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COMPARATIVE STUDY ON DIFFERENT PHYSICAL PROPERTIES OF GREY & FINISHED SINGLE JERSEY DERIVATIVES

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Abstract—Knitting is the mostly used fabric manufacturing processes in Bangladesh through which various types of knitted fabrics with different physical and chemical properties are produced. Single jersey derivatives have some dimensional, physical or chemical properties that change according to some factors and processing. These properties also change after dyeing & finishing process. As finishing is mandatory for fabric production, some tests are carried out after finishing stage & proper controlling is done according desired quality. Single jersey fabrics show low strength and higher abrasion resistance than grey fabric after dyeing & finishing. Finished fabric is more stiff than grey. Spirality & shrinkage properties of the single jersey fabric are rapidly change after dyeing & finishing and generally acceptable under the limit. Therefore, this paper is all about the comparison of physical properties among various grey and finished single jersey weft knitted fabrics which will be helpful to know for efficient production, taking corrective actions to minimize changes of basic physical properties and produce quality knit products.

Index Terms— GSM, Spirality, Shrinkage, Abrasion Resistance, Stiffness.

I. INTRODUCTION

In a weft knitted structure a horizontal row of loops can be made using one thread and the thread runs in the horizontal direction. Most of the knitted fabrics are produced by weft knitting which can be single jersey or double jersey [1]. Single Jersey is a weft knitted fabric produced with one set of needles is called single Jersey or plain knitted fabric. These fabrics have physical properties like lighter fabric, highly extensible in length & width, high drapability & good dimensional stability, high shrinkage in natural fiber, non-reversible, soft & resilience, good stretch-ability and elastic recovery. Single jersey fabrics are used for leisure wear manufacturing basically men's, women's, and kid's polo T-shirts, sports-wear.

The properties of knitted fabrics are enormously dependable on its structure. Specifically, the effect of knit structure on the bursting strength, air permeability, and bending rigidity is highly remarkable in washed fabrics [2]. Prediction of the bursting strength of a knitted fabric is difficult before testing [3]. As the bending length related with the stiffness and drape property of the fabrics, it should be taken as a consideration. Buckling behavior and puckering are also caused by these properties of the fabric [4]. Pills can be seen on the knitted fabric surface which is the result of abrasion between two surfaces. Pilling varies with the surface density and stitch length which means it can be changed during finishing or garments production [5]. Fabric shrinkage occurs commonly in weft knitted fabrics which mainly cause problems in finished items. Tension variation of yarns in knitting process and relaxation process can be the cause if this dimensional changes [6]. Spirality is one kind of distorted angle which appear as the displacement of side seam in knitted fabrics. Later this will cause a serious quality problem during garments production especially after finishing [7]. Sometimes controlling of some properties of finished fabrics are beyond our trial. In that case, analysis of fabric properties at grey stage & finished stage and comparing these properties can help us to take various control & corrective action when necessary.

II. MATERIALS & METHOD

A. Materials:

Plain single jersey (with and without finishing), Double lacoste, Lycra terry & Fleece were used as test specimens.

B. Test Method:

GSM calculation:

It is very easy to know the weight of the fabric by cutting the fabric with the GSM cutter.

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Pilling test:

Pilling test was done by ASTM D4970 method by a Martindale Abrasion Tester.

Bursting strength test:

Bursting test was done by ISO 13938-2-1999 method by a James Heal Bursting Tester.

Stiffness test:

Stiffness test was done by ASTM D1388 by Shirley Stiffness Tester.

Shrinkage test:

Shrinkage test is carried out by AATCC 135-1987 or ISO 6330 (60 degree Celsius, tumble dry).

Spirality test:

Spirality test is carried out by AATCC Test method 179 -2004.

III. EXPERIMENTS

Test	KPa	mm	s
1	221.0	36.7	22.6
2	212.7	35.5	21.9
3	203.6	33.6	19.2
Mean	212.4	35.2	21.2

Table 01: Bursting results on grey sample of plain single jersey. (only dyeing)

Test	KPa	mm	s
1	155.3	32.3	16.9
2	149.5	31.4	15.2
3	134.2	30.9	14.6
Mean	146.3	31.5	15.5

Table 02: Bursting results on finished sample of plain single jersey. (only dyeing)

Test	KPa	mm	s
1	317.7	27.1	32.2
2	310.1	26.3	31.9
3	305.3	25.8	30.1
Mean	311.0	26.4	31.4

Table 03: Bursting results on grey sample of plain single jersey.

Test	KPa	mm	s
1	302.1	33.9	30.6
2	295.2	32.0	29.2
3	280.7	30.8	28.4
Mean	292.6	32.2	29.4

Table 04: Bursting results on finished sample of plain single jersey.

Test	KPa	mm	s
1	245.4	25.8	25.1
2	238.8	24.9	24.3
3	226.6	22.4	23.2
Mean	236.9	24.3	24.2

Table no. 05: Bursting results on grey sample of double lacoste

Test	KPa	mm	s
1	195.1	31.5	19.9
2	186.1	30.7	18.9
3	178.0	30.4	18.3
Mean	186.4	30.9	19.0

Table no. 06: Bursting results on finished sample of double lacoste

Test	KPa	mm	s
1	326.1	50.0	26.1
2	318.3	49.7	25.0
3	304.4	48.1	24.6
Mean	316.2	49.2	25.2

Table no. 07: Bursting results on grey sample of lycra terry.

Test	KPa	mm	s
1	235.9	46.1	23.0
2	226.1	45.9	23.1
3	217.5	43.8	22.4
Mean	226.5	45.2	22.8

Table no. 08: Bursting results on finished sample of lycra terry.

Test	KPa	mm	s
1	308.4	48.6	24.3
2	301.2	47.1	22.9
3	295.4	46.4	21.1
Mean	301.6	47.3	22.7

Table no. 09: Bursting results on grey sample of fleece.

Test	KPa	mm	s
1	220.6	40.0	21.9
2	211.2	39.3	21.6
3	203.8	38.2	20.7
Mean	211.8	39.1	21.4

Table no. 10: Bursting results on finished sample of fleece.

According to the following figure, we can see that strength falls after finishing. If fabric is not stentered or compacted, Fabric strength falls after dyeing.
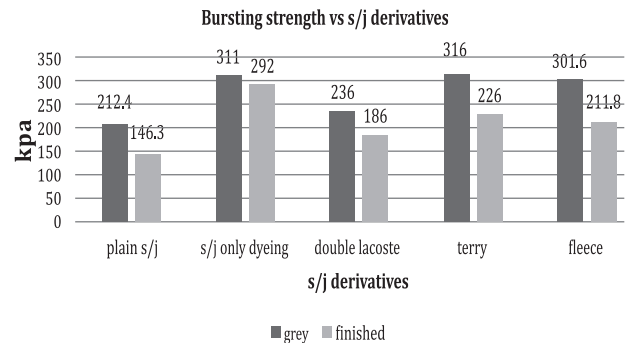

Fig no. 01: Bursting strength vs single jersey derivatives

Cycle	Rating									
	Plain Single jersey (without finishing)		Plain Single jersey		Double Lacoste		Lycra Terry		Fleece	
	Grey	Finished	Grey	Finished	Grey	Finished	Grey	Finished	Grey	Finished
100	4-5	4-5	4-5	4-5	4-5	4-5	3-4	4-5	3-4	4-5
200	4-5	4-5	3-4	4-5	3-4	4-5	3-4	4-5	3-4	3-4
300	3-4	3-4	3-4	4-5	3-4	3-4	2-3	3-4	3-4	3-4
400	3-4	3-4	3-4	3-4	2-3	3-4	2-3	3-4	2-3	2-3
500	2-3	3-4	3-4	3-4	2-3	2-3	2-3	2-3	2-3	2-3
600	2-3	2-3	2-3	3-4	2-3	2-3	2-3	2-3	2-3	2-3
700	2-3	2-3	2-3	3-4	2-3	2-3	2-3	2-3	2-3	2-3
800	2-3	2-3	2-3	2-3	2-3	2-3	1-2	2-3	2-3	2-3
900	1-2	2-3	2-3	2-3	1-2	2-3	1-2	1-2	1-2	1-2
1000	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2

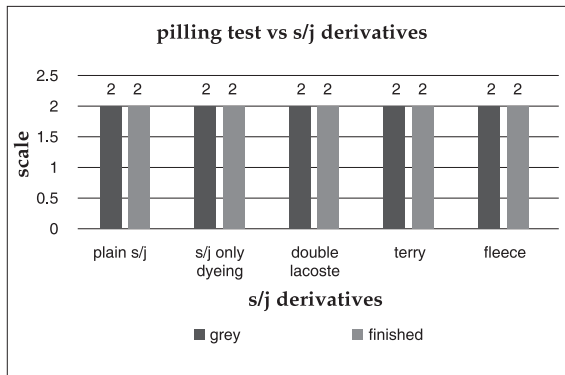Table no.11: Pilling test results for grey & finished sample of single jersey derivatives

Fig no.2: Pilling test vs single jersey derivatives (after 1000-time abrasion)

According to the figure-
After 1000-time abrasion all finished fabrics show the same appearance for pilling test though before 500-time abrasion some variations for grey and finished fabric according to the next figure-
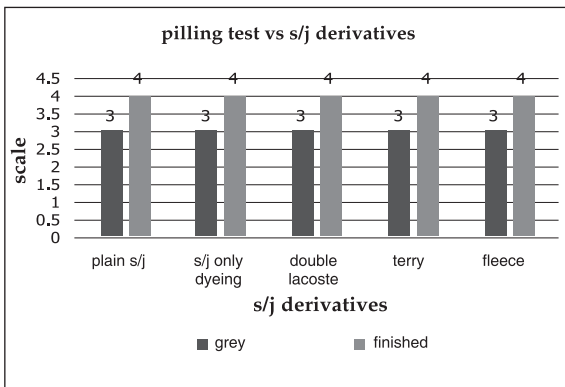

Fig no. 03: Pilling test vs single jersey derivatives (after 500-time abrasion)

Single jersey derivatives		Bending length (cm)	
		Grey Sample	Finished Sample
Plain single jersey (After dyeing)	Face	5.4	5.6
	Back	4.7	4.9
Plain single jersey (After finishing)	Face	5.5	5.8
	Back	5.0	5.4
Double lacoste	Face	5.4	5.6
	Back	4.6	4.8
Terry	Face	4.2	5.6
	Back	3.6	5.2
Fleece	Face	5.7	6.0
	Back	4.45	5.6

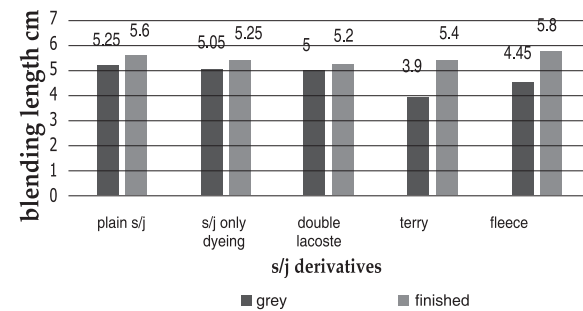Table no. 12: Stiffness test for grey & finished sample of single jersey derivatives

Fig no.4: Stiffness test vs single jersey derivatives

Single Jersey derivatives		Direction	Febric length before wash	Fabric length after wash				Shrinkage %
				X₁	X₂	X₃	Mean	
Plain single jersey (only dyeing)	Grey	Wales wise	7	6.7	6.7	6.2	6.53	6.7
		Course wise	19	18.2	17.5	18	17.9	11
	Finished	Wales wise	6	5.8	5.6	6.0	5.8	3.33
		Course wise	16	14.7	14.5	14.5	14.5	9.3
Plain single jersey	Grey	Wales wise	8	7.8	7.1	7.7	7.5	6.2
		Course wise	26	24.2	23.0	24.1	23.7	8.5
	Finished	Wales wise	5	5.1	4.9	4.8	4.9	2
		Course wise	20	19.2	19.2	19	19.1	4.5
Double Lacoste	Grey	Wales wise	14	12.9	12.9	12.8	12.8	8.5
		Course wise	6.5	6	5.8	5.9	5.8	10.7
	Finished	Wales wise	12	11.9	11.9	12	11.9	0.83
		Course wise	6	5.8	5.9	5.5	5.7	5
Lycra Terry	Grey	Wales wise	35	31.5	32	31.5	31.6	9.7
		Course wise	35	31.1	31	31	31	11
	Finished	Wales wise	35	33.2	33	33	33	5.7
		Course wise	35	33.9	34	33.7	33.8	3.4
Fleece	Grey	Wales wise	12	10.4	10.8	10.8	10.66	11.2
		Course wise	6	4.8	5.2	5.8	4.9	9.6
	Finished	Wales wise	12	11.6	11.4	11.7	11.64	3.3
		Course wise	6	5.7	5.6	5.8	5.7	5

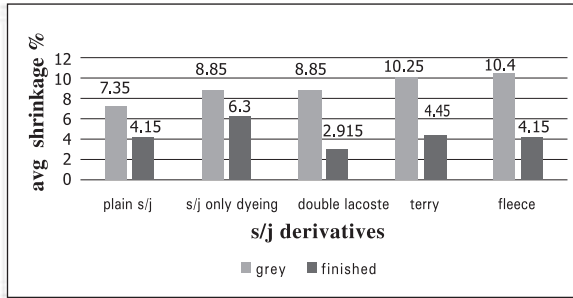Table no. 13: Shrinkage test for grey & finished sample of single jersey derivatives

Fig no. 05: Shrinkage test vs single jersey derivatives

According to the figure, grey fabric shrinks more than finished fabric. Maximum 5% shrinkage is acceptable though s/j (without finishing) has more then it. So we can take a decision that most of the shrinkage decreased by stentering and compacting.

Single jersey fabrics	Grey sample			Finished sample		
	X cm	Y cm	tanα = X/Y	X cm	Y cm	tanα = X/Y
Plain single jersey (only dyeing)	0.6	06	0.10	0.2	4.5	0.044
Plain single jersey	1.1	12	0.091	0.4	10	0.04
Double Lacoste	0.4	5.5	0.072	0.0	06	0.0
Terry	0.7	35	0.02	0.3	35	0.008
Fleece	0.9	12	0.075	0.4	10	0.04

Table no. 14: Spirality test for grey & finished sample of single jersey derivatives
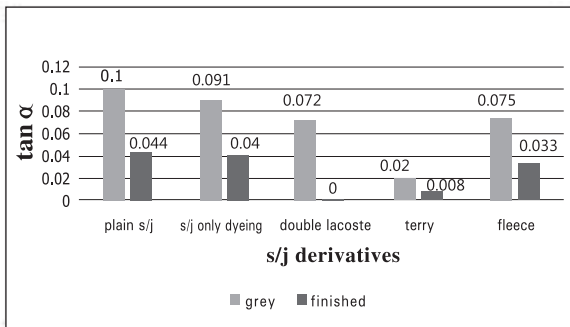

Fig no. 06: Spirality test vs single jersey derivatives

According to the figure, grey fabric has more spirality. Actually there were less knitting and dyeing fault, so spirality problem is reasonable and buyer will not claim the producer.

Fabric name	CPI		WPI		Stitch Density		GSM	
	Grey	Finished	Grey	Finished	Grey	Finished	Grey	Finished
Plain single jersey	60	49	27	36	1620	1764	154	167
Plain single jersey (only dyeing)	66	56	28	37	1848	2072	188	191
Double Lacoste	80	84	24	23	1920	1932	163	170
Lycra Terry	126	112	34	36	4284	4032	226.8	209
Fleece	100	92	26	27	2600	2484	291.1	267

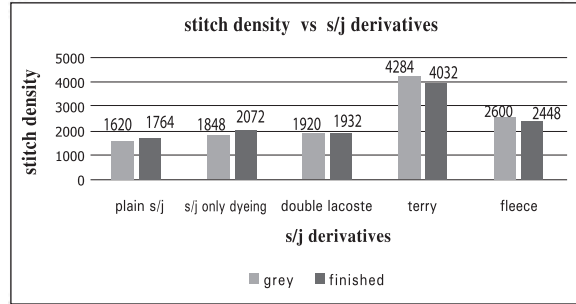*Table no. 15: Comparison of dimensional properties among single jersey derivatives*

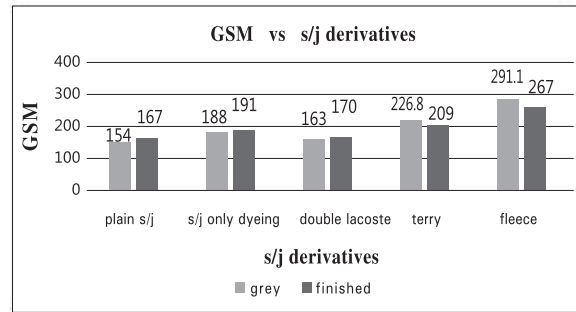*Fig no. 07: Stitch density vs single jersey derivatives*

Fig no 08: GSM vs single jersey derivatives

According to the two subsequent figure, WPI,CPI,stitch density & GSM are not constant both in grey and finished fabric. Always these parameters are higher in finished fabric than grey fabric if the fabric is remained untreated by engyme wash at the time of dyeing for removing protruding fiber.

Terry and fleece show distortion for engyme washing. For this wide variations knitting manager has to concern on finishing section since buyer does not provide grey sample. This is wrong idea that WPI increases after finishing when CPI decreases and vice versa. Heat seting is happened only when lycra is used.

Incase of terry and fleece, gsm and stitch density is higher than plain single jersey & lacoste. Suedding may decrease the gsm and stitch density for fleece.

IV. RESULT & DISCUSSIONS

Fabric name	Bursting test		Pilling test (after 1000 time abrasion)		Stiffness test average of face and back	
	Grey kpa	Finished kpa	Grey scale reading	Finished scale reading	Grey cm	Finished cm
Plain single jersey	212.4	146.3	1-2	1-2	5.25	5.6
Plain single jersey (only dyeing)	311	292	1-2	1-2	5.05	5.25
Double Lacoste	236	186	1-2	1-2	5	5.2
Lycra Terry	316	226.5	1-2	1-2	3.9	5.4
Fleece	301.6	211.8	1-2	1-2	4.45	5.8

Table no. 16: Comparison of Bursting, pilling, stiffness testing properties among single jersey derivatives

Fabric name	Shrinkage test (%)		Spirality Test (cm)	
	Grey	Finished	Grey	Finished
Plain single jersey	c-8.5	c-4.3		
	w-6.2	w-4	0.091	0.04
Plain single jersey (only dyeing)	c-6.7	c-9.3		
	w-11	w-3.33	0.091	0.04
Double Lacoste	c-10.7	c-5		
	w-8.5	w-.83	0.072	0.0
Lycra Terry	c-11	c-3.2		
	w-9.5	w-5.7	0.02	0.008
Fleece	c-9.6	c-5		
	w-11.2	w-3.3	0.075	0.033

Table no. 17: Comparison of Shrinkage & spirality testing properties among single jersey derivatives

By analyzing the results, we see that the physical & dimensional properties of fabrics change after dyeing & finishing processes. Finished fabrics show lower bursting strength than the grey fabrics. Single jersey fabrics show higher abrasion resistance which can be measured by pilling test method. After dyeing & finishing abrasion resistance of the fabric changes because of in-between processes. Finished fabrics show higher resistance than the grey. Stiffness, spirality & shrinkage properties of the finished sample of the single jersey fabrics vary from the grey sample. Stiffness depends on the bending properties of the fabrics. Stiffness increases after finishing because of stentering, heat setting & other finishing processes.

V. CONCLUSION

Grey & finished fabrics have distinct physical properties because of intermediary processes required to produce suitable fabrics for different applications. This analysis represents the changes of various physical properties of grey & finished sample of single jersey derivatives because of these intermediary processes such as dyeing, compacting, stentering, heat setting etc. Generally bursting strength of finished fabric falls as well as shrinkage & spirality which are minimized by stentering and compacting. There is no significant change in pilling but bending length will be increased after finishing. Having the knowledge of these variations should help us in the bulk production and finishing process & also help to meet the buyer requirements. Changes of physical properties can be essential sometimes to meet required demands. However, there are some cases that are studying about the corrections or minimization of these differences and further some treatments can be originated to reduce the variations of grey and finished single jersey fabrics.

Abbreviation used in this paper:
[GSM=Gram per square meter, WPI=Wales per inch, CPI= Course per inch, KPa=Kilopascal, mm=Milimeter, s=Second]

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