American Journal of Modern Physics
2023; 12(1): 9-13
http://www.sciencepublishinggroup.com/j/ajmp
doi: 10.11648/j.ajmp.20231201.12
ISSN: 2326-8867 (Print); ISSN: 2326-8891 (Online)

Impact of Variant Fibre Blend Ratios, pH Levels and Finishing Types on Comfort Properties of Polyester/Cotton Knitted Fabric

Muhammad Qamar Tusief, Muhammad Hussain Sabir

Department of Fibre and Textile Technology, Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad, Pakistan

Email address:
qamartosief@yahoo.com (Muhammad Qamar Tusief)

To cite this article:
Muhammad Qamar Tusief, Muhammad Hussain Sabir. Impact of Variant Fibre Blend Ratios, pH Levels and Finishing Types on Comfort Properties of Polyester/Cotton Knitted Fabric. *American Journal of Modern Physics*. Vol. 12, No. 1, 2023, pp. 9-13.
doi: 10.11648/j.ajmp.20231201.12

Received: November 24, 2022; **Accepted**: January 4, 2023; **Published**: January 17, 2023

Abstract: Today is the era of value added textiles. The people like to have comfortable dressing in addition to have aesthetic quality. Comfort is the key factor of all kinds of fabrics especially for knitted fabric and has a significant role in their selection. Generally the comfort properties of the knitted fabric are related to its thermal and moisture transmission behavior. The comfort of knitted fabric depends upon many factors like fibre types and their blend ratios; pretreatment, dyeing and finishing processes, various pH levels during dyeing and processing. The application of synthetic fibres with natural ones is carried out for some kind of value addition in the resultant product. Polyester and Cotton (P/C) blend is the most popular blend in the textile sector. Both fibres play significant role in the comfort related characteristics of the manufactured fabric. The variant blend ratios of these fibres significantly affect the comfort of the resulted fabric. Hence keeping in view all this the present research study was planned to have a comprehensive observation on the comfort of the P/C blended knitted fabric under variant blend ratios, pH levels and finishing types. The study revealed a significant impact of all designated factors on the comfort properties of the knitted fabric.

Keywords: Fibre Blends, Knitted Fabric, pH Levels, Finishing Types, Fabric Comfort

1. Introduction

One of the basic needs of mankind is clothing and its easiness to wear (comfort) is one of the important parameter for its selection. Comfort of the fabric is typically demarcated as “the absence of discomfort or displeasure” in the fabric [1]. The ease of wearing is the basic factor reflecting the satisfaction of the wearer in respect of his/her physical, mental and bodily balance. Comfort properties of fabric has been classified into three categories of thermo-physiological, sensorial and psychological comfort [2, 3]. Among them thermo-physiological is considered the main indicator of the comfort of the clothing. This relates to the thermal and moisture transfer abilities of the fabric which largely depends upon the raw material used in the manufacturing of the fabric [4]. Hence fibre types and their blending ratios deeply affect the comfort of the resulted fabric [5-7].

The blending of polyester with cotton is a very prominent blend of raw fibres in textile sector. The major purpose of blending of these fibres or some other fibres in textile production is to generate a better comfort and properties balance in the end product. Mostly cotton fibre is recognized for its good comfort properties while polyester is considered for its strength, whiteness, anti-wrinkle and anti-mildew properties [8]. One of the important properties in the fabric that put significant impact on its comfort to wear is the easy flow of moisture through it. Hydrophilic nature of the material determines the ability of the material to absorb moisture from the skin. In addition to this other parameters like wick ability, drying time and water permeability of the fabric significantly affect the comfort of the fabric. [9]. Fibre blends are also carried out in order to achieve some end use application to meet the costumer’s demands. Polyester/cotton fibers blended fabric has shown more durability than 100% cotton fabric [10].

The pH plays significant role during dyeing and processing of the fabric during wetting and saturation process. The pH value of textiles is the indicator of the acid and alkaline component of the fabric residue disclosing its harmful impact on human health [11]. Human skin has mild acidic (5.5 -7.0) pH value. So the exceeding value of pH of textiles may have damaging effects on the skin like itches, bacterial infraction and even dermatitis. Moreover, the textile having extreme pH may easily be damaged. Hence pH value of the textiles is not only important for human health concerns but also associated with their own quality [12].

Commonly, the finishing of textile fabric is carried out in order to enhance its aesthetic beauty and serviceability. Most commonly in functional fabrics, the thermal comfort related properties of the fabric are of utmost important that are improved by applying various kinds of finishes. Water absorbency and thermal conductivity are the main characteristics of all kinds of comfort related fabrics especially for sports wears [13]. Many researchers have carried out research to see impact of various fibre types, their blends and finishing types on comfort of polyester/cotton blended fabric. However a collective impact of fibre blends and finishing types along with varying pH levels has not been explored yet. Hence the present study was planned to investigate the combined effect of various P/C blends, finishing types and pH levels on comfort properties of the resultant fabric for paving a guide path for future research.

2. Materials and Methods

The present research work entitled “Impact of variant fibre blend ratios, pH levels and finishing types on comfort properties of Polyester/Cotton knitted fabric” was initiated in the Department of Fibre & Textile Technology, University of Agriculture, Faisalabad, and mainly conducted at Interloop (Pvt.) Ltd. Faisalabad. The details of material used and methods adopted are given below.

2.1. Fabric Preparation

The selected fibres were blended under variant blend ratios B1 (0/100) 100% Cotton, B2 (50/50) Polyester/Cotton, and B3 (100/0) 100% Spun Polyester in ecru form. Following settings of circular knitting machines were selected for preparing the fabric samples under nominated variables.

Brand	Lonati GL-544
Gauge	14"
Stitch length	0.30
No. of needles	144
Voltage	380V
Machine speed	22 rpm

Pretreatment of cotton and P/C blended Fabric

2.1.1. Scouring

All the prepared fabric samples were scoured using the following recipe.

(i). Recipe

Material	Knitted Fabric
Scouring Agent Rocugen WPL	5 g/l
Caustic Soda	3 g/l
Temperature	80°C
Time	10 minutes

(ii). Method

First of all the prepared fabric samples of cotton fabric were placed in bath for scouring. The initial temperature of the bath was about 55°C and then the temperature was raised up to 80°C. After 10 minutes at this temperature the bath was allowed to cool at low temperature. The treated samples were taken out and rinsed thoroughly first in hot and then in cold water. Lastly the samples were hydro extracted and dried.

2.1.2. Bleaching

The bleaching recipe and procedure is given below.

(i). Recipe

Material	Knitted Fabric
Wetting agent (Sandopan DTC)	5 g/l

(Chemical Base Trideceth-7 Carboxylic Acid, form liquid, mild Anionic Surfactant)

Bleaching agent (H_2O_2)	6 g/l
Stabilizer (Sifa)	2 g/l
Temperature	90°C
Time	10 min.

(ii). Procedure

After scouring and drying the samples were placed into the bleaching bath at about 40°C. The temperature of the bath raised continuously up to 90°C. After reaming the sample at this maintained temperature for about ten minutes, the bath was allowed to cool and the samples were collected after lower down the temperature. Then these samples were rinsed first in hot and then in cold water. Finally the sample was hydro extracted and dried.

2.2. Dyeing and Finishing of Fabric Samples

2.2.1. Dyeing

Knitted fabric samples were dyed with reactive dye (Black) according to Exhaust dyeing in Tupessa dyeing machine in processing development lab with following recipe.

(i). Recipe

Fabric Sample	2 kg
Synozol Black EXF	40gms
Common Salt (NaCl)	0.800 kg
Soda Ash (Na_2CO_3)	200 gm
Citric Acid (Monohydrate) (Stabilizing gent)	10 gm
Citric Acid (Enzymes)	15 gm
Meropan DPE (Soaping Agent)	10 gm
Cellusoft L	10 gm

(ii). Procedure

All samples weighted 2.0 kg. Samples were dyed in Tupessa Dyeing Machine having the capacity to process 3 kg. Scoured samples were carried out fewer than 2 cold washes for 5 minutes. Dyes, Salt and Soda ash was added and process of dyeing continued at 60°C for 80 minutes. 2 cold washes were applied.

Neutralizing was done with Citric Acid at room temperature. After ten minutes Meropan DPE for soaping was added at 90°C.

2.2.2. Finishing

Hydrophilic finishing agent RGH (1.5%) and hydrophobic finishing agents GSQ (1.5%) were applied at the end and then the samples were hydro extracted and after that they are tumble dried.

Method	Exhaust
Pick Up	100%
Temperature	140°C
Curing Time	3 min
RGH Concentration	1.5%

(Hydrophilic silicone softener used for highest requirements. TUBINGAL RGH is a micro emulsion based on a recently developed and patented Organo modified compound)

GSQ Concentration	1.5%

(Chemical Basis Polysiloxane compound, Anionic in liquid (macro emulsion) form)

The variables selected for the present study are tabulated in the Table 1.

Table 1. *Variables of the study.*

P/C blend ratios	Finishing bath pH range	Finishes types
B1= 0/100, 100% cotton	R1= 5	F1= Hydrophilic Finishes
B2= 50/50, Polyester/Cotton	R2= 6	F2= Hydrophobic Finishes
B3= 100/0, 100% Polyester	R3= 7	

2.3. Testing of the Comfort Properties

The testing of the prepared fabric samples were made by placing them on smooth surface for 24 hours conditioning under 65±2% relative humidity and 21±2°C temperature. After this treatment the testing of the samples were carried out for the following properties related to its ease to wear adopting standard test methods recommended.

2.3.1. Absorbency (AATCC 79-2010)

Fabric absorbency is one of the important comfort property of the fabric. The absorbency of the prepared samples were tested as per the standards method AATCC-2010 [14] adopting the recommended procedure as given below.

(i). Principle

The principle of water absorbency test of the fabric is based on the measurement of the time required to disappear by the water drop fell freely on the stretched surface of the fabric. This time is known as wetting time.

(ii). Apparatus

1) Embroidery hoop with a 152.4mm (6.0 in.).
2) Burette with stand.
3) Delivering 15-25 drops of water per millimeter.
4) Stopwatch.
5) Distilled of 21°C.

2.3.2. Vertical Wicking (AATCC 197-2011)

It is the ability of the fabric to transport the liquid along and/or through them. The wicking ability of the prepared samples were test as per the standard method AATCC 197-2011 [15] using the following apparatus:

1) Distilled water at 21°C.
2) Marking pens.
3) Stopwatch, Tape or ruler.
4) Surface tension meter.
5) Erlenmeyer flask.
6) Pipette.
7) Straight pins.
8) Flask.
9) Small paper clip or clamp.
10) Templates 165×25mm.
11) Double sided plate.

2.3.3. Drying Time (AATCC 199-2011)

This test is carried out to measure the drying time of the fabric with increasing temperature applying a gravimetric moisture analyzer. This property of the prepared samples was tested adopting the standard method as described under AATCC 199-2011 [15] using the following apparatus:

1) Moisture analyzer with a heating element.
2) Distilled water.
3) Vertical specimen stand.
4) Tweezers.
5) 400 ml Beaker.
6) Wire screen.
7) Specimen support platform.
8) Electronic motorized pipette.

3. Results and Discussion

The prepared fabric samples according to the selected variables as given in Table 1, were tested for their comfort properties adopting standard methods as given in Materials and Methods section. The results so observed and the analyses of data is as under.

3.1. Absorbency Time (Sec) of Dyed Fabrics

The mean values of the collected data regarding absorbency time of the fabric with respect to various fibre blend ratios, pH range and finishing types is shown in Table 2. For various blend ratios B1, B2 and B3 are 8.63 (sec), 18.14 (sec) and 26.96 (sec) respectively. These values differed significantly from one another and reflecting the fact that increasing ratio of polyester in the blend increased the absorbency time of the fabric as mentioned in a previous study [9].

Similarly absorbency time of dyed fabric samples prepared at various pH values R1, R2 and R3 are 19.27 (sec), 17.26 (sec) and 15.00 (sec) respectively. All this clears that at higher pH the hydrophilic properties of the fabric enhanced [16].

The data regarding the absorbency time of fabric with respect to various finish types reflects that fabric with finish F2 showed more absorbency time (20.83 sec) as compared to that of fabric with finish F1 (15.00 sec) as shown in Table 2. These results clear the fact that after dyeing the hydrophobic synthetic fibres usually exhibits less absorbency. Only after application of a suitable hydrophilic agent the material can fulfill its function [17].

Table 2. *Comparison of Individual Treatment Means for Absorbency Time (sec) of Dyed Fabrics.*

Blend Ratio (B)	pH Range (R)	Finishes Types (F)
B_1=8.63c	R_1=19.27a	F_1=15.00b
B_2=18.14b	R_2=17.26b	F_2=20.83a
B_3=26.96a	R_3=15.00c	

The probability level of significant difference among any values not sharing common letter is 0.05.

3.2. Vertical Wicking Time (Min) of Dyed Fabrics

The data regarding the comparison of individual means of vertical wicking time of the fabric with respect to various fibre blend ratios, pH range and finishing types is shown in Table 3. It discloses that vertical wicking for blend ratios B1, B2 and B3 are 21.35 (min), 14.94 (min) and 8.75 (min) respectively. These values differed significantly from one another. These results indicate that the wicking values were highest for the higher polyester content fabrics. This may due to the surface modification of the polyester component of the fabrics, which help improving the wicking behavior that is, liquid moisture transmission of the fabrics [18]. Similarly the mean values of vertical wicking time of fabric samples prepared at variant pH ranges R1, R2 and R3 are 14.15 (min), 16.01 (min) and 18.08 (min) respectively. These values differed significantly from one another. The results reveal that the pH range R3 gave the maximum value while the minimum value is recorded for pH range R1. Similar findings were also observed in a previous study [19] that the vertical wicking height decreases with an increasing hydrogen ion concentration, which indicates that the liquid movement began firstly in the low hydrolyze fabric pores, in which the action was faster because of the influence of the capillary action and higher capillary pressure, and then it continued to fill in the larger hydrolyze fabrics pores with a decreasing wicking rate.

In the same line the mean values of vertical wicking time of fabric samples prepared with different finishing types F1 and F2 are 16.73 (min) and 13.30 (min) correspondingly. These results can be compared with the study that the water vapors is influenced significantly by surface characteristics of the hydrophilic and hydrophobic nature of the fabrics [20].

Table 3. *Comparison of Individual Treatment Means for Vertical Wicking Time (min) of Dyed Fabrics.*

Blend Ratio (B)	pH Range (R)	Finishes Types (F)
B_1=21.35a	R_1=14.15c	F_1=16.73a
B_2=14.94b	R_2=16.01b	F_2=13.30b
B_3=8.75c	R_3=18.08a	

The probability level of significant difference among any values not sharing common letter is 0.05.

3.3. Drying Time (Min) of Dyed Fabrics

The comparison of individual treatment means for drying time (min) of dyed fabrics is presented in Table 4. It was noted that the drying time of the fabric samples for different blend ratios B1, B2 and B3 were 22.04 (min), 17.09 (min) and 11.41 (min) respectively. These values differed significantly from one another. These findings depicts the fast drying properties of fabric having high polyester ratio. These results are well supported from the study that the fabrics made up of polyester yarns dried faster than those made up of P/C blend yarn yarns and made up of cotton yarns which can be explained by the bulky structures of P/C blend and cotton yarns, giving porosity to the fabric [21].

The drying time values of samples for variant ranges of pH R1, R2 and R3 are 15.11 (min), 16.88 (min) and 19.55 (min) respectively. These values differed significantly from one another. These results are in line with the findings that the drying time is positively correlated with the fabric compactness and hydrogen ion concentration of water in the fabric. The water vapor diffusion is directly proportional to drying time [22].

The results regarding fabric drying time for various finishing types F1 and F2 are 18.50 (min) and 16.12 (min) respectively. These values differed significantly from one another. These findings well relate to the observations that after dyeing the hydrophobic synthetic fibres usually exhibits less absorbency [17], only after application of a suitable hydrophilic agent can the material fulfill its function. This significantly increases the speed at which the moisture is spread to the hydrophilic outer layer and thus considerably accelerates drying.

Table 4. *Comparison of Individual Treatment Means for Drying Time (min) of Dyed Fabrics.*

Blend Ratio (B)	pH Range (R)	Finishes Types (F)
B_1=22.04a	R_1=15.11c	F_1=18.50a
B_2=17.09b	R_2=16.88b	F_2=16.12b
B_3=11.41c	R_3=19.55a	

The probability level of significant difference among any values not sharing common letter is 0.05.

4. Conclusions

The main purposed of the current study was to investigate the impact of various P/C blend ratios, pH levels of dyeing solution and finishing types on comfort properties of the resultant knitted fabric. The following conclusions are derived from this study:

1) The fabric absorbency level improved with the increase

of cotton fibre ratio in the blend means absorbency time decreased in respect of high ratio of cotton in blend and decreased with increasing ratio of polyester (hydrophobic material) in the blend. This is because polyester fibres have hydrophobic properties, hence the increase of their ratio in the blend decreased the absorbency property of the resultant fabric. Similarly high pH level enhanced the hydrophilic properties of the resultant fabric. And this property improves further with the application of hydrophilic finishes on the surface of the final fabric.

2) The vertical wicking or moisture transmission and drying ability of the fabric improved with the increasing ratio of polyester fibre and application of hydrophobic finish while both these properties showed reverse trend with the increase of the pH level of the dyeing solution. This happened due to the increase of hydroxyl ions in the dyeing solution because of the increasing pH level of the solution. These hydroxyl ions enhanced the adsorbent properties of the resultant fabric that effected the wicking ability of the fabric.

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