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Investigation of Knitted Fabrics as Absorbable Material for Using in Medicine

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ABSTRACT. Scientific-investigation work is dedicated to knitting technology and its possibilities that have been investigated. Knitted medical products made from modified cotton and viscose yarns for use in medicine as absorbable materials after surgery were studied. The textile material was obtained on the basis of a single plain structure by using of modified yarn and a patterned fleecy structure with a 1: 1 repeat on a circular knitting machine by using of modified yarn for ground and fleece yarn. The knitting process takes place on circular machine with latch needles. Technological parameters of knitted fabrics obtained at the enterprise were studied. Parameters were determined experimentally.

KEY WORDS. Technology, knitting fabric, medical products, circular knitting machine, latch needle, loop, structure, yarn, technological parameters.

I.INTRODUCTION

The textile industry of Uzbekistan has a high, but not yet fully realized potential. It has significant competitive advantages, both in the global and national markets, due to technologies and raw materials, as well as areas of application, which is an important factor. The high potential for the development of the textile industry can be one of the "points of growth" for the entire national economy. One of the directions of technical progress in textile industry is the production of chemical fibers and development of new and modification of existing fibrous materials in order to give them special properties required in a number of special applications. An urgent problem of modern surgery is the reliable matching of biological tissues and keeping them in a fixed position with constant compression during all stages of wound healing, including postoperative edema. Currently, manual suture remains the most common and reliable, allowing to avoid a number of serious postoperative complications.

Currently, for the manufacture of surgical suture materials (SSM), bioresistant and biodegradable threads are used, which are highly biocompatible, have optimal physical and mechanical properties (strength, rigidity, deformation characteristics), good handling qualities, resistance to infection, atraumaticity, and the ability to reliably knit surgical nodes. Russian manufacturers of suture materials mainly use imported raw materials, with the exception of polycaproamide (PCA) and polyethylene terephthalate (PET) twisted and braided threads, so the development of competitive textile products for surgery in terms of quality and economic availability is an urgent task.

An important direction in the development of fibrous materials with special properties intended for the production of medical products is the creation of fibers with their own biological activity. In this regard, it seems appropriate to impart antimicrobial, antitumor, immunosuppressant and enzymatic activity to synthetic fibers and threads, and also, taking into account the specifics of the use of such materials, a combination of the listed properties in them [1].

In recent years, in reconstructive and restorative operations aimed at eliminating extensive defects in the supporting soft tissues that occur during hernioplasty, after radical resection of malignant neoplasms, infected and necrotic tissues, as well as in a number of other surgical interventions, polymer mesh implants are increasingly used. Mesh endoprostheses have found the greatest use in ventral hernia repair (hernia of the anterior abdominal wall), where they must counteract intra-abdominal pressure. The main task of endoprostheses used in hernia repair is to strengthen the damaged abdominal wall, which is exposed to intra-abdominal pressure. In this case, the mesh material gradually grows into connective tissue, which takes on part of the load acting on it.

Since polymer mesh materials that strengthen damaged tissues are increasingly used in hernia repair operations, they must have appropriate deformation and strength properties to perform this function. Mesh endoprostheses are made from filaments and have a relatively high porosity, which is required for efficient penetration of the mesh by connective tissue. At present, warp-knitted mesh materials, which have increased density and flexibility, are of general origin in the manufacture of endoprostheses, are dimensionally stable, and are prone to unraveling and shedding of the edges when

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cut in changed sizes. The knitted method of production allows reducing the sensitivity to the thickness, porosity and material consumption of endoprostheses [2].

The knitting method of production and the sphere of knitwear products using are becoming wider and wider, mainly due to the structure of the material. Recently, the development trend is aimed at creating complex structures in which technological parameters and physical and mechanical properties vary based on customer requirements [3].

Knitted fabric is characterized by a great variety of knit structures. The knit structure of knitted fabrics is the most important quality characteristic and defines knitting properties: extensibility (elongation), unraveling, surface density, thickness, form stability, etc. By applying different knit structures, it is possible to obtain knitting with different properties, pattern or structural effects. Knit structures of knitted fabrics can be classified. The basic, derivative, cardigan patterned and combined groups of knit structures are distinguished [4].

The basic group of knit structure includes knit structures, which consist of identical elements of structure (loops). The fundamental knit structures have the simplest structure. The derivative group of knit structure includes knit structures, formed from a combination of several identically basic knit structures, which mutually knitted so that, between the loop wales of one, the others loop wales or several similar loops are intermeshed. The group of patterned includes knit structures, formed on the basis of the basic or derivative knit structure, by appending additional elements into them (float loop, tuck loop, additional threads) or by changing the knitting processes, allowing to obtain knitwear or knit fabric with new properties. Combined knit structures combine the features of the different basic, derivative, or cardigan patterned knit structures.

Depending on the combination methods, knitted structures of various groups distinguish simple, derivative-combined, cardigan patterned and complex combined knitted structures. Apart from the groups (classes), the knit structures can be characterized by rapport (repeat unit) of knitting. As is known, rapport of knitting is the smallest number of loop course (rapport in height Rh) or loop wales (rapport in width Rw) after which alternation order of yarns segments as a knit stitch, float stitch, or tuck stitch in the knit structure is repeated.

Weft (crosswise) and warp (lengthwise) knitting fabrics are distinguished. In the first loop, the course is formed coherently, loop by loop or in the certain alternation of one or more yarn systems in the direction of the loop course. In the second wales of the loop is formed simultaneously by one or more yarn systems (warps), wherein one or two laps are formed from each of the warp yarn.

Many scientists in a number of research works have studied and investigated the knitted structures, their parameters and properties, achieved certain results and are given in scientific papers [5-10].

The manufacture of medical products based on knitted structures is a new direction in the field of textiles in Uzbekistan. We have recently begun to study and conduct research in this area. Several theoretical and experimental works have been carried out on the study and research of compression products for patients with varicose veins [11-14]. Today, we are also interested in the use of knitwear in surgery, in particular, absorbable products in the postoperative period. For this, several variants of samples were made from special raw materials. This article describes the experiment of obtaining samples and the results of the parameters and properties.

II.RESEARCH METHODS

In this work, knitted medical products made from modified cotton and viscose yarn for use in medicine as an absorbable material after surgery were studied. The textile material was obtained on the basis of a single plain structure by using of modified yarn 8.4 tex * 2 and a patterned fleecy structure with a 1: 1 repeat on a circular knitting machine by using of modified yarn 8.4 tex * 2 for ground and fleece yarn. The knitting process takes place on circular machine with latch needles. Technological parameters of knitted fabrics obtained at the enterprise were studied. Parameters were determined experimentally. The plain and fleecy structures are shown in Fig.1. The plain structure is a single, the loops of which along the loop rows are formed sequentially with one yarn.

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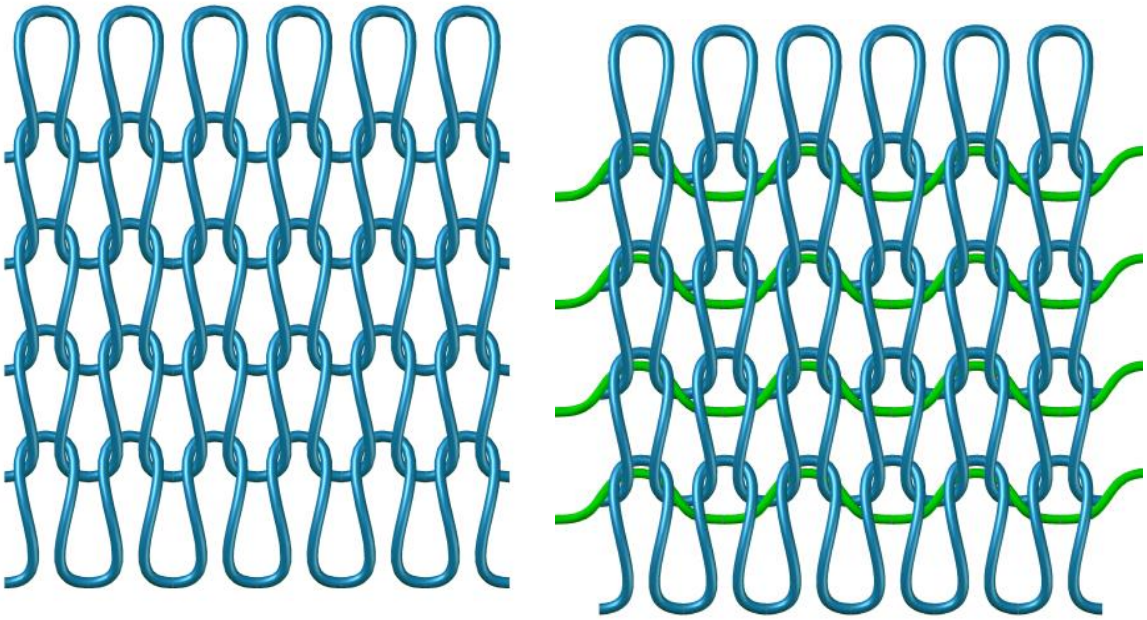

a b

Fig1. Knitting structures for using in medicine a) plain structure b) fleecy structure

The plain loop is unraveled in the opposite direction of knitting: it is impossible to unravel the knitwear in the knitting direction, because the thread is lingering at the edges. Along the line of loop columns it is twisted to the wrong side, along the line of the loop row to the front side. When stretched in length, the surface lengthens, while narrowing in width; when stretched in width, it increases in width, shortening in length.

Fleecy is called knitwear containing additional systems of yarns; some loops of one loop row of such knitwear are located not only through the loops of another loop row, but also through the fleecy yarns. In the production of fleecy structure fleecy yarns are laid on needles in the form of half loops, taken to the old loops and dropped along with them onto new ones [15,16].

Some of the fleecy yarns can be laid in one loop row of fleecy knitting structure. Depending on the number of such yarns there are simple, doubled, triple lined knitwear. Fleecy knitting structure can be formed on thebasis of all known knitting structures. According to the type of ground structure, in which the fleecy yarns are knitted, the fleecy knitting structure can be single-knitted, double-knitted and warp-knitted.

III.EXPERIMENTAL RESULTS

The main technological parameters and properties such as surface density, thickness, volume density, breaking force of knitting products were determined experimentally according to the standard method. The results of the study are shown in the table.

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TABLE

Technological parameters of samples of textile material for a medical absorbable product

Variants	Yarn contamination, %	Width of loop, A (mm)	Height of loop, B (mm)	Horizontal density,P_g,	Vertical density,P_v,	Length 0f loop, L (mm)	Surface density, M_S, g/m^2	Thickness, M (mm)	Volume density, δ, mg/sm^3	Breaking force Pp (/N)	
										on length	on width
I.1.в	cotton, 75% viscose, 25%	1,43	1,11	35	45	2,96	132,4	0,4	331	519,3	405,7
I.2.в		1,66	1,25	30	40	5,7	95,4	0,3	318	683,7	406,7
I.3.в		1,66	1,43	30	35	6,12	92,8	0,35	265,1	540,3	241
II.1.в		1,66	1,43	30	35	7,6	106,9	0,4	267,2	401,3	143,3
II.2.в		2	1,66	25	30	7,2	106,3	0,35	303,7	323	183,3
II.3.в		2	2	25	25	8,2	103,0	0,35	294,3	373,7	107,7

A number of experimental works have been carried out to determine the technological parameters of the obtained samples of textile material based on knitted structures, which will later be used in medicine as an absorbable product after surgery.

IV.RESULTS AND DISCUSSION

The thickness of the fabric (knitwear) depends on the thickness of the yarn forming it, the kind of knitting structure, the stitch density and finishing operations.

The studied samples of knitted structures are produced from the same type of yarn with the same linear density. Therefore, their thickness is maximally influenced by the knitting structure.

On fig. 2 a graph of the thickness dependence on the structural elements in the knitting rapport is presented. The results of the analysis show that the thickness of the knitwear varies between 0.3 –0.4 mm. Rapport of the fleecy structure consists of 1:1 by shift 1. When a shift is added to the rapport of the knitting structures, the thickness of the fleecy structure decreases and with an increase in the number of basic loops which, accordingly, extends the length of the fleecy float in the rapport. According to the graph equations of regression are recommended for:

- length of loop

$y = -0{,}2985x^2 + 3{,}0763x$

-thickness

$y = -0{,}0279x^2 + 0{,}2176x$

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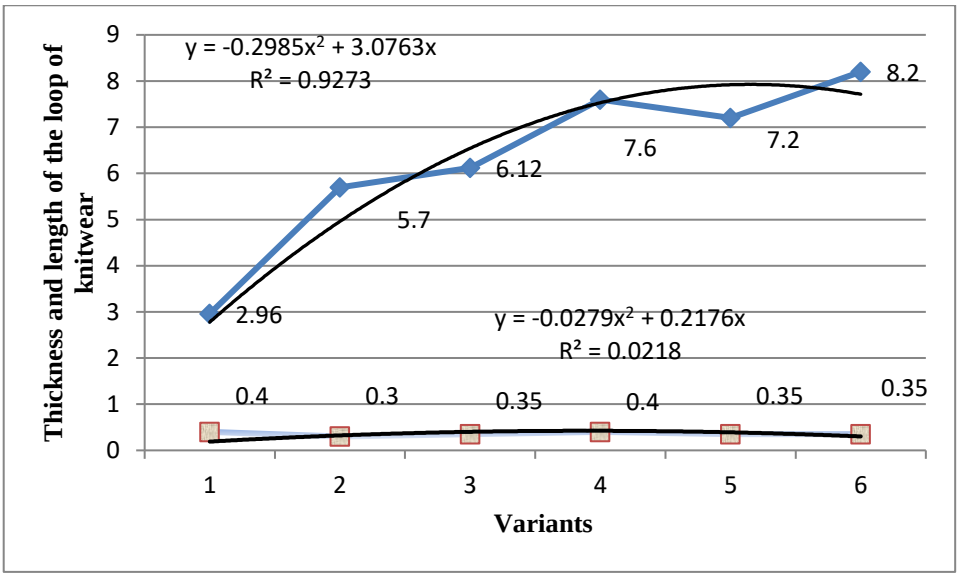

Fig2. Graph of the thickness and length of the loop of knitwear for using in medicine

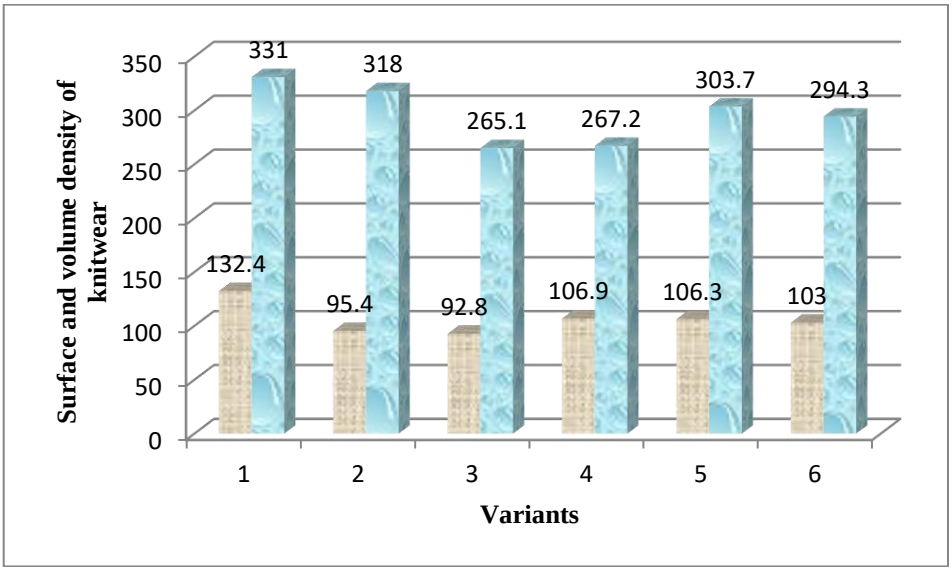

Fig3. Histogram of changes in the surface and volume density of knitwear for using in medicine

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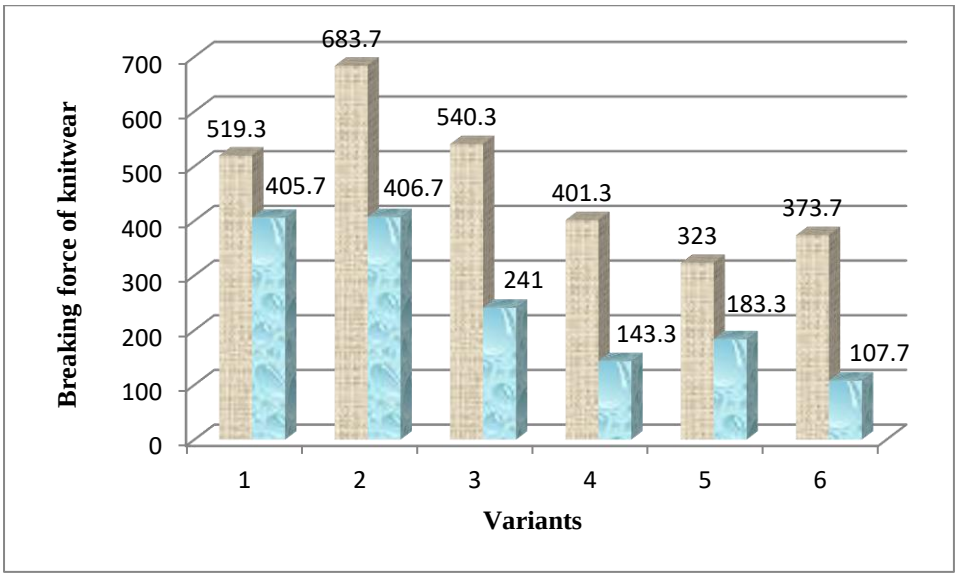

Fig4. Histogram of changes in the breaking force of knitwear for using in medicine

Thus, it was found that the shift of the fleecy tuck affects the thickness of the fleecy knit negatively, and the amount of basic loop between the fleecy float positively.

Fig.3. shows a histogram of changes in the surface and volume density of knitwear for using in medicine. The surface density is between 92.8-102.4 gr/m^2, while the volume density is between 265.1-331 mg/sm^3 . It varies 9-20%. Whilesurface density takes into account the width and height of the knitting, volume density is a parameter that takes into account the thickness as well as the width and length of the knitting. Therefore, a decrease in volume density indicates a decrease in raw material expenditure.

If the values of the obtained samples are analyzed, the breaking force in length and width during the study is given in the following diagram for knitted fabrics (fig.4). The breaking force on length is 683.7-323 N, while the breaking force on width is 406.7-107.7 N. It varies more than 50% in length and width. The shear strength performance of the variants is relatively changeable and there is more possibility to choose necessary strength parameter for knitting products relatively to sphere of usage.

V. CONCLUSION

The types and methods of obtaining knitted fabrics were studied. Different variants of effective knitted fabrics with pattern-enhancing have been created and the technology of producing has been developed. Cotton and viscose yarns were used to achieve effect and improve parameters in knitted fabrics. It is recommended for the production of knitwear for using in medicine. At the same time these variants can be recommended in accordance to sphere of using because strength properties and decreasing possibility of raw material expenditure.

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