Effects of Functional Finishing on Characteristics of Cotton Fabrics Using Garad tree (*Acacia nilotica*) Extracts

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Abstract

This work was carried out to evaluate the effect of the extracts of different Garad tree parts (leaves, seed and stem) on the physical and chemical properties of cotton fabrics. The treatment was mainly used to inhabit growth and to reduce survive of microorganisms on fabrics. However, the treated and untreated fabrics were subjected to mechanical and chemical tests. It has been noticed that the acacia extracts of all the tree parts have significantly ($p<0.05$) reduced tensile strength of cotton fabric, on warp direction. On the other hand the strength in weft direction of the fabric showed significant reduction ($p<0.05$) when leaves and seed extracts were used, while there was no significant differences noticed when stem extract was used. Tearing and breaking length properties on both directions (warp and weft) of the cotton fabrics showed significant reduction at level ($p<0.05$) for the acacia tree extracts. The color, washing and rubbing fastness properties of samples treated with acacia extracts recorded (3.5 scale) for each , which are slightly different from the results obtained by untreated sample (4 scale) .

Introduction

The increasing demand for comfortable, aesthetic, durable, functional, and safe textile products dictates the development of new and contemporary techniques of processing and designing textiles (Gupta, 2000; Tomsic *et al.*, 2008; Heywood, 2003).Textiles and fibrous materials are usually subjected to various finishing techniques to provide protection for the textiles from bio-deterioration due to the presence of some microbes which are generally fall into three main categories, bacteria, fungi and algae. However, only the first two are important in textiles. The microbial persistence in fabrics may result in the dissimilation of these microorganisms in the near environment (McNeil, 1964). Fabrics treated with antimicrobial agents, are therefore, gaining popularity as a new promising area of research. Treated fabrics are used as protective clothing in medical care centers, hotels, restaurants and food industry sectors. Both synthetic and natural antimicrobial agents are used for treatment (Lee *et al*, 1969).It was found that cotton fabrics treated with Chitosan and Fluoroplyemers exhibit durable antimicrobial activity even after laundering (Lee *et al.*, 1999). Several studies have confirmed the effect of Chitosan as an antimicrobial agent in fabrics (Kim *et al*, 1998). Infections caused by antibiotic-resistant Gram positive active bacteria such penicillin-resistant *Staphylococcus aureus* and vanomycin-resistant antibiotics are a growing concern. As more bacteria become resistant to antibiotics, the success of using antibiotic treatments in fabrics decreases (Neely and Marley, 2000). Antimicrobials are used on textiles to control bacteria, fungi, mold, mildew, and algae. This Control reduces or eliminates the problems of deterioration, staining, odors..the nano ZnO coated cotton fabrics is proved to have better strength properties, air permeability and UV absorption property.

(Ayedav *et al*, 2006). The study carried by Radhakrishnaiah *et al.*, (1999) reported changes in the mechanical and surface properties of a plain weave cotton fabric subjected to enzyme treatment with and without mechanical agitation. Mihailovic *et al.*, (2007) also treated the fabrics with gentamicin sulfate and a natural antimicrobial preparation of the autochthonous essential oil of *Picea abies*. These results confirmed the influence of the antimicrobial treatments on the tensile strength, elongation, tear strength, stiffness and elasticity. , Treatment of cotton fabrics with Actigard marginally decreases fabric tensile strength, elongation at break, roughness and WI, whereas; both wettability and crease recovery angle remain practically intact (Mohammed *et al.*, 2009). The Garad tree (*A. nilotica*), which is commonly called Acacia belongs to the family Mimosaceae. The tree has yellow mimosa-like flowers and long grey pods constricted between seeds. The bark and branches are dark with fissures. The branches bear spikes about 2 cm long. The leaves are five and densely hairy with 3 - 6 pairs of pinnae consisting of 10 - 20 pairs of leaflets that are narrow with parallel margins that are rounded at the apex and with a central midrib closely crowded. The inflorescence consists of bright yellow flowers in auxiliary head on stalks that are half way up. The flowering period of the plant is between November and March (Mann *et al.*, 2003). It was reported that the aqueous water extracts of acacia were inhabited growth and reduced survive of the Gram positive bacterium *Staph.aureus* (Idris and Abdel-Rahim, 2010). Ethanol stem bark extract of the tree was reported to have antimicrobial activity against *S. viridis, B. subtilis, S.aureus, E. coli* and *S. sonnei (*Banso,2009).

Methodology

Fabrics preparation and dyeing processes

Acacia nilotica

The different parts of the Acacia tree (seed, leaves and stem) were collected from the University of Gezira campus. The collected materials were left to dry at room temperature, then crushed into powder by using electrical device. A piece of 100% cotton fabric was purchase from local market. The fabric was cut into two specimen, one of the specimen was desized and bleached these processes were carried out according to condition recommended, while the second specimen of fabric was left without any pretreatment to be used as control sample. The weights of 10gram were taken from seed, leaves and stem of acacia, this weight was dissolved into 280 ml distilled water, boiled for half an hour and filter after cooling. These processes was carried for the three type of material used .Fabric of 28gram weight impregnated into solution for half an hour at 80^0C.The fabrics removed from solution, squeezed and dried at room

temperature. The treated and untreated fabrics were conditioned at 65+2% relative humidity and temperature 27+2 ^{0}C before testing. Different tests were carried out such as elongation at break, tensile strength, and tearing, as well as chemical tests. The tests were carried out for several times and the mean was taken.

Three samples were taken from bleached fabric the weight of each is 8.2g,these samples impregnated into dyes solution contained 5g/liter active dyes (red),10g bycarbonate,10g Urea and 25g Nacl ,the 60g from dye solution were taken divided equally on the three test tubes (20gram) for each. Amount of 240g of water was added to each tube. The tubes were heated initially at 6O^{0}C for 40 minute and gradually the temp was raised to 85^{0}C for 30 minute. The samples were removed from tubes, washed with heated soap followed with cold water wash, squeezed, dried in oven at 100^{0}C and colour fastness carried out at 140^{0}C.

Colour fastness and washing tests

Alcohol solvent was used added to three tubes contained powder of acacia (leaves, seed and stem) and 140g of water. This process carried at room temperature. The three samples from dyed fabric were taken and each sample was dipped into separate tube containing above mentioned solution and steering for 5 minute. Then samples were removed squeezed and dried at 110^{0}C.the acacia agent was fastened to fabric samples at 140^{0}C. Later on the colour fastness, washing and rubbing fastness tests were carried out for these samples.

The treated samples were subjected to washing using standard detergent (2% on weight of fabric) and Sodium carbonate (1% on weight of fabric) at 60 ^{0}C.the washing was repeated several time to assess the activity of the agent after washing.

Statistical Analysis

Data obtained was subjected to analysis using Mstat statistical package, Mean and standard deviation were tested using one way analysis of variance and mean separated was also calculated using Duncan's Multiple Range Test (DMRT) according to Mead and Gurnow (1983).

Result and Discussion

Effect of Extracts on tensile strength

The effects of the extracts of the Garad tree on Fabric tensile strength was evaluated using Grab test according to ASTM D 5034 on Galdabini material testing machine, Quasar 250 (Serial # V9AL). It works on the principle of CRE (Constant Rate of Extension). Table 1 shows the effect of coated material (leaves, seed and stem) on strength of fabric it has been noticed the acacia extract from different parts of plant has effect on tensile of treated fabric in warp as well as weft direction, the earlier study by (Sundaram,et al,2004) found that, the chemical finishing ,in general reduces the tensile strength of cotton fabrics. The results also agreed with results recorded by (Leila,2008)

confirmed that, the anti microbial finishing negatively affected tensile strength property. It was observed the strength of weft side was more affected comparable with strength of warp side, these may be due to amount of extract absorbed by weft, it seem to be higher than amount absorbed by warp, this might be due to structure of each component. Hence the absorption of the extract inversely proportion to strength. The statistical analysis presented on table 4. Showed on warp side the acacia extracts were impart significance effect on fabric strength, on the same way these extracts has impart significance effect on weft direction when the extract from leaves and seed were used, while no significance effect has been noticed when stem extract was used.

Table 1.Effect of extracts from different parts of acacia plant on tensile property of cotton fabrics

Treatment	Warp	Reduction on warp strength in (%)	weft	Reduction on weft strength in (%)
Control	36	-	22	-
Leaves	19	-47.22	12	- 45.5
Seed	22	-38.9	14	-36.4
Stem	15	-58.4	20	-9.1

Effect of extracts on breaking length

The effect of acacia extracts on elongation property of cotton fabric illustrated on table (2), it has been noticed the extracts were increased the elongation of fabric on both direction (warp and weft). On warp side the leaves and seed extract impart high improvement in elongation (55.2%,48.2% respectively),compared with effect of stem extract(3%). on the other hand the leaves and seed extracts were less effect on weft side comparable to effect of the same extracts on warp direction. On weft direction stem extract imparted higher effect (45%) comparable with effect of leave and seed extracts(8,%16% respectively).It has been noticed from statistical analysis table (4),on warp side the leaves extract has no significance effect on breaking length of cotton fabric, while significance effects were noticed when seed and stem extract were applied. On other hand on weft side the seed and stem extracts exhibits significance effect while there is no significance effect recorded when leaves extract was used.

Table2. Effect of extracts from different parts of acacia plant on elongation at break

Treatment	Warp elongation	Increase on warp Elongation in (%)	Weft elongation	Increase on weft Elongation (%)
control	29		24	
Leaves	45	+55.1	26	+8
Seed	43	+48.2	28	+16
Stem	30	+3	35	+45

Effect of extracts on tearing property

The effect of acacia extracts on tearing property presented on table (3). It is clear from the table(4) , the extracts were decreased tearing property in warp wise in general, the effect is greater when stem extract was used it has been decreased by (28.8%) follow by the effect of seed extract(27.32%) and less effect was recorded when leaves extract was applied (24.82%). It has been noticed the tearing of weft was improved when the fabric was treated with extract of seed and stem of acacia (26.5%,5% respectively). On the same way the tearing of weft was reduced when leave extract was applied (10.53%).The statistical analysis table 4, showed that on warp side there were no significance differences between the acacia extracts from (leaves, seed and stem) on tearing properties of cotton fabric. On the other hand the acacia extracts has significance effect on weft side of the cotton fabric.

Table3. Effect of acacia extracts on fabric tearing property.

Treatment	Warp	Effect on warp tearing in (%)	weft	Effect on weft tearing in (%)
Control	1330	-	950	-
Leaves	1000	-24.8	850	-10.53
Seed	980	-27.32	1200	+26.3
Stem	950	-28.85	1000	+5

Table4. ANNOVA analysis, effect of acacia extracts on fabric properties.

	Tensile strength		Breaking Elongation		Tearing	
Treatment	warp	weft	warp	weft	warp	weft
Control	36.2 a	21.20 a	31 b	23.4 c	1318 a	948 c
Leaves	19.2 c	12.60 b	29 b	25.6 bc	1038 b	851.2 d
Seed	21.6 b	14.4 b	45 a	28 a	1012 b	1210 a
Stem	15 d	20 a	43 a	35.2 a	972 b	1013 b

Different superscript letter(s) in each Column, indicate the extracts differ significantly from control at level ($p<0.05$).

Effect of acacia extracts on Colour, washing and rubbing fastness

Table (5) presented the effect of acacia extracts on colour, washing and rubbing fastness properties of cotton fabric. The treated samples gave (3.5 scale) for each property tested comparable with (4 scale), for the untreated sample. Generally the results showed that, the effect of acacia extracts on the chemical properties were similar for the whole tested samples and slightly different from untreated sample. The fastness property obtained is slightly less when it is compared with the result reported by (Jothi, 2009), using *Aloe vera* plant. This difference might be due to solubility of acacia in water. While the *Aloe vera* is not soluble in water and does not leach out making a barrier or blocking action preventing development of bacteria on surface of fabric (Yigi,2000).

Table 5.Effect of acacia extracts on colour, washing and rubbing fastness (Grey Scale).

Treatment	color fastness	Wash fastness	Rubbing fastness
Control	4	4	4
Leaves	3.5	3.5	3.5
Seed	3.5	3.5	3.5
Stem	3.5	3.5	3.5

Conclusion

In conclusion, the extracts of the different acacia tree parts (leaves, seed and stem) which are used to inhabit reproduction and reduced survival times of bacteria on cotton fabric has impart different effects on physical and chemical characteristics of cotton fabrics. In the present study the treatment was significantly reduced tensile strength and breaking length of fabric on both directions. The tearing property on weft direction was also significantly affected while no significant effect was reported on warp direction. On the other hand, color, rubbing and washing fastness were slightly affected comparable with untreated fabrics. It is clearly observed the most of the properties tested were negatively affected in spite of positive effect on some properties. Therefore research should be intensified in order to find appropriate treatment positively enhancing medical and apparel industries.

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"This article was originally presented at the 88th Textile Institute World Conference Shah Alam, Selangor, Malaysia, May, 2012".