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Consequence of Fabric Structure & Shade% on GSM & Fastness Properties

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Abstract

This paper aims to investigate the change in Gram per Square Meter (GSM) and fastness properties of cotton knitted fabric with a variety of fabric structures and shade% dyeing with reactive dyes. Here are presented the changes of GSM and fastness value from pretreatment to finishing and compared the theoretical values with the calculated ones. To complete this research work, Plain *S/J, Single Lacoste, 1X1 Rib, and Interlock fabrics were* dyed with three different shades (light-0.422%, medium-0.936%, and dark-4.88%). Different properties of knitted fabric were tested i.e. rubbing fastness, wash Fastness, perspiration, weight per unit length, etc. It is seen that as an average about 10 to 41% GSM is changed from grey stage to the finishing stage for the mentioned fabric structures. So GSM variation is possible because of shade percentage and structures. In case of fastness properties wash and perspiration are superior, whereas rubbing fastness is moderate for both fabric structures and shade %.

Keywords: GSM, Fastness, Knitted fabric, Shade%, Fabric structure.

1. Introduction

GSM suggests that gram per square meter. It is an important property for material. Whether the fabric is heavier or lighter depends on fabric GSM. Variation of GSM from fabric to fabric particularly depends on the count &stitch length of fabric [1]. GSM is modified in Pretreatment, coloring& finishing to a larger extent. Throughout these processes, GSM change depends on the kinds of chemicals & dyes used & also with the processes used. Reactive dyes with totally different depths of shade were used [2]. Reactive dye form a covalent bond with the cellulosic fibre. A chemical bond named “covalent bond” is formed between the dye molecules and therefore the hydroxyl group of cellulose fibre. Colorfastness testis used to evaluate the ability of dyes retain materials. Colorfastness and color strength are terribly crucial facts just in case of coloured textile material that is intimately regarding varied coloring parameters viz. concentration of dye, salt, alkali, and dyeing temperature [3,4]. In the present work, the effect of concentration of reactive dye (light, medium, and dark), and the structures on colorfastness and GSM were scrutinized. The results were compared for variation in fastness values below an equivalent condition as being utilized in the textile industry. A number of factors behave linearly and a few don't seem to be. The result reflects that the colour fastness prices to dry and wet rubbing are not terribly different as for various structures of the fabric [5]. However, just in case of the wash fastness property, each material reflects a fixed value i.e.4/5 regardless of dye concentration, salt and alkali concentration, coloring time, and temperature.

In this research work, an endeavor was made to scrutinize the effect of structure and shade% to observe the fabric fastness properties as well as GSM. Fabrics were dyed with three shade% with reactive dyes (Novacron Super Black G, Novacron Yellow S-3R, and Novacron Deep Cherry SD). Color Fastness to rubbing, wash, and perspiration were evaluated after dyeing. It is found that rubbing fastness decreases with depth of shade increases for both dry and wet conditions. Besides, this dark shade wash fastness is lower than light and medium shade while fabric structure does not affect on colorfastness to wash.

2. Materials and Methods

2.1. Fabrics

To complete this research work knitted fabric with the following (Table 1) specification was taken from NorbanComtex Ltd, Sarabo, Kashimpur, Gazipur, Bangladesh.

Table 1: Fabric specification.

Fabric Name	GSM
Plain S/J	160
Single Lacoste	220
1X1 Rib	220
Interlock	200

2.2. Machine and Instruments

Sample dyeing machine, pipette, dryer, scissor, beaker, Electric balance, washing machine**(**Gyrowash**),** Color Matching Cabinet, gray scale**,**crock meter, and Perspirometerwere used during this work.

2.3. Dyes and Chemicals

The dyes and chemicals were collected from "**Norban Comtex Ltd".** Reactive dyes, soda ash-Na_2CO_3, caustic soda-NaOH, bleaching agent, acetic acid (100%), and other required chemicals were used.

2.4. Procedure for Pretreatment

For the pretreatment attach all four samples to form a rope shape and load it to the machine. Fill the tank with water and add all the chemicals according to the following recipe (Table 2) needed for pretreatment. Then raise the temperature of the machine to 98^o C and run for 45 min, later on, temperature dropped to 80^o C and give a hot wash at 80^{o}C for 6 min [6]. Finally, add acetic acid for neutralization and it is done at 60^{o}C for 10 min.

Table 2: Recipe for pretreatment

Process	Chemical	Concertation	
		%	g/L
Scouring & Bleaching	Tannex EP-1014	1.20	
	Sorbe fluid NSP Prem		0.50
	Hydrogen peroxide (H_2O_2)		2.50
	Soda Ash light		2.00
Acid Neutralization	Acetic acid		1.00
	Invatex PC (peroxide killer)		0.50

2.5. Dyeing Procedure:

At first, we collect the scoured and bleached fabric from the machine and make three batches for three different shades (light,

Table 3: Recipe used for dyeing.

Process	Chemicals	Light Shade (0.422%)		Medium shade (0.936%)		Dark shade (4.88%)	
		%	g/L	%	g/L	%	g/L
Dyeing	Novacron Super Black G	0.082		0.006		4.00	
	Novacron Yellow S-3R	0.10		0.60		0.34	
	Novacron Deep Cherry SD	0.24		0.33		0.54	
	Caustic Soda						2
	Glauber Salt		30		40		80
	Soda Ash		12		14		7
Neutralization	Acetic acid		1		1		1
Soaping	Sorbefluid NSP Prem		0.20		0.20		0.20
	Wash WP		0.30		1		1
Fixing	Albatex FRD		1		1		1
Softener	Soulbio RT		0.20		0.50		1

medium, dark), where each of the batches contains the same amount and all the 4 types of fabric. Required chemicals and process sequence are summarized in table 3 for dyeing [7].

2.6. Calculation of Fabric GSM

Grey fabric GSM is measured by the following formula (1). Then after dyeing dyed fabric GSM is evaluated with the help of a GSM cutter and formula [8]. At first, fabric is cut with the help of GSM cutter and then the weight of the individual cut sample is taken by electric balance. Finally, weight of the sample fabric is multiplied with by 100. This sequence is followed for all the samples and the result is summarized in table 5.

$$GSM = WX100 \ldots\ldots\ldots\ldots(1)$$

2.7. Assessment of fabric wash fastness

Colorfastness to wash was measured according to ISO standards 105-C03[9]. To do the wash fastness test required sample size is 10 × 4 cm and a multi-fiber fabric. Then sample and multi fiber were sewn. 4 g/L detergent was added with Washing solution in the dyeing machine where liquor ratio 1:50. The sample was treated for 30 minutes at 60±20C (140±3.60F). Then the fabric is washed in regular water and dried. The change in color of the tested specimen is evaluated visually by greyscale and summarized in Table 6. This evaluation was done in color matching cabinet under D65 light.

2.8. Evaluation of Colorfastness to rubbing

To investigate the rubbing fastness, ISO standards 105-X-12 method was obeyed [10]. Two samples were taken at the size of 14cmX5cm for dry and wet rubbing testing. Then test specimen is locked on the base of the crock meter and a white-cotton fabric sample size of 5cm×5cm is set to the upper-finger of the crock meter. Later on, turn the hand crank for 10 cycles. After that, the white rubbing test cloth was evaluated by greyscale. The output of this test result was given in table 7.

2.9. Measurement of perspiration test

This test is designed to observe the effects of human perspiration on colored textile materials. According to the following (table 4) recipe perspiration test was conducted. This test was done both in alkaline and acidic condition [11]. Then composite test specimen is treated for 30 min in the following perspiration solution at room temperature and a M:L of 50:1. After that, remove excess liquor and place this sample among two glasses and plates where pressure was 12.5 KPa and then keep in an oven for 4 hours at 37°C. Then the tested sample is hanging to dry in warm air (temperature used up to 60°C). Finally, color change and staining were evaluated numerically for each sample under light-box using grayscale and put in table 8.

Table 4: Recipe used for perspiration.

Chemicals	Alkaline	Acid
L- histidine monohydrochloride monohydrate ($C_6H_9O_2N_3.HCl.H_2O$)	0.5 g	0.5 g
Sodium Chloride (NaCl)	5.0 g	5.0 g
Disodium hydrogen orthophosphate dihydrate ($Na_2HPO_4 .2H_2O$)	2.5 g	2.2 g
Distilled Water	1000 mL	1000 mL
pH	8.0	5.5

3. Results and Discussion

The effects of fabric structure and shade% on GSM and fastness are discussed below sequentially.

3.1. Effects of shade% and structures on GSM

Effects of shade% and structures on GSM are shown in table 5 and figure 1, figure 2, figure 3, and figure 4. From this table and figure, it is found that the fabrics which are dyed with dark shade have an increasing number of GSM than medium and light.

Because, dark shade absorbs more dyes than medium and
So, we can say that GSM variation is possible because of shade percentage [12]. In case of fabric structure, it is found that the 1X1 rib has more GSM variations than other structures.

Fabric Types	Before dyeing GSM	Light Shade (0.422%)		Medium shade (0.936%)		Dark shade (4.88%)	
		Dyed fab. GSM	variation	Dyed fab. GSM	variation	Dyed fab. GSM	variation
Plain S/J	160	170	0	180	0	184	24
Single Lacoste	220	231	1	252	2	256	36
1X1 Rib	220	234	4	240	0	261	41
Interlock	200	215	5	227	7	237	37

Table 5: Variation of GSM due to shade% and structure

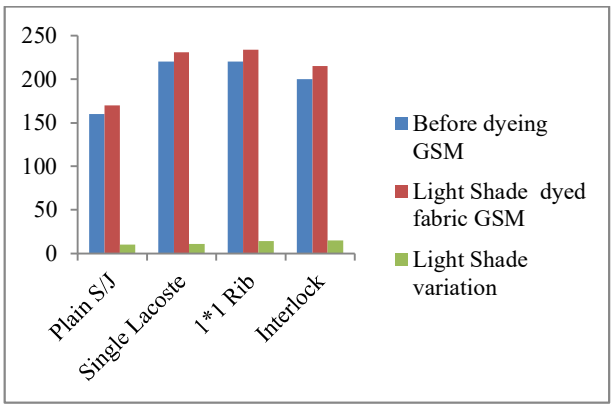

Figure 1: GSM variations for Light Shade

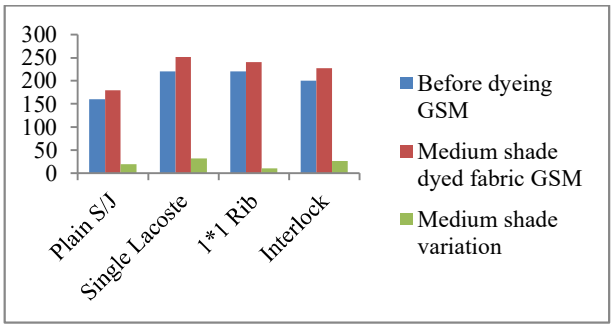

Figure 2: GSM variations for medium Shade

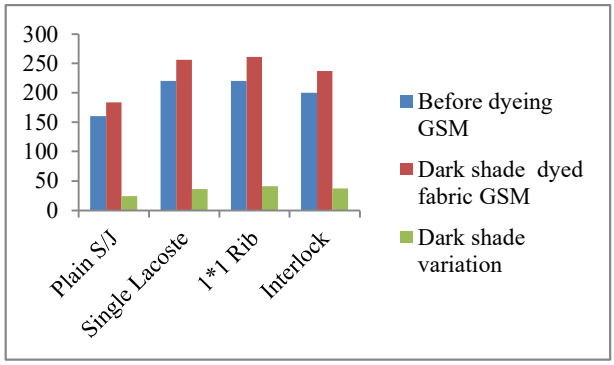

Figure 3: GSM variations for Dark Shade

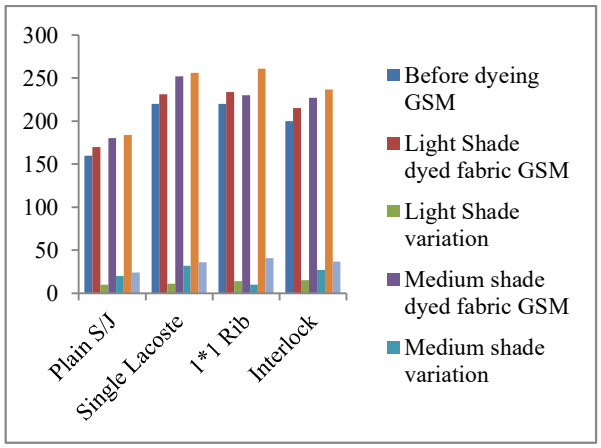

Figure 4: GSM variations due to fabric structure

3.2. Effects of shade% and structures on colorfastness to washing:

Change of wash fastness due to shade% and structure are given in table 5 and figure 5. It is observed that dark shade wash fastness is lower than light and medium shade while fabric structure does not effect colorfastness to wash.

Table 6: variation of wash fastness due to shade% and structure

Fabric ypes	Wash fastness rating		
	Light Shade (0.422%)	Medium shade (0.936%)	Dark shade (4.88%)
Plain S/J	*4/5*	*4/5*	*4*
Single Lacoste	*4/5*	*4/5*	*4/5*
1X1 Rib	*4/5*	*4/5*	*4*
Interlock	*4/5*	*4/5*	*4*

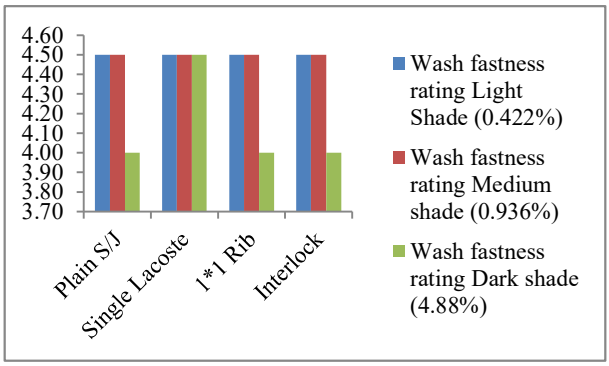

Figure 5: change of wash fastness due to shade% and structure

3.3. Effects of shade% and structures on color fastness to rubbing:

Result of rubbing fastness is placed in table 6 and figure 6. It is noticed that due to fabric structure there is no difference on color fastness to rubbing. But there is a slide change on the rate of colorfastness to rubbing for shade percentage [13]. It is due to dark shade absorb more color than the light and medium shade. So, the affinity of color staining of dark shade is more than medium or light shade.It is clear that rubbing fastness decreaseswith depth of shade increases for both dry and wet condition, but dry rubbing is better than wet rubbing.

Table 7: rubbing fastness rating

Fabric Types	Light-Shade (0.422%)		Medium-shade (0.936%)		Dark-shade (4.88%)	
	Dry-Rub	Wet-Rub	Dry-Rub	Wet-Rub	Dry-Rub	Wet-Rub
Plain S/J	4/5	4/5	4/5	3/4	4	3
Single Lacoste	4/5	4/5	4/5	3/4	4	3
1X1 Rib	4/5	4/5	4/5	3/4	4	3
Interlock	4/5	4/5	4/5	3/4	4	3

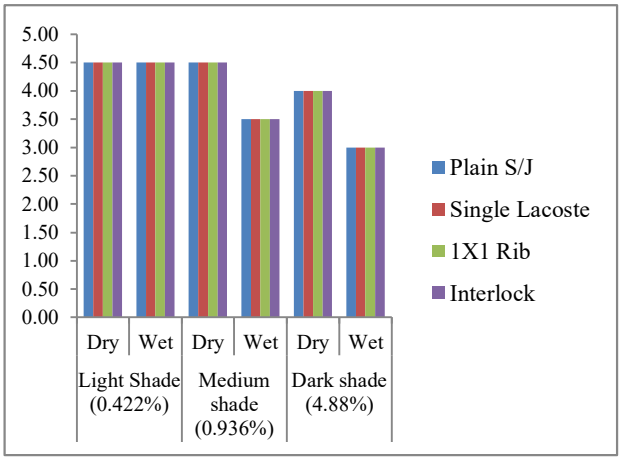

Figure 6: Effects of different wash on colorfastness to rubbing

3.4. Effects of shade% and structures on colorfastness to perspiration:

Colorfastness to perspiration is shown in table 7, table 8, and table 9. It is seen that there is no effect on light shade but there is a slight difference in the medium and dark shade for both acid and alkaline conditions.

Table 8: Colorfastness to Perspiration on Light shade

Multi-fiber Name	Color staining rating							
	Plain S/J		Single Lacoste		Interlock		1X1 Rib	
	Acid	Alkali	Acid	Alkali	Acid	Alkali	Acid	Alkali
Acetate	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Cotton	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Polyamide	4/5	4/5	4	4/5	4	4/5	4/5	4/5
Polyester	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Acrylic	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Wool	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5

Table 9: Colorfastness to Perspiration on the medium shade

Multi-fiber Name	Color staining rating							
	Plain S/J		Single Lacoste		Interlock		1X1 Rib	
	Acid	Alkali	Acid	Alkali	Acid	Alkali	Acid	Alkali
Acetate	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Cotton	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Polyamide	4/5	4/5	4	4/5	4	4/5	4/5	4/5
Polyester	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Acrylic	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Wool	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5

Table 10: Colorfastness to Perspiration on a dark shade

Multi-fiber Name	Color staining rating							
	Plain S/J		S/Lacoste		Interlock		1X1 Rib	
	Acid	Alkali	Acid	Alkali	Acid	Alkali	Acid	Alkali
Acetate	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Cotton	4/5	4	4/5	4	4	4	4	4
Polyamide	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Polyester	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Acrylic	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
Wool	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5

4. Conclusion:

It was supposed to evaluate the Consequence of material Structure & shade% on GSM & fastness properties. To do this research work cotton knitted fabric with different structures and three reactive dyes ((Novacron Super Black G, Novacron Yellow S-3R, and Novacron Deep Cherry SD) were selected, and after dyeing a remarkable change in the fastness properties and GSM variation have been found. Although rubbing fastness is lower but wash and perspiration fastness is higher for all the structures and shade%. Further research can also be conducted on this topic

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