THE EFFECTS OF DIFFERENT FIBER TYPES ON THE PERFORMANCE PROPERTIES OF THE LINING FABRIC

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Abstract: *In this study, the effects of different fiber types (regenerated cellulose fibers and synthetic fibers) on the properties of the lining fabric to be produced were investigated. Weight, seam slippage, strength, friction, drape properties of fabrics to be produced from different fibers (PES, PES/Lycra, Acetate, Rayon and Cupro) were examined. In addition to the important strength properties of the linings made of synthetic fibers, there are disadvantages such as draping and seam slippage. The lining made of Cupro fiber used in this research eliminates these disadvantages and offers an important alternative.*

Keywords: *Lining fabric, tensile strength, tearing strength, fabric drape, friction coefficient, seam slippage.*

1 INTRODUCTION

Lining has an important role in auxiliary materials and accessories in clothing. Lining is a fabric that has a weight and a handle suitable for the type and usage characteristics of the upper fabric and covers some or all of the inside of the garment.The lining is a separate piece of fabric that is attached to the garment from all edges (such as men's suits, coats, jackets) or combined freely (such as skirts) in accordance with the model of the garment [1].

Performance characteristics expected from the lining vary depending on the product type and end use. For example, the properties expected from a lining used in a jacket are different from those expected from a lining used in a swimsuit.

The main factors affecting the quality and performance of lining fabrics are as follows:

- fabric properties,
- pattern,
- compatibility with upper fabric and other materials, and
- suitability for end use [2].

The lining also provides suitability for clothing and thermal comfort. As they are smooth, moisture absorbent and soft, they provide handle comfort.

Kawabata examined the effects of lining properties of skirts upon comfort and movement. The comfort of lining fabrics and real skirts with and without lining was rated by sensory tests on the basis of sensorial comfort on the skin and body movement. Actual body movements were investigated by motion analysis while the skirts were being worn. Cuprammonium rayon (Cupro) and polyester fiber lining results are compared [3].

Ünal has investigated the fabrics commonly used for lining children's clothing. By obtaining these fabrics, their physical properties and comfort properties were evaluated with various tests. As a result, the most comfortable lining fabric recommendation has been made [4].

Özdil determined tear strength which one of the most important strength property of the fabrics were determined by using plain, twill, satin and ribs fabrics, produced with 100% cotton and 50/50% cotton/PES yarns. The results of tear strength testing were compared according to the fabric structure, material and measurement method statistically [5].

Can examined the yarn characteristics affecting the tear strength of plain fabrics. For this purpose, tear strengths of 17 different plain fabrics were measured. According to the results, yarn count, twist and strength affect the fabric tear strength. Approximately 80% of the change in tear strength can be explained by the change in yarn characteristics [6].

Öztürk examined the effect of weave type and weft density parameters on the surface roughness and friction coefficient [7].

Plattürk aimed to summarize the recent studies and investigate the fabric drape and its relation with the bending rigidity and stated innovations in the measurement of these parameters [8]

Kuyucu examined the effects of sewing parameters on seam strength in 100% polyester lining fabric. Eight different sewing threads, two stitch needles with different thickness, two different stitch tightness and three different fabric directions have been used at the fabric sewing moment [9].

Dirgar investigated performance properties of single jersey knitted fabrics made from viscose, modal, lyocell and cupro. Performance properties of the fabrics such as fabric weight per unit area, thickness, bursting strength, abrasion resistance, fabric stretch, porosity, air permeability and pilling were evaluated statistically and the importance levels of the relationship between the measured parameters were determined [10].

In this study weight, seam slippage, strength, friction, drape properties of fabrics to be produced from different fibers (PES, PES/Lycra, Acetate, Rayon and Cupro) were examined. In addition to the important strength properties of the linings made of synthetic fibers, there are disadvantages such as draping and seam slippage. The lining made of Cupro fiber used in this research eliminates these disadvantages and offers an important alternative.

2 MATERIALS AND METHODS

The aim of the study is to examine classical lining fabrics that are available in the market and widely used in the garments. For this purpose, lining fabrics produced from PES, PES/Lycra (97/3%), Acetate and Rayon fibers were examined. In addition, Cupro lining fabric, which is used today as an alternative to these fabrics, but which is not widespread due to its high price, was also examined.

Before testing, all fabric samples were conditioned for 24 hours under the standard atmospheric conditions (20±2°C temperatures, 65±5% relative humidity).

Firstly, the values (yarn count, types of fabric weave, weight, weft and warp density) of the lining fabrics obtained from the market were determined. Than, the fabric properties (tensile strength, tearing strength, fabric drape, friction coefficient, seam slippage) that will affect the performance characteristics of the lining fabric were examined.

Weft and warp yarn number determination in yarns taken out of the fabric was made according to TS EN 14970 standard.

Type of fabric weave was determined using a suitable magnifying glass.

The weight (g/m²) of the fabrics was made according to TS 251 standard.

The fabrics were cut with a grams per square meter cutter of 100 cm² and weighed on a precision digital scale. The weft and warp yarn count of the fabric was made according to TS 250 EN 1049-2. A loupe of 1 cm² is used for this procedure.

According to the TS EN ISO 13934-2 - Grap test, the tensile strength tests were carried out separately in the direction of weft and warp.

Tearing strength of fabrics was performed according to TS EN ISO 13937-1 standard on Jeames Heal trademark Model Elmatear instrument by ballistic pendulum method.

In the research, the fabric drap was measured according to the TS 9693 standard. Image analysis method was used to measure the fabric drape of lining fabrics.

In this research, the friction coefficient was determined with the Frictorq Device used in the determination of dynamic friction coefficient.

In the study, the seam slippage test was performed according to the TS EN ISO 13936-1 seam slippage method. The analysis of the test results were evaluated in the SPSS 25.0 statistical program at 0.05 significance level and the performance characteristics of lining fabrics produced from different fiber types were investigated.

3 RESULTS

The properties of the lining fabrics used are shown in Table 1. The tensile and tearing strength values of the lining fabrics used in the study in the weft and warp directions are given in Table 2.

Table 1 Characteristics of lining fabrics

Fabrics	Yarn count [Nm]		Type of fabric weave	Weight [g/m²]	Density	
	weft	warp			weft [picks/cm]	warp [ends/cm]
PES	111	109	1/1 Plain	54.42	26	34
PES/LYCRA	156	168	2/1 Twill	72.7	39	66
ACETATE	111	109	2/1 Twill	80.5	27.5	61.5
RAYON	67	75	2/1 Twill	92.4	25	46
CUPRO	116	113	1/1 Plain	72.18	35.5	50

Table 2 Tensile and tearing strength of lining fabrics

Fabrics	Tensile strength [N]		Tearing strength [N]	
	warp	weft	warp	weft
PES	438.42	354.89	31.16	40.70
PES/LYCRA	432.84	277.24	11.01	15.47
ACETATE	133.38	77.18	4.71	6.73
RAYON	239.50	129.28	18.21	23.67
CUPRO	103.41	101.71	8.96	12.33

When Table 2 is examined; considering the tensile strength values, it was observed that the weft and warp tensile strengths of the fabrics woven from PES and PES/LYCRA fibers were the highest. When the tearing strength values were examined, it was found that the fabric woven from PES fibers was the highest (Figures 1 and 2).

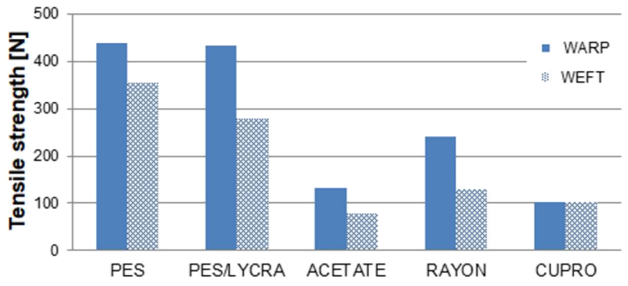

Figure 1 Tensile strength of lining fabric

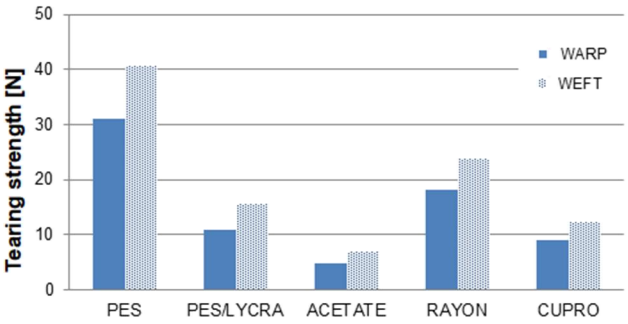

Figure 2 Tearing strength of lining fabric

In Table 3, the fabric drape and friction coefficient values of the lining fabrics used in the study are shown.

Table 3 Fabric drape and friction coefficient values of lining fabrics

Fabrics	Drape coefficient [%]	Friction coefficient [μ kinetic]
PES	52	0.222
PES/LYCRA	38	0.213
ACETATE	33	0.151
RAYON	34	0.160
CUPRO	27	0.155

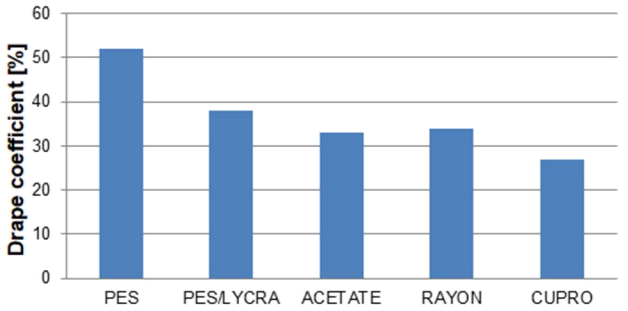

Figure 3 Drape of lining fabric

When Table 3 is examined, the fabric with the lowest drape coefficient is the fabric made of Cupro fibers. The lower the drape coefficient, the higher the drape of the fabric. Cupro has the best drape lining fabric feature (Figure 3).

One of the most important parameters affecting the drape is weight. Correlation analysis was performed to determine the direction and strength of the relationship between Cupro lining fabric and weight. When Table 4 is examined, it was determined that there was a “high” (r = 0.867), positive and significant relationship between fabric drape and weight. (According to the Pearson Correlation scale: r = 0-0.25 very weak, 0.26-0.49 weak, 0.50-0.69 medium, 0.7-0.89 high, 0.9-1.0 very high).

Table 4 Correlation analysis of Cupro lining fabric

Fabric drape	Weight
Pearson correlation (r)	0.867

Correlation is significant at the 0.05 level (2-tailed).

When the friction coefficient values were analyzed, it was observed that the fabrics with the lowest value were fabrics made of Acetate, Cupro and Rayon fiber. This result shows that the Acetate, Cupro and Rayon fabrics surfaces are smoother (Figure 4).

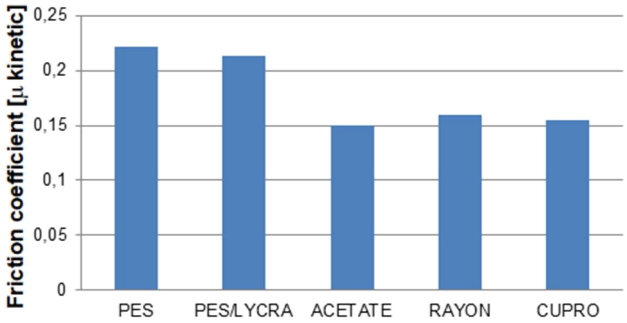

Figure 4 Friction coefficient of lining fabric

Correlation analysis was performed to determine whether there is a relationship between friction coefficient and tearing strength. The lining fabric with the highest friction coefficient is PES (Figure 4). It was determined that there is a "very weak" (r = -0.246) negative relationship between the friction coefficient of PES and the weft tearing strength. It was determined that there is a “high” (r = 0.869) positive relationship between the friction coefficient of PES and the warp tearing strength (Table 5).

Table 5 Correlation analysis of PES lining fabric

Friction coefficient	Weft tearing strength	Warp tearing strength
Pearson correlation (r)	-0.246	0.869

Seam slippage often occurs on fabrics containing slippery threads or on low density fabrics. Therefore, it is seen that in this type of fabrics, a group of threads in the fabric structure can be easily pulled over the other. Parameters such as seam allowance, stitch type and stitch density also affect this problem. These parameters are kept constant in seam slippage tests.

When Table 6 is examined, it is seen that the seam slippage strength of fabrics made of PES/LYCRA and Cupro fibers is the highest. The higher the seam slippage value, the more resistant the fabric is in terms of seam slippage. This makes PES/LYCRA and Cupro fabrics a great advantage in terms of seam slippage during use (Figure 5).

Table 6 Seam slippage values of lining fabrics

Fabrics	Seam slippage [N]	
	warp	weft
PES	29.3	65.3
PES/LYCRA	>200	>200
ACETATE	87.3	174
RAYON	62	148.5
CUPRO	158.7	>200

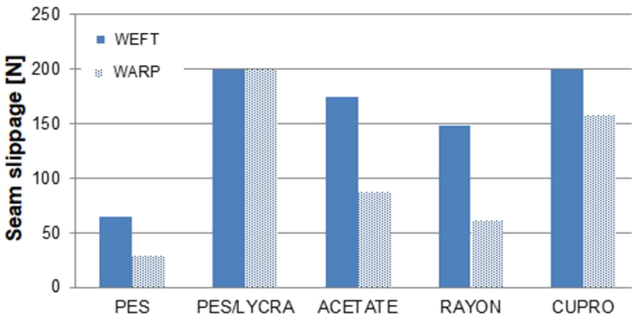

Figure 5 Seam slippage of lining fabric

4 CONCLUSIONS

Lining fabrics are one of the auxiliary materials that complement the garment. Lining fabrics affect the usage, properties, mobility and duration of use of the garment. They provide comfort to the user like a second garment inside the main fabric. Lining fabrics are woven from different yarns, in different types of weaving and are made suitable for final consumption with different finishing processes.

The wrong choice of lining causes huge problems in clothes. Lining fabrics act as a whole with the garment in which they are used. The correct determination of weft and warp densities and weaving type in lining fabrics are the most important factors that determine the durability of the fabric and the behavior of the fabric against the forces in practice.

The more dencity in the weft and warp direction of the fabric, the greater the tensile strength. The tensile strength of the fabric is higher than the sum of the strength value of the yarns that compose the fabric. This is because the weft threads are bonded to the warp threads to increase the strength. Another factor affecting fabric strength is weaving. The more the binding points of the yarns in the fabric, the higher the resistance against the tensile. According to the results of the research, the tensile strength in the direction of weft and warp of the lining fabric produced from PES/Lycra is the highest. In this case, the tensile strength of the fabric produced from PES/Lycra was highest. Fabrics made of synthetic fibers such as PES or high tensile strength fibers have high tensile strength. Since PES and PES/Lycra are synthetic, Acetate, Rayon, and Cupro regenerated cellulose fiber in the research, the tensile strength of PES and PES/Lycra is highest.

Fabrics with low weft and warp density have high tear strength. In a loose fabric structure, the friction forces between the yarns decrease, and in this case the tearing strength increases. In the research, the tearing strength of the lining fabric produced from PES yarns was the highest, since the weft and warp density was the lowest.

When evaluated in terms of fabric comfort, the drape feature is the main parameter affecting the selection, design and appearance of the textile material. Fabric drape in lining fabrics is closely related to the weight of the fabric. As the weight of the fabric decreases, its drape increases. In the research, the weight of the Cupro fabric is low and the drape coefficient is low. Thus, the most drape fabric lining fabrics used in the research is Cupro fabric with 27% drape coefficient.

Surface roughness is a very important parameter that affects the attitude of the fabric. If two fabrics will be used together with each other, as in lining fabrics, due to friction the surfaces will be deformed and strength losses can be seen in the fabrics. In order for these to occur at a minimum, it is desirable that the fabrics have a smooth surface. For this reason, surface roughness is very important in the lining fabrics. The surface roughness is evaluated with the fabric friction coefficient value. Among the lining fabrics used in the research, the fabrics with the lowest friction coefficient are Acetate, Cupro and Rayon (μ kinetic: 0.151-0.156-0.160). Since the tearing strength is affected by the friction property, when the relationship of the two properties is examined, it is seen that there is no relation in the weft direction but there is a strong relationship between the warp tearing strength and the friction coefficient.

Another point to be considered when sewing lining fabrics is to seam slippage. The higher the seam slippage value, the more resistant the fabric in terms of seam slipage. For this reason, especially the end-use is important in terms of quality performance.

In the research, PES/Lycra and Cupro lining fabrics are the most resistant lining fabrics in terms of seam slippage with a strength value of over 200 Newtons. PES/Lycra and Cupro lining fabrics have the highest weft and warp density. For this reason, it is very resistant in terms of seam slippage.

Regenerated fibers can be considered as an alternative to synthetic fibers in lining fabrics. This alternative regenerated fiber should have the advantages of synthetic fibers as well as eliminate the disadvantages. The lining made of Cupro fiber used in the research can be considered as an important alternative to the lining produced from the most widely used PES fiber in the market, especially in terms of draping and seam slippage properties.

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