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# Prospects for the Use of the Swim Bladder of the Silver Carp and the Possibility of its Application in Medicine

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## Abstract

Fish waste can serve as a raw material for medical devices. Matrices for tissue regeneration are currently in great demand in medicine, which can be obtained from the walls of the swim bladder of fish, which has a collagen composition that has properties that are inert to recipients. The most suitable in terms of overall, morphological, biological properties for the manufacture of scaffolds is the wall of the anterior chamber of the swim bladder of the silver carp, which is widespread and is an object of aquaculture in our country. In the course of this work, for the first time, the size of the anterior chamber of the swim bladder was measured in silver carp of different weight categories. According to the results of the study, the dependence of the thickness and diameter of the surface of the anterior chamber of the swim bladder on the weight of the silver carp was established, which can be very useful in selecting the material according to the required criteria for the manufacture of implantable medical plates.

**Keywords:** Silver Carp; Air Bubble; Bubble Wall; Collagen Matrix; Wall Thickness; Dimensions; Bubble Usage Potential

## Introduction

Silver carp, namely silver carp, is one of the most popular fish raw materials among the population, which has a high nutritional and biological value. This is a large schooling pelagic fish from the carp family. The silver carp lives in fresh waters, lives in flocks. The species is widely acclimatized in the European part of Russia, Central Asia and Ukraine. Reaches a length of about 1 m and a weight of 20–25 kg. In terms of taste, silver carp meat is fatty, tender and tasty, and is a valuable object of dietary nutrition. Silver carp has long been valued as a source of complete protein and vitamins in the nutrition of a child. Silver carp is the only freshwater fish that contains the same fat as marine fish - it reduces the amount of cholesterol in the blood [1]. The silver carp is gaining popularity as one of the most common fish farming objects in Russia [2]. This is a valuable herbivorous fish; in China, it has been bred in ponds for over two thousand years. It feeds exclusively on phytoplankton, that is, it is a completely herbivorous fish. Currently, it is bred in the southern regions of our country only by artificial means. The silver carp grown in fish farms is a domesticated form of wild silver carp imported from China and registered in the State Register of Breeding Achievements approved for testing under No. 9357467 in 1993 [3]. The main property of collagen, which determines its use in medicine, is the ability to stimulate the production of its own collagen matrix, due to which the collagen framework of the skin is restored. It is very important that the donor collagen has the ability to bioresorb but at the same time has the inertness of antigenic properties and the

ability to provoke an immune response, as well as to transmit infectious diseases [4]. There are various types (types) of collagen obtained from various raw materials, but not all of them are suitable for medical purposes. Of particular interest is collagen isolated from secondary collagen-containing fish raw materials. Many researchers pay special attention to it, because fish collagen differs minimally from human collagen, and is closer to it in biochemical composition than collagen from farm animals. [5]. At the same time, it is known that treated collagen-containing fish tissues are the least likely to provoke an immune response and transmit zooanthropic infections.

In medicine, fish collagen and its hydrolysis products are widely used in the form of various films, sponges, threads, tubes, dressings, patches, and other preparations for the treatment of wounds, burns, trophic ulcers, pulpitis, hypertension, and osteoarthritis [6]. In addition, collagen-containing waste from deep cutting of fish can serve as a raw material for the production of various therapeutic and prophylactic additives and cosmetics, as well as medical products. Such wastes include bone tissue represented by the ridge of fish, fins, and heads [7]. Swim bladders, bones and fish scales are promising for collagen isolation. A known method of obtaining collagen from the swim bladder of sturgeon [8]. In addition, pond fish species can also be a source of collagen-containing tissue.

The swim bladder is a rather large morphological formation. The walls of the swimbladder consist of three layers: the outer shell of connective tissue contains smooth fibers, fat cells and blood vessels, the middle fibrillar layer, consisting of collagen and elastin fibers, and the inner epithelium [9].

Bubbles have a huge potential for use, since they are strong collagen films with areas of uniform thickness, containing in their composition, in addition to the collagen framework, elastin, which makes the material sufficiently elastic and has elastic properties.

The walls of the swim bladder are predominantly composed of collagen, obtaining gelatin is one of the ways to use it rationally. Gelatin of fish origin can be used in various industries instead of the traditional one [10]. According to SF Ivanova and NN Petrova, it is possible to use swim bladder collagen films to reduce wound areas in humans and animals [11].

One of the most promising developments to date is a plate based on animal collagen, the raw material for the manufacture of which is the swim bladder of freshwater fish. There are also data on the studies of the physico-mechanical properties of the bladders of cyprinids, which show that the walls of the bladders have all the necessary mechanical properties for their use as implantable products. The physical and mechanical properties were studied to evaluate its use for the manufacture of medical plates; according to the data obtained, the anterior wall of the swim bladder with an optimal thickness of 0.15-0.2 mm has quite suitable physical and mechanical strength characteristics [12]. The air bubbles of cyprinids are two-chambered. Anatomically, they are the anterior head and posterior tail chambers. The anterior one has a larger, rounded size, and the posterior one is more elongated [13]. A number of advanced foreign studies on this topic show a huge potential in using the wall of the anterior chamber of the air bladder as scaffolds for vascular grafts and biological leaflets for an artificial heart valve ICS [14]. And the best results in terms of biocompatibility and physicomechanical properties were shown by decellularized and stabilized with glutaraldehyde material from silver carp [15].

All this opens up broad prospects for unlocking the potential of using such a fish processing product as the air bladder of cyprinids, namely the anterior chamber of the silver carp bladder as a material for many types of medical products.

An important aspect in the use of bladders for the manufacture of medical devices such as vascular scaffolds and other implantable devices in the form of plates is the size of the material (to be able to cut the plate from a homogeneous area of one bladder chamber) and the presence of a tissue area that is uniform in thickness and structure.

## Materials and Methods

The object of this study is the silver carp (Hypophthalmichthys molitrix). The research material is the swim bladder, its anterior chamber. Bubbles were extracted from fish of different weights. The fish were conditionally divided by weight into 3 groups, the weight of the fish was determined by weighing with an accuracy of 0.1 g. The resulting raw material was purified from impurities, then the anterior chambers of the bubbles were separated from the upper shell, thoroughly washed in distilled water. Then they were cut around the circumference so that they were opened. Following this, to remove blood residues on the surface, the anterior chambers of the swim bladders were treated with 7% NaCl solution for 48 hours according to the available data according to the method described in the patent [16] and the results obtained empirically.

After a visual evaluation of the chambers was carried out, on the basis of which it was found that they had thick and thin areas. The thick sections had an inhomogeneous structure and thickness and accounted for 10–15% of the

entire chamber. Thin sections had a uniform structure and thickness and amounted to 80-85%. Inhomogeneous thick sections were cut out and discarded so that the remaining sections had the shape of a circle with maximum preservation of the useful surface.

Subsequently, measurements were made of the obtained sections, homogeneous in thickness and structure.

Wall thicknesses were measured using an IGAGINS caliper. Five points were measured on each chamber. The diameter of the cut out circles was measured with a standard ruler 20 cm long.

## Results

According to the results of the study, the dependence of the thickness and diameter of the surface of the wall of the anterior chamber of the swim bladder on the body weight of the silver carp was established (Table 1).

| Indicators | Wall thickness, mm | Usable area diameter, mm |
|---|---|---|
| Weight groups m | m= 10 | m = 10 |
| 0,8-1 kg | 0,09±0,01 | 50±0,91 |
| 2-3 kg | 0,22±0,02 | 80±0,92 |
| 5-7 kg | 0,52±0,03 | 100±0,90 |

**Table 1:** Dimensions of the anterior chamber of the swim bladders of the silver carp.

According to the data presented in Table 1, the size of the anterior chamber of the swim bladders was found to be dependent on the mass of the fish, with its increase, the wall thickness also increases. So the thickness of the bladder wall with a fish weight of 1 kg averages 0.09 mm, with a weight of 2-3 kg this figure is on average 0.22 mm, and with a weight of 5-7 kg it already reaches an average value of 0.52 mm. The same trend was found for the diameter of the useful area. The diameter of the useful area of the anterior chamber of the swim bladder with a fish weight of 1 kg averaged 50 mm, with a weight of 2-3 kg 80 mm, and with a weight of 5-7 kg already 100 mm.

## Conclusion

In this work, for the first time, the dimensions of the anterior chambers of the swimming bladders of the silver carp were studied in order to be able to use them to obtain materials for medical and veterinary purposes. Such morphological indicators as the thickness and diameter of the surface of the wall of the anterior chamber of the silver carp depend on its mass. The most promising in terms of overall, morphological and biological properties for the manufacture of implantable medical plates is the anterior chamber of the swim bladder of a white silver carp weighing 2–3 kg with a wall thickness of 0.22 mm and a usable area diameter of 80 mm. Small fish weighing 0.8-1 kg give bubbles with a thin wall, which can affect their strength characteristics, in addition, there may be problems with the manufacture of products due to insufficient usable surface area. The walls of the anterior chamber of silver carps weighing 5–7 kg, as thicker and with a large surface diameter, can be used as a source of fish collagen, which is closest to human in its composition. It is lighter and better perceived by our body. Collagen is involved in the formation of tendons, ligaments, organs, tissues, skin and bones and is very important for tissue regeneration, wound healing, skin elasticity, and also prevents tissues from tearing.

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