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A comparative study on bio-polishing of woven and knitted fabrics

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Abstract
'Bio-polishing' is considered to be an example of novel use of 'biotechnology'. It is controlled hydrolysis of cellulosic fiber by the cellulose group of enzymes in order to improve surface appearance. The change, development and globalization of the world have brought up new notions and developments in the textile sector, in accordance with all the other sectors. The numbers of features expected from textile products has increased due to changes in the buyer's expectations and their awareness of quality and environment. For example, pilling is one of the major undesirable and serious problems in apparel and the textile products. It does not cause an unsightly appearance or bad handle properties, but it has an accelerating effect on the rate of fiber removal from the yarn structure, and hence materially reduces the service life. Fabric pilling is a complex phenomenon and it's comprised of different stages: yarn type construction, fabric type construction and fabric finishes play an important role in the pilling properties of fabrics. In this study woven and knitted fabrics were bio-polished and their results on pilling, color fastness to washing, light, rubbing and printing was studied.

Keywords: Bio-polishing, pilling, enzymes, woven and knitted fabrics, fastness to washing, light, rubbing and printing

Introduction
Bio-polishing is a finishing process for cellulosic fabrics and garments. It is the process of improving surface of the material. It is also an enzymatic singeing. Bio-polishing with acid cellulose effectively reduces fabric fuzz and the pilling on denim materials. A cellulosic treatment gives the fabric a durable improvement of

- Resistance to piling
- A clear lint and fuzz free surface structure
- A bio polished garment looks new even after repeated wear
- Bio polishing permanently enhances fabric look without any chemical coating
- The fabric surface obtains a silky sheen similar to that resulting from traditional measurements.

Most celluloses have 2 functionally distinct domains; a catalytic domain and a substrate binding domain or cellulose binding domain (CBD). Both these domains are linked by a glycosylated linker-peptide. The catalytic domain have an active site in the hape of the tunnel or a cleft where the hydrolytic reaction take place. The CBD peptide varies from 33-240 amino acids in length. Cotton and other natural man-made cellulosic fibers can be improved by an enzymatic treatment called bio-polishing. The main advantage of bio-polishing is the prevention of piling. Celluloses hydrolysis the micro fibrils (hairs of fuzz) protruding from the surface of yarn because they are most susceptible to enzymatic attack. This weaken the micro fibrils, which tend to break off from the main body of fiber and leave a smoother yarn surface. A ball of fuzz is called a pill in the textile trade. These pills can present a serious quality problem since they result in an alternative, knotty fabric appearance. After bio-polishing the fabric shows a much lower pilling tendency. Other benefits of removing fuzz are a softer, smoother feel and superior feel and superior colour brightness. Unlike conventional softeners, which tend to be washed out and often result in a greasy feel, the softness enhancing effects of bio-polishing are wash proof and non-greasy.

Objectives

- To compare cotton woven and cotton knitted fabric for their bio-polishing properties.
- To give enzymatic bio-polishing treatment on cotton woven and cotton knitted fabrics.
- To dye cotton woven and cotton knitted bio-polished fabric.
- To test the bio-polished and untreated fabric for properties like pilling resistance, washing, rubbing, light fastness and the clarity of printing.

Methodology

Selection of Fiber

As cotton fabric has more tendency towards piling it was selected. The cotton fabric has more protruding fibers on its surface than the synthetic fabric. It has high tendency of piling which reduce the appeal of the garment.

Selection of Fabric

In this study both woven and knitted fabric are selected.

Woven Fabric

In case of woven material, to remove protruding fiber, the fabric is singed so that singed fabric has uniform surface with soft handle in which there is a loss of strength.

Knitted Fabric

The knitted fabric is not normally singed or defused as singeing involves the risk of scorching. To remove fuzz in the fabric surface active agents are used in the knitted fabric. But it reduces the absorbency of the knitted fabric. To overcome this problem in knitted fabric, it is selected for this study.

Table 1: Sequence of process given to the various samples

Sample A	Sample B	Sample C	Sample D
Desizing ↓ Scouring ↓ Bleaching ↓ Dyeing ↓ Printing	Desizing ↓ Scouring ↓ Bleaching ↓ Bio polishing ↓ Dyeing ↓ Printing	Scouring ↓ Bleaching ↓ Dyeing ↓ Printing	Scouring ↓ Bleaching ↓ Bio polishing ↓ Dyeing ↓ Printing

Sample A → Woven Untreated fabric.
Sample B → Woven Bio-polished fabric.
Sample C → Knitted untreated fabric.
Sample D → Knitted Bio-polished fabric.

Desizing

Removal of sizing from the grey fabric which is applied during weaving. This is done to make the fabric more absorbent. The material was made into rope form and it was loaded in to the soft flow machine. The material was treated with required amount H_2SO_4 required amount of water at 40 ^{0}C for 4 hours. After the completion of desizing the material was taken out and treated with hydrochloric acid and then washed and dried.

Scouring

Scouring is the process of removing wax, fat, oil and foreign coloring matters from the fabric. The material was made into rope form. Then the material was treated with sodium hydroxide, sodium carbonate, wetting agent and the require amount of water at 90 ^{0}C for 1 ½ hours. After the completion of scouring the material is treated with HCL and washed and dried.

Bleaching

Bleaching is the process of removal of natural yellowish color and giving whiteness to the fabric. The material was made into rope form. Then the material was treated with hydrogen peroxide, sodium silicate, sodium hydroxide, hydrochloric acid and required amount of water at 80 ^{0}C for 1 hour. After the completion of bleaching the material was taken out and treated with HCL washed and dried.

Bio-polishing

Cotton and other natural fibers based on cellulose can be improved by an enzymatic treatment known as Bio-polishing. The material was made into rope form. Then the material was treated with only in enzyme and then required amount of water at 80 ^{0}C for 30 minutes with pH 5- 5.5. Then the material was washed and dried.

Dyeing

Dyeing is the process of coloring the textile material, by immersing them in an aqueous solution of dye. The material was made into rope form. The required amount of dye was dissolved in cold water and the sodium chloride, sodium carbonate and water was added. The material was entered into the dye bath. Then sodium hydroxide was added at 80 ^{0}C for 1 hour and stirred well. Wash the dyed samples with soap oil at boiling temperature for 15 minutes.

Printing

It is the process of transferring the designs or art work on a textile material in a decorative manner. The pigment color paste is mixed with binder. Suitable design is placed on the material. Printing paste is applied on the screen with the help of squeegee. The paste is moved twice or thrice from top to bottom of the screen, then the screen is taken out and washed thoroughly. Thus the design is transferred on the surface of the fabric.

Analysis and interpretations

The treated and untreated samples were subjected to the following tests and their results were tabulated as follows.

Test for Pilling

Pilling are small knots or balls of mixture of large numbers of small fibers accumulated at the surface of the fabric and entangled by the mild frictional action during processing or weaving, they are soft but firmly held on the surface of the fabric. The ability to resist the formation of pilling is known as pilling resistance.

- The pilling tester consists of 2 boxes each being lined with a metal plate supporting 3.2mm thick buffed –finish crock joining material.
- The tester features an automatic counter which stops the machine after any pre-determined number of revolutions.
- The pilling standard is visual using either the standard photo or the rating scheme.
- The tested specimens are mounted on card and then rated the standard photo or against an untested sample.

Table 2

Rate	Sample appearance	Pilling properties
5	No change	Excellent
4	Very slight change	Good
3	Slightly changed	Fair
2	Moderately changed	Poor
1	Severely changed	Very poor

Table 3

Samples	Fastness
Pilling untreated sample (A)	Fair
Pilling bio-polished sample (B)	Good
Pilling untreated sample (C)	Fair
Pilling bio-polished sample (D)	Good

From the above table, it is interpreted that the Bio-Polished samples have better pilling resistance than un bio-polished samples.

The Pilling resistance of bio- polished woven and knitted fabric is same; (i.e.) the fabric structure does not affect the Pilling resistance.

Color fastness to washing

The sample of 3"X 3" is cut from the fabric. The test sample is placed between the undyed desize fabric that used. The water solution of 5g/lit is prepared separately and the tested sample are soaked into it for 10 minutes at 50 degree Celsius. Then the sample are removed rinsed 1 cold water thoroughly squeezed well and dried.

The color change and staining of the samples are assessed by comparing with the original sample and rated using the following procedure.

Table 4

Rate	Visual appearances	Fastness properties
5	No stain	Excellent
4	Very slightly stained	Good
3	Slightly stained	Fair
2	Moderately stained	Poor
1	Strongly stained	Very poor

Table 5

Samples	Fastness
Woven Untreated Tested (A)	Fair
Woven Bio Polished Sample (B)	Good
Knitting Untreated Sample (C)	Fair
Knitting Bio polished Sample (D	Good

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From the above table, it is interpreted that the bio-polished samples have better washing fastness than un bio-polished samples.

The washing fastness of bio-polished woven and knitted fabric is same (i.e.) the fabric structure does not affect the fastness.

Color fastness to light

- A sample piece of tested cotton and knitted fabric are cut in 8" X 1" from the fabric.
- The strips of fabric is covered with a black chart paper on the first day, so that the fabric under it is not exposed to sun light.
- The second day, a division is cut from the strip for exposure and so on for eight days.
- Repeated this for all four samples and more bio-polishing samples for accuracy.
- The first division after exposure for seven day in assessed for color change with the untested specimen rated as follows.

Table 6

Rate	Color changes in tested sample	Fastness properties
5	No change	Excellent
4	Very slight change	Good
3	Slight change	Fair
2	Moderately change	Poor
1	Severely change	Very poor

Table 7

Samples	Fastness
Woven Untreated Tested (A)	Fair
Woven Bio Polished Sample (B)	Good
Knitting Untreated Sample (C)	Fair
Knitting Bio polished Sample (D)	Good

From the above table, it is interpreted that the bio-polished samples have better light fastness than un bio-polished samples.

The light fastness of bio-polished woven and knitted fabric is same (i.e) the fabric structure does not affect the fastness.

Color fastness to rubbing

- After bio polished and before bio polished sample can be carried.
- Each of the dyed material is cut to size of 4" X 2" and material is placed on the flat base of the crock meter.
- A white desized material of 3" X 3" dimension is mounted on the rubbing finger with a ring.
- A number of rubs to given is standardized and fixed as to each sample was given the rubs as standardized.
- Repeat with more samples for accuracy.

The color changed and stained of the samples are assessed comparing with the original sample using the following procedure.

Table 8

Rate	Visual appearance	Fastness properties
5	No stain	Excellent
4	Very slightly stained	Good
3	Slightly stained	Fair
2	Moderately stained	Poor
1	Strongly stained	Very poor

Table 9

Samples	Fastness
Woven Untreated Tested (A)	Fair
Woven Bio Polished Sample (B)	Good
Knitting Untreated Sample (C)	Fair
Knitting Bio polished Sample (D)	Good

From the above table, it is interpreted that the bio-polished samples have better rubbing fastness than un bio-polished samples.

The rubbing fastness of bio-polished woven and knitted fabric is same (i.e.) the fabric structure does not affect the fastness.

Clarity of Printing

Screen printing is a very simple method which can be carried out without the use of complicated and expensive equipment this is widely used printing method as today in India. The clarity of printing is determined by the visual evaluation. (i.e.)

comparing the untreated sample with the bio- polishing sample.

The sample woven bio-polished fabric has better clarity of printing than sample woven untreated fabric. Sample knitting bio-polished has better clarity of printing than sample knitted untreated fabric.

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