equipment] // Textile industry.-2007. No. 8. - p. 22-24. (In Russian)

21. Kenzhibayeva G. S., Sikhimbayeva M. T. Otqa tozimdi toqima materialdaryn ondeu [Processing of fire-resistant textile materials] // Eurasian Education, Science and Innovation Journal Volume 10, May 2022 Proceedings of the XI International Scientific Practical Conference "Machine Learning Today, Prospects and Threats" XI ISPC Mltpt 2022. 24-25 May 2022, ISSN 2700-8622 P.216-220. (In Russian)

22. Kenzhibayeva G.S., Sikhimbayeva M.T., Yeshzhanov A.A., Yeldiyar G.K. Study of the efficiency of management with an automated system in a carpet weaving factor//Proceeding IX International Conference «Industrial Technologies and Engineering» ICITE-2022, Volume II, M.Auezov South Kazakhstan University Shymkent, Kazakhstan December 9-10, 2022, 105-108.

23. Materialy tekstil'nye. Pokrytiya i izdeliya kovrovye napol'nye. Vosplamenyaemost'. Metod opredeleniya i klassifikaciya. [Textile materials. Carpet floor coverings and products. Flammability. The method of definition and classification] Interstate standard GOST 32088-2013 Moscow State Standards and forms 2016. (In Russian)

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DEVELOPMENT OF TECHNOLOGY FOR NONWOVENS WITH ANTIMICROBIAL PROPERTIES

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The article presents data on the development of nonwovens with antimicrobial properties using anavidin, polyethylene glycol and copper sulfate. The production of nonwovens is booming all over the world. In terms of their properties, nonwovens successfully compete with fabrics and replace them, and in some properties they are superior to traditional textile materials. For the production of non-woven fabrics, more than half is still accounted for by natural fibers: cotton, wool and linen fibers, waste from the processing of natural fibers, regenerated fibers. In this work, the goal is to obtain nonwovens with antimicrobial properties. Technologies have been developed that give nonwovens stable antimicrobial properties. The physicochemical properties and mechanism of interaction of the applied components have been investigated. The optimal technological parameters for the production of antimicrobial nonwovens have been determined. The development of a new technology of nonwovens with improved physical, mechanical and functional properties will help to apply nonwovens in medicine and other areas that require bacteriostatic, bactericidal and fungicidal properties of textile materials. Therefore, in order to obtain nonwovens that would meet all the requirements of domestic and foreign enterprises, it is advisable to modify both fibers and impregnating compositions.

Keywords: nonwoven fabric, antimicrobiality, microbiological destruction, antimicrobial treatment, antimicrobials, bioresistance.

РАЗРАБОТКА ТЕХНОЛОГИИ НЕТКАНЫХ МАТЕРИАЛОВ С АНТИМИКРОБНЫМИ СВОЙСТВАМИ

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В статье представлены данные по разработке нетканых материалов с антимикробными свойствами с применением анавидина, полиэтиленгликоля и сульфата меди. Производство нетканых материалов быстро растет во всем мире. Нетканые материалы по своим свойствам успешно конкурируют с текстилем или заменяют его, превосходя традиционные волокнистые материалы. Нетканые полотна изготавливаются из натуральных волокон: хлопок, шерсть, льняные волокна, переработанные и вторичные волокна, отходы натуральных волокон. В данной работе целью является получение нетканых материалов с антимикробными свойствами. Разработаны методы придания

устойчивых антимикробных свойств нетканым полотнам. Изучены физико-химические свойства и оптимальные технологические параметры для получения антимикробных нетканых материалов. Разработка новых технологий получения нетканых материалов с улучшенными физико-механическими и функциональными свойствами будет способствовать применению нетканых полотен в медицине и других направлениях, требующих наличия у текстильных волокнистых материалов фунгицидных, бактериостатических и бактерицидных свойств. Для получения нетканых текстильных материалов целесообразно проводить модификацию как волокон, так и пропитывающих композиций, которые соответствовали бы всем требованиям отечественных и зарубежных предприятий.

Ключевые слова: нетканый материал, антимикробность, микробиологическое разрушение, антимикробная обработка, антимикробные препараты, биостойкость.

БЕЙМАТА МАТЕРИАЛДАРЫНА АНТИМИКРОБТЫҚ ҚАСИЕТ БЕРЕТІН ТЕХНОЛОГИЯ ЖАСАУ

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Мақалада анавидин, полиэтиленгликоль және мыс сульфатын қолдана отырып, антимикробтық беймата алу жайлы мәліметтер келтірілген. Әлемде беймата өндірісі қарқынды дамып келеді. Бейматалар қасиеттері бойынша маталармен бәсекелесіп, олардың орнын басады, ал кейбір қасиеттері бойынша басқа текстиль материалдарынан асып түседі. Беймата өндірісінде жартысынан көбі табиғи талшықтар қолданылады: мақта, жүн және зығыр талшықтары, табиғи талшықтарды қайта өңдеу қалдықтары, қалпына келтірілген талшықтар. Бұл жұмыстың мақсаты биоцидтік бейматалар алу болып табылады. Зерттеу нәтижесінде бейматаға тұрақты антимикробтық қасиет беретін технологиялар жасалды. Қолданылатын компоненттердің физика-химиялық қасиеттері және өзара әрекеттесу механизмі зерттелді. Антимикробтық беймата алудың оңтайлы технологиялық параметрлері анықталды. Жоғары физика-механикалық және функциональдық қасиеттері бар беймата алудың жаңа технологиясы материалдың медицинада және бактериостатикалық, бактерицидтік және фунгицидтік текстиль материалдары тұтынылатын салаларға қолданылу мүмкіндігін арттырады. Сондықтан отандық және шетелдік өнеркәсіптердің барлық талаптарына сай келетін беймата шығару үшін талшық түрінде модификациялаумен қатар өңдеу композициясын алу қызығушылық туғызады.

Негізгі сөздер: беймата материалы, антимикробтық қасиет, микробиологиялық деструкция, антимикробтық өңдеу, антимикробтық препараттар, биотұрақтылық.

Introduction

Non-woven fabrics belong to the most dynamically growing assortment group of textile products. At present, the production volumes of nonwovens are ten times higher than the production volumes of natural materials. Such a demand for nonwovens is due to a whole range of specific properties that make up nonwovens and their use in household and technical purposes [1-3].

At first, textile materials were textile carriers for fixing antimicrobial components. Later, knitted materials began to be used as bactericidal dressings. However, the efficiency of the use of knitted materials, their production is costly and unprofitable due to the use of expensive raw materials [4-7]. Nonwovens are the most promising and cost-effective textile carriers [8, 9].

Final finishing is carried out in various ways: mechanical elimination of contact of the textile material with spores, insects or bacteria; treatment of substances poisonous to microorganisms; chemical change of the surface of materials - giving them antimicrobial properties. The second and third methods are most acceptable for fibrous materials for everyday use, provided that the corresponding impregnations do not change the basic properties of textile materials and are quite resistant to atmospheric influences, light, washing, and dry cleaning under operating conditions [10-12].

The development of a technology for obtaining nonwovens with antimicrobial properties, the acquisition of new information about the properties of such fabrics is an urgent scientific task [13, 14].

Materials and research methods

The samples were processed according to two formulations: 1. Anavidin disinfectant 10, 20, 30 g/l, 2. Polyethylene glycol 10 g/l, copper sulfate 5, 10, 15 g/l. Impregnation of the fabric with an antimicrobial composition was carried out in solutions for 1-2 minutes at room temperature. Next, the samples were dried in an oven for 3-5 minutes at 125 °C. Impregnation bath module 200 ml.

Results and discussion

The developed methods have antimicrobial activity and a simple technological scheme of finishing. The antimicrobial activity of the samples was determined by GOST 9.060–75 [15], the results are presented in Tables 1 and 2.

Table 1. Coefficient of resistance to microbiological destruction of finished nonwovens according to the 1-st technology

№	Concentration Anavidin, g/l	Breaking load (pre-biodegradation and post-biodegradation), kgf			
		10 days			
		longitudinal	%	transverse	%
1	10 g/l	3,492/3,196	91,52	3,748/3,337	89,03
2	20 g/l	3,543/3,118	88	3,564/2,922	81,98
3	30 g/l	3,213/2,996	93,24	3,3165/2,876	86,71
Raw material		3,100/2,191	70,67	3,218/1,950	60,59

Table 2. Coefficient of resistance to microbiological destruction of finished nonwovens according to the 2 nd technology

№	Concentration		Breaking load (pre-biodegradation and post-biodegradation), kgf			
	Copper sulfate, g/l	PEG, g/l	g/l			
			longitudinal	%	transverse	%
1	5 g/l	10	3,607/3,066	85	3,746/3,141	83,84
2	10 g/l		3,548/3,101	87,40	4,422/3,689	83,42
3	15 g/l		3,606/3,230	89,57	3,843/3,462	90,08
Raw material			3,100/2,191	70,67	3,218/1,950	60,59

After finishing with compositions, the coefficient of resistance to microbiological destruction was 93.24 % according to the first technology, 89.57% according to the second one, after 10 days of the strips being in contact with the ground. For control samples, the coefficient of resistance to microbiological destruction is 70.67 %, also after 10 days. The obtained antimicrobial effect is achieved at minimum concentrations of more than 80 %. According to GOST, a fabric is considered resistant to microbiological destruction if the coefficient is 80 +/-5 %.

The results show that the air permeability coefficient of antimicrobial nonwovens with different content of components is not significant, there is a slight increase in this parameter. The air permeability indicators of the treated materials with the proposed compositions comply with the regulatory requirements for hygienic safety, these results are presented in Table 3.

Table 3. Air permeability indicators of modified samples

№	Breathability, dm^3/m^2 *s			
1	Raw material	Concentration		
	939,1	Anavidin, 10 g/l	Anavidin, 20 g/l	Anavidin, 30 g/l
		957,8	962,9	943,7
2	939,1	Concentration		
		PEG, 10 g/l		
		Copper sulfate, 5 g/l	Copper sulfate, 10 g/l	Copper sulfate, 15 g/l
		959,1	957,7	960,2

The stiffness of fibrous materials depends on the structure, density, weave, composition and finish of the fibre. The more linear and oriented the chain molecules of a fiber-forming polymer, the greater the internal friction that restricts the movement of the molecular chains, and the less flexible the fiber is. The stiffness of fabrics is also affected by atmospheric conditions. The stiffness of fabrics changes under the influence of temperature and humidity, and the stiffness of the material increases with the thickness of the material, the linear density and the twist of the threads and yarns that form it.

The stiffness of nonwovens was determined in accordance with GOST 10550-93 [16]. The results are presented in Table 4.

Table 4. Stiffness indicators of treated nonwoven fabric

№	Stiffness G /cN			
1	Raw material	Concentration		
		Anavidin,10 g/l	Anavidin,20 g/l	Anavidin,30 g/l
	G=0,6027	G=0,6076	G=0,8722	G=0,8771
2	G=0,6027	Concentration		
		PEG, 10 g/l		
		Copper sulfate, 5 g/l	Copper sulfate, 10 g/l	Copper sulfate, 15 g/l
		G=0,7742	G=0,9555	G=0,8232

According to the data obtained, it can be seen that with an increase in the concentration of the antimicrobial drug, the nonwoven material acquires a slight stiffness for the first composition G=0.8771, for the second composition G=0.8232, compared to the untreated material G=0.6027. An increase in the concentration of an antimicrobial drug slightly leads to the stiffness of the textile material.

The arithmetic mean of the results of 10 measurements of a point sample or elementary samples GOST 12023-93 is taken as an indicator of the thickness of a spot sample [17]. The thickness of the nonwoven fabric was determined using an MT 531 thickness gauge, the results are presented in Table 5.

Table 5. Determination of the thickness of the nonwoven fabric after antimicrobial treatment

№	Thickness, mm			
1	Raw material	Concentration		
		Anavidin,10 g/l	Anavidin,20 g/l	Anavidin,30 g/l
	0,29	0,25	0,27	0,25
		Concentration		
		PEG, 10 g/l		
2	0,29	Copper sulfate, 5 g/l	Copper sulfate, 10 g/l	Copper sulfate, 15 g/l
		0,30	0,26	0,28

From the data obtained, it can be seen that the thickness of the finished samples changes slightly, this treatment does not lead to a change in the linear dimensions and thickness of nonwovens.

Conclusion

The developed methods of processing nonwovens provide antimicrobial activity. Methods of finishing materials are accessible, versatile and easy to perform. After modification with the developed compositions, the coefficient of resistance to microbiological destruction according to the first technology was 93.24%, for the second composition 89.57%, after 10 days of the strips being in contact with the ground. Studies have been carried out on the effect of the proposed compositions on the coefficient of resistance to microbiological destruction and on the physical, mechanical and hygienic properties of nonwovens.

Gratitude, conflict of interest (funding)

The work was carried out at the Almaty Technological University. The author declares that there is no conflict of interest.

REFERENCES

1. K.S. Huang, H.S. Lian, J.B. Chen, “Study on the modification of PP nonwoven fabric”, Fibres Text. East. Eur., vol. 3, (2011): pp. 82–87,

2. D. Gao, R. Zhao, X.Yang, F.Chen, X. Ning, “Bicomponent PLA Nanofiber Nonwovens as Highly Efficient Filtration Media for Particulate Pollutants and Pathogens”. Membranes. *11*(11), (2021): p.819.

3. H.Qiu, Z.Si, Y.Luo, P.Feng, X.Wu, W.Hou, Y.Zhu, M.B.Chan-Park, Xu L, D. Huang, “The Mechanisms and the Applications of Antibacterial Polymers in Surface Modification on Medical Devices”, Front. Bioeng. Biotechnol. 8, (2020): p.910.

4. Егоркина Е.А. Новый подход к решению старых проблем в области медицины и здравоохранения в России // Ж. Курьер, 2005. №1. - С. 9-11.

5. ГОСТ 11680-76. Ткани бязевой группы. Технические условия.

6. ГОСТ 7138-83. Ткани хлопчатобумажные миткалевой группы. Технические условия.

7. ГОСТ 10138-93. Ткани чистольняные, льняные и полульняные бельевые (для постельного и нательного белья). Технические условия.

8. E.W. Moon, H.-.W. Lee, J.H. Rok, J.-.H. Ha, “Photocatalytic inactivation of viral particles of human norovirus by Cu-doped TiO_2 non-woven fabric under

UVA-LED wavelengths", Science of the Total Environment, vol. 749, (2020): p. 9.

9. I. Cerkez, S.D. Worley, R.M. Broughton, T.S. Huang, "Antimicrobial surface coatings for polypropylene nonwoven fabrics", Reactive and Functional Polymers, vol. 73 (11), (2013): pp. 1412-1419.

10. S. Kim, Y. Cho, C.H Park, "Effect of cotton fabric properties on fiber release and marine biodegradation", Text. Res. J. 92, (2022): pp. 2121–2137.

11. C. Deng, F. Seidi, Q.Yong, X. Jin, C. Li, X. Zhang, J.Han, Y. Liu, Y.Huang, Y.Wang, "Antiviral/antibacterial biodegradable cellulose nonwovens as environmentally friendly and bioprotective materials with potential to minimize microplastic pollution", J. Hazard. Mater. 424, (2021): 127391.

12. S. Smith, M.Ozturk, M. Frey, "Soil biodegradation of cotton fabrics treated with common finishes", Cellulose, 28, (2021): pp. 4485–4494.

13. Дюсенбиева К.Ж., Айтулова Б.Т. Мақта маталарына антимикробтық қасиет беру. Материалы республиканской научно-практической конференции молодых ученых «Наука. Образование. Молодежь», // Алматы, 26 -27 апреля 2018 г., - С. 148-149.

13. Бектемисова Н.Х., студент 4 курса., Дюсенбиева К.Ж, Рашидова Б.Р. Тоқыма материалдарын биологиялық зақымданудан қорғау. Материалы Республиканской научно-практической конференции молодых ученых «Наука. Образование. Молодежь», Алматы, 21-22 апреля 2022 г. - С. 87-89.

14. ГОСТ 9.060–75. Метод лабораторных испытаний на устойчивость к микробиологическому разрушению.

15. ГОСТ 10550-93. Материалы текстильные. Полотна. Методы определения жесткости при изгибе.

16. ГОСТ 12023-93. Материалы текстильные. Полотна. Методы определения толщины.

REFERENCES

1. K.S. Huang, H.S. Lian, J.B. Chen, "Study on the modification of PP nonwoven fabric", Fibres Text. East. Eur., vol. 3, (2011): pp. 82–87.

2. D. Gao, R. Zhao, X.Yang, F.Chen, X. Ning, "Bicomponent PLA Nanofiber Nonwovens as Highly Efficient Filtration Media for Particulate Pollutants and Pathogens". Membranes. *11*(11), (2021): p.819.

3. H.Qiu, Z.Si, Y.Luo, P.Feng, X.Wu, W.Hou, Y.Zhu, M.B.Chan-Park, Xu L, D. Huang, "The Mechanisms and the Applications of Antibacterial Polymers in Surface Modification on Medical Devices", Front. Bioeng. Biotechnol. 8, (2020): p.910.

4. Egorkina E.A. Novyj podhod k resheniyu staryh problem v oblasti mediciny i zdravoohraneniya v Rossii [A New Approach to Solving Old Problems in the Field of Medicine and Health Care in Russia] ZH. Kur'er, 2005. №1. - S. 9-11 (In Russian)

5. GOST 11680-76. Tkani byazevoj gruppy. Tekhnicheskie usloviya [Calico fabrics. Specifications] (In Russian)

6. GOST 7138-83. Tkani hlopchatobumazhnye mitkalevoj gruppy. Tekhnicheskie usloviya [Cotton fabrics of the mitcale group. Specifications] (In Russian)

7. GOST 10138-93. Tkani chistol'nyanye, l'nyanye i polul'nyanye bel'evye (dlya postel'nogo i natel'nogo bel'ya). Tekhnicheskie usloviya [Linen fabrics, linen and semi-linen linen fabrics (for bed linen and underwear). Specifications] (In Russian)

8. E.W. Moon, H.-.W. Lee, J.H. Rok, J.-.H. Ha, "Photocatalytic inactivation of viral particles of human norovirus by Cu-doped TiO_2 non-woven fabric under UVA-LED wavelengths", Science of the Total Environment, vol. 749, (2020): p. 9.

9. I. Cerkez, S.D. Worley, R.M. Broughton, T.S. Huang, "Antimicrobial surface coatings for polypropylene nonwoven fabrics", Reactive and Functional Polymers, vol. 73 (11), (2013): pp. 1412-1419.

10. S. Kim, Y. Cho, C.H. Park, "Effect of cotton fabric properties on fiber release and marine biodegradation", Text. Res. J. 92, (2022): pp. 2121–2137.

11. C. Deng, F. Seidi, Q.Yong, X. Jin, C. Li, X. Zhang, J.Han, Y. Liu, Y.Huang, Y.Wang, "Antiviral/antibacterial biodegradable cellulose nonwovens as environmentally friendly and bioprotective materials with potential to minimize microplastic pollution", J. Hazard. Mater. 424, (2021): 127391.

12. S. Smith, M. Ozturk, M. Frey, "Soil biodegradation of cotton fabrics treated with common finishes", Cellulose, 28, (2021): pp. 4485–4494.

13. Dyusenbieva K. ZH., Ajtulova B.T. Maqta matalaryna antimikrobtyq qasiet beru [Imparting antimicrobial properties to cotton fabrics] Materialy respublikanskoj nauchno-prakticheskoj konferencii molodyh uchenyh «Nauka. Obrazovanie. Molodezh'», // Almaty, 26 -27 aprelya 2018 g., - S. 148-149 (In Kazakh)

14. Bektemisova N.H., student 4 kursa., Dyusenbieva K.ZH, Rashidova B.R. Toqyma materialdaryn biologialyq zaqymdanudan qorğau [Protection of textile materials from biological damage] Materialy Respublikanskoj nauchno-prakticheskoj konferencii molodyh uchenyh «Nauka. Obrazovanie. Molodezh'», // Almaty, 21-22 aprelya 2022 g., - S. 87-89 (In Kazakh)

15. GOST 9.060–75. Metod laboratornyh ispytanij na ustojchivost' k mikrobiologicheskomu razrusheniyu [Laboratory Test Method for Resistance to Microbiological Degradation] (In Russian)

16. GOST 10550-93. Materialy tekstil'nye. Polotna. Metody opredeleniya zhestkosti pri izgibe [The materials are textile. Canvas. Methods for Determining Flexural Stiffness] (In Russian)

17. GOST 12023-93. Materialy tekstil'nye. Polotna. Metody opredeleniya tolshchiny [The materials are textile. Canvas. Thickness Determination Methods] (In Russian)