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## Livestock Fibers

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**ABSTRACT:** The fibers of animal origin include silk, wool, chitin-glucan fibers. Silk fibers are thin long threads produced by the silk-removing glands of a silkworm (silkworm) and wound around a cocoon. Cocoon thread is two elementary threads (silk) glued together with sericite - a natural adhesive produced by a silkworm. Silk is especially sensitive to the action of ultraviolet rays, so the service life of natural silk products in sunlight is sharply reduced. Natural silk is widely used in the manufacture of dressing fabrics and piece goods (headscarves, scarves and scarves), sewing threads.

**KEY WORDS:** fiber, cortical, chemical fibers, silkworm, Silk fibers, cocoons, silk fibroin, chitin-glucan fibers.

### I. INTRODUCTION

Wool - sheep hair fiber (almost 97% of the total production of wool), goats, camels and other animals. The following types of fibers are found in wool:

- 1) down - the thinnest and most elastic fiber with an inner ("cortical") layer composed of spindle-shaped cells and an outer scaly layer;
- 2) spine - a thicker fiber, which also has a loose core layer, which consists of sparsely located plates perpendicular to the fiber axis;
- 3) transitional hair, in which the core layer is discontinuous along the length of the fiber (occupies an intermediate value between the fluff and spine in thickness);
- 4) "dead" hair - coarse, very thick, stiff and brittle fiber with a highly developed core layer. Sheep wool, consisting of fibers of the first or second kind, is called homogeneous, consisting of fibers of all kinds - heterogeneous. Woolen fiber is characterized by low strength, high elasticity and hygroscopicity, low thermal conductivity. It is processed (in its pure form or in a mixture with chemical fibers) into yarn, from which fabrics, knitwear, and also filters, pads, etc. are made. Silk is a product of the isolation of silk-releasing glands of insects, of which silkworm is of main industrial importance.

### II. MAIN PART

Silk fibers. With a 3,000-year history, silk is one of the oldest materials used by mankind. For millennia, the methods of processing and producing natural silk were strictly kept secret by the Chinese. Although the production of silk products today is widespread, nevertheless, Chinese silk bedding is still smoother, more delicate and elegant than others.

The silkworm eats mulberry leaves before moving to Cocoon. To protect the cocoon, the caterpillar produces a protein gel substance from the glands, which hardens upon contact with air. The caterpillar needs about eight days to complete the formation of its cocoon.

Silk fibers are obtained from cocoons by a delicate process known as silk spinning. Cocoons are first heated in water to dissolve the outer sticky membrane. The ends of the fibers obtained from 4-8 cocoons are joined together and twisted, and then combined with similarly created fibers to produce yarn that is continuous and, unlike other natural yarns, such as cotton or wool, consists of very long fibers. One silk fiber in length can reach 1500 meters.

Natural silk is the thinnest natural protein fiber, which has unique properties to absorb moisture and regulate temperature depending on the season and ambient temperature. The natural properties of silk allow it to be considered an excellent material for filling blankets and pillows of high class, as well as the manufacture of bed linen and clothes.

Wool is the hairline of sheep, goats, camels and other animals. The bulk of wool (94-96%) for the textile industry is supplied by sheep.

The wool taken from the sheep is usually very dirty and, in addition, very heterogeneous in quality. Therefore, before sending the wool to a textile mill, it is subjected to primary processing. Primary processing of wool includes the following processes: sorting by quality; loosening and beating; a sink; drying; packing in bales.

Sheep's wool consists of four types of fibers: down - a very thin, crimped, soft and durable fiber; round in the cross section of the transitional hair - a thicker and coarser fiber than the fluff; fiber stiffer than transitional dead hair - verythick across and coarse unripe fiber, covered with large plate scales. Wool, which consists mainly of fibers of the same type (fluff, transitional hair), is called homogeneous. Wool containing fibers of all these types is called heterogeneous. The peculiarity of wool is its ability to peeling, which is explained by the presence of a scaly layer on its surface, a significant crimp and softness of the fibers. Due to this property, rather dense fabrics, cloth, drapes, felt, as well as felt and felted products are produced from wool. Wool has low thermal conductivity, which makes it indispensable in the production of coat, costume and dress fabrics and knitwear for the winter range.

The advantages of silk over other natural materials:

- regulates the temperature regime (you are warm in winter and not hot in summer);
- has hypoallergenicity (silk is the only natural material that does not cause any allergic reactions);
- resistant to bacteria, has a dirt-repellent effect;
- completely eliminates the possibility of the appearance of dust mites (in contrast to down products);
- the filler from silk does not fall inside the blanket (due to the uniformity of the silk thread);
- silk products are well ventilated and do not accumulate static electricity;
- resistant to long-term operation.

Despite the successful use of suture materials from synthetic threads in surgical practice, to date, natural silk is the most frequently used for these purposes. In this case, modifications of natural silk are made with nitrofuryl acrolein. He can also modify the wool. Similarly, neomycin and brilliant green were attached to silk fibroin. Antibiotic filaments were active against staphylococcus and E. coli.

Protein fibers. Among the fibers of protein origin, of particular interest for medical purposes are collagen fibers, which have the ability to absorb in living tissues and organs. Suture sutures that are absorbable in the body are valuable in that they do not need to be removed after healing of organs and tissues sewn by them.

Surgical practice needs not only absorbable sutures, but also absorbable cotton wool, sponge, tampons, various explants, which could be left in the postoperative wound and then would not need to be removed after performing their functions inside the body.

Until recently, the only absorbable material that is used on a more or less large scale in surgical practice is catgut, usually made from the small intestines of sheep. The most suitable catgut substitute are suture threads from collagen, a protein of animal connective tissue, which in biological media of the human body is able to undergo enzymatic hydrolysis and be excreted in short terms naturally. Despite the successful use of suture materials from synthetic threads in surgical practice, to date most often continue to use natural silk for these purposes. In this case, modifications of natural silk are made with nitrofuryl acrolein. He can also modify the wool.

Chitin-glucan fibers. Currently, the attention of scientists and technologists is attracted to natural polymers as environmentally friendly substances obtained from renewable sources. Chitin is extremely widespread in nature, forming the outer skeleton of crustaceans, insects, is found in some types of algae, in mushrooms, yeast and other microorganisms. These complexes often contain calcium salts ( $\text{CaCO}_3$ ). Therefore, to isolate chitin in its pure form, it is necessary to carry out demineralization (removal of  $\text{CaCO}_3$ ) and deproteinization with dilute solutions of hydrochloric acid and caustic soda, respectively. Complexes of chitin with glucans are practically inseparable and therefore are used together with modification.

Among them, chitin and its derivatives took a strong place. Chitin -natural polysaccharide having a chemical structure:

poly [1 -> 4, D-2 - acetamido - 2 - deoxyglucopyranose] (Fig. 1).

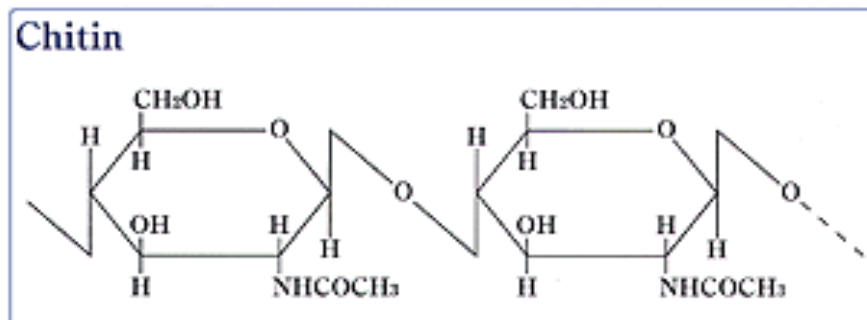


Fig. 1. Chitin structural formula.

Being present in organisms, chitin is a complex with proteins, glucans.

These complexes often contain calcium salts (CaCO<sub>3</sub>). Therefore for isolation of chitin in its pure form, it is necessary to carry out demineralization (CaCO<sub>3</sub> removal) and deproteinization with dilute solutions of hydrochloric acid and sodium hydroxide, respectively. Complexes of chitin with glucans are practically inseparable and therefore are used together with modification.

Chitin is a highly crystalline polymer in which intramolecular and intermolecular bonds exist between both hydroxyl groups and between hydroxyl and aminoacetyl groups. This leads to a low chelating ability of chitin in relation to metal ions. To enhance the binding of metal ions, it is necessary to destroy the supramolecular structure of chitin or replace the acetamide group with an amine one, or introduce additional chelating groups (amino acid, carboxyl, phosphoric acid, etc.).

Despite the close chemical structure of chitin and cellulose, their properties are significantly different. Unlike cellulose, chitin weakly swells in alkali solutions and does not dissolve in the solvents used for cellulose: copper-ammonia complex, iron-tin-sodium complex, triethylbenzylammonium hydroxide, cadmium-ethylenediamine complex. This is probably due to the absence of two adjacent hydroxyl groups in the chitin macromolecule, which are responsible for the formation of molecular compounds in cellulose molecules.

Chitin can be dissolved in concentrated hydrochloric, sulfuric nitric and phosphoric acids. Upon dissolution of chitin in acids, its gradual hydrolysis occurs. As a result of deep hydrolysis, the corresponding glucosamine salt is formed.

Solutions of chitin in acids are unstable, their viscosity varies over time. Therefore, it is impossible to determine the true value of the molecular weight of chitin from measurements of intrinsic viscosity, as well as by methods of osmometry, light scattering, or sedimentation-diffusion in acid solutions. An attempt was made to estimate the molecular weight of chitin by measuring its viscosity in 50% nitric acid, followed by extrapolation of the measured values to zero dissolution time. A comparison of the obtained values with similar viscosity values for wood pulp in a copper-ammonia solution showed that chitin and wood pulp have similar molecular weights. However, this method is very approximate.

To assess the degree of polymerization (SP) of chitin, the copper number method (determination of the content of terminal amide groups) is used. The test sample of chitin had SP 103.

When heated, chitin dissolves in concentrated solutions of some salts, and according to the dispersion force, the salts are arranged in the series: LiSCN > Ca (SCN)<sub>2</sub> > CaJ<sub>2</sub> > CaBr<sub>2</sub> > CaCl<sub>2</sub>. Partial dissolution of chitin is observed in mixtures of dimethylformamide with nitrogen dioxide.

Hit ozan. The chemical properties of chitosan depend on the chemical structure. A large number of free amino groups in the chitosan molecule determines its ability to bind hydrogen ions and acquire an excess positive charge, so chitosan is an excellent cation exchanger. In addition, free amino groups determine the chelating and complexing properties of chitosan. Chemical structure of chitosan is shown in Fig.2.

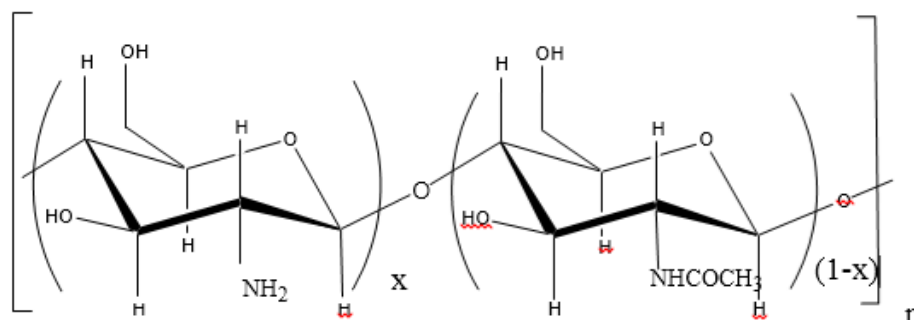


Fig. 2. Chitosan (1,4, β, D 2-amino, 2-deoxy-glucopyranose).

This explains the ability of chitosan to bind and firmly hold metal ions (in particular, radioactive isotopes and toxic elements) due to a variety of chemical and electrostatic interactions.

The large number of hydrogen bonds that chitosan is capable of forming determines its ability to bind a large number of organic water-soluble substances, including bacterial toxins that form in the large intestine during digestion.

On the other hand, the abundance of hydrogen bonds between chitosan molecules leads to its complete solubility in water, since the bonds between chitosan molecules are stronger than those between chitosan molecules and water



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molecules. At the same time, chitosan swells and dissolves in organic acids - acetic, citric, oxalic, succinic, and when swelling it is able to firmly retain the solvent in its structure, as well as the substances dissolved and suspended in it.

Chitosan is also able to bind saturated hydrocarbons, fats and fat-soluble compounds due to hydrophobic interactions and a network structure, which brings it closer to the cyclodextrins by sorption mechanisms.

The splitting of chitin and chitosan to N-acetyl-D-glucosamine and D-glucosamine occurs under the action of microbial enzymes - chitonases and chitobiasis, so they are completely biodegradable and do not pollute the environment.

Thus, chitosan is a universal sorbent that can bind a huge range of substances of an organic and inorganic nature, which determines the broadest possibilities of its use in human life.

Despite the huge literature on the relationship of the sorption properties of chitosan with its chemical structure, it cannot be said that studies in the field of chemistry of chitin / chitosan is close to completion. Constantly discovered new properties of this substance, in particular, the detected biological activity has not yet been adequately explained in terms of chemical structure. The available data that the nature of the biological activity of chitosan depends on its molecular weight and degree of deacetylation, need further verification and study. However, this hypothesis is very relevant, since the clarification of the relationship of the chemical structure and biological activity will allow the creation of substances that retain the known properties of chitosan and have new useful qualities.

Derivatives of chitosan compounds such as N, N, N-trimethyl chitosan, NN-propyl-N, N-dimethyl chitosan and N-furfuryl-N, N-dimethyl chitosan were obtained using 96% chitosan as 96% deacetylation and the following molecular weights-  $2.14 \cdot 10^5$ ;  $1.9 \times 10^4$ ; 7.8103. Chitosan amino groups react with aldehydes

in the intermediate compound, the Schiff base. The quaternary salts of chitosan were obtained by reaction of the Schiff base with methyl iodide. The molecular weight of the initial chitosan sample affected the degree of conversion to the quaternary compound and the water solubility of the resulting derivative.

Although there is a lot of chitin in nature, it has limited use due to its insufficient solubility and reactivity. Chitosan is soluble in acetic acid and other organic solvents. Chitosan has some bactericidal and fungicidal effects. However, chitosan shows its biological activity only in an acidic environment, since it is poorly soluble at pH above

Thus, water-soluble chitosan derivatives that dissolve in acid can have a good chance of being introduced into medical practice as antibacterial agents. Quaternary ammonium salts of chitosan have been investigated for increased solubility. Published information on the formation of N-dimethyl chitosan and the preparation of N-trimethyl chitosan iodide with formaldehyde and sodium borohydride. Ammonium trimethyl chitosan iodide was also obtained by the reaction of low acetylated chitosan with methyl iodide and sodium hydroxide under controlled conditions. N-alkyl chitosan was prepared by introducing an alkyl group into the amine groups of chitosan via a Schiff base. To obtain the quaternary ammonium salt of chitosan, which is soluble in water, a reaction of N-alkyl chitosan derivatives with methyl iodide was carried out. The antibacterial effect of this chitosan derivative was enhanced with increasing chain length of the alkyl substituent.

The effect of molecular weight on antibacterial and fungicidal activity was investigated. The antibacterial effect of the quaternary chitosan derivative against *Escherichia coli* was studied by calculating the minimum bacterial growth stopping concentration (MORBK) and the minimum bactericidal concentration (MBC) in water, 0.25% and 0.5% acetic acid medium. The results showed that antibacterial activity against *Escherichia coli* is associated with molecular weight. The antibacterial activity of quaternary ammonium salts of chitosan in acetic acid is more pronounced than in water. Their antibacterial effect is all the more pronounced, the higher the concentration of acetic acid. It was found that the bactericidal effect of the derivative is stronger than chitosan.

Chitosan with a molecular weight in the range of 10,000 to 100,000 may be useful to limit bacterial growth. Chitosan squid with a molecular weight of 220,000 shows the greatest antibacterial activity. Chitosan with an average molecular weight of 9300 is effective in limiting the growth of *Escherichia coli*, while chitosan with a molecular weight of 2200 accelerated the growth of bacteria.

In the domestic literature there is information on the synthesis of Quaternary ammonium compounds of chitosan using organic bases and studies on the properties of the compounds obtained. For the synthesis, distilled dry methyl and ethyl iodide were used. Hydroiodic acid formed during the reaction was bound with organic bases: pyridine, 2,4-lutidine, 2,4,6-collidine and triethylamine. The resulting compound was isolated from the reaction mixture by filtration, washed with methanol, and dried.

The ability of these polysaccharides to fiber and film formation, ion exchange, high biological activity in the absence of toxicity determines the prospects for their use in medicine, biotechnology, cosmetic, food, textile and many other industries. It should be noted such medical aspects as the use in medical practice of radiation-modified heteropolysaccharides, in particular, chitosan. In parallel with this, when using radiation technology, the problem of



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disinfecting materials and destroying pathogenic microflora is automatically solved. Chitosan (CT) is one of the most effective radioprotector. Its important difference is its biocompatibility (prepared from natural chitin) and biodegradability under the action of enzymes, which is not always a desirable factor. To ensure the prolonged action of chitosan, there are at least two possible routes. The first way is a change in its molecular structure, an increase in packing density with a corresponding decrease in the availability of CT units for enzymes. The second way is the conversion of HT to a water-insoluble form. Therefore, the great interest of science and industry to the search and use of polymers of natural origin, such as chitin and chitosan, is logical. These polymers have a number of interesting properties, high biological activity and compatibility with human, animal and plant tissues, do not pollute the environment, since they are completely destroyed by microorganism enzymes, and can be widely used in environmental protection activities.

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