

S. Uyanik,
*Z. Degirmenci,
*M. Topalbekiroglu,
F. Geyik

Examining the Relation Between the Number and Location of Tuck Stitches and Bursting Strength in Circular Knitted Fabrics

DOI: 10.5604/12303666.1170266

University of Gaziantep,
Vocational High School,
Department of Textile,
Gaziantep, Turkey

*University of Gaziantep,
Department of Textile Engineering,
Gaziantep, Turkey

Abstract

Single jersey fabrics are the most common type among knitted fabrics. Their patterns are designed by loops, tuck and float stitches and their combinations. The tuck stitch has important influences on fabric properties as it increases the fabric weight, thickness and width, and makes the fabric more porous than others. In this research 12 different circular knitted fabrics were produced with different numbers of tuck stitches and were also dyed. As the most important performance property for knitted fabrics, their bursting strength properties were investigated. The aim of the study was to examine the relation between the tuck stitches and bursting strength in circular knitted fabrics according to the number and location of tuck stitches in the pattern. To achieve the most correct result, graphics and statistical analyses were used.

Key words: tuck stitch, bursting strength, single jersey fabric, circular knitted fabrics.

Introduction

Knitted fabrics have a versatile using area because of their fast and easy production, low cost, softness, elasticity and comfort properties. In general, knitted fabrics are produced by warp and weft knitting techniques. Circular knitting is a type of weft knitting, in which many different patterned fabrics can be knitted by this technique; however, all of them are formed by loop, float stitch and tuck stitch with different combinations. A tuck stitch is formed, as suggested by its name, when the yarn is tucked into the structure by the needle, instead of being formed into a loop. The tuck stitch is usually used in fabric patterning, the insertion of problematic yarns, the shortening of jacquard floats and garment marking. It also has important influences on fabric properties as it increases the fabric weight, thickness and width, and provides more porosity than other fabrics [1].

A tuck stitch is composed of a held loop, one or more tuck loops and knitted loops. It is produced when a needle holding its loop also receives a new one, which becomes a tuck loop because it is not intermeshed through the old loop, but is tucked in behind it on the reverse side of the stitch. Tuck stitches may occur singly, with across adjacent needles, or on the same needle in successive knitting cycles. Tuck loops reduce the fabric length and length-wise elasticity because the higher yarn tension on the tuck and held loops causes them to rob yarn from adjacent knitted loops, thereby making them smaller and providing greater stability and shape retention. The fabric width is increased because the tuck loops pull the held loops downwards, causing them to spread outwards and make extra yarn available for width-wise elasticity [2]. In **Figure 1** some knitted pattern examples formed by tuck stitches are shown.

All the patterns shown in **Figure 1** were formed with tuck stitches, but both their number and location were different from each other. The number of tuck stitches and their location change the pattern besides the structural property and strength of the fabric. A few studies were found related to the influence of the tuck stitch on the properties of circular knitted fabrics in the literature available. Kaya (2006) investigated performances such as the dimensional stability, skewness, pilling resistance and bursting strength of plain knit and lacoste fabric. She observed that the bursting strength of lacoste was less than plain knit, and there was not an important difference in the bursting strength of unwashed and washed fabrics [4]. Shahbaz et al. (2005) revealed that fabric strength largely depends upon that of the yarn. Ertugrul and Ucar (2000) reported that the fabric weight, yarn strength and yarn elongation are the major parameters



Figure 1. Some knitted pattern examples formed by tuck stitches [3].

that affect the bursting strength of knitted fabrics [6]. Önal and Candan (2003) found that the knit type and fabric tightness greatly influence fabric shrinkage, and double pique knits shrink less widthwise but more lengthwise than plain knits and fleecy knits [7]. Kane et al. (2007) indicated that the combination order of knit-tuck stitches played an important role in all the fabric properties. The result of their study showed that the addition of tuck stitches to knit stitches improved fabric properties like abrasion resistance, air permeability, water absorbency, thermal insulation, compression, bending, shear, tensile properties and handle values [8]. Emirhanova and Kavusturan (2008) revealed that the effect of knit structure on the bursting strength, air permeability and bending rigidity is highly significant, and tuck stitch fabrics have the lowest resistance to abrasion [9].

For knitted fabrics, the bursting strength is an extremely important property in many ways. The fabric should have sufficient strength against forces acting upon it during dyeing, finishing and use [10]. In the bursting strength property of the fabric, the elongation and strength of the yarn as well as the structure of the fabric are the effective parameters. Generally it is thought that firstly the weakest yarn is broken, but this is not actually correct. The real effect is “stronger yarns are less elastic and reach the elastic limit quickly and break” (Özdil 2003) [11]. The bursting strength of the fabrics are measured by the pneumatic or hydraulic method. In both methods vertical pressure is put on the sample under a vacuum and the pressure is determined at the first bursting detect. In this test the time is set between 20 ± 5 s, the inflation rate adjusted according to this time, and the diaphragm correction is performed.

In the present study, twelve different knitted fabrics were produced using tuck stitches with different combinations, and it was aimed to investigate the relationship between the bursting strength and tuck stitches. In this research the effect of tuck stitches and dyeing on the structural properties of the sample knitted fabrics were also analyzed. All the analyses were made statistically and graphically.

Material and method

In this research, by using 19.7/1 tex, 100%, carded ring spun yarn, twelve dif-

ferent sample knitted fabrics were produced with a Monarch branded circular knitting machine. The properties of the machine were 28 E, 30”, 84 feeders, and 2582 needles, at 30 r.p.m. speed. The knitted fabrics produced were dyed to compare the bursting strength values of each sample group. The dying process included kiering, dyeing and washing processes. In **Table 1**, a needle diagram and pattern properties of the sample knitted fabrics are presented. In this table, the sample knitted fabrics were numbered from 1 to 12 according to the number of tuck stitches (NTS). The num-

bers of tuck stitches of the fabric structures were determined a considering the total stitch density of the largest pattern, which had 84 courses and 4 wales ($84 \times 4 = 336$ stitch), and these numbers were used to define them in the manuscript.

In **Table 1**, the name, needle diagram and pattern properties of the samples are given. Some of the samples given in the table already have a known pattern type but others were formed with combinations, and hence they did not have known traditional names. Before testing, all the

Table 1. Pattern properties and needle diagrams of samples.

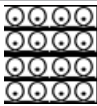
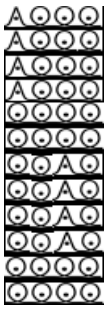




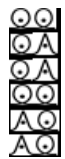


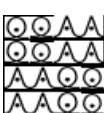
Sample No	Pattern properties	Needle diagram	Sample No	Pattern properties	Needle diagram
1	This sample is named "single jersey" and it has no tuck stitch.		2	This sample is a combination of sample 4 with 48 courses and sample 1 with 36 courses.	
3	This sample is a combination of sample 6 with 54 courses and sample 1 with 30 courses.		4	This sample is named 'honeycomb' and it has 4 tuck stitches and 2 plain stitches in the same needle. This type is known as a zigzag pattern.	
5	This sample has 2 tuck stitches and 1 plain stitch in the same needle.		6	This sample has 4 tuck stitches in the same needle	
7	This sample is named 'honeycomb' and it has 5 tuck stitches 1 plain stitch in the same needle. This type is known as a zigzag pattern.		8	This sample is named 'single lacoste' and it has 1 tuck stitch and 1 plain stitch in the same needle. This type is known as a zigzag pattern.	
9	This sample is named 'double lacoste' and it has 2 tuck stitches and 1 plain stitch in the same needle. This type is known as a zigzag pattern.		10	This sample has 2 tuck stitches in the adjacent needles for the 1st and 2nd courses and then 1 tuck stitch in the other needles for the 3rd and 4th courses. This type is known as a zigzag pattern.	
11	This sample is named 'English pique' and it has 2 tuck stitches but no plain stitch in the same needle. This type is known as a zigzag pattern.		12	This sample has 2 tuck stitches in the adjacent needles for the 1st and 2nd courses and then 1 tuck stitch in the other needles for the 3rd and 4th courses. This type is known as a zigzag pattern.	

Table 2. Structural properties of fabric structures; *336 S is the smallest stitch number which contains all the samples.

Sample	Number of tuck stitches/336 S*	Stitch length, mm	K (constant)	Course density, cm ⁻¹ (cpc)		Wale density, cm ⁻¹ (wpc)		Weight, g/m ²		Thickness, mm	
				gray	dyed	gray	dyed	gray	dyed	Gray	dyed
1	0	2,7	0,37	21	20	12,5	15,5	130	153	0,44	0,44
2	32	2,7	0,37	17,5	18	12,5	14	137	168	0,50	0,50
3	43	3,01	0,332	20	18,5	11,5	13	135	144	0,52	0,50
4	56	2,7	0,37	17	17,5	11,5	13,5	146	172	0,53	0,54
5	56	2,7	0,37	17	17,5	11,5	12,5	138	159	0,54	0,51
6	67	3,01	0,332	20	19,8	11	11,7	137	152	0,56	0,52
7	70	3,15	0,317	13	14,5	12	11,5	132	150	0,54	0,56
8	84	2,6	0,384	14	14,5	11	12	142	180	0,53	0,56
9	112	2,65	0,377	17	17,5	11	11,5	168	184	0,69	0,64
10	126	2,54	0,393	13,5	13,5	11	12,6	137	161	0,60	0,61
11	168	2,6	0,384	15	15,5	10,5	11,7	145	174	0,62	0,63
12	168	2,26	0,442	15	14	12	14	137	166	0,59	0,65

samples were conditioned in accordance with the standard ASTM D1776-08 [12]. As structural properties, the stitch length, course density, wales per centimeter (wpc), weight and thickness were measured according to international standards [13, 14]. The bursting strength test was applied as directed in the EN ISO 13938-2 standard [15] on a James Heal Truburst Bursting Strength Test Machine in ten different places per sample, and test results were evaluated in kPa.

Results and discussion

Structural Properties

The number of tuck stitches and their locations are important factors for the stitch length, K (constant), course density, and wale density. The structural properties of gray and dyed sample knitted fabrics are given in **Table 2**.

According to **Table 2**, the stitch length values of all sample knitted fabrics are close to each other. The dyeing process increases the wale density 1 cm as well

as weight values of the sample knitted fabrics, but it does not affect their course density and thickness proportionally. This situation relates to the location of tuck stitches of the fabrics.

Bursting strength of sample knitted fabrics

To measure the strength of the knitted fabrics, a bursting strength test device was used. There are two types: pneumatic and hydraulic. In the present study, a pneumatic one (James Heal, Truburst tester) was used. In **Figure 2.a**, inflated knitted fabric and in **Figure 2.b** bursted knitted fabric examples are presented.

During the test, air pressure was applied to the fabric vertically; then by means of the air the fabric began to inflate (**Figure 2.a**), and after the fabric reached the maximum inflation height the fabric burst (**Figure 2.b**). The bursting strength of the fabrics is proportional to the structural properties of the fabric. These properties are the yarn, fabric pattern, and tightness of the fabric and finishing treatments applied. In this study, except

the pattern of the fabrics, all the other properties are the same. The patterns of the sample knitted fabrics were differentiated from each other by changing the number and location of tuck stitches inside them, as in **Figure 1**. All the tests were done with keeping the time constant. Then the results were calculated after diaphragm correction. Corrected diaphragm bursting strength test results of both gray and dyed fabrics are given in **Table 3**.

According to **Tables 2** and **3**, for most of the gray and dyed samples, it is seen that while the number of tuck stitches decreases (**Table 2**), the bursting strength values (**Table 3**) increase. Forming tuck stitch causes the structure pattern to be more porous, which causes a decrease in the resistance of the fabrics to pressure. The tucked loop's yarn is under tension according to the number of stitches, and hence when the effect of pressure breaking of the yarn eases, then the bursting strength decreases and therefore the bursting of these fabrics gets easy as well.

Effects of the Number and Location of Tuck Stitches on the Bursting Strength Values of Gray Sample Knitted Fabrics

The number and location of tuck stitches of the sample knitted fabrics are different from each other. To see the effect of the number and location of tuck stitches on the bursting strength of the fabrics, a graph was drawn, given in **Figure 3**.

According to **Figure 3** the bursting strength of the sample knitted fabrics changes between approximately 363 to 774 kPa. To conclude the bursting strength degree of the sample knitted fabrics, the values and patterns are evalu-

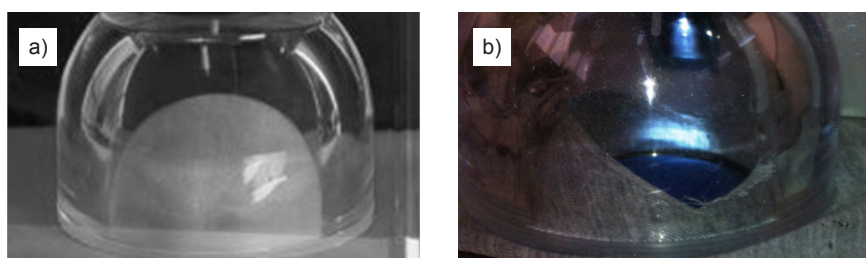


Figure 2. a) inflated knitted fabric, b) bursted knitted fabric.

Table 3. Bursting strength test results of sample knitted fabrics.

Sample numbers	1	2	3	4	5	6	7	8	9	10	11	12
Gray (kPa)	688	578	428	556	407	385	434	689	653	723	680	774
Dyed (kPa)	725	496	400	486	363	356	372	616	540	521	599	667

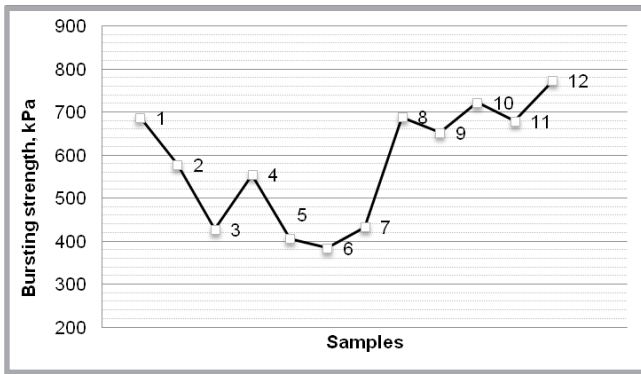


Figure 3. Bursting strength of gray fabrics according to the number and location of tuck stitches.

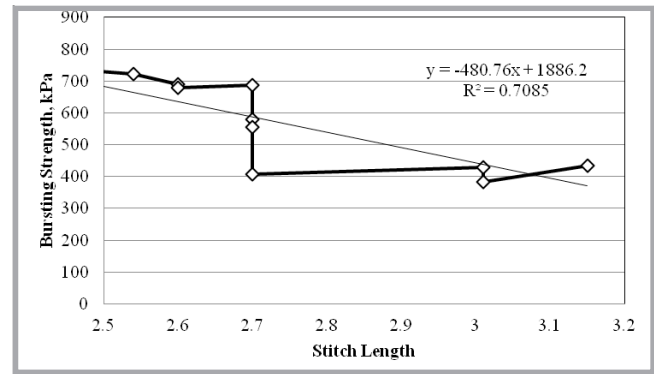


Figure 4. Effect of stitch length on the bursting strength of sample knitted fabrics.

ated together. Sample 1 is plain fabric and has no tuck stitch. The bursting strength of this sample is presented as a control group. As seen from **Figure 3**, the bursting strength of samples 3, 5 and 6 are lower than the others. The pattern designs of tuck stitches in these samples are not zigzag, as shown in **Table 1** (column of needle diagram). When the location of tuck stitches are not in a zigzag form, the fabric will not pick up very much; in other words the loops inside the fabrics do not come together very much. Then the tightness of the structure is low, and hence the resistances of the fabrics to air pressure decreased and the bursting strength of these samples is low. Especially with an increasing number of tuck stitches, the width of the fabric increases and the slackness of the structure grows. Therefore the bursting strength of sample 6 is lower than the others.

In the honeycomb patterns, which have zigzag structures, the tightness of the fabric is high. Bursting strength values of the honeycomb patterned fabrics are high too, but in these patterns the loops come together lengthwise, and while the length of the fabric decreases, the width of the fabric increases. Therefore in these patterns the fabric does not pick up as the other zigzag structured fabrics. The difference is seen clearly in numbered samples 4 and 7. Although their repeat is the same, in sample 7 there are five tuck stitches over one needle, while there are four sample 4. As a result, sample 7 expands widthwise more than sample 4, and the toughness of the sample decreases; therefore the bursting strength of sample 7 is lower than that of sample 4.

In the samples with a zigzag structure whose repeats in the lengthwise and widthwise direction are short, the fabrics are extremely tough due to the effect of

tuck stitches, which increases the bursting strength of the fabrics. The bursting strength values of samples 8, 9, 10, 11 and 12 are very close to that of sample 1, namely single jersey fabric, and notably high. The reason for this situation is the toughness of these samples.

The number of tuck stitches of samples 11 and 12 are the same, but the bursting strength value of sample 12 is higher than that of sample 11. In sample 12, tuck stitches are formed over adjacent needles and tuck stitches transformed to float the loop form at the same time. This float behaves like a reinforcement in this sample; thus the bursting strength value of sample 12 increases.

In samples 11 and 10, the bursting strength value of sample 10 is higher than that of sample 11. The tuck stitches are over adjacent needles in both of the two samples, but the number of tuck stitches of sample 10 is higher than that of sample 11, and hence there is a difference between two samples.

Effect of stitch length on the bursting strength values of grey sample knitted fabrics

Stitch length is the fundamental unit which controls all the physical properties of weft knitted fabrics. In the literature, stitch length is an effective factor for thickness, wpc, cpc, weight and other performance properties of knitted fabrics [8]. Therefore to check the effect of stitch length on the bursting strength of the sample knitted fabrics, a graphical analysis is made, given in **Figure 4**.

According to **Figure 4**, with an increase in the stitch length of the fabrics, their bursting strength decreases with 70% regression, which is related to the loop density (wpc × cpc). If the stitch length value

is low, the loop density is high, and hence higher loop density means higher resistance to the pressure force applied. Then the bursting strength values of the sample knitted fabrics with a lower stitch length are higher. Moreover in this figure it is seen that the stitch length is not the only factor which affects the strength of the fabric, but also the thickness and weight are important structural parameters because the bursting strength values of the samples which have the same stitch length values (2.7) but different weight and thickness are different too.

Effect of dyeing on bursting strength

The dyeing process was conducted with chemicals, temperature and also water. The yarn used in the sample knitted fabrics was 100% cotton. Cotton is a hydrophilic fibre, thus it likes water. The structure of cotton fabrics changes after treatments with water, in which the yarn swells, the loops shorten and the porous structure changes. The structure of the sample knitted fabrics changes by dyeing according to the number and location of tuck stitches. The effect of dyeing on the bursting strength property of the sample fabrics is shown as a graph (**Figure 5**).

As shown in **Figure 5**, the bursting strength values of all dyed sample knitted fabrics are lower than those of all gray samples, except plain knit. This result may be explained by the fact that there are waxes and oil coming from yarn and knitting elements in gray fabrics. These cause that fibres which come out of the yarn section stick to yarn, and thus the yarn strength increases. This result is supported by Ertugrul and Ucar (2000) [6]. Yarn strength decreases when waxes and oil are extracted from yarn in the dyed samples. Since the knitted fabric strength depends on the yarn strength inside the fabric, all the factors cause a fall in the

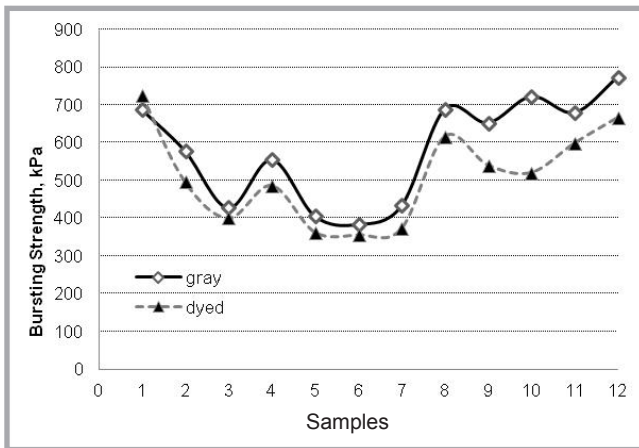


Figure 5. Effects of dyeing on bursting strength.

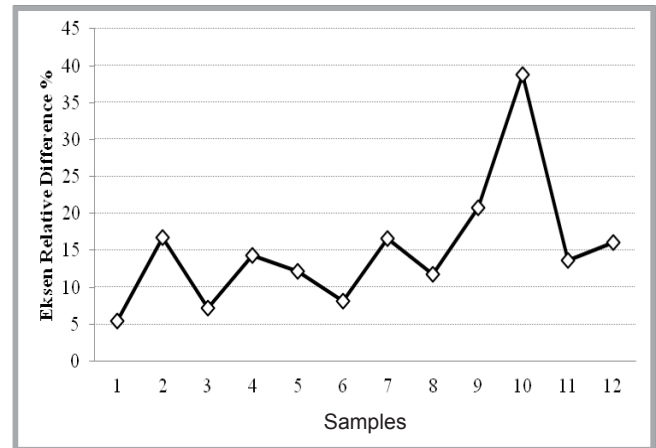


Figure 6. Relative differences between bursting strength values of sample knitted fabrics before and after the dyeing process.

strength of yarns and, hence, a decrease in the strength of the fabrics. The main reason for the low bursting strength of dyed fabrics is the problem mentioned.

As for plain knit, the bursting strength of the dyed sample is higher than the bursting strength of the gray sample, the reason for which can be that the loop density of the dyed sample (310 stitches)

is higher than that of the gray sample (262 stitches). Since the dyeing process is done with water besides other chemicals, the structure of the fabrics changed according to their pattern. When the dyed and gray fabrics' bursting strength values are evaluated together, it is clear that dyeing decreases the strength, but at the same time the bursting strength behaviour of the dyed samples is not as

same as that of the gray ones. To see the difference in more detail, the relative difference between the bursting strength values of the sample knitted fabrics before and after the dyeing process are assessed and presented as a percentage in the graph in Figure 6. The bursting strength of each sample before and after the dyeing process was measured and its relative difference evaluated. To measure this value, Equation 1 was used.

$$RF = (BSG - BSD)/BSD \times 100\% \quad (1)$$

Table 4. Two way ANOVA of bursting strength test results; *The degree of freedom number refers to the "variant number-1", **F means the division of the square average of test values to the square of fault values.

Source	Type III sum of squares	*Degree of freedom	Mean Square	**F	Significance	Partial eta squared
Dyeing	156934.401	1	156934.401	249.512	0.000	0.722
Pattern	1744114.548	11	158555.868	252.090	0.000	0.967
Interaction	121408.427	11	11037.130	17.548	0.000	0.668
Error	60380.688	96	628.965	-	-	-
Total	3.785E7	120	-	-	-	-

Table 5. Pearson correlation of gray knitted sample fabrics; *) Correlation is significant at the 0.05 level (2-tailed), **) Correlation is significant at the 0.01 level (2-tailed).

	Number of tuck stitches	cpc	wpc	Weight, g/m ²	Thickness, mm	Bursting strength, kPa
Number of tuck stitches	1	-0.633*	-0.575	0.367	0.796**	0.515
cpc	-0.633*	1	0.280	-0.109	-0.427	-0.353
wpc	-0.575	0.280	1	-0.510	-0.679*	-0.180
Weight, g/m ²	0.367	-0.109	-0.510	1	0.761**	0.196
Thickness, mm	0.796**	-0.427	-0.679*	0.761**	1	0.294
Stitch length	-0.560	0.295	0.365	-0.352	0.354	-0.842**

Table 6. Pearson correlation of dyed knitted sample fabrics; *) Correlation is significant at the 0.05 level (2-tailed), **) Correlation is significant at the 0.01 level (2-tailed).

	Number of tuck stitches	cpc	wpc	Weight, g/m ²	Thickness, mm	Bursting strength, kPa
Number of tuck stitches	1	-0.712**	-0.428	0.455	0.949**	0.515
cpc	-0.712**	1	0.323	-0.314	-0.724**	-0.439
wpc	-0.428	0.323	1	-0.215	-0.492	0.129
Weight, g/m ²	0.455	-0.314	-0.215	1	0.567	0.519
Thickness, mm	0.949**	-0.724**	-0.492	0.567	1	0.445
Stitch length	-0.560	0.338	-0.097	-0.690*	0.470	-0.723**
Dyeing	0.260	-0.160	0.353	0.382	0.156	0.909**

In Equation 1, RF means the relative difference, BSG – the bursting strength of gray fabrics, and BSD - the bursting strength of dyed fabrics. Except for sample 1, measurements were made according to this equation. For sample 1, BSG and BSD values were interchanged because its BSD was higher than its BSG.

According to Figure 6, the bursting strength values of the samples decreased with the ratio by between 5% and 20%, except sample 10. The decrease in percentage of sample 10 is 38%, the reason for which is related to the number of float yarns. Since the dyeing process affects the float yarns more than the yarns inside a stitch, this sample is affected by the dyeing process more. The number of float yarns is the most in this sample, and hence the decrease in the ratio is the most.

Statistical analyses of the effects of the number and location of tuck stitches on the bursting strength of gray and dyed knitted fabrics

In order to understand the statistical importance of the combination of the number and location of tuck stitches (pattern)

and dyeing for the bursting strength, two way ANOVA was performed, the results of which are shown in **Table 4**. For this aim, the statistical software package SPSS 17.0 was used to interpret the experimental data. All the test results were assessed at significance levels ≤ 0.05 and ≤ 0.01 .

According to **Table 4**, the effect of the number of tuck stitches in gray fabrics, dyeing and the number of tuck stitches in dyed fabrics on bursting strength values of the sample knitted fabrics are significant because their significance values* are smaller than 0.05. The most effective factor for bursting strength values of the fabrics is the number of tuck stitches because the partial eta square value of this source is closer to 1 than the others.

In addition to the variance analyses, the correlation of the structural property number of tuck stitches and bursting strength values of the sample knitted fabrics is useful to enhance the clarity of the study. Pearson correlation analysis test results are shown in **Tables 5** and **6**.

According to the correlation results given in **Table 5**, there is a negative, strong and 0.01 significance level correlation between the stitch length and bursting strength values of the gray sample knitted fabrics, meaning that the bursting strength of gray sample knitted fabrics can be explained according to their stitch length with 84.2 percent. Also there is a positive and strong correlation between the number of tuck stitches and thickness at a 0.01 significance level, while there is negative and strong correlation between the number of tuck stitches and cpc at a 0.01 significance level. This means an increase in the number of tuck stitches also results in an increase in the fabric thickness and in the number of tuck stitches, causing a decrease in the cpc of the fabric.

According to the correlation results given in **Table 6**, there is a negative, strong and in 0.01 significance level correlation between stitch length and bursting strength values of the dyed sample knitted fabrics. This means that the bursting strength of the dyed sample knitted fabrics can be explained according to their stitch length with 72.3 percentage. Also there is the same relation between the number of tuck stitches and cpc and the thickness parameters in both the gray and dyed fabrics. According to the same table, dyeing is an effective parameter for

the bursting strength of the fabrics because there is positive, strong and in 0.01 significance level correlation between bursting strength values of the gray sample knitted fabrics and those of the dyed ones. This correlation was calculated by comparing the measurement test results of gray samples and those of the dyed ones.

Conclusions

It was established that the tuck stitches, stitch length and dyeing process are effective factors for the bursting strength of knitted fabrics.

The main conclusions from the experiment performed are as follows;

- With an increase in stitch length (from 2.54 to 3.15), the bursting strength of the sample knitted fabrics decreases (from 778 to 428 kPa).
- The number and location of tuck stitches are effective parameters for the bursting strength property, but the location of tuck stitch is more decisive than the number of tuck stitches, because it is seen from samples 4 - 5 and 11 - 12 that their tuck stitch number is the same but their bursting strength values are different.
- When tuck stitches form in adjacent needles, the sample which has more tuck stitches has more resistance to the bursting force (like in the samples 10 and 11).
- The dyeing process which extracts waxes from yarns decreases the bursting strength of the sample knitted fabrics.
- Samples which have more float yarns are affected by the dyeing process more and their bursting strength decreases more (like in the sample 10).
- When the location of tuck stitches is not in a zigzag form, the fabric does not pick up very much and the tightness of the structure is low; thus the resistances of the fabrics to the air pressure force decreases and the bursting strength of these samples is low (as in samples 3, 5 and 6).
- Generally with an increasing in the number of tuck stitches, the width of the fabric grows and the slackness of the structure increases.
- The bursting strength values of honeycomb patterned fabrics are as high as other zigzag patterned fabrics, but in these patterns the loops come together lengthwise, and while the length of the fabric decreases, the width of the fabric increases. Therefore in these

patterns the fabric does not pick up as the other zigzag structured fabrics, hence their bursting strength are lower than other zigzag patterned fabrics.

References

1. Yakartepe M, Yakartepe Z. *Textiles in General*. T.K.A.M. Textile & Clothing Research Center, Istanbul, 1999.
2. Uyanik S. *Influences of the Tuck Stitch on the Performance of the Circular Knitted Fabrics with Single Bed*. M.Sc. Thesis, Textile Engineering University of Gaziantep, Turkey, 2008.
3. Spencer DJ. *Knitting Technology*. 3rd edition, Woodhead Publishing Limited, 2001.
4. Kaya T. *An Investigation about the Performance of Circular Knitted Fabrics Manufactured with Polypropylene Continuous Filament Yarns*. M.Sc. Thesis Textile Engineering University of Gaziantep, 2006.
5. Ertugrul S, Ucar N. Predicting Bursting Strength of Cotton Plain Knitted Fabrics using Intelligent Techniques. *Textile Res. J.* 2000; 70: 845-851.
6. Shahbaz B, Jamil AN, Farooq A, Saleem F. Comparative Study of Quality Parameters of Knitted Fabric from Air-jet and Ring Spun Yarn. *J. Applied Sci* 2005; 5 (2): 277-280.
7. Onal L, Candan C. Contribution of Fabric Characteristics and Laundering to Shrinkage of Weft Knitted Fabrics. *Textile Res. J.* 2003; 73: 197-191.
8. Kane CD, Patil UJ, Sudhakar P. Studies on the Influence of Knit Structure and Stitch length on Ring and Compact Yarn Single Jersey Fabric Properties. *Textile Res. J.* 2007; 77: 572-582.
9. Emirhanova N, Kavusturan Y. Effects on Knit Structure on the Dimensional and Physical Properties of Winter Outerwear Knitted Fabrics. *Fibres & Textiles in Eastern Europe* 2008; 16: 69-74.
10. Ertuğrul S, Uçar N. Predicting bursting strength of cotton plain knitted fabrics using intelligent techniques. *Textile Research Journal* 2000; 10: 845-851.
11. Özdil N. *The Physical quality control methods of fabrics*. 1st Edition, Bornova/İzmir, 2003.
12. ASTM Practice D 1776. Conditioning Textiles for Testing.
13. TSE EN 12127 April 1999. Textiles-Fabrics-Determination of mass per unit area using small samples.
14. TSE EN 14971 July 2006. Textiles-Knitted Fabrics-Determination of number of stitches per unit length and unit area.
15. EN ISO 13938-2. Textiles – Bursting Properties of Fabrics – Part 2: Pneumatic Method for Determination of Bursting Strength and Bursting Distension of Knitted Fabric from Air Jet and Ring Spun Yarn. *Journal of Applied Sciences* 2005; 5(2): 277-280.

Received 06.05.2015 Reviewed 02.05.2015