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IMPROVING TECHNOLOGY FOR PRODUCTION OF SURGICAL THREAD FROM NATURAL SILK

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Abstract

This article presents the results of research work carried out at the Uzbek Research Institute of Natural Fibers in the field of improving the production technology of twisted non-sterile surgical threads from natural silk. The results of production tests of the improved technology in the conditions of production enterprises are also presented. The article also presents the results of studies of the quality indicators of surgical threads obtained by different methods or technologies.

Keywords: surgical silk thread, cocoons, cocoon thread, unwinding, cocoon reeling, raw silk, quality, folding, twisting, twisted, technology, improvement.

INTRODUCTION

Working with emergent language involves the process of interacting with and supporting the development of language that is still in the early stages of emergence. This can occur in various contexts, such as language acquisition in young children, second language learners, or individuals with communication disorders. It is a crucial aspect of language development and requires a sensitive and supportive approach to facilitate effective communication and language growth.

One of the key principles of working with emergent language is creating a nurturing and responsive environment that encourages communication. This involves providing ample opportunities for individuals to express themselves and interact with others. Whether it is through verbal communication, gestures, or other forms of expression, creating an environment that values and supports all attempts at communication is essential for fostering language development.

- ✓ Unplanned language items arising naturally during interaction that are then focused on through modification or clarification
- ✓ Includes errors, but also alternative ways of expressing the same or related meanings and forms.
- ✓ Language that teachers or learners judge to be in some way new, interesting or useful to share.
- ✓ Responses to questions or problems raised by learners about an aspect of language.

This practical addition to the Teaching English series raises awareness of what emergent language (EL) is, highlights its importance and makes the case that focusing on EL is an essential part of learning a language and therefore a skill that every language teacher should possess or work to develop. It offers useful definitions and explains the pedagogy, alongside practical suggestions and opportunities for reflection, to help all teachers work with EL effectively and confidently.

Every unplanned language point that naturally comes out during classes that the instructor chooses to focus on for explanation or modification is known as emergent language (EL), and this method is becoming more and more popular every year. Its origins may be traced back to the Dogme movement, a popular movement that advocated using student and teacher-generated materials instead of course books or prescribed literature in the classroom. Emergent language incorporates the knowledge gained by employing

Dogme and contemporary pedagogical approaches. But dealing with EL is seen to be an extremely challenging ability to learn, particularly for inexperienced or rookie instructors.

As a result, it is rarely covered in-depth in teacher training manuals or on training courses.

When working with emergent language, it is important to use strategies that support the gradual progression of language skills. Modeling language is a powerful tool in this regard, as it provides individuals with examples of how to use language effectively. By consistently modeling appropriate language use and providing rich language input, caregivers and educators can help individuals internalize language structures and expand their vocabulary.

Furthermore, using visual supports can aid comprehension and reinforce language learning. Visual aids such as pictures, charts, and graphic organizers can help individuals make connections between words and their meanings, as well as provide additional context for understanding language. Visual supports are particularly beneficial for individuals who may struggle with verbal communication or have difficulty processing auditory information.

It is crucial to recognize and celebrate the progress made by individuals with emergent language, regardless of how small it may seem. Positive reinforcement and acknowledgment of efforts can significantly boost confidence and motivation for further language development. By creating a supportive and encouraging atmosphere, individuals are more likely to engage in communication and take risks in using new language skills.

Flexibility and creativity are also essential when working with emergent language. Each individual has unique needs and abilities, so it is important to adapt communication strategies to suit their specific requirements. This may involve using alternative communication methods, such as gestures, pictures, or augmentative and alternative communication (AAC) devices. Understanding and respecting the individual's preferred mode of communication can greatly enhance their ability to express themselves effectively.

- Enhanced Communication Skills: Working with emergent language helps individuals develop and improve their communication skills, enabling them to express their thoughts, needs, and emotions more effectively.
- Increased Confidence: As individuals receive support and encouragement in using their emerging language skills, they gain confidence in their ability to communicate, leading to greater self-assurance in social interactions.
- Language Development: By providing a nurturing environment and using effective strategies, working with emergent language can facilitate the growth of vocabulary, grammar, and overall language comprehension.
- Improved Social Interaction: Developing language skills through support and guidance allows individuals to engage more actively in social interactions, fostering connections with others and enhancing their social skills.
- Cognitive Development: Engaging with emergent language can stimulate cognitive processes such as memory, problem-solving, and critical thinking, contributing to overall cognitive development.

To sum up, dealing with emergent language demands tolerance, compassion, and a thorough comprehension of the developmental stages associated with language learning. People with emerging language can be enabled to grow as communicators and realize their full potential by providing a safe and caring environment. In order to assist language skill development in people at different stages of language development, caregivers, educators, speech-language pathologists, and other professionals collaborate.

References:

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In medical practice, many surgical threads are used for sutures and ligatures, produced from various textile threads using various technologies and methods. Surgical threads are mainly made from natural silk, nylon (polyamide), lavsan (polyester) and polypropylene filament threads. Surgical threads are produced by twisting and weaving methods, they can be produced in sterile or non-sterile form, they are produced with surgical needles or without needles. A distinction is made between absorbable surgical sutures and non-absorbable surgical sutures. Absorbable surgical sutures are made from animal intestines, mainly sheep intestines. Non-absorbable surgical sutures are made from chemical complex sutures. Surgical threads made of natural silk are semi-absorbable threads, i.e. these threads are eliminated from the body within a year.

Currently, surgical sutures from natural silk are produced in two ways: twisted and braided. Twisted surgical threads made of natural silk in non-sterile form can be produced in bulk packages, in skeins or in conical cartridges in accordance with current standards. The following assortments of non-sterile twisted silk threads are produced: 000, 00, 0, 1, 2, 3, 4, 6, 8 [1]. Surgical threads from natural silk are also produced by braiding in the following assortments: 2p, 3p, 4p, 5p, 6p, 8p, 10p [2,3,4,5]. In recent years, absorbable surgical sutures have begun to be produced from complex chemical sutures [3,6]. In the production of woven silk surgical threads, silk threads are first folded depending on the range of surgical threads and they are given a twist of 100 to 150 cr/m. Then, after fixing the twist, three twisted threads are added, then these threads are weaved and a surgical thread of a certain conventional number is formed. It should be noted here that the breaking characteristics of surgical threads produced by the torsion method are higher than the breaking characteristics of surgical threads produced by the weaving method.

MAIN PART

Twisted non-sterile surgical threads from natural silk are produced according to the methods of the Interstate Standard GOST 396-84 [1] or the Regulated Technological Regime for the production of sewing threads and special-purpose threads from natural silk [7] in special workshops of silk spinning enterprises. The assortments, as well as the proposed and existing structures of twisted non-sterile surgical sutures made of natural silk are shown in table 1 [8].

Table 1. Proposed structure of non-sterile, twisted surgical sutures made of natural silk

	sortments of silk surgical sutures	Designations for the structure of assortments of surgical threads according to the current standard GOST 16736–71	
		Structure according to standard	Proposed structure
1	000	2,33 tex x 2S1000 x3Z 1000	2,33 tex x 2S 1000 x 3Z1000
2	00	2,33 tex x 4S 800 x 3Z 800	33 tex x 4S 800 x 3Z 800
3	0	2,33 tex x 5S 650 x 3Z 650	33 tex x 5S 650 x 3Z 650
4	1	3,22tex x 5S 550 x 3Z 550	33 tex x 7S 550 x 3Z 550

5	2	3,22tex x 8S 450 x 3Z 450	33 texx 11S 450 x 3Z 450
6	3	3,22tex x 9S 450 x 3Z 450	33 tex x 15S 450 x 3Z 450
7	4	3,22tex x17S 450 x 3Z 450	33 tex x 24S 450 x 3Z 450
8	6	3,22tex x31S 400 x 3Z 400	33 tex x 45S 400 x 3Z 400
9	8	3,22tex x38S 300 x 3Z 300	33 tex x 60S 300 x 3Z 300

From the analysis of the data given in Table 1, it is clear that surgical threads made of natural silk according to the existing structure are produced from two assortments of raw silk: 2.33 and 3.23 tex. According to the requirements of current standards, each range of raw silk has different quality indicators, i.e. The lower the linear density of raw silk, the greater the requirements for it. Based on this, we proposed to improve the existing technology for the production of surgical threads by changing the structure of surgical threads, while in all assortments of surgical threads using the same assortment of raw silk - 2.33 tex. At the same time, in the structure of surgical threads, only the number of raw silk threads in the cross section of surgical threads was changed, and the resulting linear density of surgical threads, number, direction of twist and other indicators remained unchanged. According to the requirements of the current Interstate Standard GOST 396-84, surgical threads in terms of physical and mechanical parameters must correspond to the indicators given in Table 2.

Table 2. Physico-mechanical parameters of twisted non-sterile silk surgical threads in accordance with the current standard GOST 396-84

№	The name of indicators	Assortments of threads and standards for them								
		000	00	0	1	2	3	4	6	8
1	Resulting linear density, tex, no more	12,0	23,5	30,0	40,0	64,5	88,0	143,0	270,0	350,0
2	Coefficient of variation in linear density, % not more than	7,0	6,0	5,2	4,8	4,2	3,8	3,5	3,0	3,0
3	Breaking load of thread, daN, (kgs), not less	0,36 (0,37)	0,6 (0,70)	0,88 (0,90)	1,22 (1,25)	1,96 (2,00)	2,35 (2,40)	4,36 (4,45)	8,33 (8,50)	10,29 (10,50)
4	Elongation at break, %	15-25	15-25	15-25	15-25	15-25	15-25	20-30	20-30	20-30
5	Breaking load when testing a thread in a knot, daN, (kgs), not less	0,15 (0,15)	0,34 (0,35)	0,49 (0,50)	0,69 (0,70)	1,27 (1,30)	1,57 (1,60)	2,55 (2,60)	4,51 (4,60)	5,78 (5,90)
6	Breaking elongation when testing a thread in a knot, %	5-15	5-15	5-15	5-15	8-18	8-18	8-18	10-20	10-20
7	Deviation from nominal twist, kr/m	±60	±40	±35	±25	±20	±20	±20	±20	±20
8	Coefficient of variation in twist, %, no more	3,2	3,6	4,0	4,5	4,5	5,0	5,0	5,0	5,0

Analysis of the data given in Table 2 shows that quite high demands are placed on finished surgical threads made from natural silk. The mass content of soap and fatty-wax substances in surgical threads, determined by chemical analysis, should not exceed 1.7% by weight of the threads. If the finished surgical thread does not meet the requirements of the standard in at least one indicator, the threads of this batch are not allowed for further sale.

In the production conditions of a silk spinning enterprise, surgical threads were produced from natural silk using improved technology. At the beginning of the work, we determined the resulting linear density of the produced range of surgical threads by calculation using the formula we proposed (1).

$$T_{р.л.п.} = \frac{nT_{ф}}{(1-\frac{a}{100})} \cdot (1-\frac{в}{100}) \quad (1)$$

where T_(p.l.p.) is the resulting linear density of surgical threads, tex; T_f. – linear density of the raw silk used, tex; n – number of raw silk threads in surgical threads, pcs; – thread twisting, %; – amount of boiled sericin and fatty-waxy substances during boiling of surgical sutures, %.

The twisting of surgical threads was determined using the empirical formula (2) proposed by S.A. Anuchin [9].

$$U = 2{,}5K^{2}\sqrt[4]{n} \cdot T/10^{7} \quad (2)$$

The calculated values of surgical threads, developed in different ways, confirmed the correctness of the theoretical formula we developed, which is shown by the data given in Table 3.

Table 3. Resulting linear densities of surgical threads determined by different methods

№	Assortments of surgical threads	Resulting linear density of silk surgical threads, tex			
		Thread structure		Thread structure	
		Indicators according to the current standard GOST 396-84	Determined using the formula of S.A. Anuchin I option	Determined by laboratory tests II option	Preliminarily determined by the formula we proposed III option
1	000	2,33 tex x 2 S 1000 x 3 Z 1000		2,33 tex x 2 S 1000 x 3 Z 1000	
		up to 12.0	11,21	11,7	11,22
2	00	2,33 tex x 4S 800 x 3 Z 800		2,33 tex x 4S 800 x 3 Z 800	
		23,5 гача	22,57	22,6	22,57
3	0	2,33 tex x 5S 650 x 3 Z 650		2,33 tex x 5S 650 x 3 Z 650	
		up to 30,0	28,03	28,8	28,05
4	1	3,22tex x 5S 550 x 3 Z 550		2,33 tex x 7 S 550 x 3 Z 550	
		up to 40,0	38,69	38,9	39,23
		3,22tex x 8 S450 x 3 Z 1000		2,33 tex x 11 S450 x 3 Z450	
5	2	up to 64,5	62,02	63,0	61,70
		3,22tex x 9S 450 x 3 Z 450		2,33 tex x 15 S 450 x 3 Z 450	
6	3	up to 88,0	69,99	86,9	84,98
		3,22tex x 17S 450 x 3 Z 450		2,33 tex x 24 S 450 x 3 Z 450	
7	4	up to 143,0	135,99	140,0	139,13
		3,22tex x 31S 400 x 3 Z 400		2,33 tex x 45S 400 x 3 Z 400	
8	6	up to 270,0	248,04	268,0	268,79

		3,22tex x 38S 300 x 3 Z 300		2,33 tex x 60S 300 x 3 Z 300	
9	8	up to 350,0	301,81	347,0	348,42

The analysis of data in table 3 shows that the resulting linear density obtained by calculation according to the proposed formula is close to the standard values and the values obtained by laboratory tests. A eto confirms the correctness of the proposed formula.

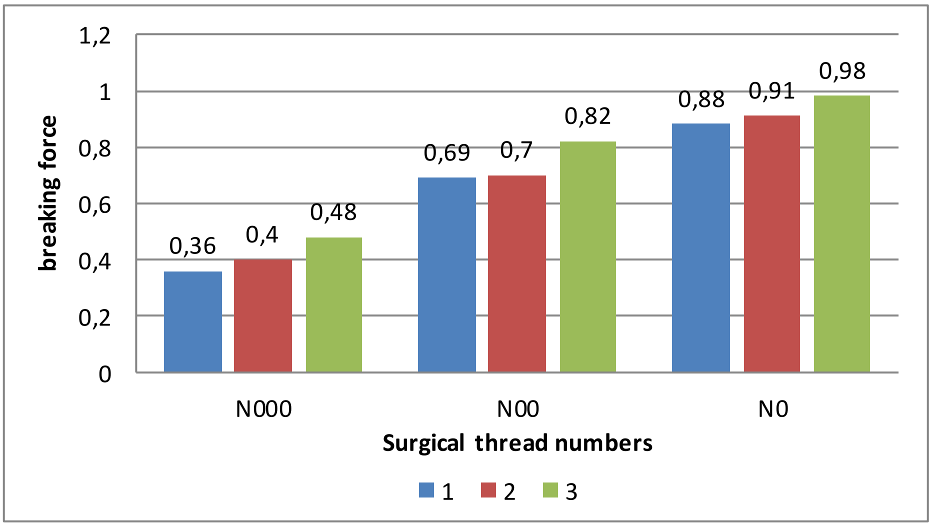
After the manufacturing batch of surgical threads from natural silk and improved technology, the threads were subjected to laboratory tests and specified physical-mechanical and chemical-technological parameters, the results of which are shown in tables 4, 5 and 6.

Table 4. Results of laboratory tests and determination of physical-mechanical and chemical-technological parameters of surgical nites № 000, № 00, № 0

The name of indicators	Indicators of surgical threads by assortment								
	Accor ding to GOST 396-84	Assortment № 000		Accor-ding to GOST 396-84	Assortment № 00		Accor-ding to GOST 396-84	Assortment № 0	
		control	expe-rienced		contro l	expe-rienced		ontrol	expe-rienced
;sortment of surgical threads	000	000	000	00	00	00	0	0	0
ıear density of raw silk, tex	2,33	2,33	2,33	2,33	2,33	2,33	2,33	2,33	2,33
value of the soak solution	-	-	8,75	-	-	8,75	-	-	8,75
mperature of the locking solution, °C	-	-	55±3	-	-	55±3	-	-	55±3
ngitudinal locks, min.	-	-	15	-	-	15	-	-	15
[value of the decoction solution	-	10,75	.0,75	-	10,75	10,75	-	10,75	10,75
iling temperature, ^{0}C	-	5-110	5-100	-	5-110	)5-100	-	5-110	)5-100
ntinue decoction, min.	-	60-90	20-25	-	60-90	20-25	-	60-90	20-25
nount of residual soap and grease. real,%	ıp to 1,70	1,67	1,10	ıp to 1.70	1,65	1,15	to 1,70	1,68	0,92
sulting linear density of surgical threads, tex	ıp to 12,0	11,21	11,7	ıp to 23,5	22,57	22,6	to 30,0	28,03	28,8
efficient of variation in linea density, %	to 7,0	6,6	5,2	to 6,0	5,8	5,3	) to 5,2	4,9	4,2

eaking load of thread, daN, (kgs), not less	),36 (0,37)	0,40 0,42)	3 (0,50)	0,69 (0,70)	0,70 0,70)	0,82 (0,85)	0,88 (0,90)	0,91 0,93)	0,98 (1,00)
Elongation at break, %	5-25	18	19	.5-25	16	17	15-25	22	19
Breaking load of thread in a knot, daN, (kgs), not less	),15 (0,15)	0,16 0,17)	9 (0,20)	0,34 (0,35)	0,35 (0,38)	0,48 (0,50)	0,49 (0,50)	0,53 (0,55)	0,62 (0,65)
Breaking elongation at a node, %	5-15	10	12	5-15	9	11	5-15	10	14
Torsion number, kr/m	.000	980	1000	800	820	810	650	670	640
Coefficient of variation in twist, %	3,2	3,2	2,8	3,6	3,4	3,0	4,0	3,8	3,1
Deviation from nominal twist, kr/m	±60	-20	0	±40	+20	+10	±35	+20	-10

From the analysis of the data given in Table 4, one can see that the obtained surgical threads according to the proposed structure have indicators very close to standard indicators and significantly exceed those of the control threads; this is also visible from the histogram constructed according to the data in Table 4 (see Fig. 1).



where 1 is the indicators of the standard, 2 are the indicators of the threads of the control version, 3 are the indicators of the experimental version.

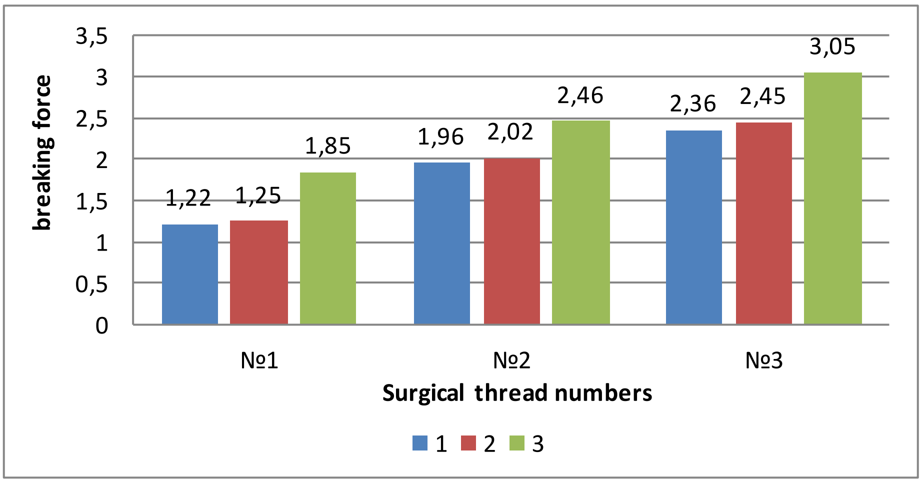
Fig.1. Comparative histogram of the breaking load of surgical threads made of natural silk of assortments No. 000, No. 00, No. 0 obtained from the control and experimental options with the indicators of the current standard.

Table 5 shows the physical-mechanical and chemical-technological indicators of surgical threads of assortments No. 1, No. 2, No. 3, developed according to the experimental and control variants of the study.

Table 5. Results of laboratory tests to determine the physical-mechanical and chemical-technological parameters of surgical threads of assortments No. 1, No. 2, No. 3

The name of indicators	Indicators of surgical threads by assortment								
	According to GOST 396-84	Assortment № 1		According to GOST 396-84	Assortment № 2		According to GOST 396-84	Assortment № 3	
		control	experienced		control	experienced		control	experienced
ssortment of surgical threads	1	1	1	2	2	2	3	3	3
near density of raw silk, tex	3,22	3,23	2,33	3,22	3,23	2,33	3,22	3,23	2,33
value of the soak solution	-	-	8,75	-	-	8,75	-	-	8,75
mperature of the locking solution, °C	-	-	55±3	-	-	55±3	-	-	55±3
ngitudinal locks, min.	-	-	15	-	-	15	-	-	15
value of the decoction solution	-	0,75	10,75	-	0,75	10,75	-	10,75	0,75
iling temperature, ^{0}C	-	5-110	5-100	-	5-110	5-100	-	5-110	5-100
ntinue decoction, min.	-	0-90	20-25	-	0-90	20-25	-	50-90	20-25
nount of residual soap and grease. real,%	up to 1,70	1,65	1,05	up to 1,70	1,50	1,0	up to 1,70	1,60	0,85
ulting linear density of surgical threads, tex	up to 40,0	38,69	38,9	up to 64,5	62,02	63,0	up to 88,0	69,99	86,9
efficient of variation in linear density, %	up to 4,8	4,6	3,2	up to 4,2	4,0	3,0	up to 3,8	3,7	1,7
eaking load of thread, daN, (kgs), not less	1,22 (1,25)	1,25	1,85	1,96 (2,00)	2,02	2,76	2,36 (2,4)	2,45	3,05
Elongation at break, %	15-25	18	21	15-25	17	23	15-25	19	20
Breaking load of thread in a knot, daN, (kgs), not less	0,69 (0,70)	0,72 (0,75)	0,92 (0,95)	1,27 (1,30)	1,35 (1,38)	1,65 (1,70)	1,57 (1,60)	1,60 (1,63)	1,95 (1,98)
Breaking elongation at a node, %	5-15	8	12	8-18	10	15	8-18	11	15
Torsion number, kr/m	550	530	545	450	460	460	450	440	460
Coefficient of variation in twist, %	4,5	4,3	3,3	4,5	4,1	3,05	5,0	4,5	3,5
Deviation from nominal twist, kr/m	±25	-20	-5	±20	+10	+10	±20	-10	+10

From the analysis of the data given in Table 5, one can see that the obtained surgical threads using the improved technology have indicators very close to standard indicators and significantly exceed the similar indicators of the control threads; this is also visible from the histogram constructed according to the data in Table 5 (see Fig. .2).



where 1 is the indicators of the standard, 2 are the indicators of the threads of the control version, 3 are the indicators of the experimental version.

Fig.2. Comparative histogram of the breaking load of surgical threads made of natural silk of assortments No. 1, No. 2, No. 3 obtained from the control and experimental options with the indicators of the current standard.

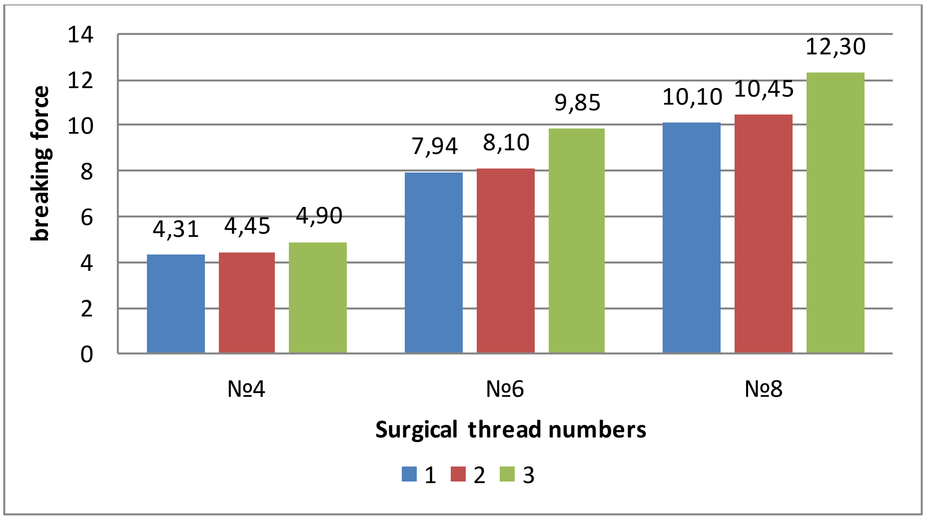
Table 6 shows the physical-mechanical and chemical-technological indicators of surgical threads of assortments No. 4, No. 6, No. 8, developed according to the experimental and control variants of the study.

Table 6. Results of laboratory tests to determine the physical-mechanical and chemical-technological parameters of surgical threads of assortments No. 4, No. 6, No. 8

The name of indicators	Indicators of surgical threads by assortment								
	According to GOST 396-84	Assortment № 4		Accor-ding to GOST 396-84	Assortment № 6		Accor-ding to GOST 396-84	Assortment № 8	
		control	expe-rienced		ontrol	expe-rienced		ontrol	expe-rienced
sortment of surgical threads	4	4	4	6	6	6	8	8	8
near density of raw silk, tex	3,22	3,23	2,33	3,22	3,23	2,33	3,22	3,23	2,33
value of the soak solution	-	-	8,75	-	-	8,75	-	-	8,75
mperature of the locking									

solution, °C	-	-	55±3	-	-	55±3	-	-	55±3
ngitudinal locks, min.	-	-	15	-	-	15	-	-	15
value of the decoction solution	-	10,75	10,75	-	10,75	10,75	-	0,75	10,75
iling temperature, ^{0}C	-	5-110	5-100	-	5-110	5-100	-	5-110	5-100
ntinue decoction, min.	-	0-90	0-25	-	0-90	0-25	-	0-90	20-25
nount of residual soap and grease. real,%	up to 1,70	1,60	0,85	up to 1,70	1,40	0,72	up to 1,70	1,55	0,70
sulting linear density of surgical threads, tex	p to 143	35,99	140	to 270	48,04	268	to 350	01,81	347
efficient of variation in lin density, %	3,5	3,3	2,7	3,0	2,8	2,1	3,0	2,5	1,4
eaking load of thread, daN, (kgs), not less	4,31 (4,40)	4,45 4,50)	4,90 (5,0)	4 (8,10)	8,10 8,25)	9,85 10,0)	10,10 (10,30)	0,45 0,65)	12,30 (12,5)
Elongation at break, %	0-30	23	25	0-30	25	27	20-30	24	28
Breaking load of thread in a knot, daN, (kgs), not less	2,56 (2,6)	2,62 2,65)	2,68 2,75)	1 (4,60)	4,55 (4,6)	4,95 5,05)	8 (5,90)	5,85 6,00)	6,50 (6,70)
Breaking elongation at a node, %	8-18	15		20	15	18	10-20	15	18
Torsion number, kr/m	450	440	450	400	390	395	300	310	290
Coefficient of variation in twist, %	5,0	4,8	3,5	5,0	4,5	3,0	5,0	4,5	2,1
Deviation from nominal twist, kr/m	±20	-10	0	±20	-10	-5	±20	+10	-10

From the analysis of the data given in Table 6, one can see that the obtained surgical threads using the improved technology have indicators very close to standard indicators and significantly exceed the similar indicators of the control threads; this is also visible from the histogram constructed according to the data in table 6 (see Fig. 3).



where 1 is the indicators of the standard, 2 are the indicators of the threads of the control version, 3 are the indicators of the experimental version.

Fig.3. Comparative histogram of the breaking load of surgical threads made of natural silk of assortments No. 4, No. 6, No. 8 obtained from the control and experimental options with the indicators of the current standard.

From the data presented in the tables and histograms above, it is clear that surgical threads produced using improved technology in all indicators significantly exceed similar indicators of surgical threads produced using existing technology. From the data presented in the tables and histograms above, it is clear that surgical threads produced using improved technology in all indicators significantly exceed similar indicators of surgical threads produced using existing technology.

CONCLUSIONS

1.Surgical threads used in medical practice are produced from various threads of natural and synthetic origin, the main ones being natural silk, polyamide, polyester, and polypropylene threads.

2. Surgical threads are produced by twisting and weaving. However, braided surgical threads are first given a twist of 100-150 kr/m, then the twisted threads are braided. Surgical threads can be produced non-sterile, sterile, with surgical needles, or without needles in various forms or packaging.

3.Nine assortments of surgical threads are produced from natural silk, starting from the thinnest No. 000, ending with the thickest No. 8. They are produced in non-sterile or sterile form, twisted.

4.A new structure of surgical threads made from natural silk has been proposed, according to which all assortments of surgical threads are produced from the same assortment of raw silk - 2.33 tex. The new structure of surgical threads allows us to significantly improve the quality indicators of the finished threads.

5.Production tests of the proposed structure confirmed the correctness of the change in the structure of surgical threads made of natural silk; quality indicators, especially the breaking load of the threads, increased by 30-40% compared to the existing structure.

6.For the preliminary determination of the resulting linear density of surgical threads made of natural silk, an empirical formula was proposed for the first time, which was tested in the production conditions of silk spinning enterprises. This formula allows manufacturers to plan all the quality indicators of the threads before starting production of surgical threads, which is very important for manufacturers.

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