Application of natural oil on light weight denim garment and analysis of its multi-functional performances

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Received 26 June 2012; revised received and accepted 24 August 2012

This study is aimed at imparting functional finishes to denim garments using natural oils in order to enhance the value of end product. The fabrics selected for the study to prepare the denim garments are 100% cotton, cotton /polyester, 100 % tencel and tencel /polyester blended fabrics. All the four fabrics, constructed with 2/1 right hand twill, are subjected to de-sizing and enzyme washing. The enzyme washed garments are subsequently treated with the combination of two different natural oils (sweet citrus and rose oils) to induce fragrance. The garments are tested for the efficacy of few functional properties like anti-microbial, anti-fungal and UV protection. Finishing has been carried out using exhaustion method and the treated garments are evaluated using AATCC standards. The results show that cotton and cotton/polyester garments have very good sense of functional properties as compared to tencel and tencel/polyester garments.

Keywords: Anti-fungal finish, Anti-microbial finish, Citrus oil, Denim, Enzyme washing, Exhaustion method, Garment, Rose oil

Traditionally, denim was made as 14-16 ounce twill woven fabric using cotton ring-spun indigo dyed yarn. Most of the jeans are made from 100% cotton or a blend of cotton and polyester. Sometimes, spandex yarns are added for stretch and comfort. A novel cellulose-based fibre tencel is being introduced in denim blends with polyester. It is well known that cotton contributes absorbency and comfort. The fabric also tends to soften with wear and laundering, giving the feel of well-worn blue jeans. Presence of polyester in the fabric contributes durability, stability and wrinkle resistance. It also facilitates ease of care in laundering and reduces the time taken for drying the garments as well. Tencel fibre performs similarly to cotton in absorbency and comfort.

Tencel blended with polyester will make possible a variety of textures. Cellulase enzymes are derived from micro organisms and used by the garment processors as replacement of stones. Apart from the innovations in fabrication, application of functional finishes to garments, such as fragrance finish, antimicrobial finish and antifungal, add up more value to the end product in the current market scenario. The inherent properties of the textile fibres provide room for the growth of micro-organisms. The increasing awareness for hygienic lifestyle and effects of global warming are raising necessity and expectation in consumers for a wide range of textile products finished with antimicrobial properties, UV protection, stain release, etc. In addition, the structure of the substrates and the chemical processes may also induce the growth of microbes. Humid and warm environment still aggravate the problem. Infestation by microbes causes cross infection by pathogens and development of bad odor.

When lots of chemicals are used in imparting finishes for a single fabric, it may cause incompatibility, pollution and thereby health hazards. Hence, instead of using various chemicals, a single bath finish which will satisfy the multi-functional properties can be done using natural products. Essential oils are the highly concentrated extracts from herbs, plants and flowers. They are used in single or in combination to bring about soothing and curative process in mind and body. Aroma oils have a calming, stimulating, pain reducing and mood enhancing effects. They are utilized in areas of perfumery, cosmetology, pharmaceutics and allied industries. The scents of lavender, rose, citrus or vanilla have been encapsulated into fabrics and proved a good way to meet important psychological and emotional needs. This imparts a pleasant, new-clothing odor which can mask unpleasant odors and is similar in action to a deodorant. The market is constantly changing universally and there forth the demand of consumers is also increased. This increase in demand as well as tremendous competition in the market, opens up opportunities for value addition to all forms of textile materials. Recently consumers’ expectations are very much higher, they expect their clothing to perform multiple functions from aesthetic to basic protection from the elements. The main objective of the study is to develop denim garments...
with multi-functionality like UV protection, antibacterial and antifungal properties using natural oils.

**Fabric Development**

Four light weight denim fabrics (weave 2/1 RHT, construction 124×70, weight 5-5.5 OZ) were prepared. The specifications of the developed samples are Sample A —100% cotton (30s ring-spun warp and weft), Sample B — 100% tencel (30s ring-spun warp and weft), Sample C — cotton-polyester blend (30s ring-spun warp and 150 denier weft), Sample D — tencel-polyester (30s ring-spun warp and 150 denier weft).

**Garment Construction**

The garment selected for the study was kids wear for the age group 3 - 5 years (girls). An A-line frock with full front open two-piece placket, round necked, sleeveless frock was used for the study. The pattern for the frock was drafted based on a set of standardized body measurements. A marker plan was developed in order to reduce the wastage of the fabric. The marker was placed on the developed cotton denim fabric. The fabric was cut and the garments were constructed using the single needle lock stitch machine. The steps in construction of the A-line frock were placket finishing (facing and binding), attachment of the shoulder (flat-felled seam), neck finishing (bound seam), side seam finishing (flat-felled seam), armhole finishing (bound seam) and hemline finishing (double folded)

**Method of Desizing**

The A-line frocks developed were subjected to enzymatic desizing process for removal of size particles. The process was carried out using 0.5 g/L non-ionic wetting agent, 0.5 g/L bio-tempasel (desizing enzyme) at temperature 65–70°C for 20 min. The MLR was maintained at 1:20. The desized garments were washed and rinsed twice after the process.

**Enzyme Bio-wash**

Bio-wash is a technique involving the use of enzyme to produce soft denim. In this study commercially available cellulase enzyme was used to bio-wash denim garments. During bio-wash pH was maintained between 5 and 5.5, and temperature at 55-60°C keeping MLR at 1:15. The bio-wash was carried out for 30 min.

**Application of Natural Oils to Denim Frocks**

The natural oils selected to incorporate multi-functional finish to the denim garments were sweet spring citrus and rose oil. The odour of the citrus will keep fresh and give energy while rose oil will reduce the tension, fatigue and negative thoughts. The finishing was carried out using exhaustion method. In this method, the garments finished with enzyme are dipped into the bath containing 1% wetting agent, 50% sweet spring citrus and 50% rose oil for half an hour at room temperature. The MLR was maintained at 1:5, the pH of the treatment was taken as 6, and then the garment was dried at 21°C.

**Functional Analysis**

**Antibacterial Test**

The antibacterial test was done using the agar diffusion method (SN 195920). The untreated control fabric and treated fabric samples were placed in close contact with AATCC bacteriostasis agar, which was previously inoculated with a day culture (slant cultures) of the test organisms (Staphylococcus aureus and Escherichia coli). After incubation, it was analysed by visual examination and also under a microscope (× 40 magnification). The evaluation was made on the basis of absence or presence of an effect of bacteria in the contact zone under the specimen and the possible formation of a zone of inhibition around the test specimen. The area of inhibition zone is a measure of antimicrobial effectiveness.

**Analysis of Antifungal Activity**

Qualitative method (AATCC 30) was used for the study to analyse the anti-fungal activity. An inoculum of 1.0mL was evenly distributed over the surface of the agar. The fabric discs were pre wetted (not rubbed or squeezed) in water containing 0.05% of a non-ionic wetting agent (triton X-100) and placed on the agar surface. The inoculum of 0.2 ml was distributed evenly over each disc by means of a sterile pipette. All the specimens were allowed to incubate at 28ºC for 7 days.

At the end of the incubation period the percentage of the surface area of the disc covered with the growth of the fungus was reported by observing visually and by using a microscopic (× 50 magnification) and then interpreted as follows:

(i) No growth (If present, the size of the growth free zone in mm was reported).

(ii) Microscopic growth (visible only under the microscope).

(iii) Macroscopic growth (visible to the naked eye).
Ultraviolet Protection Factor

The ability of a fabric to block UV light is given by the ultraviolet protection factor (UPF) values. The UPF values are calculated according to AATCC test method 183-2004, transmittance or blocking of erythemally weighted ultraviolet radiation through fabrics using Shimadzu UV/V spectrophotometer. Erythema refers to the abnormal redness of the skin (sunburn) due to capillary congestion (as in inflammation). Measurements were performed in a UV–visible spectrophotometer using an integrating sphere loaded with conditioned sample (21 ± 1°C, 65 ± 2% RH, for 4 h) from 280 nm at an interval of 1 nm. The percentage blockings of UVB (280–315 nm) were calculated from the transmittance data.

Assessment of Functional properties of Finished Garments

The four garments were finished with the essential oils by dip dry method and it was subsequently tested for the functional properties like antibacterial, antifungal and UV protection.

Antibacterial Test

The activity of the treated cotton and cotton/polyester fabrics against Staphylococcus aureus is shown in Fig. 1(a) and the activity of the tencel and tencel/polyester fabrics against the same bacteria is shown in Fig. 1(b). The inhibition of growth of Escherichia coli in cotton and cotton/polyester is represented in the Fig. 2(a) and that of tencel and tencel/polyester is depicted in Fig. 2(b). The results are tabulated in the form of zone of inhibition (Table 1).

The results of the antibacterial test furnished in the Table 1 prove that among the finished denim fabrics cotton/polyester and tencel/polyester denim fabrics inhibit the growth of the bacteria tremendously than the pure cotton and tencel fabrics. It is also proved that the growth of Gram positive bacteria is inhibited more than that of the Gram negative bacteria in all the cases.

Antifungal Activity

The antifungal activity of the finished fabric is analyzed by the qualitative method (AATCC 30). Figure 3 shows clearly that the growth of fungi is more in case of tencel and cotton /polyester denim fabrics. The finished cotton and tencel/polyester fabrics showed an inhibition of growth of fungi with a zone of inhibition of 30 mm.

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Zone of inhibition, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S. aureus</td>
</tr>
<tr>
<td>Cotton</td>
<td>34</td>
</tr>
<tr>
<td>Cotton/polyester</td>
<td>39</td>
</tr>
<tr>
<td>Tencel</td>
<td>33</td>
</tr>
<tr>
<td>Tencel/polyester</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 1—Analysis of antibacterial activity
denim fabrics inhibit the growth of the fungi completely. Both the finished fabrics show 100% antifungal activity followed by the cotton/ polyester (80%) and tencel (65%) denim fabrics.

### Ultraviolet Protection Factor

The result of UVB in percentage is mentioned in Table 2. According to the standards of AATCC 183, the percentage of UVB between 93 and 96 is graded as good, between 96 and 97 as very good and between 97 and 99+ as excellent.

Table 2 shows that the percentage of ultraviolet protection factor is excellent in case of cotton (97.5%) and tencel/polyester (97.9%) followed by the cotton/polyester (96.5%) and tencel (94.7%) denim fabrics.

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Average % UV blocked</th>
<th>UPF range for classification category</th>
<th>UV protection category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>97.5</td>
<td>40–50+</td>
<td>Excellent</td>
</tr>
<tr>
<td>Cotton/ polyester</td>
<td>96.5</td>
<td>25–39</td>
<td>Very good</td>
</tr>
<tr>
<td>Tencel</td>
<td>94.7</td>
<td>15–24</td>
<td>Good</td>
</tr>
<tr>
<td>Tencel/polyester</td>
<td>97.9</td>
<td>40–50+</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

The combination of natural oils (sweet spring citrus oil and rose oil) used in the present study has successfully resulted in multifunctional activities such as antimicrobial, antifungal and UV protection. Among the four fabrics selected for the study 100% cotton gives the best results in all the functional finishes followed by cotton/polyester, tencel and tencel/polyester fabrics. As denim apparels are worn by the consumers for an extended period of time, this attempt of applying multi-functional finishes to denim garments will pave a new way to denim industry in satisfying the needs and requirements of their customers.

### References