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The Comparative Assessment Of The Degree Of The Toxic Element Accumulation In The Organism Of Different Fish Species Reared In Recirculating Aquaculture Systems.

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ABSTRACT

The article is devoted to the comparative assessment of the degree of the toxic element accumulation in the organism of different fish species reared in recirculating aquaculture systems (RAS). The differences were found in the degree of the toxic element accumulation in the organism of sterlet and sharp tooth catfish.

Keywords: sterlet, sharp tooth catfish, toxic elements, radionuclides, fish breeding, RAS

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INTRODUCTION

Aquaculture as a fast-growing industry of food production effectively utilizes feed and water resources, and fish is a unique source of polyunsaturated fatty acids, high-grade proteins, minerals and vitamins useful for the human body [3, 4].

An excessive fishing load on natural reservoirs, as well as a constant increase in the population's demand for fish products, stimulated the rapid technological development of industrial methods for breeding and rearing fish, namely recirculating aquaculture systems(RAS) [2, 3].

The use of RAS in fish breeding is a promising world tendency. The water recirculation provides higher stable production of aquaculture products. Such systems are durable and can be operated economically. The possibility to regulate the parameters of the aquatic environment, the competent management of the system and the maintenance of fish health, taking into account sanitary and veterinary measures followed in RAS, make it possible to raise viable young fish and obtain high quality products [1, 4, 6].

As a result of the accumulation of waste products and feed components in water, various xenobiotics are likely to be built up in the tissues and organs of fish that reduce the safety of commercial fish products [5].

An interesting question was the study of the degree of accumulation of toxic elements in the tissues of fish of different species reared in RAS.

MATERIALS AND METHODS

The studies were conducted at the scientific laboratory of fish breeding and reproduction as a structural unit of the Department of small animal science, livestock breeding technology and aquaculture of Ulyanovsk State Agrarian University.

The samples of sterlet and African sharp tooth catfish reared in RAS served as the research material. The samples were selected according to corresponding regulatory documents (State standard 31339-2006 «Fish, non-fish objects and products from them. The rules of accepting and methods of selecting samples»).

The fish quality was evaluated according to microbiologic, parasitological indices, as well as the safety parameters (Sanitary regulations and standards 2.3.2.1078-01 «Hygienic safety requirements and food value of foodstuffs»).

The determination of toxic elements in fish (Cd, As, Hg, Pb) and radionuclides (⁹⁰Sr, ¹³⁷Cs) was conducted with the method of atomic absorption spectrometry with the use of spectrometer AAS-130 at the Simbirsk reference center for veterinary service in the city of Ulyanovsk.

RESULTS AND DISCUSSION

Heavy metals and radionuclides accumulated in fish pose the greatest hazard which can cause the poisoning in the organism and changes in the life activity processes.

To identify the degree of accumulation of toxic substances in the fish organism the studies were conducted to determine the fish safety qualities, the results are given in Table 1.

Table 1: Indices of the fish safety level

№	Name of a harmful agent	Measurement unit	The fish study result		Max. permis. value	Regulatory document
			sterlet	sharp tooth catfish		
Toxic elements						
1	Cd	mg/kg	0,02±0,002	0,08±0,003	0,2	State standard 30178-96

2	As	mg/kg	0,1±0,010	0,01±0,002	1,0	State standard 26930-86
3	Hg	mg/kg	0,008±0,001	0,01±0,001	0,6	Method. guidelines (MG)5178-90
4	Pb	mg/kg	0,12±0,004***	0,85±0,003	1,0	State standard 30178-96
Pesticides						
5	HCH	mg/kg	0,028±0,001	0,005±0,0008**	0,03	MG 2142-80
6	DDT and its metabolites	mg/kg	0,028±0,001	0,005±0,0009**	0,3	MG 2142-80
Microbiological agents						
7	<i>Listeria monocytogenes</i>	g	Not detected	Not detected	at 25,0 is not permissible	State standard 32031-2012
8	<i>Staphylococcus aureus</i>	g	Not detected	Not detected	at 0,01 not permissible	State standard 31746-2012
9	<i>Vibrio parahaemolyticus</i>	CFU/g	Not detected	Not detected	not more than 100	MG 4.2.2046-06
10	Coliforms	g	Not detected	Not detected	at 0,001 not permissible	State standard 31747-2012
11	Number of mesophilic, aerobic and facultative anaerobic microorganisms	CFU/g	fewer than 1 x 10 ²	fewer than 1 x 10 ²	not more than 1x 10 ⁵	State standard 10444.15-94
12	Pathogens, including salmonella	g	Not detected	Not detected	at 25,0 not permissible	State standard 31659-2012
Parasitological agents						
13	Live parasite larvae		Not detected	Not detected	not permissible	MG 3.2.988-00
Radionuclides						
14	Sr 90	act. unit/kg	3,8±0,03**	5,2±0,04	100	State standard 32163-2013
15	Cs 137	act. unit/kg	3,9±0,04***	7,4±0,06	130	State standard 32161-2013

Note: ** - p<0,01, *** - p<0,001

The data obtained testify that the content of toxic elements in the studied samples of fish does not exceed the values of maximum permissible concentrations.

Cadmium and lead, as the most toxic heavy metals possess a very distinct tendency to accumulate in living organisms. According to the data of our research the content values of Cd and Pb in the organism of sharp tooth catfish are 0,08 mg/kg and 0,85 mg/kg, whereas the concentration of these elements in the organism of sterlet is equal to 0,02 mg/kg and 0,12 mg/kg respectively. The result obtained points to the fact that the organism of sharp tooth catfish accumulates Cd by 25 % more in comparison with sterlet. At the same time the content of Pb in the organism of sterlet by 14 % reliably lower in relation to the values of sharp tooth catfish. However, there is a tendency towards a decline of the concentration of As in tissues of sharp tooth catfish. This value is by 10 % lower than in sterlet. The study to determine the content of Hg in the organism of fish did not reveal essential distinctions.

Radionuclides in the organism are absorbed by the liver, causing the organs' malfunctioning and change of the mineral composition of bones. The concentration of radionuclides Sr 90 in the studied samples of sterlet amounts to 3,8 act. unit/kg, Cs 137 - 3,9 act. unit/kg, which is reliably much lower by 50 % in comparison with the corresponding parameters in the organism of sharp tooth catfish.

Pesticide ingress into the habitat of fish may lead to poisoning, and as a sequence, to the death of aquatic organisms. According to the research results of the pesticide content its lowest concentration was

found in the catfish organism (0,005 mg/kg) in comparison with the relevant values of sterlet (0,028 mg/kg). This can be connected with a different composition of feed diets.

From microbiological indices in fish samples, the presence of mesophilic aerobic and facultative anaerobic microorganisms was detected in the amount of fewer than 1×10^2 CFU / g (at a rate of 1×10^5 CFU / g). Other pathogens were not detected.

CONCLUSION

The results of the studies conducted give grounds to assert that fish reared in RAS is completely safe in view of microbiological, parasitological and chemical indices. The level of dangerous toxic substances does not exceed the maximum permissible concentrations. At the same time, differences were found in the degree of accumulation of toxic elements: in the organism of sterlet, the content of elements (Cd, Pb) by 25% and 14% and the radionuclide concentration by more than 50% is significantly lower in comparison with the corresponding parameters in the organism of sharp tooth catfish.

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