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# TECHNOLOGIES OF USING SILK FIBER WASTES IN THE PRODUCTION OF FILAMENTS USED IN BIOMEDICINE

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**Abstract**
This article provides detailed information on the production of high-quality medical products in modern medicine, including methods for the effective use of silk fiber waste. Also, methods and technologies for the production of raw materials used in the preparation of filament products that are specifically intended for human health, harmless to human health, and beneficial not only from silk fiber itself, but also from waste generated during the production of silk fiber. These technologies play an important role in improving the quality of life of patients and improving the healthcare system.

**Keywords**. Silk fiber, biocompatibility, biodegradability, non-toxicity, high mechanical strength, filament.

## INTRODUCTION

With each new step in the development of innovative materials and technologies in the field of biomedicine, new opportunities and effective solutions are emerging. In particular, the role of natural materials is increasing in areas such as regenerative medicine, the creation of artificial tissues and organs, as well as targeted drug delivery. For these purposes, natural polymers, in particular silk fibers, are very important due to their high biocompatibility, biodegradability, mechanical strength, and support for cell growth. The use of silk fiber waste is not only environmentally beneficial, but also provides effective solutions for the development of new materials in biomedicine. This article will discuss in detail the technologies for producing filaments using silk fiber waste and the role of these materials in biomedicine.

### Silk fibers and their importance in biomedicine

Silk fiber is a natural thread obtained mainly from Bombyx mori (white silkworm) and other species of silkworms, and has a fine structure. The composition of silk consists of fibroin and silk, each of which is characterized by its own unique biological and mechanical properties. Fibroin is the main component of silk fiber and silk, and has high strength, elasticity and improved adaptability to the biological environment. Silk itself plays an additional role in the silk fiber production process and increases the high mechanical strength of the material.



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Since silk fibers have biocompatibility (compatibility with the body) and biodegradability (natural decomposition in the body), they are widely used in medicine. They are also used as very effective materials to support the regeneration of tissues and organs. Materials made from silk fibers play an important role in supporting the growth of cells, as well as maintaining and developing them in the necessary form.

**Silk fiber waste: purpose and use**

Silk fiber waste usually arises from silk manufacturing industries and comes in various forms: silk fibers, collected from isocyanates, as well as raw silk and other wastes. These wastes are mainly incompatible materials for processing and development, but due to their high-quality polymeric properties, they can be effectively used in the creation of medical materials.

The main advantages of silk fiber waste:

• **Non-toxicity:** Since silk fiber waste is composed of natural substances, it does not harm the body and is safe.

• **Biocompatibility:** Silk fibers adapt well to the biological systems of the body and promote their cell growth.

• **High mechanical strength:** Silk fibers have high strength, which makes them good candidates for conversion into medical materials.

• **Environmental friendliness:** Since silk fiber waste is composed of natural polymers, its processing and use in biomedicine is environmentally friendly.

**Using silk fibers in filament production**

What is a filament?

Filaments are long, thin wire-shaped pieces of material that are used in medicine, mainly in 3D printing, tissue and organ reconstruction, as well as in drug delivery systems. The process of producing filaments from silk fiber waste includes the following steps:

1. Preparation and cleaning of silk fiber waste. Silk fiber waste is first collected, cleaned, and prepared for use in medicine. In this process, unnecessary substances are removed from the waste and it is made to a high purity. The size and shape of the silk fiber waste are adjusted for filament



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production. During the cleaning process, the waste is prepared for recycling using chemical or mechanical methods.

2. Polymerization and modification. Polymers (silk and fibroin) obtained from silk fiber waste can be recycled and subjected to polymerization processes. In this process, the silk and fibroin molecules are modified and they become materials with high strength. Also, with the help of other additives, the polymers are further improved and adapted for the production of filaments.

3. Filament production. The main stage of the process of producing filaments from silk fibers involves the use of electrospinning technology. In the electrospinning process, using a high-voltage electric field, the silk fiber solution is collected in the form of thin threads. These threads are specially adapted to have the desired properties by controlling their diameter and length. The filaments obtained using the electrospinning process have high mechanical properties and meet the requirements of biocompatibility.

4. Filament testing and quality control. The prepared filaments undergo quality control. Before they are used in biomedicine, they are tested for properties such as biocompatibility, biodegradability and mechanical strength. At the same time, the interaction of the filaments with tissues and cells, their support for cell growth and good integration into tissues are checked.

**New technologies and future prospects**

Technologies for using silk fiber waste to create new materials in medicine are rapidly developing. Currently, with the help of 3D printing and electrospinning technologies, opportunities are emerging to further improve the structures and properties of silk fiber materials. At the same time, new research is being conducted to develop these materials in forms integrated with human cells.

**Conclusion**

Silk fiber waste can be widely used in biomedicine as an effective and environmentally friendly material for the production of filaments. Their properties such as high mechanical strength, biocompatibility, biodegradability, as well as environmental friendliness make them very suitable for use in regenerative medicine, prostheses, implants, and drug delivery systems. The development of technologies for working with silk fiber waste opens up broad opportunities for the creation of new materials in biomedicine, which, in turn, will greatly contribute to improving human health.

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