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ANALYSIS THE EFFECTS OF CHANGE IN YARN COUNT AND STITCH LENGTH ON PHYSICAL PROPERTIES OF WAFFLE KNIT FABRIC

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ABSTRACT

Chowdhury MR (2018) Analysis the effects of change in yarn count and stitch length on physical properties of waffle knit fabric. *J. Innov. Dev. Strategy*. 12(1), 32-40.

For appropriate fabric production physical properties is an important parameter. Now a day's waffle knitted fabric is widely used for several end uses. The present research attempts to find the effect of yarn count and stitch length on waffle fabric physical properties. Three different yarn counts i.e. 26/1Ne, 30/1 Ne and 40/1 Ne used for producing miss waffle knit fabric. The samples produced with fixed dial Stitch length i.e. 1.95 mm and various cylinder stitch length (for 26/1 Ne waffle fabric) i.e. 3.90 mm. 3.95 mm, 4.00 mm and (for 30/1 Ne waffle fabric) cylinder stitch length selected 3.80 mm, 3.85 mm, 4.00 mm, and finally (for 40/1 Ne waffle fabric) cylinder stitch length were 3.65 mm, 3.70 mm, 3.75 mm. and then different physical properties such as pilling, rubbing fastness, bursting , color fastness measured in terms of change in yarn count & stitch length of waffle knit.

Key words: *waffle knit, yarn count, stitch length, physical properties.*

INTRODUCTION

Knitwear industry keeps great contribution in the Bangladesh socio-economic development. The sector is producing top quality knit garments for global fast fashion brands. But most of the goods produce by this single jersey derivatives fabric such a plain, single lacoste, double lacoste, polo pique etc. Development of rib derivatives such as Tuck waffle & Miss waffle fabric creates a new era for knit fabric manufacturing and marketing. Four primary structures – plain, rib, interlock and purl-are the base structures from which all weft knitted fabrics and garments are derived (Spencer 2001).

Waffle fabric, or sometimes honeycomb fabric, is usually made of cotton or microfiber. This type of fabric design can be produced both knitting and weaving process. Basically Waffle knit is a derivative of basic rib knitted structure, so in waffle knit it characteristics mostly like double jersey knit fabric. This is a balanced knit fabric. Though waffle is a double jersey rib derivatives but its shows different appearance both technical face and back. In the technical face it appearance of the technical face of plain fabric but on the other side it appearance like honeycomb.

Waffle knit can be produced by changing the knit loop with tuck or miss in a basic rib structure. If the knit loop replace with tuck loop then it termed as tuck waffle on the other hand if the knit loop replace with miss loop then it termed as miss waffle. Waffle knit fabric can be used for as decorative dress purpose, sweater, heavy jersey, muffler, insulating fabric, blankets, absorbent fabric , dishtowels, Sports jersey, basket covers and lamp shades with versatile cotton utility fabric. The role of mechanical/physical properties of a fabric is an important parameter to understand in order to achieve trouble - free tailoring of garments made from such fabrics (Shishoo 1995).

Physical characteristics are the dynamic physical parameters of fabric. They are physical changes in the fabric that result from applying outside forces on the fabric. Most of the durability and utility values of fabric are characteristics and not properties. There are four major categories of fabric characteristics that interest the apparel manufacturer. They are Style characteristics, Utility characteristics, Durability characteristics, Product production characteristics.

Utility characteristics are changes in the fit, comfort, and wearing functions of the garment when the fabric engages a mechanical thermal, electrical, or chemical force during the utilization of the garment. The two major types of utility characteristics are transmission and transformation. A transmission characteristic transmits mass or energy through the fabric. Transmission characteristics include: Air permeability (includes all gases and vapor), Heat transmission (thermal conductivity), Light permeability, Moisture transmission. Radioactivity transmission (the degree with which radioactive energy such as x-ray and gamma rays can penetrate fabrics). Transformation characteristics charge a physical property of the fabric. The property dimension(s) is altered without destroying the fabric. Changes which disintegrate the fabric are durability characteristics. Transformation characteristics include: Colorfastness, Crease resistance, Crock resistance, Dimensional stability, Pilling, Shrinkage, Static electricity etc.

Durability characteristics are the capacities of fabric to maintain the style and utility characteristics during wear. It is the measure of stress which destroys the fabric or the fabrics ability to repeat a desired style or utility characteristic. The durability characteristics are: Abrasive strength (the measure of rubbing action), Bursting strength (the measure of vertical pressure), Launder-ability (the measure of washing), Tearing strength, Moth resistance, Tensile strength Radiation absorption strength (the rate at which radiation energy either disintegrate a

fabric or destroys utility characteristics). Fire resistance, Corrosive strength (the measure of chemical action, acid or alkaline), Dry cleaning durability (the measure of dry cleaning performance). It was also perceived that higher GSM fabrics have more pilling tendency than lower GSM (Smriti 2015).

ICI's Pilling Box and the number of the pills formed and type of fuzz for each sample were measured using an electronic balance (Ozdil *et al.* 2005). As it is known that, pilling is a condition that arises in wear because of the little pills of entangled fiber that are formed by a rubbing action on loose fiber present on the surface of the fabric. Pilling is originally a fault & the deteriorated surface produced for pilling is undesirable for the consumer.

Textile is rubbed with a dry rubbing cloth and with a wet rubbing cloth. The machine provides two combinations of testing conditions through two alternative sizes of rubbing finger: one for pile fabrics; one for solid color or large print fabrics.

Color fastness to rubbing is a basic test used by customers to determine the quality of a colored fabric and has been an area of concern for processors for many years. A fastness is a place, such as a castle, which is considered safe because it is difficult to reach or easy to defend against attack. This test is designed to determine the degree of color which may be transferred from the surface of a colored fabric to a specify test cloth for rubbing (which could be dry and Wet). If the color fastness to rubbing is good then it's other properties like washing fastness and durability etc. improves automatically because the rubbing is a method to check the fixation of the color on the fabric. So if the fixation is good it's washing properties will be good.

Bursting Strength is a reliable index of the strength and performance of materials like paper, paperboards, corrugated boards and boxes, solid fiber boards, filter cloth, industrial fabrics, leather etc. The burst test is frequently used as a general guide to the strength of paper, solid board and corrugated board. Bursting strength is usually quoted in kpa. We determine bursting strength using a digital hydraulic paper or digital hydraulic board burst tester. This research attempts to investigate the effect of stitch length and different yarn count on waffle knitted fabric's physical properties i.e. pilling, rubbing fastness, color fastness to light and bursting strength.

MATERIALS AND METHODS

Raw material and equipment's used

In this research work, we produced miss waffle knitted fabric sample using three different yarn count i.e. 26/1 Ne, 30/1 Ne, 40/1 Ne, and each sample consist three different cylinder stitch length but dial stitch was fixed. Cylinder stitch length changed by varying variable dia for quality (VDQ) pulley. Total nine (9) samples were produced. These fabric samples are presented in Table 1 and Waffle fabrics dyeing recipe is presented Table 2, & Table 3, specification of different testing and knitting machine is given.

Table 1. Waffle sample produce using three different yarn counts and average GSM

Sample No	Yarn Count	(Fixed Dial Stitch Length + Cylinder Stitch Length) mm	Average GSM
1	26/1 Ne	1.95 + 3.90	216
2		1.95 + 3.95	215
3		1.95 + 4.00	214
4	30/1 Ne	1.95 + 3.80	197
5		1.95 + 3.85	195
6		1.95 + 4.00	190
7	40/1 Ne	1.95 + 3.65	146
8		1.95 + 3.70	144
9		1.95 + 3.75	142

Table 2. Waffle Fabric Dyeing recipe

Waffle Fabric Dyeing recipe
Wetting agent → 0.5 g/l
Stabilizer (H2O2) → 0.5 g/l
↓ (60^oC x 5')
Caustic → 2 g/l
↓ (60^oC x 15')
Hydrogen peroxide → 2.5 g/l
↓ (60^o - 80^oC)
Temperature rise up to 105^oC
↓ 30'
Acetic acid → 1 g/l + H_2O_2 Killer → 0.5 g/l

Cont'd

↓ (60°C x 10')
Acetic acid → 0.8 g/l [To Control PH - 4.5 - 5.5] Enzyme → 1.5 g/l
↓ (55°C x 45')
Sequestering agent / → 0.35 g/l
↓ (90°C x 5')
Leveling Agent) → 0.5 g/l
↓
Dye stuff
↓ 60°C x 35' → Runtime → 20'
Glauber Salt
↓ 60° x 10' → Runtime → 20'
Soda ash
↓ 60° x 40' → Runtime → 60'
Bath drop after shade matching
↓
Hot rinse
↓ (60° x 10')
Soaping
↓ (80° - 90°C x 10')
Cold rinse
↓ (45° x 10')
Neutralize
↓ (45° x 10')
Softening
↓
Unload
↓
Hydro extraction
↓
Drying

Table 3. Different machine specification

Machine Name	**Machine Description**
Double Jersey Circular Knitting Machine	Machine Brand- Unitex Machine origin- Singapore, Machine Feeder -78 Machine Dia - 32 Inch., Machine Gauge- G 18, RPM- 10.
Light Color Fastness Tester	Machine Brand- Q-SUN, Machine Model - Q-SUN Xe-2 Machine origin- Q-Lab Headquarters Westlake, OH USA Apparatus: Xenon Arc lamp light fastness tester equipped with axenon lamp, suitable filter systems and various control systems (Water or Air cooled type); Specimen holders; Masks; Black Standard Temperature (for ISO) Black Panel Thermometer (for AATCC); Color Matching Cabinet.
Bursting strength tester	Brand Name – MESDAN LAB Machine origin- Hessen – Germany. Machine Model – 338B- Lab, Measuring Range – 0-20 kg/cm^2
Crock meter	Brand Name – JAMES H. HEAL & CO LTD. Machine origin- Halifax, England. Apparatus: Grey Scale, 1. Grey Scale for assessing Change in color. ISO 105 A02:1993 2. Grey Scale for assessing staining. ISO 105- A03:1993
ICI Pilling and Snagging Tester	Brand Name – TESTEX Machine origin-P.R. China., Machine Model - TF223 Additional Apparatus :Rotation Speed - 60 +/ -2 rpm Pilling Assessment Viewer, Set of 5 Photographic Standards Mounting Jig (used to install specimens easily) Cork liner – pack of 6, Rubber tube – pack of 4

Test Methods (Determination of Physical Properties):

A) Determination of waffle knit fabric GSM by GSM cutter:

Principle:

The mass per unit area is determined by exposing a fabric sample to the standard atmosphere for testing textile until it has reached equilibrium with that atmosphere. Specimens of known dimensions are than taken and weighed and the mass per unit area of the sample calculated.

Test Method:

B.S. 1051, 1981 and ISO 139, 1973.

Test procedure:

Samples are conditioned for 24 hours in a standard atmosphere of 27 ± 2^{0}C and 65±2% RH. The method for measuring GSM was simply following the steps. Firstly, to take the conditioned fabric for test on the GSM cutter pad so that no crease or crinkle is formed. Secondly, to cut the fabric with GSM cutter (cut area was 100 square cm).Thirdly, to take the weight of the fabric by an electric balance. Fourthly, multiply the weight of the cut sample by 100. The result is the GSM of the fabric.

B) Determination of pilling of waffle knit fabric by ICI Pilling box method:

Principle

Pilling is rapidly replicate on fabrics in a fraction of the time due to normal wear. Pilling is formation of little balls of fibers (pills) on the surface of a fabric which is caused by abrasion in wear. Pilling is the tendency of fibers to come loose from a fabric surface and form balled particles of fiber.

Testing Standard

ISO 12945-1: 2000.

Test procedure

After preparing the all samples, all of them were carried out for the pilling test. The pilling test was performed according to It needs to condition the specimen before pilling. It was conditioned in standard temperature 20oC+2oC and relative humidity 65%+2% for at least 16 hrs, the test is carried out in same atmosphere.

A specimen (125 mm x 125 mm) is cut from fabric Stitched face-to-face and turned inside out. The fabric tube is then mounted on rubber tubes. The loose ends taped with PVC tape. All the four samples are then tumbled together in a cork-lined box 9" x 9" x 9" and allowed for required 10800 revolution cycle. The specimens are taken out and removed from rubber tube and rated.

Evolution

The samples are then given a rating of between 1 to 5 by using photographic assessment. The visual assessment table is given below:

Table 4. Pilling Assessment rating

Pilling Rating	Pilling Evolution
5	No Pilling
4	Slight Pilling
3	Moderate Pilling
2	Severe Pilling
1	Very Severe Pilling

C) Determination of color fastness to rubbing of waffle knit fabric using Crock meter:

Principle

This test is designed to determine the degree of color which may be transferred from the surface of a colored fabric to a specify test cloth for rubbing (which could be dry and Wet).

Testing Standard

BS EN ISO 105-X12:2002

Test procedure

Then test specimens (textile samples) put on the base of the crock meter. Using the spinal clip, set 5 Cm × 5 Cm of the white cotton fabric to the finger of the crock meter. Lower the covered finger on the test sample. Turn hand crank at the rate of the one turn per second. Remove the white rubbing test cloth and e valuate with grey scale.

Evolution

Dry crocking test:

First we take the sample of (4×1.5) cm. Then the fabric is placed on the emery paper. Pinned specimen holder is used to fix the fabric. After that crocking cloth is about 3×5 cm has settled with finger by spring clip. Loading unit is applied put the finger pinned the operating handle is operated by using of hand. 10 stocks the direction of every stock is 1 sec. Then the sample is collected of composed with grey scale. Crocking cloth is collected and compound with scale.

Wet crocking test:

In the case of wet crocking test crocking cloth in wetted with distilled water and excess water is sequences that it contains its own mass of water. Then the fabric is placed on the emery paper. Pinned specimen holder is used to fix the fabric. After that crocking cloth is about 3×5 cm has settled with finger by spring clip. Loading unit is applied put the finger pinned the operating handle is operated by using of hand. 10 stocks the direction of every stock is 1 sec. Then the sample is collected of composed with grey scale.

D) Determination of bursting strength of waffle knit fabric using bursting strength tester:

Principle

A test specimen is clamped over an expansive diaphragm by means of a circular clamping ring. Increasing compressed air pressure is applied to the underside of the diaphragm, causing distension of the diaphragm and the fabric. The pressure is increased smoothly until the test specimen bursts. The bursting strength and bursting distension are determined.

Testing Standard

EN ISO 13938 is in two parts as follows:

EN ISO 13938-1 Textiles - Bursting properties of fabrics - Part 1: Hydraulic method for determination of bursting strength and bursting distension (ISO 13938-1:1998).

EN ISO 13938-2 Textiles - Bursting properties of fabrics - Part 2: Pneumatic method for determination of bursting strength and bursting distension (ISO 13938-2:1998),The testing standard followed during bursting test with this standard.

Test procedure

All of the nine waffle samples bursting strength effect were tested using bursting strength tested according to hydraulic method for determination of bursting strength and bursting. Firstly take one sample and clamped it on the upper moveable clamping ring. Then start stabilizer and power switch, when the light of the tester is green, then move the two index wheel and make it zero position of the circular display. This display gives the bursting strength in Kpa. After pressing on switch it started to work and makes the fabric burst. The bursting strength result can be getting from two index wheel. Same process applied for rest of other samples.

Evolution

Bursting strength express in Kpa, and This data is getting from index wheel.

E) Determination of color fastness to light of waffle knit fabric using light fastness tester:

Principle

A specimen of the textile to be tested is exposed to artificial light under prescribed conditions, along with agreed standards (blue wool reference).The colorfastness is being assessed by comparison of the color change of the exposed portion to the masked control portion of the test specimen using gray scale or blue references used.

Testing Standard

EN ISO 105-B02:2014, Tests for color fastness — Part B 02: Color fastness to artificial light: Xenon arc fading lamp test.

Test procedure

All of the nine waffle specimens can be tested simultaneously against a single set of Blue Wool Reference standards. Place the card mounted with specimens into the specimen holder and cover with the exposure mask which covers the center one-third portion. Place the card with the blue standards into the specimen holder and cover with the exposure mask which covers the center one-third portion. Place the holders into the light fastness tester. Fill empty holders with OBA free card. Expose the specimens and blue standards, and frequently inspect in a color matching cabinet under D65 light using the grading mask, until the exposed area compared with the unexposed area. Re-cover the specimens and blue wool standards with the mask which covers the left two thirds. Continue to expose and frequently inspect in a color assessment cabinet under D65 light using a grading mask, until the 2nd exposed area compared with the unexposed area. At this point remove the specimens from the light fastness tester for assessment in the color assessment cabinet under D65 light, using the grading mask.

To avoid miss-rating of specimen due to photo chromism, it has to be conditioned at least 24 h in the dark at room climate. Samples assigning rating done by standard blue wool fabric. It has a range of (8-1).

Evolution

Color fastness to light assigning rating done by standard blue wool fabric. It has a range of (8-1).

Table 5. Color fastness to light assessment rating

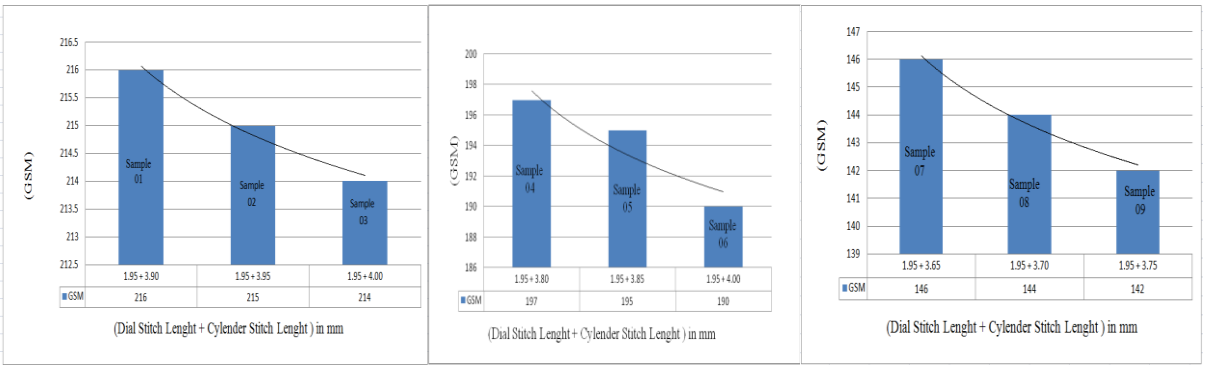
Grade	Degree of Fading	Light Fastness Type
8	No fading	Outstanding
7	Very slight fading	Excellent
6	Slight fading	Very good
5	Moderate fading	Good
4	Appreciable fading	Moderate
3	Significant fading	Fair
2	Extensive fading	Poor
1	Very extensive fading	Very poor

RESULTS AND DISCUSSION

Effect of yarn count and stitch length on waffle fabrics GSM:

Table 6. Effects of yarn count & stitch length on waffle fabrics gsm

Sample No	Yarn Count	(Fixed Dial Stitch Length + Cylinder Stitch Length) mm	Average GSM
1	26/1 Ne	1.95 + 3.90	216
2		1.95 + 3.95	215
3		1.95 + 4.00	214
4	30/1 Ne	1.95 + 3.80	197
5		1.95 + 3.85	195
6		1.95 + 4.00	190
7	40/1 Ne	1.95 + 3.65	146
8		1.95 + 3.70	144
9		1.95 + 3.75	142



(a) (b) (c)

Fig. 2. (a) Comparison between change in cylinder stitch length on waffle fabric GSM (26/1 Ne yarn)
(b) Comparison between change in cylinder stitch length on waffle fabric GSM (30/1 Ne yarn)
(c) Comparison between change in cylinder stitch length on waffle fabric GSM (40/1 Ne yarn)

Observation –A:

From table 6, here three waffle sample produced by same 26/1 Ne yarn count. There dial stitch length fixed i.e. 1.95 mm and used three different cylinder stitch length i.e. 3.90 mm, 3.95 mm and 4.00 mm. again 30/1 Ne yarn count. There dial stitch length fixed i.e. 1.95 mm and used three different cylinder stitch length i.e. 3.80 mm, 3.85 mm and 4.00 mm. lastly 40/1 Ne yarn count. There dial stitch length fixed i.e. 1.95 mm and used three different cylinder stitch length i.e. 3.65 mm, 3.70 mm and 3.75 mm. From table 6 and figure 2 it clearly concludes that increasing the indirect yarn count liable for decreasing gsm and vice versa. On the other hand for each fabric it shows that increasing the cylinder stitch length also liable for decreasing the gsm of waffle knit fabric.

Effect of yarn count and stitch length on waffle fabrics pilling:

Table 7. Effects of yarn count & stitch length on waffle fabrics pilling

Sample No	Yarn Count	(Fixed Dial Stitch Length + Cylinder Stitch Length) mm	Average GSM	Pilling Cycle	Pilling Grade	Average Pilling Grade	Evaluation
1	26/1 Ne	1.95 + 3.90	216	10800	4 4 4	≈≈ 4	Slight pilling
2		1.95 + 3.95	215	10800	4 4 4	≈≈ 4	Slight pilling
3		1.95 + 4.00	214	10800	3-4 4 3-4	≈≈ 3-4	Moderate pilling to Slight pilling
4	30/1 Ne	1.95 + 3.80	197	10800	4 4 4	≈≈ 4	Slight pilling
5		1.95 + 3.85	195	10800	4-5 4-5 4-5	≈≈ 4-5	Slight to no pilling
6		1.95 + 4.00	190	10800	4 4-5 4-5	≈≈ 4-5	Slight to no pilling
7	40/1 Ne	1.95 + 3.65	146	10800	5 5 5	≈≈5	No pilling
8		1.95 + 3.70	144	10800	4-5 4-5 4-5	≈≈ 4-5	Slight to no pilling
9		1.95 + 3.75	142	10800	5 5 4-5	≈≈ 5	No pilling

Observation –B:

From table 7 it clearly seen that the waffle samples having different count & different stitch length shows different gsm. Higher stitch length causes lower gsm and vice-versa. On the other hand increasing the indirect yarn count causes lower gsm and vice-versa. Finally It clearly seen that high gsm shows high pilling and vice-versa.

Effect of yarn count and stitch length on waffle fabrics color fastness to rubbing:

Table 8. Effects of yarn count & stitch length on waffle fabrics color fastness to rubbing

Sample No	Yarn Count	(Fixed Dial Stitch Length + Cylinder Stitch Length) mm	Average Grey Scale ratting for shade change due to Dry rubbing	Average Grey Scale ratting for staining due to Dry rubbing	Average Grey Scale ratting for shade change due to wet rubbing	Average Grey Scale ratting for staining due to wet rubbing
1	26/1 Ne	1.95 + 3.90	5 (Excellent Color fastness)	4-5 (Very slight staining to no staining)	3-4 (Fair to Good Color fastness)	3-4 (Moderate to fair staining)
2		1.95 + 3.95				
3		1.95 + 4.00				
4	30/1 Ne	1.95 + 3.80				
5		1.95 + 3.85				
6		1.95 + 4.00				
7	40/1 Ne	1.95 + 3.65				
8		1.95 + 3.70				
9		1.95 + 3.75				

Observation –C:

From table 8, all waffle knit samples were colored using red color reactive dye. Then color fastness to rubbing is observed using crock meter and found that average Grey Scale ratting for shade change due to Dry rubbing is 5 (Excellent Color fastness), average Grey Scale ratting for staining due to Dry rubbing is 4-5 (Very slight staining to no staining) on the other hand for wet rubbing average Grey Scale ratting for shade change due to wet rubbing is 3-4 (Fair to Good Color fastness) and average Grey Scale ratting for staining due to wet rubbing is 3-4 (Moderate to fair staining) is found.

Effect of yarn count and stitch length on waffle fabrics bursting strength:

Table 9. Effects of yarn count & stitch length on waffle fabrics bursting strength

Sample No	Yarn Count	(Fixed Dial Stitch Length + Cylinder Stitch Length) mm	Bursting Strength (Kpa)	Average Bursting strength (Kpa)	Observation / Remarks
1	26/1 Ne	1.95 + 3.90	206.00	206.50	Fabric Burst
2		1.95 + 3.95	205.50		Fabric Burst
3		1.95 + 4.00	208.00		Fabric Burst
4	30/1 Ne	1.95 + 3.80	200.00	201.83	Fabric Burst
5		1.95 + 3.85	203.00		Fabric Burst
6		1.95 + 4.00	202.50		Fabric Burst
7	40/1 Ne	1.95 + 3.65	191.00	194.33	Fabric Burst
8		1.95 + 3.70	197.50		Fabric Burst
9		1.95 + 3.75	194.50		Fabric Burst

Observation –D:

From table 9, It can be conclude that the waffle samples having different count & different stitch length shows different gsm. Higher stitch length causes lower gsm and vice-versa. On the other hand increasing the indirect yarn count causes lower gsm and vice-versa. In case of bursting strength, higher gsm waffle knit fabric shows higher bursting strength and vice-versa.

Effect of yarn count and stitch length on waffle fabrics color fastness to light:

Table 10. Effects of yarn count & stitch length on waffle fabrics color fastness to light

Sample No	Yarn Count	(Fixed Dial Stitch Length + Cylinder Stitch Length) mm	Condition of light fastness	Grade	Evaluation Standard
1	26/1 Ne	1.95 + 3.90	Arc Lamp and Air Cool Xenon Lamp	Up to Grad 4 (Blue Wool Scale)	Moderate light fastness or Appreciable fading
2		1.95 + 3.95			
3		1.95 + 4.00			
4	30/1 Ne	1.95 + 3.80			
5		1.95 + 3.85			
6		1.95 + 4.00			
7	40/1 Ne	1.95 + 3.65			
8		1.95 + 3.70			
9		1.95 + 3.75			

Observation –E:

From table 10, it can be conclude that All waffle samples were shows Grade 4 (Blue wool scale) that's means Moderate light fastness or Appreciable fading. Though all samples are dyed with same type of dye that's why waffle samples shows same grade.

CONCLUSION

The buyer is always aware of the physical properties and characteristics of the fabrics. It is the manufactures responsibility to select the appropriate fabrics for their intended applications, but it is the responsibility of the fabric producer to provide as much information as possible to help customers make appropriate fabric selections. Like physical properties, i.e. gsm, pilling, rubbing fastness, color fastness to light, and so on. This research gives a clear idea that how change in yarn count & cylinder stitch length affects various physical properties of waffle knit fabric.

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