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Analysis of Technological and Physical-Mechanical Performance of Single-Line Knitwear Fabrics

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Abstract

Futer fabric is very popular in the production of knitted textiles due to a number of positive features. This knitted fabric is characterized by high quality, long-term color retention and durability. The article analyzes the physical and mechanical properties of futer knitwear used for children's sportswear. The properties of knitted fabric, woven on the basis of a mixture of polyester, lycra and spun cotton yarn, features of adherence to children's sportswear and ways of improving other positive properties have been investigated.

Keywords: *Futer, polyester, laycra, supreme, firiction, physic-mechanical index, surface density, air permeability, thickness, tensile strength.*

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Introduction

Today, our country has natural resources that can create great opportunities for the development of textile and light industry. Using these resources, the production of high quality and competitive sewing and knitwear from yarn, silk and knitted fabrics is one of the leading directions of our economy.

In this research work, the stability of shape retention is ensured due to additional elements in the knitted fabric as well as changes in the structure of the fabric.

In recent years, futter fabric has become very popular in the production of knitted textiles due to a number of its positive properties. This knitted fabric is characterized by high quality, long-term color retention and durability. In many cases, this fabric is woven with cotton and synthetic materials (lycra or polyester), which ensures its strength and elasticity [1].

The two-thread futter is used to sew sportswear, homewear, tops and children’s clothing for spring and winter. There are several types of futter fabrics:

- Made of 100% cotton.
- Cotton fabric with lacquer and polyester.

Supreme fabric is mainly made of natural cotton fibers, but there are also types that are woven with lycra to ensure its elasticity (2%, 2.5%, 3%.4%.5%, etc.). Such a low percentage of synthetic fibers in the composition does not affect the quality of natural knitted fabric, but rather improves its operational properties. Because it is so soft, supreme fabric has become a favorite fabric of children's clothing manufacturers. It is usually used to make baby clothes, T-shirts and blouses. This type of fabric is also suitable for sewing adult clothes. It is used to make T-shirts, shirts or shorts, as well as underwear and pants [2].

It is natural for a number of knitwear companies to have some shortcomings and problems with the elongation, abrasion resistance, and air permeability of knitted fabrics. Based on these characteristics, three different samples of knitted fabrics for children's sportswear were analyzed [3].

Materials and Methods

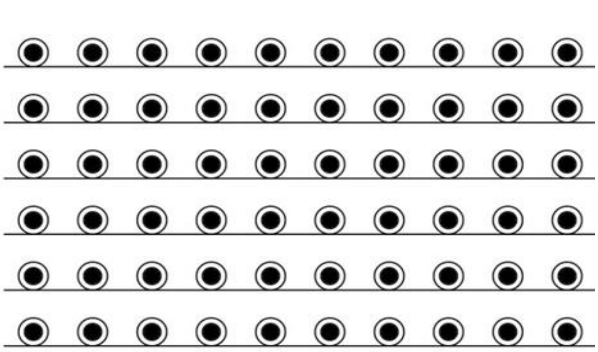
Sportswear should be comfortable, protect the athlete's body from various injuries, and ensure high results. Therefore, exploitative features are an important issue. Based on these requirements, a knitted fabric with high efficiency and positive properties should be selected for a children’s sports set.

All fabrics in sportswear must have the following characteristics:

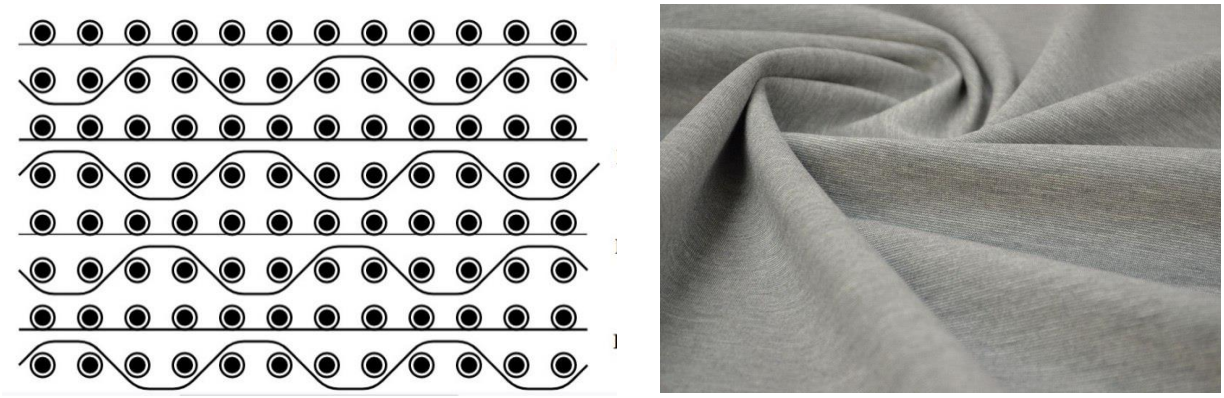
- Comfort of clothes.
- Hygienic.
- Hygroscopicity.
- Lexibility.
- Air permeability.
- Heat storage.

Children wear clothes made of cotton and linen, such as sports pants, T-shirts, and shorts, to work out in gyms. When sewn from a knitted fabric made of 100% natural cotton, they have good air circulation, provide comfort to the body, but lose their shape after washing [4]. Therefore, in the manufacture of sportswear, it is advisable to use synthetic yarns (lycra, polyester) along with cotton yarn spun into knitted fabrics.

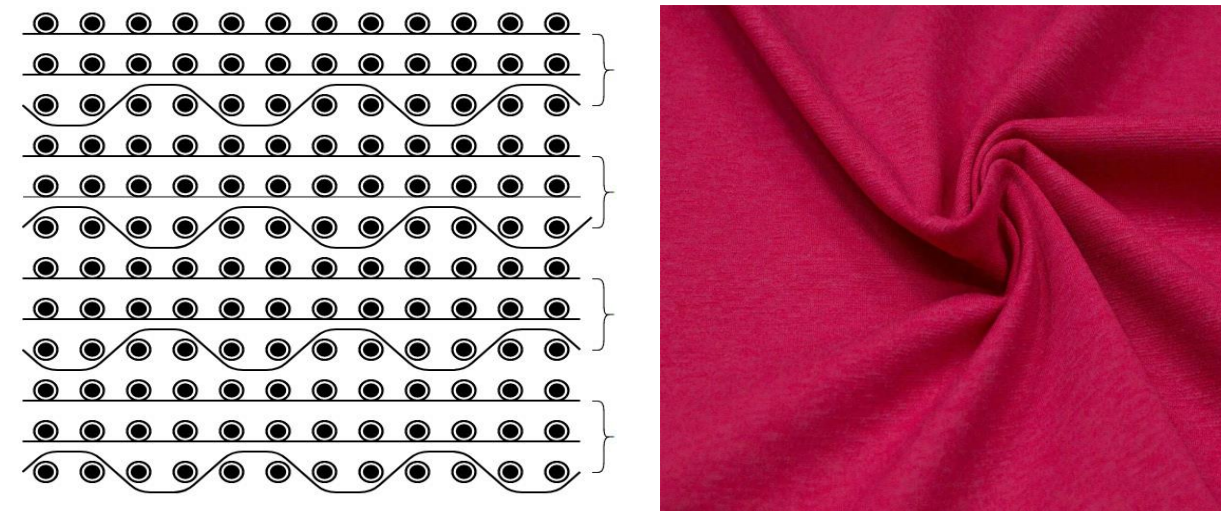
This feature increases the hygroscopicity of the product, maintains its shape well and allows the skin to breathe. The following three types of knits are used to knit and knit.



Option 1



Option 2



Option 3

Figure 1. Graphic Notation and Structure of Futter and Supreme Knitwear Patterns

Knitted fabric report with good hygienic air permeability and high shape retention features Knitted fabric consisting of rows of circular needles differs from each other by changes in the type of raw material and the sequence of tissue reports. In option 1, the amount of yarn is 95% of spun cotton yarn, 5% of Lycra; In option 2, Spun cotton yarn 75%, POLY 23%, Lycra 2%; In option 3, spun cotton yarn is 75%, POLY 25%, and this share of yarns led to changes in the physical and mechanical properties of knitted fabrics.

Characteristics of the physical and mechanical properties of knitted fabrics include: strength, elongation at break, elongation at low tensile strength, resistance to single and repeated elongation, resistance to shrinkage and abrasion, and resistance to heat and moisture treatment [5].

Results and Discussion

Physico-mechanical properties of 3 different variants of knitted fabric samples obtained on the basis of rubber fabric on a single-needle knitting machine in order to study the effect of spun cotton yarn and lycra and polyester yarns with high shape-retaining properties on the physical and mechanical properties of the fabric. It was determined experimentally on modern equipment installed in the laboratory of the Namangan Institute of Engineering and Technology, and the results are given in Table 1.

Table 1

Results of Physical and Mechanical Parameters of Experimental Samples

Indicators		Variants I	II	III
Thread type, linear densities		Spun cotton thread 24 tex	Spun cotton thread 30 tex, 100 POLY	Spun cotton thread 30 tex, 150 POLY
% of yarns in fabric		Spun cotton yarn 95% Laykra 5%	Spun cotton thread 75% POLY 23% Laykra 2%	Spun cotton thread 75% POLY 25%
Knitted surface density Ms (gr/m2)		161	245	194
Knitting thickness T (mm)		0,544	0,849	0,836
Dimensional density δ (mg/cm3)		295	288	232
Air permeability B ($cm^3/cm^2 \cdot sec$)		30,20	8,068	18,04
Interruption force R (N)	along the length	202	192	171
	width	138	218	225
Breakdown L (%)	along the length	68,05	100,7	59,95
	width	119,2	75,15	63,55
Irreversible deformation $\varepsilon_н$ (%)	along the length	7	35	27
	width	10	30	23
Recurrent deformation ε_o (%)	along the length	93	65	73
	width	90	70	77
Friction resistance I (m/ circle)		45000	71200	52150

Air permeability refers to the permeability of materials to themselves. Air permeability is defined as the coefficient of the amount of air passing through 1 cm^2 of fabric per second at a given pressure difference on both sides of the material.

The air permeability coefficient V (cm^2 / cm^2·sec) is determined by the following formula.

$$B = V / \left(S * T` \right),\ cm^3 / cm^2 \times sec$$

Here:

V - the amount of air passing through the fabric at a given pressure difference ΔP, cm^3;

S - fabric area, cm^2;

T - the time it takes for the air to pass through the fabric, sec.

Air permeability properties of woven knitted fabrics change from 8,068 to 30,20 cm^3/cm^2·sec. The lowest air permeability was observed in variant II of knitted fabrics and its volume was 8,068 cm^3 / cm^2·sec. The highest air permeability was observed in variant I of the knitted fabric samples and its volume is 30.20 cm^3 / cm^2·sec.

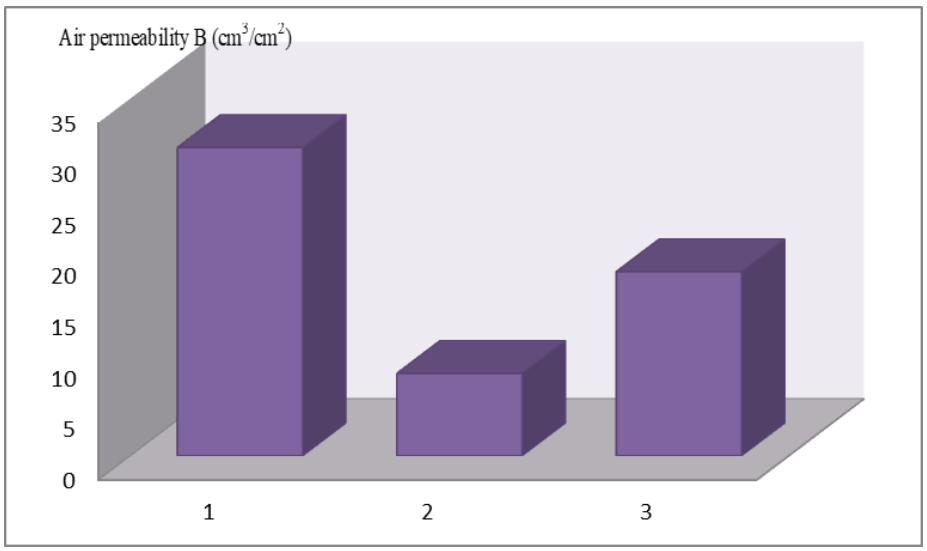


Figure 2. Histogram of Changes in air Permeability of Knitted Fabric

The description of the cut is a key indicator used to assess the quality of knitted fabrics. All GOST and TS used for knitted fabrics include normative parameters on elongation and tensile strength [6]. Breakage force is the force exerted on a sample to elongate at a given size and speed. The breaking force is expressed in Newtonian units. The tensile strength of the samples was determined using a standard method using a YG-026T dynamometer.

Tissue toughness, ie the analysis of tensile strength, shows that the strongest fabric in terms of height, variant I, has a value of 202 N, which is 31 times higher than variant III (Fig.3).

The width-strength of the fabric was also observed in variant III, which has a tensile strength of 225 N, which is 87 times more than in the first variant.

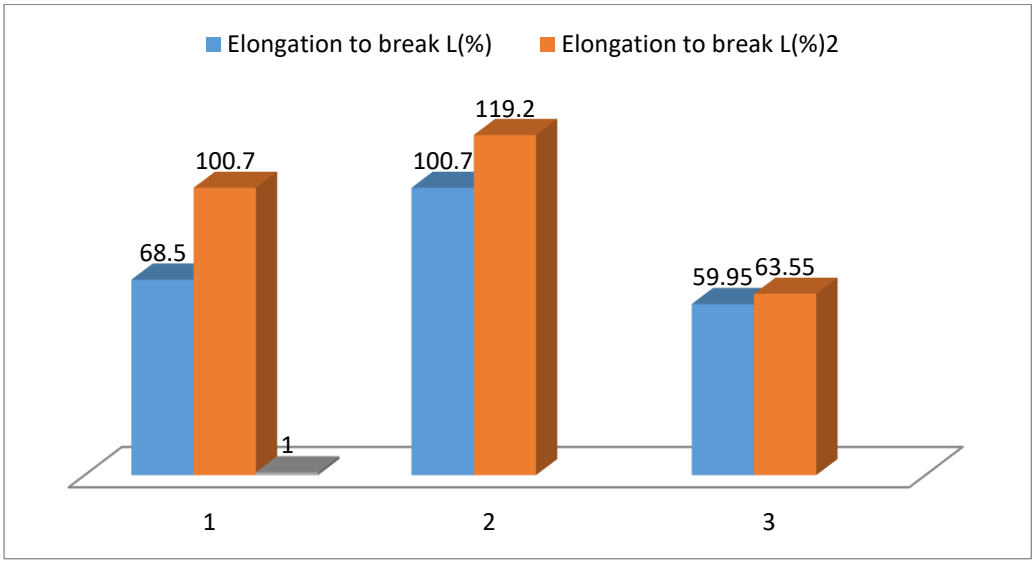


Figure 3. Histogram of the Tensile Strength Change of Knitted Fabrics

The elongation of a knitted fabric is defined as its elongation under the action of an applied force. Elongation is defined as the elongation of the test specimen. Elongation is expressed in absolute or relative units. When knitted fabrics with a length of 100 mm clamped to the tool are tested, their absolute and relative sizes are the same.

The elongation of knitted fabrics ranged from 59.95% to 100.7%. The highest elongation was observed in variant II of the knitted fabric, which was 100.7% (Fig.4). Knitted fabric was found to be 40.75% less elongated than Option II (Option III). The length of the knitted fabric in variant III was the lowest, at 59.95%.

The width of the knitted fabric varies from 63.55% to 119.2%. The maximum width elongation was observed in option I, which was 119.7%. The minimum width elongation was observed in variant III of knitted fabric, which was 63.55%. The width of the knitted fabric variant I was 56.15% less than the basic fabric (variant III), and the width of the variant III of the knitted fabric was close to the width of the fabric variant III, which was 75.15%.

Deformation of knitting changes with the elasticity, stiffness and number of loops of yarn. Not only the description of the deformation, but also the state of knitting is determined by two main internal forces: the elastic force of the yarn bending to the ring tends to straighten and change the shape of the yarn. As a result, there is a frictional force between the threads, which prevents the placement of the threads in the loop and interferes with the structure of the knitted fabric.

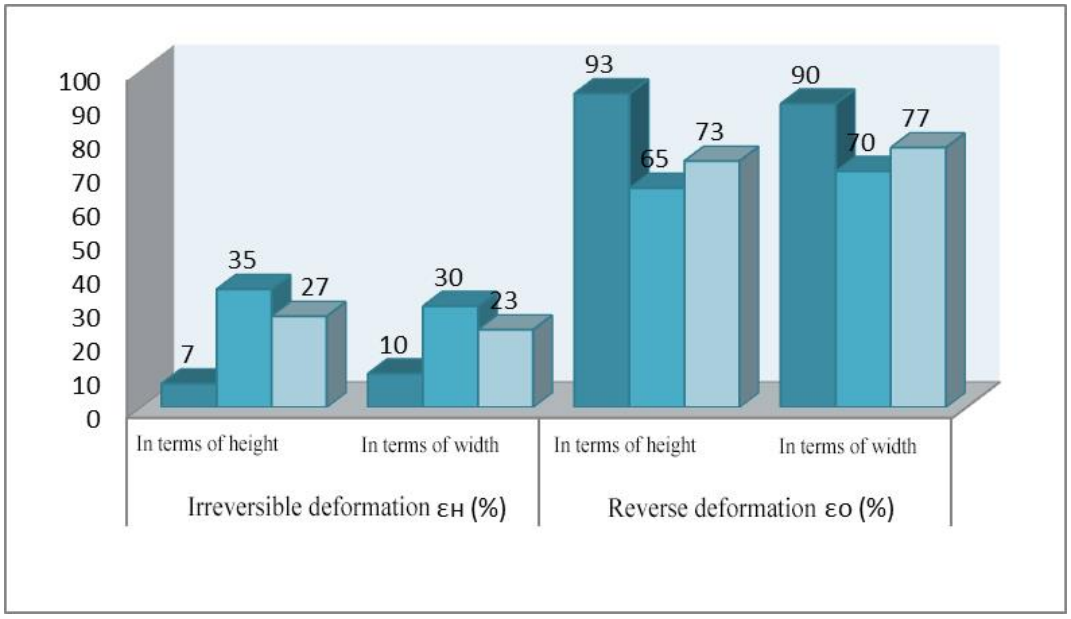


Figure 4. Histogram of Irreversible and Reversible Deformation of Knitted Fabrics

Shape retention In high-quality knitted fabric samples, the proportion of longitudinal reformation varies from 65% to 93%, and the proportion of reverse deformation in width varies from 77% to 90% (*Figure 4.*).

These rates of re-deformation indicate that the knitted fabric quickly returns to its original position after elongation. In the process of wet processing of knitted fabrics (washing, drying) the decrease in size is called penetration, and the increase is called tensile. Knitted fabrics have a significantly higher elongation than woven fabrics and have a high elasticity, even under low stresses [7].

The principle of operation of machines for finishing knitted fabrics is almost the same as for machines for finishing knitted fabrics. It was noted that one of the main reasons for the high level of penetration is the excessive deformation of knitted fabrics in finishing operations [8].

During the use of knitted products, the fabric breaks when it comes in contact with the surrounding objects, and as a result, some parts of the product become unusable [9].

The variants with the highest abrasion resistance of the obtained knitted fabrics are options II and III. The most durable knitted fabric was observed in variant II, its abrasion resistance was 71,200,000 revolutions, variant III's abrasion resistance was 52,150,000 revolutions, and variant II's abrasion resistance was 19,050 higher than Option III's abrasion resistance (*Figure 5*).

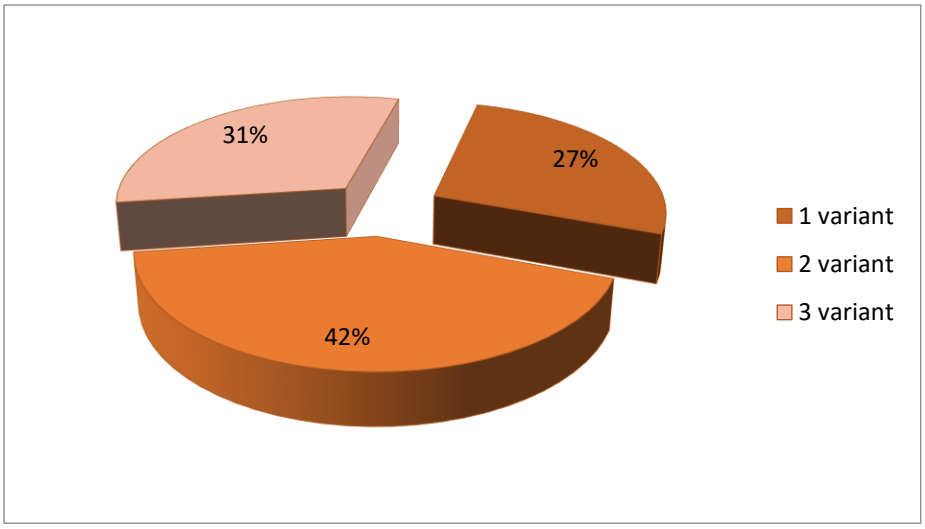


Figure 5. Histogram of Changes in Abrasion Resistance of Knitted Fabrics

The results of three variants of knitted fabric were obtained on the machine FY200, which determines the wet puffiness of the fabric, and its performance is given in the table below (variant 1,2,3).

Moisture resistance of glad knitwear (variant 1)

Table 2.

Fabric Moisture Management Capability Test Report

Fabric Name	: MMT-1	Relative Humidity	: 70%
Test Description	: SDLATLAS	Pump Time (s)	: 20
Date / Time	: 09:53:09 04/17/21	Measure Time(s)	: 120.0
Operator	: sdlatlas	Fabric Weight (g) MMT	: 18.000
Temperature [°C]	: 22	Serial No.	: MMT

Supreme Knitwear Wet Absorption Index (variant 1)

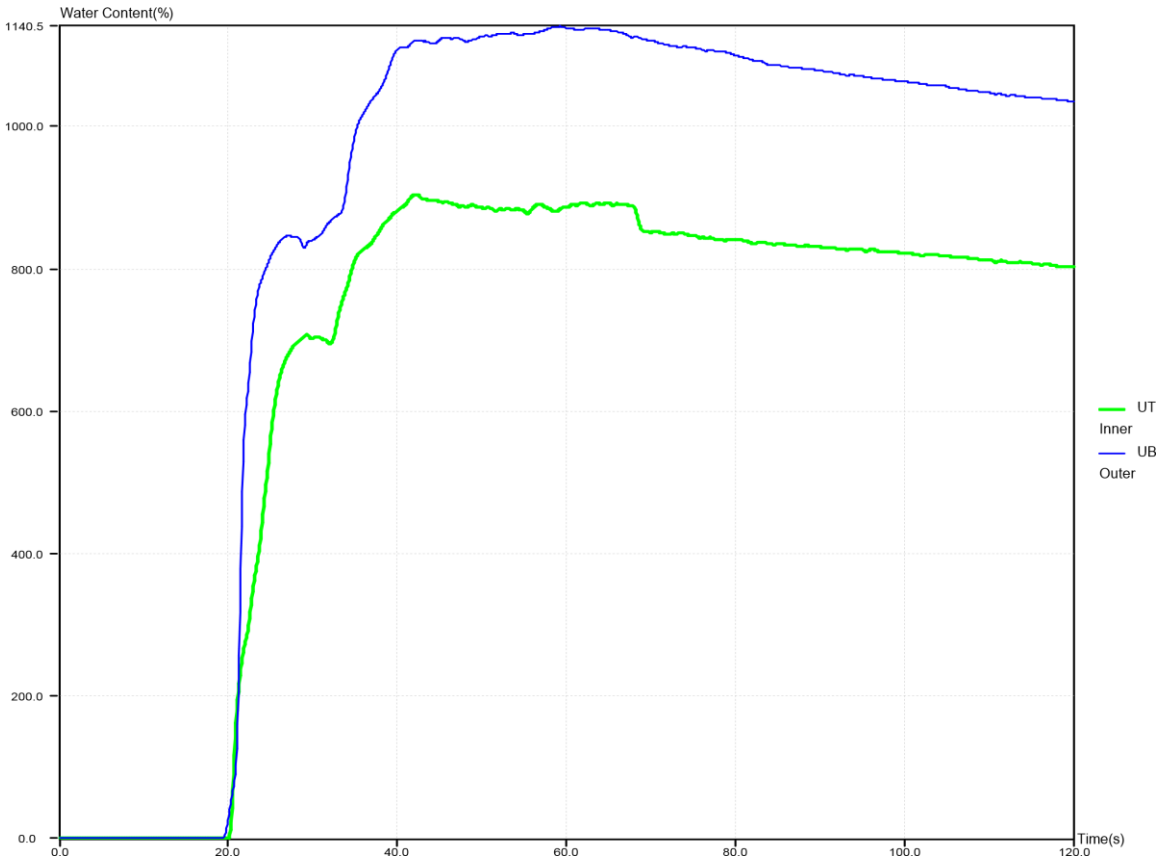


Figure 6. Water Content vs Time

Table 3.

Moisture Resistance of Glad Knitwear

Indicators	Top Surface	Bottom Surface
Wetting Time	19.375	18.907
Absorption rate(%/s)	39.1774	47.2906
Max wetted radius(mm)	15.0	15.0
Spreading Speed(mm/s)	0.825	0.8325
One Way Transport Capability	193.9355	
Test Description	SDLATLAS	

Futer Knitted Wet Wool Swelling Index (Option 2)

Table 4.

Fabric Moisture Management Capability Test Report

Fabric Name	: MMT-1	Relative Humidity	: 70%
Test Description	: SDLATLAS	Pump Time (s)	: 20
Date / Time	: 10:28:33 04/19/21	Measure Time(s)	: 120.0
Operator	: sdlatlas	Fabric Weight (g) MMT	: 18.000
Temperature [C]	: 22	Serial No.	: MMT

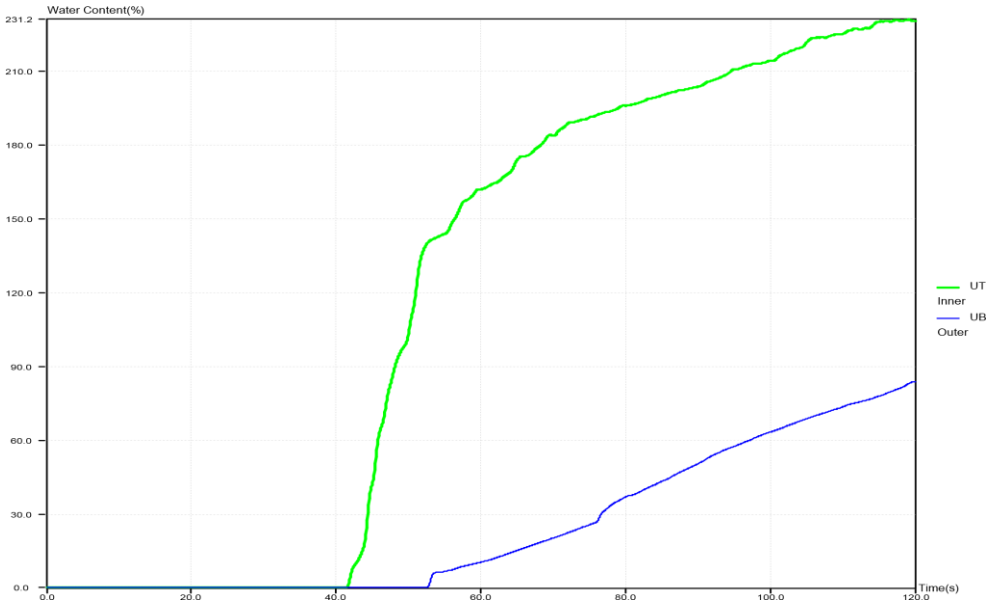


Figure 7. Water Content vs Time

Table 5.

Futer Knitted Wet Wool Swelling Index

Indicators	Top Surface	Bottom Surface
Wetting Time	41.372	52.604
Absorption rate(%/s)	11.832	3.8662
Max wetted radius(mm)	5.0	5.0
Spreading Speed(mm/s)	0.12	0.0942
One Way Transport Capability	-93.0203	

Test Description	SDLATLAS

Moisture absorption index of footwear (option 3)

Table 6.

Fabric Moisture Management Capability Test Report

Fabric Name	: MMT-1	Relative Humidity	: 70%
Test Description	: SDLATLAS	Pump Time (s)	: 20
Date / Time	: 13:00:10 04/19/21	Measure Time(s)	: 120.0
Operator	: sdlatlas	Fabric Weight (g) MMT	: 18.000
Temperature [C]	: 22	Serial No.	: MMT

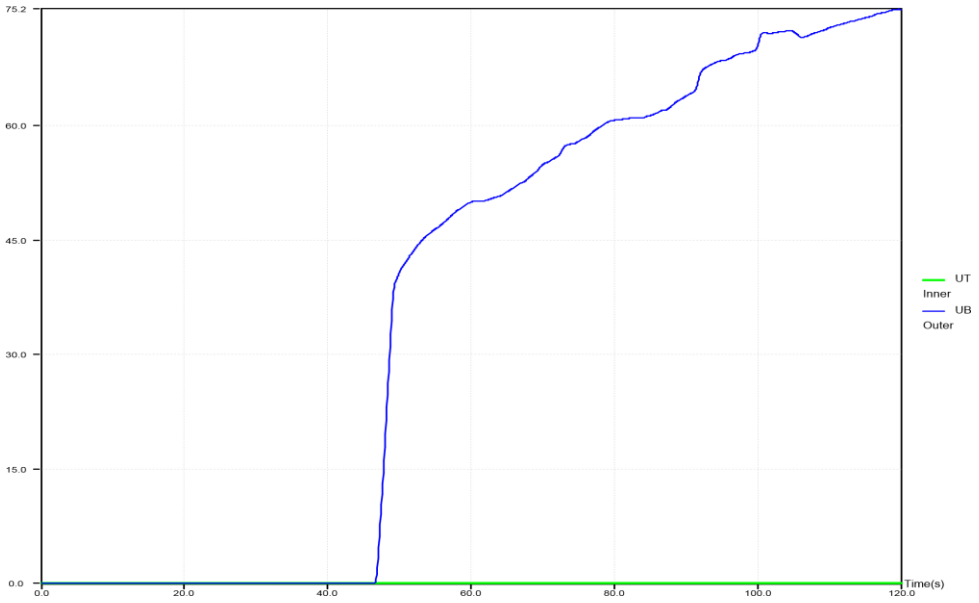


Figure 8. Water Content vs Time, Water Content (%)

Table 7.

Fabric Moisture Management Capability Test Report

Indicators	Top Surface	Bottom Surface
Wetting Time	120.0	46.519
Absorption rate(%/s)	0.0	10.9661
Max wetted radius(mm)	0.0	5.0
Spreading Speed(mm/s)	0.0	0.1068
One Way Transport Capability	36.5718	
Test Description	SDLATLAS	

Option 1 was rated the best in terms of wet puffiness and the result was 93.0203.

Conclusion

In this research work, the physical and mechanical properties and technological characteristics of three types of samples were analyzed on the basis of knitted fabric obtained on a circular knitting machine. The above analysis of the physico-mechanical properties of knitted fabrics showed that changes in the structure of the fabric led to changes in the air permeability, toughness, elongation and abrasion resistance of knitted fabrics. Using this index analyzes, the second sample was rated positively compared to the remaining first and third sample samples. Knitted fabrics are knitted cotton yarn, polyester and lycra yarn, which have high retention properties, toughness and good appearance, ie spun cotton yarn 75%, POLY 23%, Lycra 2% The cross section allows you to get a product that gives good results on all indicators.

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