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Research Paper

Quality improvement of wool fabric using neem extract

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■ **ABSTRACT :** Herbal antimicrobial finish has been imparted to the wool fabric using methanolic neem extract by exhaust method. Finish was applied in tw/13o concentrations (3g/l and 5g/l) on grey as well as enzymatically scoured wool fabric and compared. The antimicrobial activity of the finish was accessed by quantitatively by AATCC-100 test method in terms of bacterial reduction. Effectiveness of finish was also accessed after washing the samples, using standard ISO: 6330-1984E with pre-determined number of washing cycles. Fabric strength and bending length was assessed using standard test method. It was observed that neem has been found effective against bacterial growth on wool fabric even after 20 washing cycles. neem treated scoured wool fabric showed very good antimicrobial activity than neem treated grey wool fabric. Tensile strength of treated sample was found to be lower than that of the untreated one. Fabric became stiffer after neem application and stiffness increased with increase in treatment concentration.

■ **KEY WORDS :** Antimicrobial, Neem, Wool, Enzymatic scouring, Bacterial reduction and treatment

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Wool fibre is good absorbent and can absorb up to 36 per cent of its weight. Wool fibres contain natural pigments, waxes and protein (keratin) which provide basic requirements such as moisture, nutrients, oxygen and temperature for bacterial growth and multiplication. Wool has some resistance to bacteria and mildew. However, micro-organisms may attack if stains left on wool, and if it is stored in a damp area. Rot producing bacteria will bring about the destruction of wool that has been subjected to moisture and soil for long period of time. Generally, pathogenic micro-organisms like *Pseudomonas aeuroginosa*, *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Candidaalbicans* have been found on woollen textiles. They damage the textile substrate and also may promote skin contamination and inflammation in sensitive people (Haug *et al.*, 2006). Micro-organism proliferation can cause mal-odours, stains and damage the mechanical properties of the component fibres that could cause a product to be less effective in its intended use.

Therefore, there is a need to inhibit the microbiological growth on woollen fabric, in industrial as well as apparel usages. Bacterial growth on the textiles can be inhibited by applying the antimicrobial finish. The synthetic antimicrobial agents are very effective against a wide range of microbes, but these agents are associated with some side effects. To overcome the problems arise from chemical antimicrobial finish; herbal finishes can be used to control the microbial growth on textiles. neem leaves, seeds and bark possess a wide spectrum of antibacterial action against Gram-negative and Gram-positive micro-organisms (Chopra *et al.*, 1952 and Almas, 1999). The present research work is aimed at developing a method to improve the quality of wool fabrics using neem extract. The neem leaves extract was applied on wool fabric and antimicrobial activity was assessed.

■ RESEARCH METHODS

Pure wool fabric with a weight of 260g/m^2 was used to carry out the experiment. For scouring of wool fabric, protease enzyme was used. Methanol, citric acid and acetic acid were used for extraction and application of neem extract on the wool fabric.

Fresh mature green neem (*Azadirachta indica*) leaves were collected, washed and dried in hot air oven at temperature 40^{o}C. After complete drying, they were made

into a fine powder by crushing and grinding. Powder was then subjected to organic solvent (methanol) to get the concentrated methanolic extract. Extraction was carried out by SOXHLET method as per standard described by Mukherjee (2002). Wool fabric was enzymatic scoured by following the optimized standard conditions *i.e.* concentration -0.5g/l; temperature- 40°C; pH- 9 for 30 minand material to liquor ratio 1:30. Objective of enzymatic scouring was to remove impurities from the grey wool fabric and increase the absorption rate of herbal agent.

Methanolic neem leaf extract was applied on pure wool fabric. Finish was applied on fabric by exhaust method. neem extract in two concentrations (3 g/l and 5g/l) was set in a bath. The material to liquor ratio was taken as 1:20. The samples were entered into the antimicrobial bath with pH 5-6 adjusted with acetic acid. The bath temperature was raised to 70°C and it was kept at this temperature for 30 minutes. A post treatment was given with 8 per cent (on the weight of fabric) citric acid at room temperature. Finally samples were washed with cold water and dried. Both types of samples i.e. grey and scoured wool fabrics were subjected to neem treatment.

The antimicrobial activity of control and finished samples was determined using AATCC-100-2004 test method. To assess the bacterial count of treated and untreated samples, bacterial growth in inoculated and incubated samples was determined through serial dilution (10^{-1}, 10^{-2} and 10^{-3}). 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 Petri dishes were placed in the incubator set as 30°C for 24 hours for the growth of bacteria. The colonies of bacteria were counted manually and per cent reduction was calculated on mean bases. 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. The fabric samples were then again subjected to bacterial testing and the bacterial growth was analyzed.

Performance properties of the treated samples were evaluated using standard test methods. Tensile strength of fabric was determined on paramount universal tensile tester (Analogue model) using ASTM-D1682-64 test method. The bending length of the sample fabrics was determined by the paramount stiffness tester using BS 3356: 1961 test method.

■ RESEARCH FINDINGS AND DISCUSSION

Table 1 shows that wool fabric treated with neem extract was found to have good resistance to bacterial attack. It was observed that there was confluent lawn of growth in control sample. After the treatment of grey wool fabric with 3g/l neem extract by exhaust method, per cent bacterial reduction value was 90.75 per cent which increased to 95.02 per cent with 5g/l concentration. Per cent reduction value was further increased to 96.72 and 96.67 per cent with 3g/l and 5g/l neem concentration, respectively, when treatment was given to enzymatically scoured wool fabric.

From the observations it can be concluded that neem treated scoured wool samples showed very good percentage of bacterial reduction as compared to neem treated grey wool samples. It may be due to reason that enzymatic scouring remove the natural impurities and increase the absorption rate of antimicrobial agent. Ammayappan and Jeyakodi Moses (2009) supported the findings that pre-treated wool fibre with formic acid prior to *Aloe vera* and turmeric application showed better antimicrobial activity as compared to untreated wool. Ash Demir *et al*. (2010) also reported that enzymatic treatment removed the fatty bonded layer of wool fibre and promote the chitosan absorption rate, hence antimicrobial activity.

It was also concluded from the above results that by increasing the extract concentration per cent bacterial reduction progressively increased. These findings are in line with the results reported by Joshi *et al*. (2007) that as the concentration of neem seed extract increased the zone of inhibition increased up to 5 per cent extract concentration and then it decreased.

Table 2 shows the efficacy of neem finish on wool fabric by exhaust method in respect to washing. It was observed that there was confluent lawn of growth in control sample. When grey wool fabric was treated with 3g/l concentration of neem extract, per cent bacterial reduction was found 90.75 per cent which increased to 95.02 per cent with 5g/l concentration. Per cent reduction value for neem treated grey wool fabric remained same up to 10 washing cycles. On 15 washing cycles, per cent bacterial reduction decreased and was found 88.41 per cent for grey wool fabric treated with 3g/l neem extract and 91.50 per cent with 5g/l neem extract concentration. At the end of 20 washing cycles,

Table 1 : Bacterial reduction of treated and untreated wool fabric by quantitative method

Method of Application	Conc (g/l)	Bacterial reduction in neem treated wool fabric									
		Grey fabric (NS_2)					Scoured fabric (NS_3)				
Dilutions	-	10^{-2}	10^{-3}	10^{-4}	Mean (10^2)	Per cent reduction	10^{-2}	10^{-3}	10^{-4}	Mean (10^1)	Per cent reduction
Exhaust method	3	107	9	1	9.9	90.75	14	Nil	Nil	4.6	96.72
	5	101	5	Nil	5.03	95.02	9	Nil	Nil	3.0	96.67
Control (S_1)		Confluent lawn of growth									

NS_2= *Neem* treated grey sample, NS_3= *Neem* treated scoured sample

per cent bacterial reduction value reached to 67.25 per cent with 3g/l and 72.61 per cent with 5g/l grey wool fabric treated with neem extract.

It was further indicated that when the neem treatment was given to enzymatically scoured wool fabric very good resistance to bacteria was observed. When scoured wool fabric treated with 3g/l and 5g/l neem extract by the same method, per cent bacterial reduction was found 96.72 per cent and 96.67 per cent, respectively. Effectiveness of neem treated scoured wool fabric was assessed after different number of washing cycles and found that samples have good resistance to bacterial attack up to 20 washing cycles. After 20 washing cycles, per cent reduction value decreased and observed 72.11 per cent with 3g/l and 74.60 per cent with 5g/l neem treated scoured wool fabric.

From the results of Table 2, it can be concluded that neem treated scoured wool fabric samples showed very good wash durability of finish as compared to neem treated grey wool fabric. Ammayappan and Jeyakodi Moses (2009) reported that there was no bacterial and fungal growth in the finished fibrous substrates up to 20 washings and after 25 washings, two bacterial and two fungal colonies were observed in wool/ rabbit hair substrate. Ash Demir *et al.* (2010) also reported that wool samples pre-treated by enzymes prior to finish application showed much better washing stability than untreated wool fabric. Vyas *et al.*

Table 2 : Efficacy of neem finish on wool fabric

Treatments		Grey fabric (NS_2)					Scoured fabric (NS_3)				
Dilutions		10^{-2}	10^{-3}	10^{-4}	Mean (10^2)	Per cent reduction	10^{-2}	10^{-3}	10^{-4}	Mean (10^1)	Per cent reduction
Washing cycles	Conc. (g/l)										
0	3	107	9	1	9.90	90.75	14	Nil	Nil	4.6	96.72
	5	101	5	Nil	5.03	95.02	9	Nil	Nil	3.0	96.67
5	3	107	9	1	9.90	90.75	14	Nil	Nil	4.6	96.72
	5	100	5	Nil	5.03	95.02	9	Nil	Nil	3.0	96.67
10	3	107	9	1	9.90	90.75	14	Nil	Nil	4.6	96.72
	5	101	5	Nil	5.03	95.02	9	Nil	Nil	3.0	96.67
15	3	121	10	2	14.03	88.41	16	Nil	Nil	5.3	96.69
	5	116	8	1	9.86	91.50	11	Nil	Nil	3.6	96.67
20	3	145	38	6	47.5	67.25	19	4	1	53.0	72.11
	5	142	34	6	36.06	72.61	18	3	1	49.3	74.60
Control (S_1)		Confluent lawn of growth									

NS_2= Neem treated grey sample, NS_3 = Neem treated scoured sample

Table 3: Effect of neem treatment on tensile strength (kg) of wool fabric

Application method	Concentration (g/l)	Tensile strength of wool fabric (kg)			
		NS_2		NS_3	
		Warp	Weft	Warp	Weft
Exhaust method	3	17.88	9.21	17.08	9.08
	5	16.15	8.40	16.00	8.13
Control (s_1)	-	18.36	10.33	18.02	9.95

NS_2= Neem treated grey sample, NS_3 = Neem treated scoured sample , At 5.0 % level of significance, Values of C.D., Warp: Method- NS, Concentration- 0.155, Treatment- 0.17, Weft: Method- NS, Concentration- 0.074, Treatment- 0.053

Table 4 : Effect of neem treatment on bending length (cm) of wool fabric

Application methods	Concentration (g/l)	Bending length of wool fabric (cm)			
		NS_2		NS_3	
		Warp	Weft	Warp	Weft
Exhaust method	3	1.38	1.16	1.12	1.10
	5	2.08	1.98	1.83	1.66
Control (s_1)	-	1.17	1.08	0.96	0.90

NS_2 = Neem treated grey sample, Ns_3 = Neem treated scoured sample at 5.0 % level of significance
Value of C.D. Warp: Method- NS, Concentration- 0.135, Treatment- 0.078
Weft: Method- NS, Concentration- 0.084, Treatment- 0.084

(2011) observed that there was no bacterial growth in the finished samples up to 15 washings. In contrast to the results, Rajendran *et al.* (2011) stated that antimicrobial activity was actively retained in the herbal treated cotton fabrics up to 5 washes. After 5 washing cycles, the percentage bacterial reduction value was very low and there was no activity found in the fabrics after 10 washes.

It is evident from the results shown in Table 3 that the tensile strength of control grey wool fabric was 18.36 kg in warp and 10.33 kg in weft direction. After giving the 3g/l neem treatment to grey wool fabric, tensile strength was 17.88 kg in warp and 9.21 kg in weft direction which decreased to 16.15 kg in warp and 8.40 kg in weft direction with 5g/l neem concentration. Tensile strength of control scoured wool fabric was 18.02 kg in warp and 9.95 kg in weft direction.When the treatment was given to enzymatically scoured wool sample, tensile strength decreased and found 17.08 kg in warp and 9.08 kg in weft direction with 3g/l neem extract and 16.00 kg in warp and 8.13 kg in weft direction with 5g/l concentration as compared to the neem treated grey wool fabric.

Tensile strength of neem treated wool samples decreased as compared to their control samples. This is due to the fact that cross linking treatment with citric acid during finishing process reduced the fabric strength. Joshi *et al.* (2007) reported that cross linking between the molecules stiffened the macro-molecular network and caused fibre embrittlement, which reduced the tensile strength of herbal treated fabrics. Sathianarayanan *et al.* (2010) also reported that pomegranate extract cross-linked with resin decreased the tensile strength by about 15 per cent and *Tulsi* extract reduced the strength about 13 per cent in warp direction. However, Krishnaveni and Mani (2012) reported that herbal finish has increased the tensile strength of the fabrics both warp and weft way when compared to the untreated samples. Regarding the concentration, as the concentration of neem extract increased, significant decrease in tensile strength of neem treated samples was observed. Purwar (2005) also reported that retention of tearing strength decreases as the concentration of neem bark extract increases from 1-5 per cent.

With the perusal of results obtained in Table 4 that bending length of control grey wool fabric was 1.17 in cm in warp and 1.08 cm in weft direction. Bending length of 3g/l neem treated grey wool samples was 1.38 cm in warp and 1.16 cm in weft direction which increased to 2.08 cm in warp and 1.98 cm in weft direction with 5g/l neem concentration. Bending length of control scoured wool fabric was 0.96 cm in warp and 0.90 cm in weft direction. When the neem treatment was given to enzymatically scoured wool fabric then bending length increased as compared to the controlled sample. But it decreased to 1.12 cm in warp and 1.10 cm in weft with 3g/l and 1.83 cm in warp and 1.66 cm in weft direction with 5g/l neem treated scoured wool samples as compared to neem treated grey wool fabric.

From the results of Table 4, it can be concluded that when neem extract was applied on wool fabric, bending length of treated fabric was found to be increased as compared to their control sample. These results are in line with the findings of Krishnaveni and Mani (2012). They stated that herbal finish has increased the bending length of treated fabric both warp and weft way, when compared to untreated sample. Joshi *et al.* (2007) also described that bending lengths were more or less same before and after the herbal treatment. As the concentration increased, significant increase in bending length was observed in both directions. Similar results were found by Younsook *et al.* (1999) where it was observed that bending length increased with increase of treatment concentration due to the surface deposition of chitosan molecules. Significant decrease in bending length was observed in neem treated scoured wool samples as compared to neem treated grey wool samples. It may be due to the fact that enzymatic scouring of the samples impart smoothness and softness and result in decrease in bending length.

Conclusion:

From the present study, the following conclusions are derived:

- As the concentration of extract increased, per cent bacterial reduction was also increased.
- Enzymatically scoured wool fabric treated with neem extract showed very good antimicrobial activity than neem treated grey wool fabric.
- The antimicrobial effect on the neem treated wool fabric sample was durable even after 20 washing cycles.
- Tensile strength of neem treated fabric decreased slightly as compared to control sample.
- Treated wool fabric became stiffer as treatment concentration increased.
- Since the active neem ingredient extracted from neem leaves can serve as appropriate alternative for quality improvement of the wool fabric.

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