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Study on the Effect of Dyeing and Finishing Parameters on Cotton Knitted Two Thread Fleece Fabric and 1x1 Rib Fabric

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Abstract: Dyeing and finishing parameters are important factors which have various impacts on cotton knitted two thread fleece and 1x1 rib fabrics respectively. Various technical properties like physical, dimensional and dyeing properties of 1x1 rib and two thread fleece knitted fabric after different wet processing stages and sequences have been influenced by dyeing and finishing parameters. For this purpose, it was taken two types of knitted fabrics such as $32^{(S)}$, 1×1 Rib and $13^{(S)}$, $28^{(S)}$ two thread fleece. The grey fabric was subjected to pretreatment process involving scouring, bleaching and enzyme wash. The pretreated fabrics were then dyed and finished to ready to stitch fabrics. At the end of each process stage, samples were collected and analyzed for various physical properties. In every state except dyeing, weight has successively decreased. Total weight loss found for 1x1 rib is 9.59% and for two thread fleece is found 11.49%. Tensile strength also decreased in each stage except in dyeing. Total strength loss found for 1x1 rib is 43.31% and for two thread fleece is 32.72%. Shrinkage has found in both length wise and width wise direction. Length wise shrinkage for 1x1 rib is found -3.35% and in width wise is found -3.50%. For fleece fabric, length wise shrinkage is found -3.25% and in width wise is found -2.70%. The abrasion resistance of different stages for 1x1 rib and fleece fabric are same in dry state. But at dyeing stage, test result is found a little different from other stages at wet state assessment. The results show that, the properties of the fabric changes to a considerable extent after each stage of wet processing. The finishing process whether the dyed fabric is padded with softener and dried in a dryer alters fabric properties to a considerable extent. It improves fabric handle and imparts a soft feel to fabric.

Keywords: Cotton, 1x1 Rib Fabric, Two Thread Fleece Fabric, Enzyme, Dyeing, Finishing

1. Introduction

It goes without saying that, use of cotton knitted fabric has been increasing in world wide. People around each corner of the world, each custom, casts feel comfortable wearing cotton knitted fabric due to proper fitting properties, softer handle properties and high extension at low tension compared to woven manufactured fabric [1]. Cotton in recent years has become most widely used textile fiber in the world. Its current market share captured 56% for all fibers used for apparel and textile home furnishings and sold in the U.S. Though China dominates the world's largest producer of cotton, but most of this is used locally. The United States of America has been the largest and major exporter for so many years [2]. In recent years, various textile dyes and chemicals like wetting agent, soaping agent, anti creasing, anti staining agents have been most commonly used for cotton for its wide range of application and better fastness properties [3]. The textile industry has been regarded as one of the biggest energy, water and chemical consumers [4-5]. With a view to observe with precise environmental regulations and to save water and energy, several types of biotechnological components have entered the textile sector. A good number of various biological compounds like bio-polishing, bio scouring, bio finishing for textile processing have been described in many review [6-7] and scientific [8-9] papers. Cotton fibers are treated with various chemical processes to obtain properties suitable for dyeing and further processing. For scouring, various non-cellulose components like (wax, pectin, proteins, hemi-celluloses) that surround the fiber cellulose core are removed, and as a result, fibers become hydrophilic. For the past few years, reactive dyes have

become most commonly used dyes, as because the reactive dyes are the best for cotton for its wide range of application and better fastness properties [10]. There are more than 50% of cellulosic fibers are dyed with reactive dyes. Market Share of reactive dyes among all textile dyes captured about 29%. Due to their strong bonding with many surfaces of synthetic and natural fabrics, reactive dyes are used for dyeing cotton, wool, nylon, silk, and modified acrylics [11-12]. In Bangladeshi textile dyeing and finishing industries, reactive dyes are hugely used. According to the chemical structures of reactive dyes, the reactive site of the dyes reacts with functional group on fiber under influence of alkali and heat. In this research we use cotton knitted (two thread fleece and 1x1 rib) fabric, dyeing chemicals and finishing agents.

2. Materials and Methods

2.1. Materials

Fabric: The fabrics which were used for experiment were 1×1 rib and two thread fleece 100% cotton knitted fabric.

1×1 rib fabric specification: $32^{(S)}$ combed yarn, 2.7 mm stitch length and 200 GSM.

Two thread fleece fabric specification: $13^{(S)}$, $28^{(S)}$ combed yarn and 240 GSM.

Instruments used:

For this experiment, we use Dilmener dyeing machine, de-watering machine, dryer, compacting machine, tumble machine, electric balance, washing machine, strength tester machine.

2.2. Methodology

All process has done in exhaust method. All wet processing process was done in bulk production machine.

Table 1. *Recipe for pretreatment and dyeing procedure.*

Name of the Chemicals	Amount
Detergent	0.5 g/l
Sequestering agent	0.50 g/l
Stabilizer	0.50 g/l
Anti-creasing agent	1.00g/l
Caustic soda	2.00 g/l
Hydrogen peroxide	1.70 g/l
Peroxide killer	0.40 g/l
Acetic acid	1.00 g/l
Enzyme	0.80 g/l
Cotton levelling agent	0.50 g/l
REMA YELLOW-RR	0.08714%
REMA RED-RR	0.0342%
REMA BLUE-RR	0.027%
Salt	20 g/l
Soda	5 g/l
Softener	1.00 g/l
Wash off (liquid)	1.00 g/l

Dyeing Procedure with cold brand reactive dyes:

Set the bath with substrate at room temperature and add wetting agent, sequestering agent and anti-creasing agent. Add (dosing) and half amount of salt. Raise the temperature to 60°C and add (dosing) rest amount of salt and soda ash. Run bath for 60 minutes at 60°C. Drop the bath and carry on after treatment process.

For better color fastness after treatment process is very important. First need complete removal of salt and alkalis by rinsing. Usually several rinsing process is done to get better result. Then the substrate is neutralized by acid (acetic acid) wash. After that it needs soap wash to confirm that the goods are totally free from unfixed dyes. In case of deep shade, it is recommended to give one more soap wash with early mentioned (after treatment) recipe.

Rinse with 50°C hot water for 15 minutes.

Neutralize and lower the P^H to 5.5-6.5 with acetic acid at 50°C.

Soap wash according to below recipe:

Detergent: 0.5 g/l

Soda ash: 1.00 g/l

Temperature: 95°C

Time: 15 minutes

P^H: 9.5

M: L: 1:7

Rinse with 90°C hot water for 10 minutes.

Rinse with cold water for 10 minutes.

After completing dyeing, at first dewatering is done. Then applying softener in the samples. Samples were dried in dryer machine at 150°C and compacting at compactor machine. Finally tumble is done at tumble dryer machine.

3. Results and Discussion

3.1. Weight Measurement of 1×1 Rib Fabric on Different Stage

Table 2. *Weight measurement of 1×1 Rib fabric.*

Name of different stages	Weight in (gm)	Weight loss or increase percentage (%)
Grey	460gm	-------
Scouring and bleaching	430gm	7% loss
Enzyme	425gm	1.18% loss
Dyeing	431gm	1.39% increase
Finishing	425gm	1.41% loss

3.2. Weight Measurement of Two Thread Fleece Fabric on Different Stages

Table 3. *Weight measurement of two thread fleece fabric.*

Name of different stages	Weight in (gm)	Weight loss or increase percentage (%)
Grey	480gm	-------
Scouring and bleaching	446gm	7.62% loss
Enzyme	435gm	2.53% loss
Dyeing	440gm	1.14% increase
Finishing	434gm	1.34% loss

3.3. Strength Measurement of Two Thread Fleece Fabric on Different Stages

Table 4. *Strength measurement of two thread fleece fabric.*

Name of different stages	Pressure (KPa)	Distension (mm)	Time(s)	Strength loss or increase percentage (%)
Grey	249.93	33.20	70.63	--------
Scouring and bleaching	239.83	39.06	68.1	3.72% loss
Enzyme	180.80	36.00	53.13	28.18% loss
Dyeing	198.16	37.53	57.53	7.65% increase
Finishing	195.63	39.53	57.06	0.82% loss

3.4. Strength Measurement of 1×1 Rib Fabric on Different Stages

Table 5. *Strength measurement of 1×1 Rib fabric.*

Name of different stages	Pressure(KPa)	Distension(mm)	Time(s)	Strength loss or increase percentage (%)
Grey	254.63	51.46	80.13	----------
Scouring and bleaching	210.70	55.86	68.94	16.23% loss
Enzyme	157.30	52.82	55.46	24.31% loss
Dyeing	161.10	50.16	58.68	5.49% increase
Finishing	164.62	54.94	57.1	2.77% loss

3.5. Dimensional Stability (Shrinkage)

Specimen for 1×1 Rib fabric:
Sample size:
Total area – 25×25 cm
Marked area – 20×20 cm
Shrinkage test:
Let us consider,
Average length after washing
= (19.5+19.5+19)/3
=19.33 cm
So, Length wise shrinkage
= {(19.33-20)/20} ×100%
=-3.35%
Average width after washing
=(19.5+19.2+19.2)/3
=19.30 cm
So, width wise shrinkage
={(19.30-20)/20} ×100%
=-3.50%
Specimen for Two thread fleece fabric*:*
Sample size:
Total area – 25×25 cm
Marked area – 20×20 cm
Shrinkage test:
Let us consider,
Average length after washing= (19.2+19.5+19.35)/3
=19.35 cm
So, Length wise shrinkage
={(19.35-20)/20} ×100%
=-3.25%
Average width after washing
=(19.5+19.3+19.60)/3
=19.46 cm
So, Width wise shrinkage
={(19.46-20)/20}×100%
=-2.70%

Shrinkage test results of different structures of knitted fabrics are given below.

Table 6. *Shrinkage test result.*

Name of different fabrics	Lengthwise shrinkage	Widthwise shrinkage
1×1 Rib fabric	- 3.35%	- 3.50%
Two thread fleece fabric	- 3.25%	- 2.70%

From the above table, we see that shrinkage has occurred both length wise and width wise. Length wise shrinkage results in different structures of fabric are same but width wise shrinkage result of 1×1 Rib fabric is higher than other fabrics.

3.6. Abrasion Resistance of 1×1 Rib Fabric

Grading has been done according to grey scale for staining.

Table 7. *Abrasion test result of 1×1 Rib fabric.*

Item	Item Description	Grade(Dry)	Grade(Wet)
1	1×1 Rib (Grey)	5	4-5
2	1×1 Rib (Scouring and bleaching)	5	4
3	1×1 Rib (Enzyme)	5	4
4	1×1 Rib (Dyeing)	5	4
5	1×1 Rib (Finishing)	5	4-5

From the above table, we can see that abrasion resistance of different stages of 1x1 rib fabric is same in dry and wet state test result.

3.7. Abrasion Resistance of Two Thread Fleece Fabric

Grading has been done according to grey scale for staining.

Table 8. *Abrasion test result of two thread fleece fabric.*

Item	Item Description	Grade(Dry)	Grade(Wet)
1	Two thread fleece (Grey)	5	4-5
2	Two thread fleece (Scouring and bleaching)	5	4
3	Two thread fleece (Enzyme)	5	4-5
4	Two thread fleece (Dyeing)	5	4
5	Two thread fleece (Finishing)	5	4

From the above table, we can see that abrasion resistance of different stages of two thread fleece fabric is same in dry state test result. But at dyeing stage, test result is little difference from other stages at wet state assessment.

4. Conclusion

This study exposed that the fabrics found from the enzymatic scouring bleaching process show more softer handle and much less weight loss% than conventional process. At the grey stage, 480g two thread fleece fabric and 460g 1x1 rib fabric were taken and after five successive pretreatment stages like scouring, bleaching, enzyme wash, dyeing and finishing; we got the fabric weight for two thread fleece and 1x1 rib are 434g, 425g respectively. We have found both length wise and width wise shrinkage for these types of fabric. For two thread fleece fabric, length wise shrinkage found -3.26% and in width wise -2.70%. For 1x1 rib fabric, length wise shrinkage found 3.35% and in width wise -3.50%. It can be said that, enzymatic process will play a vital role in future textile processing. The abrasion resistance of the different stages of the fabrics found quite similar of grade-5 in dry state but in finishing stage, there were a little bit difference occurred.

However, the study will be helpful for industrial wet processing for an actual assessment among these particular knitted structures. It will be also helpful for those who are willing to do further experiment relevant to it.

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