



## Blood protein spectrum in representatives of the fish superclass

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### Abstract

Blood protein spectrum of representatives of the Fish superclass was studied, indicators were compared and evaluated.

The highest rates of total protein, albumins and  $\alpha$ -globulins, as well as the lowest values of  $\beta$ - and  $\gamma$ -globulins in *Cyprinus carpio* compared with *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix* and *Carassius* were established. The obtained parameters are directly dependent on the type of the studied fish species nutrition.

*Ctenopharyngodon idella* has a higher level of  $\gamma$ -globulins than other fish species, indicating better immune responses in fish of this species.

The detected blood protein spectrum of in representatives of the Fish superclass can be used in aquaculture to assess their functional state, health and degree of adaptation to environmental conditions.

**Keywords:** blood proteins, protein fractions, representatives of the Fish superclass

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### INTRODUCTION

The study of biochemical processes in the animal body is important for determining the state of metabolism (Kravcova 2013, Zalepuhin 2005). The main components of blood plasma are proteins. They play an important role in animal vital activity as the body plastic material. Due to the large range of functions performed, blood proteins and their concentrations are one of the main parameters of the physiological state of animals. Thus, proteins are active participants of metabolic processes and they can be used as an energy substrate (Lapirova and Flerova 2013). Synthesis of these polymers occurs mainly inside the liver from body received nutrient. Thanks to serum proteins, blood from a complex solution of many substances turns into the specialized tissue, where integration of body metabolic processes takes place (Ageev et al. 1982, Vasil'eva 1982).

A large number of investigations is devoted to the study of the blood biochemical composition of the higher vertebrates (Arslanova 2011, Efremov and Martynov 2012, Kravcova 2013, Popkova 1997). Less studied is the question of the blood biochemical composition of the lower vertebrates, including fish.

The aim of this study is a comparative assessment of the blood protein spectrum in representatives of the Fish superclass.

### MATERIALS AND METHODS

Peripheral blood of the following representatives of the Fish superclass was used in the study: *Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Carassius carassius*.

The objects of the study were blood proteins. The blood was taken from the caudal vein. The animals were pre-anesthetized by ether. In order to avoid blood clotting, heparin was used in an amount of 10 units per 1 ml of blood. After taking the blood, it was centrifuged at 1500 rpm for 10 minutes. Next, a layer of plasma was collected. In the the plasma samples obtained after centrifugation total protein was determined colorimetrically, by biuret reaction, and the protein fractions were determined nephelometrically (Vasil'eva 1982). The protein coefficient was calculated by computing the albumin-globulin ratio (Popkova 1997).

The results were processed by methods of variation statistics. Using Microsoft Excel 2010 and IBM SPSS Statistics 20 mean sample (M) and standard error (m) were calculated. The reliability of differences between the compared groups features values was determined, using Student's t-distribution. The level of statistically significant changes was  $p < 0.05$ .

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**Table 1.** Fish blood protein indicators

Indicators	Animal type			
	<i>Ctenopharyngodon idella</i>	<i>Carassius carassius</i>	<i>Hypophthalmichthys molitrix</i>	<i>Cyprinus carpio</i>
Total protein, g/l	11.90±0.85	9.45±0.50 <sup>*</sup>	15.52±0.54 <sup>#</sup>	57.95±1.02 <sup>#@</sup>
<b>Protein fractions, %:</b>				
albumins	13.34±3.23	15.24±3.98	14.12±0.12	34.29±0.15 <sup>#</sup>
α-globulins	8.24±0.29	15.21±2.20 <sup>*</sup>	16.50±0.12 <sup>*</sup>	19.88±0.17 <sup>#@</sup>
β-globulins	42.21±2.67	41.30±2.55	40.36±0.17	27.66±1.37 <sup>#@</sup>
γ-globulins	36.21±2.95	28.24±2.98 <sup>*</sup>	29.02±0.60 <sup>*</sup>	18.17±1.34 <sup>#@</sup>
Albumin-globulin ratio	0.15±0.01	0.18±0.01 <sup>*</sup>	0.16±0.01 <sup>#</sup>	0.52±0.05 <sup>#@</sup>

Note: <sup>\*</sup> – compared to white cupid;  
<sup>#</sup> – compared to silver crucian;  
<sup>@</sup> – compared to silver carp ( $p < 0.05$ ).

## RESULTS AND DISCUSSION

It was found that the total protein content in *Cyprinus carpio* is several times higher than in other representatives of the Fish superclass (see **Table 1**).

For *Carassius carassius*, the value of this indicator is 20.59% lower, in *Hypophthalmichthys molitrix* it is 30.42% higher compared to *Ctenopharyngodon idella*. In turn, the total protein concentration in the blood of *Hypophthalmichthys molitrix* is 64.23% higher than that of *Carassius carassius*. The albumin content of *Cyprinus carpio* is 2.5 times higher than that of *Ctenopharyngodon idella* and 2 times higher than that of *Carassius carassius*. The highest rate of α-globulins was also detected in the blood of *Cyprinus carpio*. Its values are higher by 58.55%, 23.49% and 17.0% respectively compared to *Ctenopharyngodon idella*, *Carassius carassius*, *Hypophthalmichthys molitrix*. Level of α-globulins in *Carassius carassius* и *Hypophthalmichthys molitrix* is also 84.59% and 2% higher compared with *Ctenopharyngodon idella*. The concentration of β-globulins in *Cyprinus carpio* is 52.60%, 49.31% and 45.91%, γ-globulins – 99.28% 55.42% and 59.71% lower, respectively, compared to *Ctenopharyngodon idella*, *Carassius*, *Hypophthalmichthys molitrix*.

According to the literature, in cold-blooded animals that do not have a constant body temperature, unlike mammals that are warm-blooded, the metabolism is extremely unstable and can depend on factors such as the composition of the diet, the period of activity, etc. (Strebkova et al. 2010). In general, all experimental fish species have shown high levels of total protein, indirectly indicating active metabolic processes and synthetic reactions of the body (Chikov and Tleceruk 2009).

The obtained results concerning the quantitative content of the albumin fraction can be justified by different types of nutrition of the considered fish species. Thus, *Ctenopharyngodon idella* feeds exclusively on plant food, animals of this species have the lowest rates of albumin fraction. *Carassius carassius* and *Hypophthalmichthys molitrix* have mixed nutrition with a predominance of phytoplankton and vegetation, and albumin indices in their plasma are higher than in *Ctenopharyngodon idella*. *Cyprinus carpio* has a mixed diet with a predominance of animal origin food, which is richer in protein, is better absorbed and with lower

energy costs compared to plant food. Accordingly, the level of albumin fraction in animals of this species is the highest in comparison to other studied fish species. The high level of albumin in the blood is an important indicator for assessing the physiological state of the body. This protein fraction is used as the main reserve of amino acids. Albumin plays an important role in the formation and maintenance of osmotic blood pressure, and is an important carrier of various substances (Ivanov 2003). Albumins serve as a reserve of amino acids for protein synthesis. In addition, due to the large surface of the micelles and their high negative charge, proteins of this fraction adsorb and transport a number of substances (HPLC, bilirubin, bile acid salts, hormones, toxins, a significant part of calcium ions, etc.), thereby having a regulatory effect on metabolic processes (Kapitatenko and Dochkin 1988).

The highest albumin-globulin ratio also indicates a more active use of blood albumins as a plastic material in the proteins synthesis of various organs and tissues by *Cyprinus carpio* compared to other fish species.

By contrast, the β-globulin content of *Cyprinus carpio* is the lowest. It is known that β-globulins are responsible for the transport of many substances, they retain in solution about 75% of all plasma fats and lipids, as well as metals (Kapitatenko and Dochkin 1988). Consequently, it can be assumed that *Cyprinus carpio* has the least active transport of fats and lipids, compared to other studied animals.

Level of γ-globulins is the highest for *Ctenopharyngodon idella*. Serum immunoglobulins are known to play an important role in maintaining local immunity, as they are the primary receptors for antigens and characterize the body's immune response. The function of secretory immunoglobulin is to provide the so-called immune exclusion, that is, to prevent the penetration of various antigens into the body through the mucous barriers and inhibit the colonization of epithelium by bacteria and viruses (Bolotnikov and Konopatov 1993). Thus, the high immune responses of *Ctenopharyngodon idella*. can be indirectly assumed.

## CONCLUSION

As a result of research it was found that the total protein content of *Cyprinus carpio* is several times

higher than that of the other representatives of the Fish superclass.

The albumin content of *Cyprinus carpio* is 2.5 times higher than that of *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* and 2 times higher than that of *Carassius carassius*. The highest rate of  $\alpha$ -globulins was also detected in the blood of *Cyprinus carpio*.

The concentration of  $\beta$ -globulins in *Cyprinus carpio* is 45.91-52.60%,  $\beta$ -globulins is 55.42-99.28% lower, respectively, compared with other studied representatives of the Fish class.

The highest protein coefficient value was registered in *Cyprinus carpio*, then its value decreased in the series of *Carassius carassius* - *Hypophthalmichthys molitrix* - *Ctenopharyngodon idella*.

## SUMMARY

1. The studied fish species have high levels of total protein, indirectly indicating active metabolic processes and synthetic reactions of the body.

2. The level of albumin in the blood depends on the type of fish food. The predominance of food of animal origin increases the protein content of this fraction in the blood, the consumption of mainly vegetable food contributes to a lower concentration of albumins in blood plasma.

3. The highest coefficient of albumin-globulin ratio was registered in *Cyprinus carpio*, which allows it to more actively use the proteins of this fraction for the synthesis of proteins of various organs and tissues compared to other fish species.

4. *Cyprinus carpio* has the least active transport of fats and lipids compared to other fish species due to the low content of  $\beta$ -globulins.

5. High levels of  $\gamma$ -globulins in *Ctenopharyngodon idella* indicate high immune responses in fish of this species.

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