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Modern approaches to building woolen fibers with new functional properties

Purpose. Analyze data on ways to improve wool fibers by providing them with a set of new physico-chemical properties. Methods. Biochemical, statistical. Results It is found that the prospective is the modification of the wool surface by means of physical and chemical factors, the production of "intelligent" textiles, as well as the use of fiber keratin as matrix for the creation of biomaterials. An effective way of solubilizing wool fibers is proposed, which allows the fraction of microfibrillary proteins to be obtained as a basis for nanotechnology. Conclusions Innovative technologies will provide competitive advantages to textile materials due to the modification of wool raw materials.

Key words: wool fiber, modification, physico-chemical properties, keratin.

The volume of the world wool market is now-among consumers, the demand for roughly $ 4 billion is also rising, which is on natural and environmentally friendly materials, three times smaller than in 1990. Such a fall is fully consistent with the wool. However, in order to keep the production of this raw material in competition with the synthetic ones over the last 20 years due to the reduction of fibers, it is necessary to develop an innovative head of sheep in Australia and New Zealand. The technologies that can be used to match the wool production and the competitive advantages of textiles using textile fibers are sharply reduced by materials, due to the modification, it has been introduced and in many industries was replaced with nano-raw materials or created on the basis of cheap fibers [2] . Keratin new functional materials, which Despite the fact that the cost of thin currently in demand in medicine, cosmetology, now remains 3-4 times larger than electronics. Prices for synthetic fibers, finished products, the purpose of the work - the analysis of available data made from it, several times exceeds in relation to ways to improve the physical and chemical value of wool as raw materials and provides the technological properties of wool in the operation of light industry, tor lochon, as well Their use for nano-trade, transport, etc. It should be noted that the technology. Methods of research - biochemical, static. Research results. Violet fibers are almost 95% composed of keratin, one of the most common fibrillar proteins, which differs from the other structural proteins in the content of cystine (7-20% of the total amino acids). The remnants of this amino acid form inter- and intra-districular disulphide bonds, with the help of which a compact 3-dimensional structure is formed that provides keratins with resistance to chemical influences and the action of enzymes. On the other hand, the presence of a large number of disulfide bonds (0.8 mMol / g) is the basis for many chemical modifications of fibers, which significantly affect its physicochemical properties [14]. Consequently, wool fiber is a natural bio-composite in which the polypeptide chains of keratins play the role of the matrix, and the keratin-associated proteins - the reinforcing agent and provide a wide range of structural and mechanical properties that are characteristic of the technical composite materials. Currently, there is no synthetic fiber, which would have similar heat-insulating, respiratory and wet-absorbing properties [6]. Wool fibers are safe for health and are capable of biodegradation. In general, the wool has a unique micro-morphology, the main advantage of which is the presence in the structure of keratin of many functional groups - carboxylic, hydroxyl, amidic, as well as thiol / disulphide compared to synthetic fibers, which are generally monomorphic, which is significantly Limits the possibility for their modification. The innovative approaches to the creation of wool fibers with new physico-chemical properties, first of all, provide for the formation of a functional coating of the wool surface with desired properties, in particular, antimicrobial, hydrophobic, fire-resistant, self-cleaning, resistant to shrinkage, and others. The outer woolen fiber is covered with a layer of lithium-plating, which give its surface hydrophobic properties. Recently, a number of innovative technologies have been developed, which are based on changing the properties of the surface layer of the fiber by way of removing this lipid layer. As a result, the protein surface of the fiber is formed with functional groups, which can be joined covalently to various components. Such fibers acquire new properties and have a greater potential for longevity [4, 5].

An important direction for the modification of wool fibers is the use of nanotechnologies that enable the micro-nanoparticles to be fixed on their surface to provide a variety of effects. The formation of reactive groups on the surface of the wool fiber as a result of treatment with ultraviolet radiation, ozone, or high-performance plasma is used for covalent attachment of nano-particles of argentum, silicon, and titanium. In particular, argentum nanoparticles, which have antibacterial properties, electrical and thermal conductivity in the form of bio-materials, can be widely used in medicine, cosmetology and electronic industry [1]. A wide range of enzymes is used for a specific modification of the surface of the inlining fibers. The advantage of their use is ecologicality. Enzyme treatment is used, first of all, against collapse, shrinkage of woolen fibers. The so-called biopolymerization of the fiber surface with the help of proteolytic enzymes enables the removal of the components of the protruding fibers and, thus, reduce their ability to dump [3]. As a result of treatment of the surface of the fiber with high-frequency plasma, it improves its ability to moisture, staining, resistance to dipping. Chemical processing using ozone oxidizes the surface and changes the ionic balance, which improves the plasticity and reactivity of the top of the fiber, chlorination increases its sorption characteristics, and treatment with hydrogen peroxide and acid anhydrides - the ability of the fiber to dye [7]. Phenomena are also nanotechnologies that are used in the production of "intellectual" textiles, and industrialized countries of the world are shifting priorities, in particular, the production of traditional textiles is replaced by "intellectual". Thus, Woolmark (the world leader in producing high quality Merino Wool) produces products labeled "Woolscience" that contain woolen fibers with fundamentally new properties. Application of technologies of micro-encapsulation of aromatic substances in the inventive fiber makes it possible to produce products with odors, and these capsules are resistant to the action of moisture, washing and chemical cleaning.

Fig. 1. Degree of protein extraction depending on its duration: 1 - urea + thiouure + 2-me; 2 - tGk + urea

Fig. 2. electrophoregram of proteins: 1-2 - extracted from woolen fibers; 3 is a molecular weight marker

The use of the method of electric power (electrospinning) of natural proteins makes it possible to obtain nanofibers that are structurally similar to the extracellular matrix. Thus, nanofibers based on keratin / fibroid are now used in tissue engineering for the manufacture of frames and water purification from heavy metals. There are numerous reports in the literature about the possibility of using keratin of wool fibers to create biocompatible nanomaterials, which is extremely important for the development of nanotechnologies. They are based on the ability of extracted keratins to self-assemble and polymerize into complex 3-dimensional structures, and the existence of free functional groups provides imobilization of biologically active substances, or the modification of such frames [8, 10, 12]. As a matrix, the mi-crofibrillary fraction or -keratosis, which is divisible from the fibers, is predominantly used. However, the key problem is to pick up an appropriate solvent that can translate fibrillar proteins into a solution. Typically, a mixture of solvents in which the components have different functions are used for this purpose, for example, one ingredient breaks hydrogen bonds, others - disulphides. To compare the efficiency of extraction of keratin from woolen fibers, we used a solution of 0.2 M thioglycolic acid with 8 M urea (pH 11) and a solution containing 2.6 M thiourea, 5 M urea and 2-mercaptoethanol (pH 8.5). The degree of extraction of keratin from the wool fiber depends on its duration and the composition of the solvent (Fig. 1). The addition of thiourea to the buffer mixture containing urea and 2-mercaptoethanol contributed to an increase in the amount of extracted protein from the fiber almost twice, while the content of extracted keratin by the action of thioglycolic acid and urea did not exceed 1 mg / g. An electrophoretic analysis of the extrast of keratin obtained after treatment of wool fibers with 2-mercaptoethanol in the presence of thiourea and urea (Fig. 2) was carried out. The electrophoregram shows a characteristic protein separation of at least 8 bands. We identified the proteins of intermedial filaments of type I and II with a molecular weight of 45-65 kDa and keratin-associated proteins with a molecular weight of 10-30 kDa. Morphologically, the proteins of intermedial filaments belong to microfibrillary (or low-sulfur proteins), and keratin-associated proteins - to high-sulfur, tyrosine and glycine-rich prot proteins. It should be noted that such a solution of keratins can be used to create thin films for attachment of fibroblasts and their proliferation [12], sponges for the immobilization of biologically active substances [11], hydrogels for the regeneration of peripheral nerves [13], filters for zv ' Heavy metals [9]. Nanodispersion of fibrillar proteins is also used as a component of composite materials for tissue lamination, and the coloring of viobium, pre-treated with keratin solution, significantly increases the adsorption of the dye.

Conclusions

World trends show that the demand for environmentally friendly materials. This means that functional fabrics and "intelligence-that target modification of woolen fiber" textiles will continue to grow. And biocomposites based on their basis. The key factor for consumers will be new functional properties and movement towards natural use and will grow.

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