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Effect of Antibacterial Finish on Physical Properties of Cotton Fabric

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A B S T R A C T

The study focused on the development of bacterial resistant cotton fabric using lemon peels waste. It is also intended to produce eco-friendly antimicrobial cotton fabric and to protect the consumers from infections. The antimicrobial finish has been imparted to the cotton fabric by exhaust and pad dry cure methods. Finish was applied in 5g/l concentration on grey cotton fabric. Physical properties of grey, controlled and finished samples were tested to analyze the effect of these processes on physical properties of the fabric.

Introduction

Textiles have always played a central role in the evolution of human culture by being at the forefront of both artistic and technological development. In recent years, consumer's attitude towards hygiene and active lifestyle has created a demand for a wide range of functional textiles.

The protective aspect of textiles have provided the most innovative ground for further developments because hygienic textiles and congenial micro environment are prime requirements for human being to live comfortably and healthy. The major hindrance that comes in their way is micro-organisms, which are the causative agents of deterioration, staining and unpleasant odor. Apart from these effects, microbes cause harm to human being by transmitting diseases and infections. An unpleasant odor is also developed when bacteria convert human perspiration into a foul smelling substance (Sushila, 2018). Microbial action is a dominant factor limiting the service life of all textiles. Textile material and garments are susceptible to microbial attack, as these provide larger surface area and absorb moisture required for microbial growth (Cardamone, 2002). Fabric made from natural fibers is in demand due to their inherent properties like comfort-ability, good absorbency and being eco-friendly.

Due to humid and temperate climatic conditions, people prefer to wear cotton fabric due to its inherent properties like comfortability, good absorbency, eco-friendly nature, light weight, soft hand, durability and many more. Besides so many advantages, cotton fabric have a drawback of being susceptible to microbial attack because it retain water, oxygen and other nutrients like waxes, pectin's, cellulose and protein. Microbial growth on the textiles can be inhibited by applying anti-microbial agents, however, synthetic anti-microbial agents leads to fabric strength loss, make the fabric stiff, change the colour of the fabric and also harm the environment (Thilagavathi and Kannaian 2010). To overcome these problems, natural products for textile finishing are gaining significant momentum (Lee *et al.,* 2009).

The use of natural products for antimicrobial finishing of textile has opened up new avenues in the field of technical textiles. Although there are many natural sources that are rich in antimicrobial agents, the study on their use in textiles is very limited. The major challenges in application of natural sources for textile application are that majority of the sources are complex mixtures of several compounds and also the composition varies in different species of the same plant. Plant and fruit products are more reliable since their in bioactive compounds results in combating various microbes. Among various fruits citrus are widely used in almost all countries. Peels waste are being highly perishable and seasonal, is a serious problems to the processing industries and pollution monitoring agencies. The citrus fruit peels are rich in nutrients and phyto-chemicals. These can be efficiently used as economical antimicrobial agents as they are available for no cost, eco-friendly and non-toxic. Moreover, remarkable climatic changes and increasing pollutants in the environment also necessitate the antimicrobial finished clothes to protect the human body and keep the sound health. Hence, there is a great demand for finish non- toxic and eco-friendly bioactive compounds as these finishes not only improve the intrinsic functionality of the fabric but also a production process that is as environment friendly as possible. Thus, use of lemon peels extract as antimicrobial finish will be beneficial for textile and food processing units and also for the pollution monitoring agencies.

Materials and Methods

Preparation of lemon peels extract for application on cotton fabric

Lemon fruit peels were collected, washed, shade dried and grinded to make into a fine powder. Extract was prepared by cold aqueous maceration. Lemon peels extract was analyzed for yield percentage and antibacterial property at different concentrations. Extraction of lemon peels was done at three different time periods. The yield percentage of 36 hrs. was found to be higher than that of 12 and 24 hrs. Concentration of 5mg/ml exhibited strong zone of inhibition. Therefore, 36 hours time period and 5mg/ml concentration was continued for application of finish on desized and scoured cotton woven fabric by exhaust and pad dry cure methods.

Determination of physical properties after preparatory processes and finishing

Physical properties of grey, controlled (scoured) and finished samples were tested to analyze the effect of these processes on physical properties of the fabric.

The effect of antimicrobial finish on physical properties (fabric count, weight and thickness) was analyzed to assess the efficacy of antibacterial finish on finished cotton fabric as per the standard test methods.

Results and Discussion

Preliminary data of the cotton fabric

Cotton fabric in grey state exhibiting medium weight was selected for the study. Three parameters i.e. fabric weight, count and thickness of selected fabric were evaluated [Table 1].

Effect of preparatory processes on physical properties of grey fabric

Cotton fabric was subjected to desizing and scouring which involves removal of starch and impurities present in the fabric to make it more absorbent for further textile processing.

Cotton fabric was subjected to desizing followed by scouring. The pretreated cotton fabric was studied with respect to change in physical properties i.e. geometrical properties [Table 2].

Effect of antibacterial finish of lemon peels extract on geometrical properties of cotton fabric

The effect of lemon peels extract finish on the geometrical properties of finished fabric, with respect to their controlled sample, was studied as per standard test methods [Table 3 and figure 1, 2, 3 and 4].

Fabric count: Decrease in fabric count of cotton fabric samples finished by both exhaust and pad dry cure methods with lemon peels extract of 5g/l concentration was observed when compared to their respective controls. This decrease was may be due to the absorption and coating of lemon peels extract as well as finishing agent by the yarns, which resulted in swelling of fibers, thus reducing the fabric count. Gupta (2016) reported decrease in fabric count of woven fabric and stitch density of knitted fabric finished with and without resin cross linking agent in the presence of *S. cumini* (L.) leaves extract. Sumithra and Raja (2020) also reported decrease in fabric count of the finished fabric treated with the combination of herbal extracts of *Ricinus communis, Senna auriculata* and *Euphorbia hirta* in ratio 1: 3: 2.

Fabric weight: Cotton fabric samples finished by exhaust and pad dry cure methods with lemon peels extract of 5g/l concentration, resulted in significant increase in weight of cotton fabric. The increase in weight may be attributed to the absorbance of lemon peels extract as well as other finishing agents. Sood (2014) reported increase in weight of cotton fabric after application of herbal extract.

Fabric thickness: Cotton fabric samples finished by exhaust and pad dry cure methods with lemon peels extract exhibited significant increase in fabric thickness, which was observed as 2.7 and 5.5 %, respectively as compared to controlled cotton fabric. Although, the decrease in fabric count of cotton fabric was observed after finish, the increase in thickness of finished fabrics was may be due to the coating as well as absorption of lemon peels extract and other finishing agents, thus might be leading to swelling of fibers. The results are in line with those of Nagpal (2017) who reported that thickness of all the samples increased significantly after finishing with weed plant extract and their combinations with exhaust and pad dry cure method. Sood (2014) reported increase in thickness of cotton fabric when treated with *Eucalyptus citriodora* leaves extract.

Table.1 Preliminary data of the cotton fabric

Properties / Fabric	Fabric count (ends and picks/sq. inch)	Fabric weight (g/m^2)	Fabric thickness (mm)
Cotton fabric	49×25	107	0.35

Table.2 Effect of preparatory processes on geometrical properties of cotton fabric

Physical Parameters / Fabric		Grey fabric Mean ± S.E	Desized and scoured fabric Mean ± S.E	Per cent change	t-value
Fabric count (ends and picks per square inch)	Warp	49±0.58	51±1.00	+ 4.00	1.73
	Weft	25±1.73	26±2.31	+ 4.00	0.35
Weight per unit area (g/m^2)		107±2.30	107.4±3.10	+ 0.37	0.10
Thickness (mm)		0.35±0.04	0.36±0.05	+ 2.85	0.17
Bulk ($cm^{3/}gm$)		3.27±0.04	3.35±0.02	+ 2.45	1.92*

**Significant at 1% level of significance, *Significant at 5% level of significance

Table.3 Effect of antibacterial finish of lemon peels extract on geometrical properties of cotton fabric

Properties / Fabric		Exhaust method	t-value	Pad dry cure method	t-value	Controlled
Fabric count (ends and picks per square inch)	Warp Mean ± S.E	50±3.61	0.27	49±2.52	0.74	51±1.00
	Weft Mean ± S.E	25±1.00	0.36	25±1.15	0.39	26±2.31
	Mean ± S.E(m)	37.5	-	37	-	38.5
	Percent change	-2.59	-	-3.89	-	-
Fabric weight(g/m^2)	Mean ± S.E(m)	107.6±2.86	+1.80	109.8±3.97	+2.20	107.4±3.10
	Percent Change	0.05		0.48		
Fabric thickness (mm)	Mean ± S.E(m)	0.37±0.01	0.21	0.38±0.01	0.42	0.36±0.05
	Percent change	+2.70	-	+5.50	-	-
Fabric bulk (cm^3/gm)	Mean ± S.E(m)	3.40±0.26	0.19	3.46±0.04	2.64**	3.35±0.02
	Percent change	+1.40	-	+3.20	-	-

**Significant at 1% level of significance, *Significant at 5% level of significance

Fig.1 Comparative analysis of fabric count of cotton fabric after preparatory processes and lemon peels extract finish

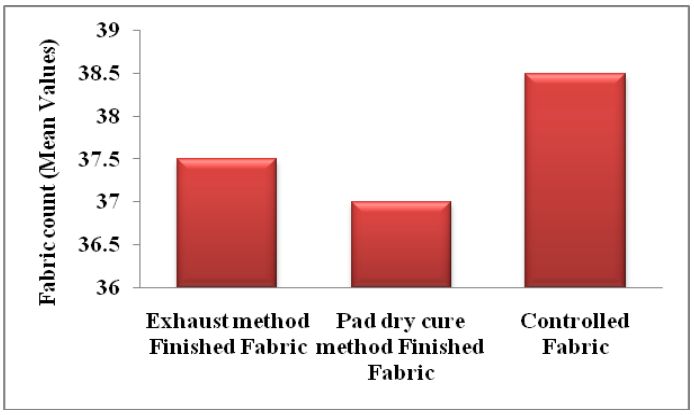


Fig.2 Comparative analysis of fabric weight of cotton fabric after preparatory processes and lemon peels extract finish

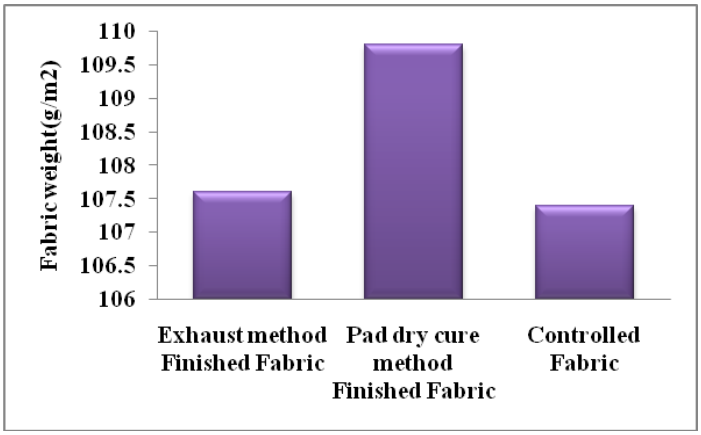


Fig.3 Comparative analysis of fabric thickness of cotton fabric after preparatory processes and lemon peels extract finish

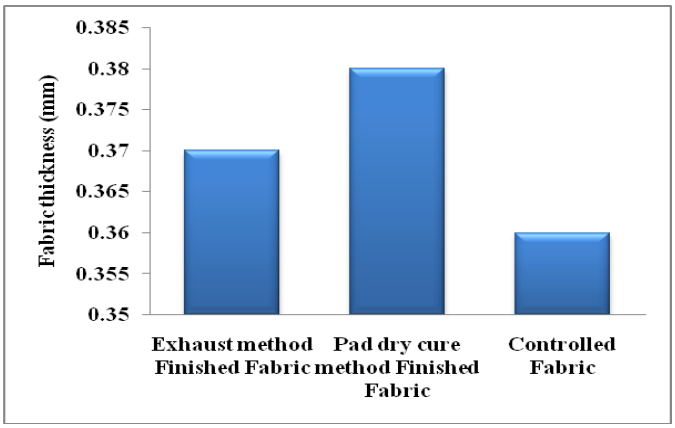
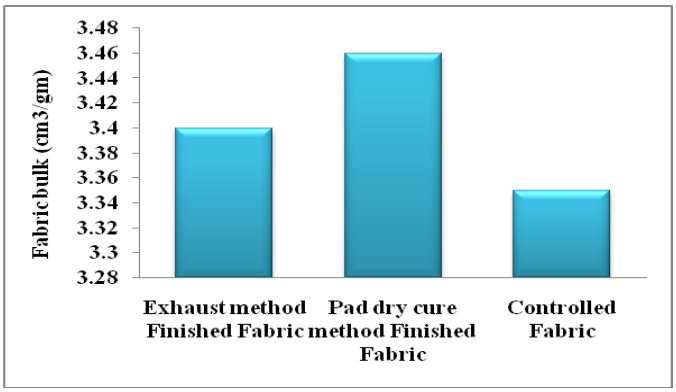


Fig.4 Comparative analysis of fabric bulk of cotton fabric after preparatory processes and lemon peels extract finish



Fabric bulk

The bulk of the cotton fabric samples finished by exhaust and pad dry cure methods with lemon peels extract of 5g/l concentration, increased by 1.4 and 3.2 %, respectively. As bulk is directly proportional to thickness of fabric, significant increase in bulk was observed. The results are supported by investigations of Gupta (2016) who reported increase in bulk of woven fabric finished with and without resin cross linking agent in the presence of *S. cumini* (L.) leaves extract.

In conclusion cotton fabric after finishing treatment by exhaust method resulted in 2.59 % decrease in fabric count with 1.80 % increase in weight and 2.70 % increase in thickness whereas 3.89 % decrease in fabric count with 2.20 % increase in weight and 5.50 % increase in thickness was observed in cotton fabric finished by pad dry cure method, when compared to controlled fabric sample.

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