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Consumer Features of Shirt Fabrics

A B. Zholdasova[1], A.D. Daminov[2], S.S. Rakhimkhodzhaev[2]
Karakalpak State University named after Berdakh[1]
Tashkent Institute of Textile and Light Industry[2]

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ABSTRACT

Technology should be used to produce shirts with cotton threads in the warp and modal threads in the weft, while also taking the local climate into consideration. High-quality shirt textiles are produced from cotton threads, yarns, and their combinations thanks to contemporary high-speed weaving equipment. F1 (designed fabric, summer version) has the following qualities, according to a comparison of fabric samples made using raw materials F0 (standard fabric) and F1. The absolute values of the breaking load are the same and meet standards. The greater the weaving of the fabric, the greater the elongation at the break. The reason for this is that modal fibers have a larger elongation at break than cotton fibers. The tissue sample F5 showed the maximum elongation at break, while the tissue sample F1 showed the least elongation at break value; the hygroscopicity of absolute values increased by 12% and complies with standards. Due to an increased tissue report, shirt fabric's hygroscopicity increases by 33% for F5 tissue samples; crease resistance absolute values also increase by 35% and meet norms. Because of a higher fabric report, shirt fabric's resistance to wrinkles is 15% lower for F5 fabric samples. Adding extra modal fibers to shirt fabric while maintaining the same final thread count results in a softer, more flexible fabric. The shirt fabric's loss of strength decreases with the amount of modal fibers increases. This is a result of modal fibers' exceptional resilience to light weather; criteria are met and absolute air permeability rises by 25%. Because of the enhanced fabric report, air permeability for developed fabric samples increases by 15% for F5 fabric samples; absolute drapability improves by 5% and satisfies requirements. Due to an increase in fabric report, drapability for F5 fabric samples in the generated fabric samples increases by 13%.

1. Introduction

The qualities of the textiles used to produce shirts determine their features primarily. The required thermal conductivity for shirt materials must be in accordance with the temperature; additionally, the material must be somewhat breathable, have the lowest water capacity, be somewhat hygroscopic, be the least prone to contamination, have low gas absorption (adsorption); be soft and elastic; not irritate the skin; be able to reflect ultraviolet light; be able to resist bacterial contamination; and not accumulate static charges. A fabric's physical and mechanical qualities are what mostly define how appropriate it is for a given shirt. The features weight, thickness, hygroscopicity, vapor permeability, hygienic air permeability, hydrophobicity (capillarity), water capacity, permeability, porosity, thermal conductivity, elasticity, flexibility, wrinkle ability, shrinkage, drying speed, dust holding capacity, and reflection coefficient are the most important qualities in terms of hygiene. Textiles are not a single, unchanging substance. Textile fibers and air, the quantity of which varies according to the fabric's structure, make up its intricate structure [5-8]. Porosity is a crucial fabric quality that is closely linked to volumetric weight. The ratio of pore volume to material volume, stated as a percentage, determines a material's porosity. The air permeability, vapor conductivity, and other characteristics of the textiles are determined by the way in which the same amount of air is distributed throughout the tissues. The breathability of fabrics, i.e., the degree of permeability to air, largely determines its suitability for a particular type of clothing. It is represented as the volume of air (dm3) that moves through a unit of fabric surface (1 m2) at a specific pressure (h = 5 mm Hg) in a given amount of time (s). The link between hygroscopicity and materials' sanitary qualities is a key signal. A fabric's capacity to take in and hold onto water vapor from the surrounding air is known as its hygroscopicity. Mechanical features, such as strength, elongation, abrasion, drapability, etc., are a group of characteristics that specify how a material responds to various external pressures applied to it. Shirt wearability is determined by taking into account strength. The lengthening of a cloth at the point of tearing or stretching is called elongation. The ability of a fabric to deteriorate and resist various wear factors, such as light, sun, water/rain, washing, and many forms of technological processing, is known as wear resistance. A fabric's capacity to create supple, moveable folds when suspended is known as its drapeability. The material's weight and degree of elasticity determine its rapability [9–12].

2. MATERIALS AND METHODS

2.1. MATERIALS

The fabric used in this investigation was made in a weaving mill under carefully monitored circumstances. Both samples of the created shirt fabric and one sample of standard fabric were made. The TOYOTA JAT 810 air jet looms were used to weave each sample, with the same reed spacing, rpm, and reed type. Table 1 contains a list of fabric codes along with descriptions. For every sample, cotton thread served as the base's raw material. Cotton thread was utilized for the weft and a plain weave was used for typical F0 cloth. The weft of the designed shirt fabric was composed of modal threads, plain weave, half-rep, rep, matting, and twill for the remaining alternatives F1, F2, F3, F4, and F5

Table 1.Coding of samples of developed fabrics

Fabric sample code	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Weave fabric	Canvas	Canvas	Semi-reps	Reps	Matting	Twill
Raw materials: The basis Weft	c/p c/p	c/p modal	c/p modal	c/p modal	c/p modal	c/p modal
Linear thread density, tex The basis Weft	11,8x2 11,8x2	11,8x2 11,8x2	11,8x2 11,8x2	11,8x2 11,8x2	11,8x2 11,8x2	11,8x2 11,8x2

2.2. METHODOLOGY

2.2.1. THE SEQUENCE OF THE PROCESS

The following technological route was followed in order to process the raw materials using the typical technological parameters needed to produce weaving [13–16].

Raw materials → warping → wading → weaving → grading → finishing.

The following is the sequence in which shirt fabric is formed during weaving. According to Fig. 1, one more lavsan weft 3—with a linear density of 23.6 x 2 tex—is laid following the laying of 10 wefts from modal threads 2, which have a linear density of 11.8 x 2 tex. This welt arrangement is repeated the desired number of times throughout the breadth of the fabric. You can increase the variety of shirt fabrics through the use of thick (fabric section a) and thin (fabric section b) threads to create relief surfaces on the fabric, or strips that are four to five millimeters wide and decrease the fabric's surface density to lighten the design of shirts.

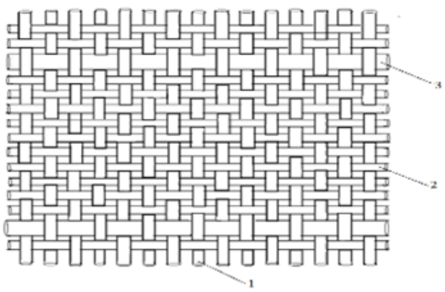

Fig 1

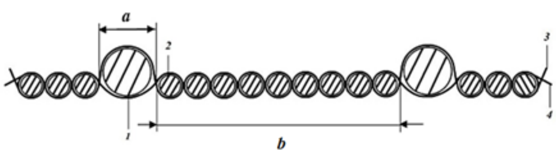

Fig 2

Figure 1 shows the texture of a plain weave fabric,
Where 1 is a cotton warp thread, 2 is a modal weft thread, 3 is a Dacron thread.
In Fig. 2. A fragment of fabric with furrows: where 1 is a thick thread; 2 is a thin thread; 3,4 is another system of threads.

2.2.2. FABRIC TESTING

In this study the fabric samples were tested for features such as tensile strength, tensile strength, abrasion, strength loss, wrinkle resistance, hygroscopicity, air permeability, drapability. Five replicate samples of six fabrics were used for the study, as listed in Table 1, and the average of three observations was taken for each sample [17–20]. .

2.2.2.1 Determining the strength and elongation at the breaking fabric

Fabrics, yarns, and other textile items can have their tensile qualities measured with the AUTOCRAPH AG-I tensile testing machine. A unique computer program powers the AG-I tensile testing apparatus. It is required to enter all preliminary test parameters into the computer before beginning testing. In accordance with GOST requirements, warp and weft samples are cut into 300 x 50 mm strips for tensile character testing of fabrics. The samples are then placed inside the clamps. There are 200 millimeters between each clamp. Pressing the START button enables the top clamp to lift. Following the tissue rupture, a graph and table with the test findings are displayed on the computer screen. They present the following data:

1) Breaking load, N;
2) Breaking elongation %,
3) Coefficient of variation, etc.

A total of five measurements were made in the weft direction and five in the warp direction. Samples of the typical warp and weft were obtained.

2.2.2.2. DETERMINATION OF FABRIC FOR ABRASION

The test specimen is abraded in various directions on the M-235 device. The material to be tested is placed on the disk, and six samples are cut off with a specific cutter before testing. To provide strain on the sample, a weight is placed on top of the circular and its edges are fastened with rings. Attached to the disk is an abrasive surface, a particular fabric. In the media, the disk is installed. Pressing the Start button causes the media to spin at 47.5 ± 2.5 rpm. Each spot on the fabric surface is subject to abrasive forces in a different direction because of the eccentric arrangement of the disks. The procedure halts as soon as holes start to show up in the test sample, and the number of rotation cycles is recorded and displayed on the display.

2.2.2.3. DETERMINATION OF FABRIC FOR LOSS OF STRENGTH

FADE METER X-15 is a device that measures how resistant textile materials are to the effects of light weather. for evaluating the effects of weather (sun, rain, humidity) on fabrics colored. 20 ± 2 °C is the room temperature. 65 ± 2% relative air humidity. Strip dimensions: 65 x 55 mm; test chamber temperature: 20 to 120 °C; humidity: 0.1 to 100%; water flow rate: 4-5 l/min. Strip samples are created in order to assess the material's resilience to the impacts of light weather. Samples are mounted in a chamber called the FADE METER - X15, which has revolving drums. The humidity and temperature inside the chamber are automatically maintained. The display can be used to keep an eye on the work's progress. The apparatus is illuminated with 1.5 kW xenon lamps. The sprinkler unit, heater element, and blowing apparatus for the samples are turned on in compliance with the designated test protocol. The 108 strips—six strips each from 18 samples—are arranged face down on a xenon light simultaneously. There is a 4-hour, 48-minute test. Following testing, the strips are evaluated using a point system and compared to a standard scale.

2.2.2.4. DETERMINATION OF FABRIC FOR Wrinkle resistance

This device is intended to assess how resistant different textiles are to creases. The gadget is compliant with ISO 2313 and the Japanese standard LS-L-1059-1. AW-6 Monsant model. Size of sample: 15 x 40 mm. Specific weight at load: 500 g. Scale of graduation: 0.1 ~ 180 degrees. In order to evaluate a fabric's ability to resist wrinkles, a sample of 15 by 40 mm (warp and weft) must be cut out. Next, put the sample into a glass plate that has been twisted. Put 500g of weight on top of it. and hold off for five minutes. After being taken out of the glass plate, the sample is placed within the sample clamp. Five minutes later, the index's opening angle a is found. Using the following formula, one can derive the crease resistance coefficient K based on the obtained results:

$$K = (a/180)100\%$$

a - opening angle;

K - crease resistance coefficient

2.2.2.5. DETERMINATION OF FABRIC FOR AIR PERMEABILITY

For a variety of uses, the AP-360SM gadget measures the air permeability of textile materials. By contrasting the device's data with a unique table, the air permeability results are evaluated. Check the water level in the tank, the vertical pressure gauge, and the inclined pressure gauge before you begin. Verify that the gadget is properly linked to the electrical network. One of the round holes, each with an area of roughly 1.1.4, is fitted into the interchangeable table, depending on the fabric's density. 2, 3, 4, 6, 11, and 16 cm². After that, the material sample is positioned above the vacuum chamber and clamped down. Now let's turn on the gadget fan. We should halt the procedure and examine the vertical pressure gauge, which displays a particular hydrostatic pressure, when the hydrostatic pressure in the inclined pressure gauge approaches 12.7 mmWg. We will calculate the air permeability index cm3/cm².sec using a special table.

2.2.2.6. DETERMINATION OF FABRIC FOR HYGROSCOPICITY

MD-6P is the device used to measure humidity. When textile materials are exposed to high humidity, they have the ability to either release absorbed moisture into a low humidity environment or absorb water vapor from the surrounding high humidity air. Textile materials' capacity to both absorb and release moisture has a big impact on the mechanical and physical characteristics of such materials. Humidity is one of the most significant hygroscopic characteristics of textile fabrics. Humidity (actual humidity) $\bar{W}$, % indicates the percentage of the material's mass that is made up of moisture at a specific real air humidity. Drying material samples to constant weight in a drying cabinet or conditioning device at 105–110ºC is how humidity is measured. The instrument is used to ascertain the sample's true moisture content. Please wait 17 seconds after turning on the device before beginning the testing. Next, select the automated mode of operation, and the apparatus starts weighing the plates. The test samples must then be placed on each plate, the device door must be closed, and the "SET" button must be pressed. The apparatus starts to dry after automatically calculating the sample's starting (wet) mass (m). The instrument weighs the sample automatically after five minutes. This procedure is carried out repeatedly until the sample's dry absolute weight and final (dry) mass (m) are determined. The device then signals that the procedure is complete. Click the "Print" button to view the test results (Mf, Ms, Wf).

2.2.2.7. DETERMINATION OF FABRIC FOR DRAPEABILITY

In order to assess a material's drapability, a test item is made up of one, two, or more samples that are (400 1) x (200 1) mm and are cut in one of three directions (diagonal, longitudinal, or transverse). Four puncture locations should be marked throughout the sample's breadth. The sample should then be folded three times, with the center fold facing the tester, then punctured onto a needle that is fixed on a stand and more than 400 mm up from the stand's base. The material is crushed on the needle using stoppers if the folds diverge. After 30 minutes of hanging the sample, the distance A between the lower edge's corners is measured, allowing for a 1 mm error.

The fabric drapability coefficient (K, %) is calculated using the formula:

Drapability is determined by the formula:

$$K = \frac{(200-A)100}{200} = 100 - A/2$$

A is the distance between the corners of the lower edge in mm;

The higher the K value, the better the drape of the material.

3. RESULTS AND DISCUSSION

The instruments from the CENTEXUZ laboratory were used to study the qualities of shirt fabric stated above. For the experiment, standard and developed shirt fabric samples are provided. Weft density Ru = 190 threads/dm, fabric density Po = 276 threads/dm, plain weave, linear density along the warp, and linear density over the weft are found in standard and developed fabric samples. For ordinary 100% cotton thread in warp and weft coded T0, To = Tu = 11.8x2 tex. One lavsan weft thread is laid in the created fabric after four to five weaving reports using a modal thread for the weft. We accept the following five weaves: twill, matting, semi-rep, rep, and plain. The developed fabric samples, which had various weaves, were coded F1, F2, F3, F4, and F5. Samples of the developed fabrics were produced on a TOYOTA loom. Table 2 shows the characteristics of the standard and developed fabrics.

Table 2. Characteristics of standard and developed fabric.

№	Name	Units of measurement	Indicators	
			Article 886	New fabric
1	Thread composition weft warp extra weft	-	c/p c/p c/p	c/p modal lavsan
2	The amount of additional lavsan weft laid in relation to the modal weft	-	-	1:10
3	Linear density basis of the weft	teks teks teks	11,8 x 2 c/p 11,8 x 2 c/p 11,8 x 2 c/p	11,8 x 2 c/p 11,8 x 2 modal 23,6 x 2 lavsan
4	Surface density of fabri	gr./m^2	120	76
5	Breathability	dm^3/sec	150	200
6	Abrasion resistance	cycles	600	900
7	Hygroscopicity	%	5	7
8	Crinkle resistance	%	25	39
9	Tensile strength basis of the weft	H	290 190	290 220
10	Extension basis of the weft	%	14 12	14 16

The study then moved on to the mechanical and physical characteristics, such as elongation at break (%) and tensile strength (N), where samples of shirt fabrics with various weaves were examined.

3.1. Fabric strength and elongation at break as a function of weave and raw material.

Tables 3 and 4 present the results from the examination of the developed shirt fabrics' samples' mechanical characteristics (elongation at break and tensile strength).

Table 3.Effect of raw material and fabric weave on tensile strength

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Warp tensile strength	290	290	290	285	270	270
Tensile strength of weft threads	190	190	185	181	172	170

Table 4. Effect of raw material and fabric weave on fabric elongation at break.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Elongation at break of fabric along the base	14	14	15	16	18	18
Elongation at break of weft fabric	12	12	12	12	13	14

Table 3 indicates that the weave of the fabric has a major impact on the tensile strength of the material. The absolute values of the fabric samples based on the raw materials F0 (standard fabric) and F1 (developed fabric, summer version) are the same and meet the specifications. Fig. 3 shows the graphs that were created to show how fabric weave affects shirt materials' tensile strength. It is evident from the graphs (Fig. 3) that the fabric's tensile strength diminishes with increasing weave. This is because a smaller weave pattern is invariably associated with higher fabric weight and more dense fabric.

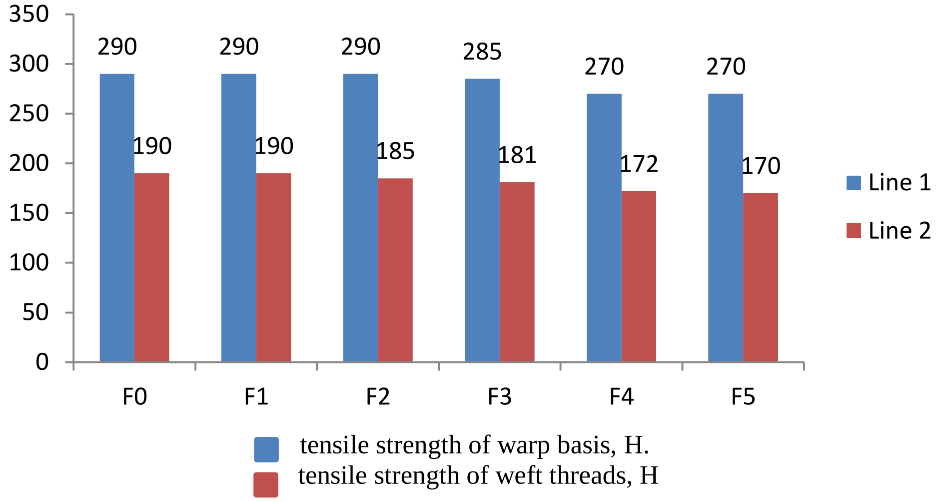

Figure 3 shows a histogram showing how fabric weave and raw materials affect shirt fabrics' tensile strength.

Table 4 analysis demonstrates that the fabric's weave has a substantial impact on the elongation at break of the fabric samples as well. A graph illustrating the impact on shirt fabric elongation at break is presented in Figure 4.

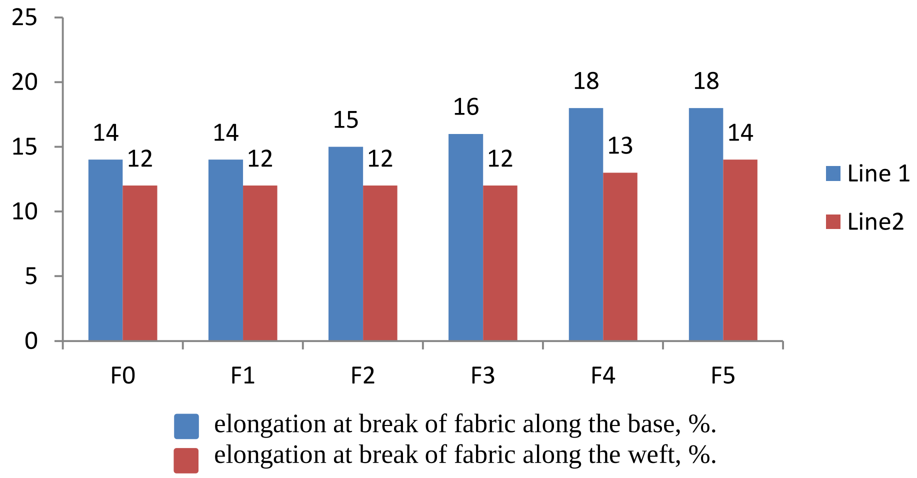

Fig.4. Histogram of the influence of raw materials and fabric weave on elongation at break of shirt fabrics.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Fabric abrasion, cycles	600	1100	900	800	800	700

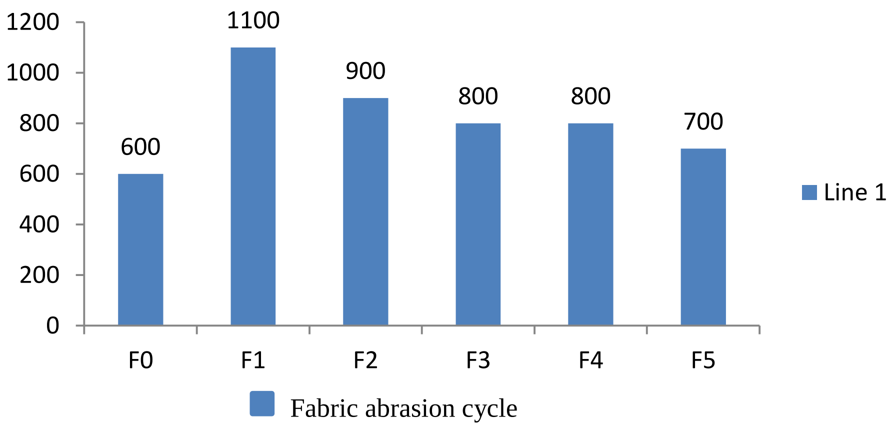

Figure 5: Histogram showing how fabric weave and raw materials affect shirt fabric abrasion.

Since modal fiber is more abrasion resistant than cotton fiber, it is also clear that shirting materials' abrasion resistance improves with modal content.

The term "hygroscopicity" describes a fabric's capacity to retain vapours from air with a 98% relative humidity. Natural textiles that are hygroscopic readily take up and release moisture into the environment.

Sweating is caused by the accumulation of moisture in the undergarment area by non-hygroscopic textiles. The GOST requires that the hygroscopicity index should be at least 5% []. It should be noted that the addition of synthetic fibers helps to lessen hygroscopicity when examining natural and blended fabrics that include yarn and synthetic threads. The impact of hygroscopicity on the fundamental protective qualities of the material package must be considered when designing products for environments with high ambient humidity.

3.1. The influence of raw materials and fabric weave on the hygroscopicity of shirt fabrics.

Table 6 shows the results of the influence of raw materials and fabric weave on the hygroscopicity of the fabric.

Table 6. The influence of raw materials and fabric weave on fabric hygroscopicity.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Hygroscopicity of fabrics, %.	5	6,0	6,8	7,0	7,5	8,0

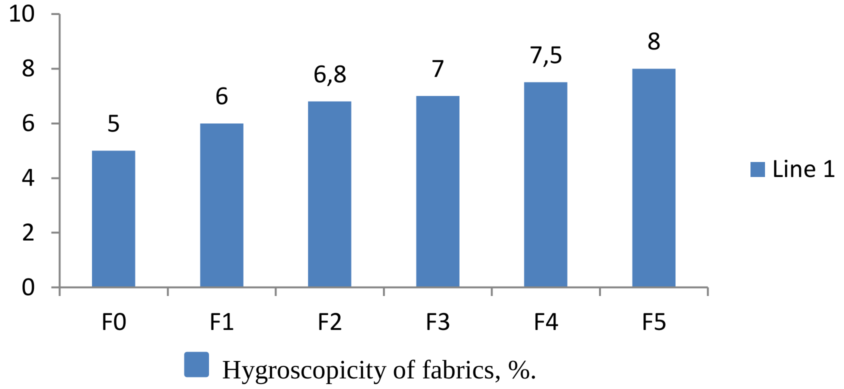

Figure 6 shows a histogram showing how fabric weave and raw materials affect how hygroscopic shirt fabrics are.

The hygroscopicity of absolute values improves by 12% and satisfies the norms when fabric samples based on raw materials F0 (standard fabric) and F1 (developed fabric, summer version) are compared. For F5 fabric samples, the hygroscopicity of shirt fabric increases by 33% as a result of a higher fabric report.

3.1. How fabric weave and raw materials affect shirt fabrics' ability to resist wrinkles.

Clothes that have wrinkles taint the look and make sewing more difficult. A loose fit is advised for items made of cotton textiles.

The results of the impact of fabric weave and raw ingredients on shirt fabrics' resistance to wrinkles are displayed in Table 7.

Table 7: The impact of fabric weave and raw materials on shirt fabrics' resistance to wrinkles.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Fabric resistance, %.	25	39	36	30	30	33

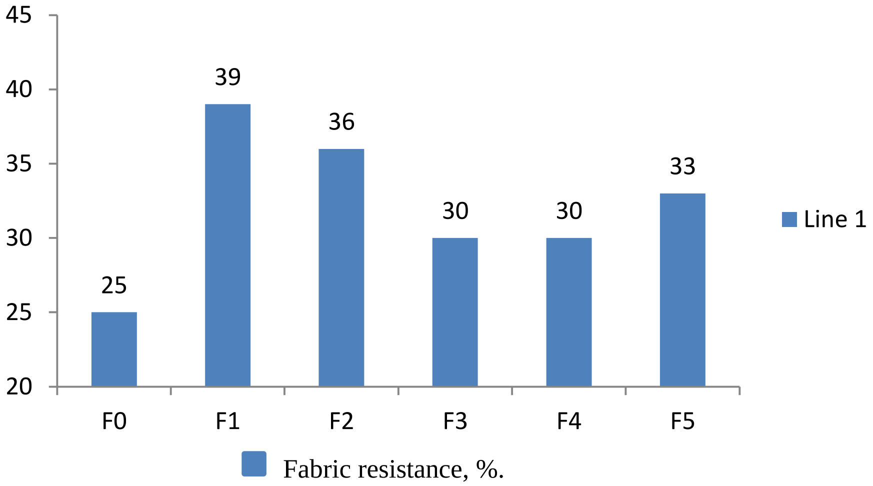

Figure 7 shows how fabric weave and raw materials affect how resistant shirts are to wrinkles.

The absolute values of wrinkle resistance rise by 35% and satisfy the norms when fabric samples based on raw materials F0 (standard fabric) and F1 (developed fabric, summer version) are compared. Because of a higher fabric report, shirt fabric's resistance to wrinkles is 15% lower for F5 fabric samples.

Softer and more flexible shirt fabric is produced by adding additional modal fibers while maintaining a constant final yarn weight. We have sample F5's minimum values and sample F1's maximum values in the created fabric samples. Clothes are prone to wrinkling when handled, washed, and dried. Regarding the shirt fabric's aesthetic appeal, recovery from these folds is one of the desired properties of the fabric. Prior research indicates that the architecture and fiber composition of the fabric have a major impact on wrinkle reduction. In this instance, the modal content of the shirt fabric has a reasonably good ability to recover from wrinkles.

3.1. The influence of raw materials and fabric weave on the loss of strength of shirt fabrics.

Table 8 shows the results of the influence of fabric report on the loss of strength of shirt fabrics.

Table 8. The influence of raw materials and fabric weave on the loss of strength of shirt fabrics.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Loss of fabric strength, %.	45	50	48	48	49	49

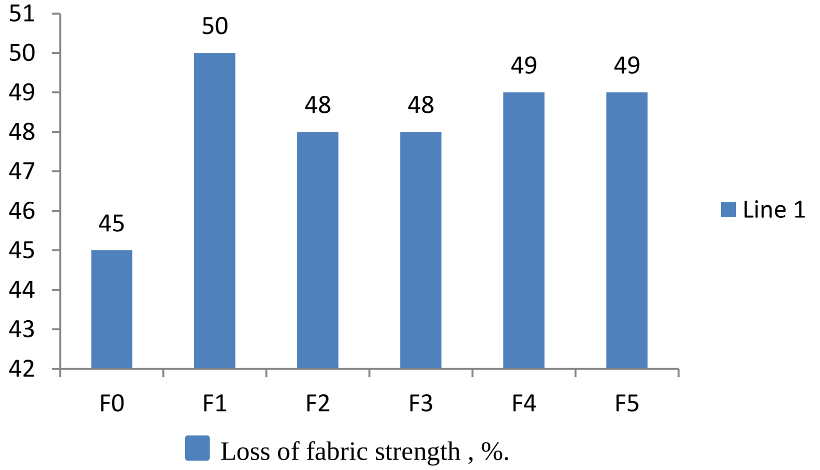

Fig. 8. Histogram of raw materials and the influence of fabric weave on the loss of strength of shirt fabrics.

The rate at which the shirt fabric loses strength decreases as the modal fiber content rises. The strong resilience of modal fibers to light weather is the cause of it.

3.1. The influence of raw materials and fabric weave on the breathability and drapability of shirt fabrics.

Additionally, the impact of shirt fabric on comfort metrics was examined. The fabric's drape and breathability are two aspects of comfort. The impact of fabric weave and raw materials on the breathability of shirt textiles is displayed in Table 9.

Table 9. The influence of raw materials and fabric weave on the breathability of shirt fabrics.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Breathability of fabric, $dm^3m^2c^2$	150	200	220	220	235	235

Table 9 indicates that the air permeability of absolute values rises by 25% and satisfies standards when fabric samples based on raw materials F0 (standard fabric) and F1 (developed fabric, summer version) are compared. Because of the increased fabric report, breathability for F5 fabric samples increases by 15% in created fabric samples.

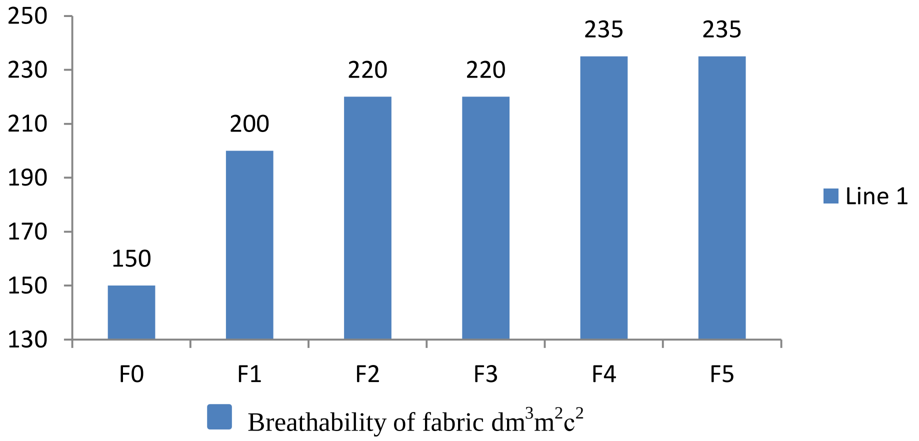

Fig.9. Histogram of the influence of raw materials and fabric weave on the breathability of shirt fabrics.

The F5 fabric sample has the highest air permeability, whereas the F1 sample has the lowest air permeability, according to an analysis of these histograms. Fabrics having a lower fabric weave report value exhibit higher levels of air permeability. The F1 sample exhibits increased work on the shirt fabric, resulting in a more compact, voluminous, and thicker material that presents a high level of air flow. Consequently, greater stretchability with less breathability can be achieved with a smaller fabric weave. A fabric's degree of stiffness is gauged by its capability. More draped fabrics are softer. Texture draping and tactile comfort are impacted by rigidity. Very little drape makes a fabric uncomfortable to wear and does not fit the body well. The findings of the fabric weave's impact on the drapability of shirt textiles are shown in Table 10.

Table 10. The influence of raw materials and fabric weave on the drapability of shirt fabrics.

Fabric samples	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**
Drapability of fabrics, %.	25	26,4	28,5	29,3	30,2	30,6

Table 10 indicates that the drapability of absolute values increases by 5% and meets the standards when fabric samples based on raw materials F0 (standard fabric) and F1 (developed fabric, summer version) are compared. Because of the increased fabric report, drapability for F5 fabric samples in the created fabric samples increases by 13%. A histogram illustrating how fabric weave affects shirt materials' drapability is presented in Figure 10. The graph indicates that the F5 fabric sample has the highest drapeability, whilst the F1 and F0 samples have the lowest drapeability.

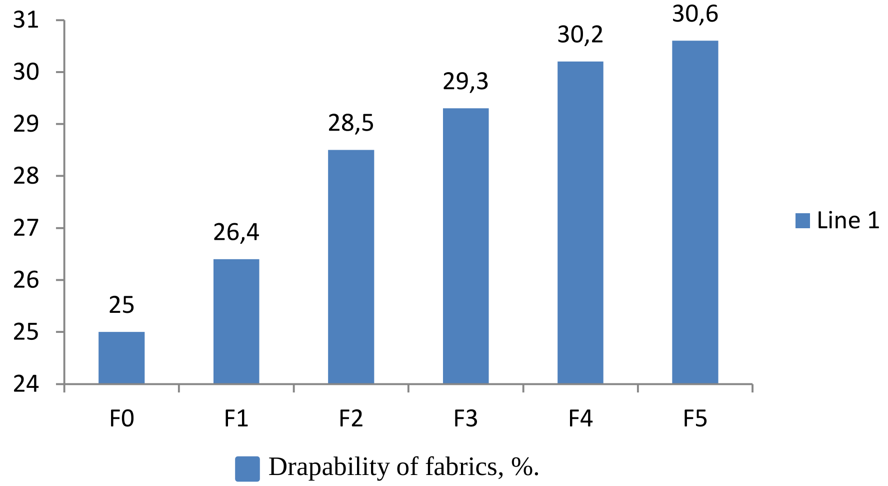

Fig. 10. Histogram of the influence of raw materials and fabric weave on the drapability of shirt fabric.

4. CONCLUSIONS AND RECOMMENDATIONS

1. The absolute values of the fabric samples compared by raw material (T0, standard fabric) and created fabric (T1, summer version) are the same and meet the specifications. The greater the weaving of the fabric, the greater the elongation at the break. The reason for this is that modal fibers have a larger elongation at break than cotton fibers. Fabric sample T5 showed the greatest elongation at break, and fabric sample T1 showed the minimum elongation at break value.

2. The hygroscopicity of absolute values increases by 12% and satisfies the norms when fabric samples are compared by raw material T0 (standard fabric) and T1 (developed fabric, summer version). Due to an increase in fabric report, shirt fabric hygroscopicity increases by 33% for T5 fabric samples.

3. Wrinkle resistance absolute values rise by 35% and satisfy standards when fabric samples based on raw materials T0 (standard fabric) and T1 (developed fabric, summer version) are compared. Because of a higher fabric report, shirt fabric's resistance to wrinkles is 15% lower for T5 fabric samples.

4. Softer and more flexible fabric is produced by adding more modal fibers to shirt fabric while maintaining a constant final yarn weight. The shirt fabric's loss of strength decreases with the amount of modal fibers increases. This is because modal fibers have a great resistance to light weather.

5. The air permeability of absolute values improves by 25% and satisfies the norms when fabric samples based on raw materials T0 (standard fabric) and T1 (developed fabric, summer version) are compared. Because of the increased fabric report, breathability for T5 fabric samples increases by 15% in created fabric samples.

6. Comparison of fabric samples by raw material T0 (standard fabric) and T1 (developed fabric, summer version) drapability of absolute values increases by 5% and meets the standards. For the developed fabric samples, drapability increases by 13% for T5 fabric samples, due to an increase in fabric report.

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