^{3})**	**% Reduction**	**10^{-2}**	**10^{-3}**	**10^{-4}**	**Mean (10^{1})**	**% Reduction**
Washing Cycles	**(Conc.) (g/l)**										
0	3	> 300	98	19	14.4	52.00	19	Nil	Nil	6.3	96.69
	5	> 300	69	12	9.45	68.50	13	Nil	Nil	4.3	96.70
5	3	> 300	98	19	14.4	52.00	19	Nil	Nil	6.3	96.69
	5	> 300	69	12	9.45	68.50	13	Nil	Nil	4.3	96.70
10	3	> 300	98	19	14.4	52.00	19	Nil	Nil	6.3	96.69
	5	> 300	69	12	9.45	68.50	13	Nil	Nil	4.3	96.70
15	3	> 300	103	22	16.15	46.17	24	Nil	Nil	8.0	96.67
	5	> 300	75	17	12.25	59.17	15	Nil	Nil	5.0	96.67
20	3	> 300	111	35	23.05	23.17	29	2	2	83.0	71.38
	5	> 300	82	28	18.1	39.67	19	1	1	43.0	77.37
Control		Confluent lawn of growth									

AS_2 = *Aloe vera* treated grey sample
AS_3 = *Aloe vera* treated scoured sample

Table 3 shows the effect of washing on antibacterial activity of treated cotton fabric in terms of number of bacterial colonies observed. It depicts that Wash durability of *Aloe vera* treated grey fabric was found effective up to 10

washes. On 15 washes % reduction value was decreased and found 46.17% and 59.17 % with 3g/l and 5g/l concentration respectively. At the end of 20 washing cycle the % reduction value reached to 23.17% and 39.67 % with 3g/l and 5g/l extracts concentration respectively. In case of *Aloe vera* treated scoured cotton fabric, wash durability was found excellent up to 15 washes. After 20 washing cycles the % reduction value reached to 71.38% and 77.37 % with 3g/l and 5g/l extracts concentration respectively.

From the above findings it can be concluded that *Aloe vera* treated scoured cotton fabric showed the good wash durability as compared to herbal treated grey cotton fabric. This is due to the pre-treatment of the fabric which made the fabric more absorptive hence good antimicrobial activity. Julia, *et al*. (1998) reported that pre-treatment increases absorption rate of antimicrobial ingredients hence better wash durability. *Aloe vera* treated scoured cotton samples have very good percentage bacterial reduction up to 20 washing cycle. The findings are also in accordance with Ammayappan and Jeyakodi Moses (2009) they reported that there is no bacterial and fungal growth in the finished fibrous substrates up to 20 washings and after 25 washings two bacterial and two fungal colonies are observed in cotton substrate. Jothi (2009) also stated that finish durability to washing of antimicrobial property of the *Aloe vera* treated cotton sample is 98.00 % after 50 washing. *Aloe vera* treated grey cotton samples showed good percentage bacterial reduction up to 15 washing cycles. Sathianarayanan *et al.,* (2010) emphasised that fabrics treated with Tulsi and Pomegranate extract show good resistance to bacterial attack and wash durability up to 15 washes. Thilagavathi and Kumar (2005) concluded that antimicrobial activity of neem, pricky chaff flower and pomegranate treated cotton fabric diminish gradually as the number of wash frequencies increases.

It was further observed that by increasing the extract concentration, percentage bacterial reduction as well as wash durability of the finish progressively increased. The present findings are in line with the results reported by Joshi *et al.,* (2010) that as the concentration of neem seed extract increased the zone of inhibition increases up to 5% extract concentration and then decreased.

CONCLUSIONS

Aloe vera extract application has been done successfully by pad-dry-cure method on cotton fabric as an antimicrobial finish. Finished fabric shows the very good antibacterial activity as compared to controlled fabric. *Aloe vera* treated scoured fabric shows excellent antimicrobial activity than *Aloe vera* treated grey fabric.

As scouring improves the absorption rate of *Aloe vera* extract hence antimicrobial activity of *Aloe vera* treated scoured samples. As the concentration of herbal finish increases growth of bacteria decreases. Wash durability test was also revealed that the finish was able to withstand upto 20 washes in case of *Aloe vera* treated scoured sample. So, In future, this study will surely helpful for the textile engineers to produce eco-friendly antimicrobial textile products.

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