IMPACT OF REPEATED WASHINGS ON DIMENSION STABILITY AND FABRIC PHYSICAL FACTORS OF WOVEN COTTON FABRIC.

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Abstract

During the lifetime use, fabric undergoes repeated washings. It may change dimensions and physical properties of the fabrics which may alter the comfort properties of the fabrics. Therefore, it is essential to study the effect of repeated washings on dimension stability and fabric physical factors of woven cotton fabric. Results reveals that fabric cover factor, fabric thickness, fabric weight and fabric shrinkage increase with increase of washing cycles.

Key words: Cover Factor, Dimensional stability, Fabric thickness, Fabric weight

1. INTRODUCTION

Dimensional stability of fabric is important to both manufacturers and consumers, as unacceptable dimensional change is often the primary reasons for rejection the product by consumer. Most dimensional change attributed to relaxation shrinkage occurs during the first washing cycle, with fabrics progressively changing with each additional cycle until stability is achieved [1, 2, 3].The highest changes occur in the properties and appearance of clothing textile materials manufactured from natural or man-made cellulosic fibres [4].

Fabric physical properties such as cover factor, thickness, weight are important for garment manufactures as well as end users. The fabric cover factor is dependent on the density of both sets of threads: warp and weft. Thickness depends upon diameter of yarn, weave and shrinkage.

The fabric goes a number of washing cycles in its useful life. Washing may cause dimensional change which may alter the fabric physical properties such as cover factor, thickness and fabric weight. These factors may affect various thermo-physiological properties of fabrics. So the fabric physical properties and dimensional stability must require to evaluate. In this paper the effect of repeated washing on various physical properties and dimensional stability are accessed in plain woven cotton fabric. Manufacturers may use the results from the study to provide better care instruction for their final product's quality. The results of the study may also provide knowledge for consumers to make an informed choice of how to care for their textile and clothing.

2 Material & Method

2.1 Sample Plan

To study the impact of repeated washing, five fabric samples were prepared using 100% cotton yarn [Table 1]. They were processed for repeated wash at various stages such as 0-wash, 4-wash, 8-wash, 12-wash and 16-wash.

2.2 Raw Material

For this study, 100% cotton ring spun yarn was produced using J-34 cotton. The parameter of yarn are given in the Table 1.

Table 1 Yarn parameter

Fibre type	Varity of cotton	Warp count	Weft count	Twist per inch	
Cotton	J-34	$2/40^s$	20^s	Warp single = 26	Weft single = 18

The yarn in the hanks form firstly scoured, bleached, anti-chlorine and optical brightened as in practice in small scale industry for production of fabric. This yarn is used for production of woven fabric for sale in domestic market. This is cost effective process. The details recipes of

scouring, bleaching, anti-chlorine and optical brightening treatments are given in the Table 2, Table 3, Table 4 and Table 5 respectively.

Table 2 Scouring recipe

Material to liquor	1:20
HCL	5cc/lit
Temp	27 ±1˚ C
Time	15 min

Table 3 Bleaching recipe

Bleaching powder ($Caocl^2$)	7gm/lit
By caustic soda drops PH	10.8 - 11
Wetting agent (Turkey red oil)	1gm/lit
Temp	27±1˚ C
Time	90 min
Material to liquor	1:20

Table 4 Anti-chlorite recipe

Sodium hydro-sulphite	1gm/lit
Temp	27˚±1˚C
Time	15 min
Material to liquor	1:20

Table 5 Optical brightening recipe

Tinopol	0.50%
Material to liquor	1:20
Temp	27˚±1˚C
Time	5 min

2.3 Fabric Samples Preparation

The plain woven fabric has been prepared in Cimco Over Pick Power Loom for shirting fabrics using processed yarn (scoured, bleached, anti-chlorine and optical brightened). In this loom shuttle is used for carrying the weft. It inserts 140 picks per minute. The loom width is 44 inch. Fabric constructional particular are given in Table 6.

Table 6 Fabric constructional particulars

Fabric sample	Weave	Linear density (Ne)		Thread density	
		Warp	Weft	Ends/ inch	Picks/ inch
100% Cotton Fabric	Plain	2/40s	20s	52	48

2.4 Preparation of washed fabric samples

The fabrics were washed at 27°C in semi automatic washing machine using 0.75 g/l solution of non-ionic detergent (96% concentration) while material to liquor ratio was kept as 1:40. One washing cycle completes in 12 minutes. Fabrics were washed, rinsed in clean water and loose water is extracted by using drier and samples were dried in sun light.

For the study, 5 sampled of fabric were prepared by processing the fabric samples at 0-wash, 4-wash, 8-wash, 12-wash & 16-wash (Table 7). Results are analyzed using computer software "STATISTICA 6.0."

Table 7 Fabric processing particulars

Sr. No	Fabric Sample code	No of washing cycles
1	A	0-wash
2	B	4-wash
3	C	8-wash
4	D	12-wash
5	E	16-wash

2.5 Test Method

The above fabric samples are tested for various properties. Before test each samples are conditioned as per standard test method.

1. **Thread Density:** The ends and picks per inch of woven fabric samples were assessed visually by using a pick glass according to the (IS: 1963-81) standard test method [5]. The weave density was measured from three different places of each woven fabric samples; the average of three reading was then calculated.
2. **Fabric Cover Factor:** Fabric cover factor was evaluated by Peirce formula expressed as: $Fabric\ cover\ factor(K_c) = K_1 + K_2 - \frac{K_1 \times K_2}{28}$ Where, K_1 = Warp cover factor, K_2 = Weft cover factor [6].
3. **Fabric Thickness:** KES-F- Compression Tester Instrument was used for fabric thickness determination [7]. The specimen is compressed by two circular plates of steel having an area 2 cm^2. The velocity of the compression is 20 micron/sec. The fabric thickness in mm is taken as the thickness when P (pressure) = 0.5 g-f/cm^2.
4. **Fabric Weight:** Fabric weight was measured by Kawabata evaluation system [8]. The unit is taken in [mg/cm^2]. The fabric weight was measured from three different areas of each woven fabric samples.
5. **Dimension stability:** Dimension stability was measured according to the BS 4931 Standard Test Method for preparation, marking and measuring of textile fabrics, garments and fabric assemblies in tests for assessing dimensional change [9].

3. RESULTS AND DISCUSSION

The key dimensional characteristics that are likely to change upon repeated washing are fabric cover factor, fabric thickness, fabric weight and fabric shrinkage.

The effect of repeated washing on EPI, PPI, Fabric cover factors, Fabric thickness, fabric weight and fabric shrinkage of fabric sample A (0 wash), B (4 wash), C (8 wash), D (12 wash) and E

(16 wash) were assessed. The result of EPI, PPI and Fabric physical factors such as fabric cover factor, fabric thickness and fabric weight are given in Table 8.

Table 8 Dimensional changes of fabric samples upon Repeated Washing

Sample code	No of wash cycle	EPI	PPI	Fabric Cover Factor	Fabric Thickness at pressure 0.5 g-f/cm² in [mm]	Fabric Weight [mg/cm²]
A	0 wash	52	48	17.9	0.857	12.16
B	4 wash	52	51	18.29	0.921	13.74
C	8 wash	51	52	18.29	0.924	13.8
D	12 wash	54	51	18.57	0.926	13.88
E	16 wash	56	52	18.95	0.928	14.05

Table 9 Correlation (R) of fabric shrinkage with fabric factors

Factors	Correlation (R)
Cover Factor	0.81
Fabric Thickness	0.99
Fabric Weight	0.99

3.1. Changes in Fabric Cover factor upon repeated washing

The results of fabric cover factor changes upon repeated washing were calculated of all 5 samples and given in the above Table 8.

From the Table 8 & Fig 1, the result shows that after repeated washing the cover factor mostly increases. In case of sample B & C there are slight change in EPI & PPI noticed, so the result of cover factor not affected. There is good correlation (R= 0.81) found in fabric cover factor and fabric shrinkage as shown in above Table 9.

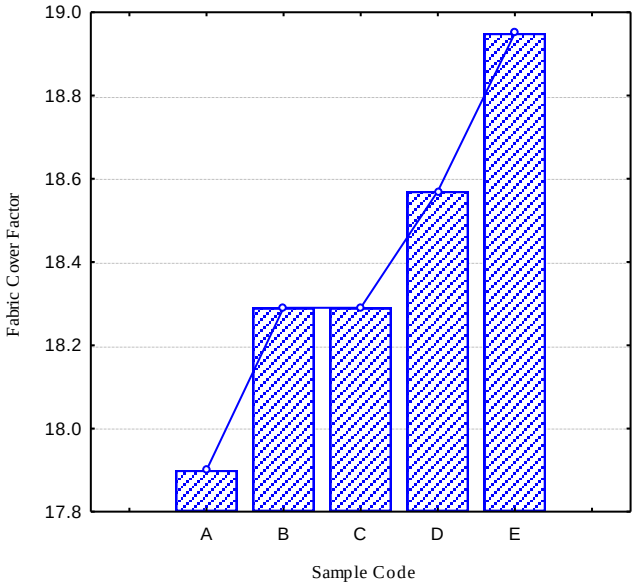

Fig 1 Changes in Fabric cover factor after repeated washing

3.2. Changes in Fabric Thickness upon repeated washing

The fabric thickness of all 5 samples was measured and results are given in the above Table 8.

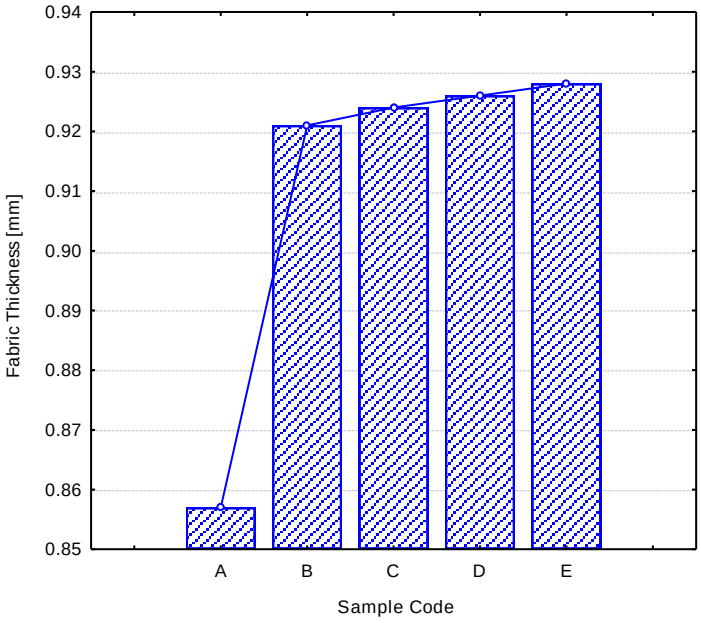

Fig 2 Changes in Fabric thickness after repeated washing

Table 8 & fig 2 results showed that a significant increases fabric thickness among without washed and washed samples & number of washing cycles (i.e., 0, 4, cycles). However in subsequent washing stages fabric thickness slight increase in the B (4 wash), C (8 wash), D (12 wash) and E (16 wash) fabric samples. There is very good correlation (R= 0.99) found in fabric thickness with fabric shrinkage [Table 9].

3.3 Changes in Fabric Weight upon repeated washing

The fabric weight was calculated of all 5 samples and results are tabulated in the above Table 8.

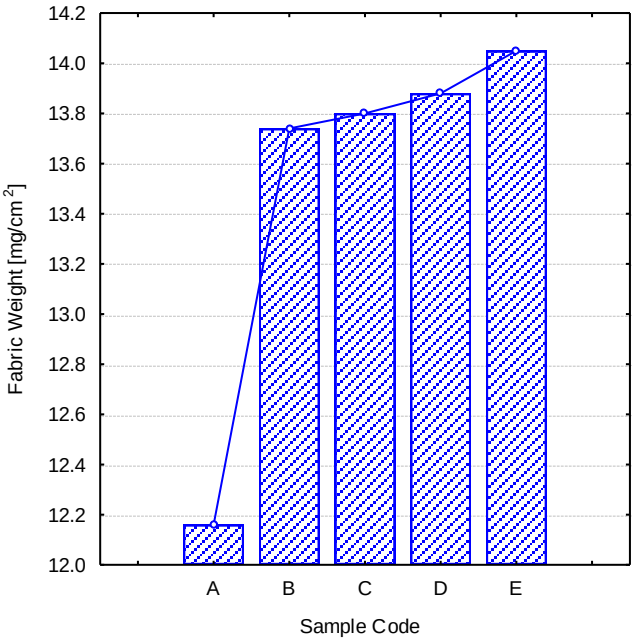

Fig 3 Changes in Fabric Weight after repeated washing

From Table 8 & Fig 3 it is observed that after washing, fabric weight initially increases rapidly and after 4 wash slowly increase. Changes in the weight of fabric with after repeated washing may be attributed to shrinkage. There is very good correlation (R= 0.99) found in fabric weight with fabric shrinkage [Table 9].

3.4 Changes in Fabric Shrinkage upon repeated washing

The fabric shrinkage was calculated of all 5 samples and results are tabulated in the Table 8.

Table 4.3 Fabric Shrinkage

Fabric sample code	Fabric Dimensions							Fabric Shrinkage (%)
	Length wise (cm)			Width wise (cm)			Total areal avg. (cm^2)	
	side - a	side - b	avg.	side - c	side - d	avg.		
A	30.0	30.0	30.0	30.0	30.0	30.0	900.00	0.00
B	25.2	25.2	25.2	27.4	27.4	27.4	690.48	23.28
C	25.0	25.0	25.0	27.0	26.8	26.9	672.50	25.28
D	24.8	24.8	24.8	26.2	26.4	26.3	652.24	27.52
E	24.6	24.8	24.7	26.2	26.0	26.1	644.67	28.37

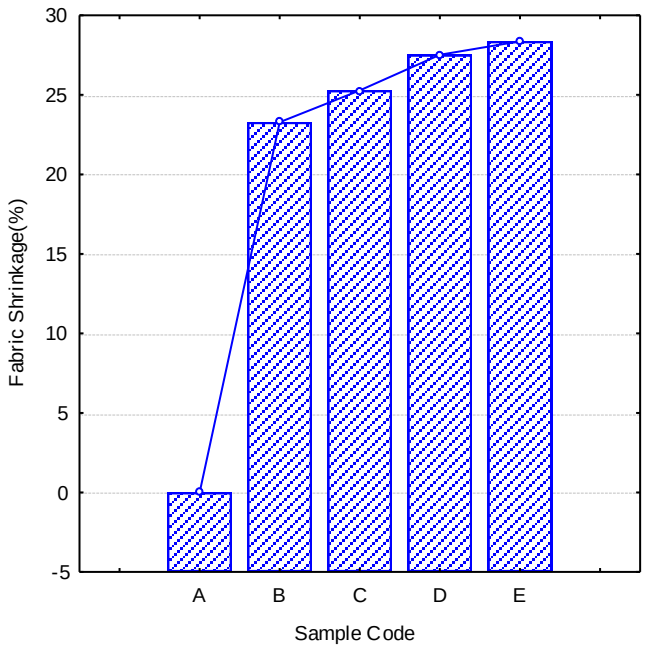

Fig 4 Changes in Fabric Shrinkage after repeated washing

Figure 4 shows that the fabric shrinkage rapidly increases up to 4 wash (sample A to sample B) and slowly increase up to 16 wash (sample B to sample E). From Fig 4 we can see that there is huge difference in between sample A (0 wash) and sample B (4 wash). The difference is little in case of sample B (4 wash), C (8 wash), D (12 wash) and E (16 wash).

4. CONCLUSION

The results show that after repeated washing the fabric cover factor, fabric thickness, fabric weight and fabric shrinkage increase and this increase abruptly upto 4 wash and there after slightly changed. The cover factor, fabric thickness and fabric weight increase due to fabric shrinkage which arises due to repeated washing.

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