Study of the effect of protein feed on the weight gain and liver condition of sterlet

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Abstract. The aim of the studies was to determine the possibility of partial or complete replacement of fish meal with an alternative feed protein (gaprin) in the production of balanced feeds for sterlet. In the experimental groups, fish meal was replaced with gaprin in the following ratios: 50/50 - in group 2; 25 fish meal / 75 gaprin - in group 3. After 60 days, the final weight in group 2 was 6.4% higher than in the control; in group 3 - by 19.4%. The average daily gain in the control was 1.3 g; in group 2 - 1.4 g; the highest - 1.6 g - in group 3. The decrease in feed costs per 1 kg of gain, compared to the control, was in group 2 by 8.0%, in group 3 - by 10.6%. Histological studies have shown that when using 100% fish meal, the liver condition of fish is normal, in other cases deviations from signs of fibrosis to the initial stages of liver necrosis were noted. Blood parameters were within the norm for this age group of fish.

1 Introduction

Optimization and improvement of sturgeon farming is of great importance in the development of domestic aquaculture. Demand for sturgeon products is currently growing worldwide due to the value of their caviar and boneless meat.

Sturgeons (Chondrostean, Acipenseriformes) are one of the oldest surviving families of bony-cartilaginous fish and represent a unique and commercial group of fish whose numbers continue to decline worldwide [1-3].

Sterlet, Acipenser ruthenus, is a small sturgeon that is widespread in Central and Eastern Europe and Asia. Due to its early sexual maturity and its economic importance, the sterlet has become one of the most common sturgeon species in many countries [4-6].

Fish feed production in the Russian Federation is currently expanding and improving due to the lack of stable supplies of imported feed due to the geopolitical situation. The requirements for making up sturgeon diets and the search for alternative protein are relevant. High-quality fishmeal is in short supply, and for sturgeon fish, a balanced protein diet is the key to the success of a fish farm and an increase in the yield of marketable products [7-10].

Intensive production of valuable aquaculture objects faces the need to find new sources of high-protein components of animal origin for partial replacement of fish meal.

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The purpose of the conducted research was to determine the possibility of partial or complete replacement of fish meal with an alternative feed protein (gaprin) in the production of balanced feed for sterlet.

To achieve the set goal, the following tasks were set:

- to evaluate the impact of the developed compound feed recipes on the survival rate of the sterlet population;
- to evaluate the physiological and biochemical parameters of sterlet when using an alternative feed protein (gaprin);
- to form an evidence base for the prospects of partial or complete replacement of fish meal when using gaprin to balance sterlet feed.

2 Materials and Methods

The experiment on young sterlet was carried out in pools. The duration of the experiment was 60 days. The number of fish with an initial weight of 30 g was 150 pcs. per group. The scheme of the experiment is presented in Table 1.

Table 1. The design of the experiment

Group	Fish, pcs.	Diet, % of fish meal to additive	Amount of additive, kg	Amount of feed, kg
1 control	150	100 % fish meal	-	30
2 experimental	150	50/50	5.25	30
3 experimental	150	25/75	7.87	30

In the experimental groups, fish meal was replaced with gaprin in the following ratios: 50/50 - in the second; 25 fish meal / 75 gaprin - in the third.

Gaprin is the biomass of an inactivated cell culture.

The first control group received complete compound feed manufactured by Praktika LLC with 100% fish meal in its composition (Table 2).

The nutritional value of Praktika LLC feed is presented in Table 2.

Table 2. Nutritional value of Praktika LLC feed

Item	Value
Crude protein	42 %
Fat	14 %
Moisture	9 %
Crude fiber	3.0 %
Phosphorus	1.6 %
Ash	10 %
Lysine	2.8 %
Methionine+Cystine	1.4 %
Vitamin A	22500 IU
Vitamin D_3	5250 IU
Vitamin E	300 mg
Energy (per 1 kg of feed):	
Total energy	4990 kcal
Digestible energy	4380 kcal

The protein content in gaprin is not less than 75-76%.

The indicators characterizing the quality of microbiological protein are presented in Table 3.

Table 3. Nutritional value of the microbiological protein gaprin

Parameter	Measured value
Nutritional value, %	
Crude protein content by weight	72.6 ± 3.0
Fat content by weight	9.6 ± 1.0
Ash content by weight	5 – 10
Moisture content by weight	< 8
Iron	380-700
Copper	150-250
Zinc	50-90
Amino acid profile, %	
Aspartic acid	6.36 ± 0.88
Glutamic acid + Glutamine	6.84 ± 0.94
Histidine	1.65 ± 0.61
Serine	2.67 ± 0.33
Arginine	4.09 ± 0.89
Glycine	3.89 ± 0.40
Threonine	3.41 ± 0.37
Alanine	5.54 ± 0.65
Tyrosine	2.29 ± 0.73
Valine	4.10 ± 0.59
Proline	2.71 ± 0.43
Leucine + Isoleucine	8.54 ± 0.90
Phenylalanine	3.02 ± 0.43
Lysine	3.89 ± 0.40
Methionine	1.80 ± 0.24
Cystine + Cysteine	0.44 ± 0.11
Tryptophan	1.25 ± 0.12

The testing methods were carried out in accordance with the regulatory documentation:

- extracts from the methods of hydrochemical studies of samples from fishery waters (approved 10/20/1983).

3 Results and Discussion

The survival rate of fish in all groups was 100%.

At the beginning of the experiment, the fish weight was the same. After 60 days of the experiment, the following differences were observed: in the second group, the final weight was 6.4% higher than in the control; in the third group, by 19.4%. The average daily weight gain in the control was 1.3 g; in the 2nd group, 1.4 g; the highest, 1.6 g, was in the third group (Table 4).

Table 4. Weight gain of fish

Item	Group		
	1	2	3
Initial weight, g	30.0	30.0	30.0
Final weight, g	106.0±4.3	113.33±4.41*	126.7±6.8**
Gross weight gain by group, g	11400	12500	14500
Average daily gain of 1 fish, g	1.30±0.04	1.40±0.05*	1.60±0.09**

Note: reliability of differences with control * - at P<0.05; ** - at P<0.01

The intestinal microflora parameters in fish in all groups were normal, but increased in the control, which indicates the microbiological stability of gaprin in the diets of the experimental groups.

Blood parameters were within the normal range for this age group of fish.

In group 1, no disturbances in the physiological state of the liver were observed. Functions are normal. The organ contours are smooth, the granularity is uniform. The parenchyma is not damaged. Focal changes are absent. Liver tissue is normal (Fig. 1).

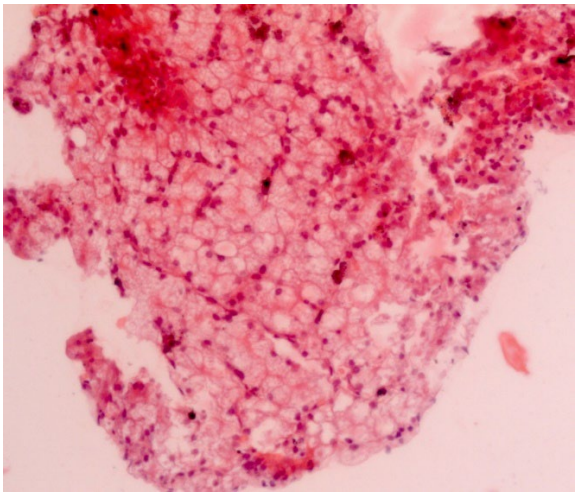

Fig. 1. Fish liver sample from group 1

In group 2 initial stages of necrosis are observed during cultivation. Changes in the cell nucleus and cytoplasm are observed. Changes in the nucleus are manifested in the form of karyopyknosis, karyorrhexis and karyolysis. Pycnosis and lysis of nuclei are visible. Shrinkage and hyperchromia of the nucleus are caused by DNA condensation, some nuclei are subject to fragmentation or rupture into lumps.

The necrotic zone is surrounded by an inflammatory ridge, the adjacent tissue area is infiltrated with leukocytes (Fig. 2).

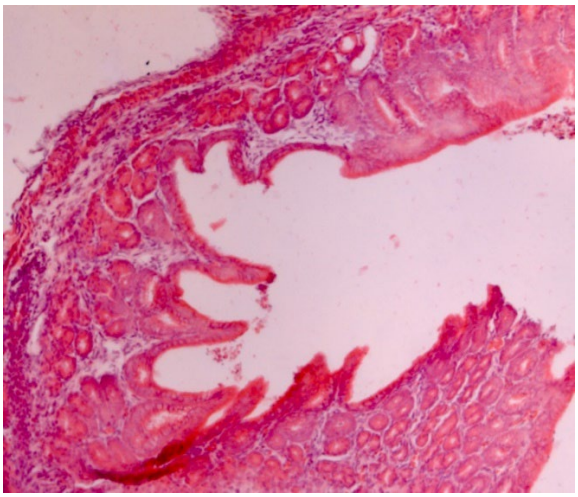

Fig. 2. Fish liver sample from group 2

The liver condition in the third group – with fibroelatosis, it can function normally, but the growth of individual vascular fibroses indicates an increase in the toxic load on the body (Fig. 3).

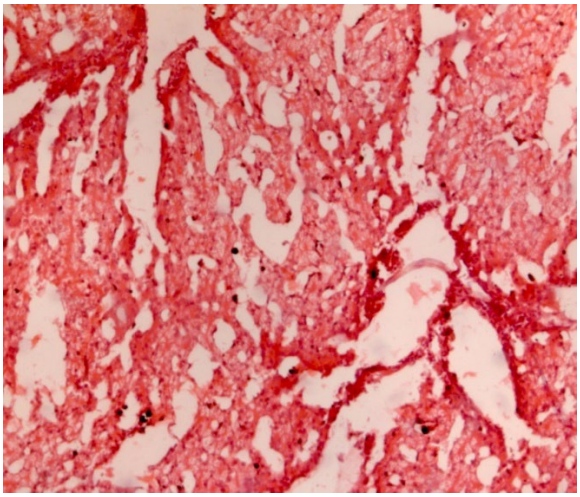

Fig. 3. Fish liver sample from group 3

Connective tissue growths, individual vascular fibroses and bile duct fibroelastoses are observed. Liver function is not impaired.

Histological studies have shown that when using 100% fish meal, the condition of the sterlet liver was normal, in other cases, deviations from signs of fibrosis to the initial stages of liver necrosis were noted.

The economic efficiency of using gaprin for partial replacement of fish meal in sterlet diets is presented in Table 5.

Table 5. Economic efficiency indicators of using gaprin for partial replacement of fish meal in sterlet diets

Indicators	Group		
	1	2	3
Gross weight gain, kg	11.4	12.5	14.5
Feed consumed, kg	20.6	19.4	15.9
Cost of gaprin, rubles per kg of gain	-	32.5	16.3
Cost of feed consumed, rubles	3296.0	3104.0	2544.0
Production costs, rubles	10696.0	10 504.0	9944.0
Cost of 1 kg of gain, rubles	938.2	840.3	685.8
Cost of gross output, rubles	13680.0	15 000.0	17 400.0
In % to control	100.0	89.6	73.1
Profit, rubles	2711.0	4496.0	7456.0
Additional income, rubles	-	+1785.0	+4745.0

The gross weight gain in the 2nd experimental group exceeded the control indicator by 0.9 kg; in the 3rd – by 3.1 kg.

The cost price of 1 kg of fish weight gain compared to the control in the 2nd experimental group decreased by 10.4%, in the 3rd – by 26.9%.

4 Conclusion

The survival rate of fish in all groups was 100%.

At the beginning of the experiment, the fish weight was the same. After 60 days of the experiment, the following differences were observed compared to the control: in the second group, the final weight was higher by 6.4%; in the third group - by 19.4%.

The average daily gain in the control was 1.3 g; in the 2nd group - 1.4 g; the highest - 1.6 g - in the 3rd group.

In the experiment on yearlings of sterlet, the reduction in feed costs per 1 kg of gain, compared to the control, occurred in the 2nd group by 8.0%, in the 3rd - by 10.6%.

The intestinal microflora indicators are normal, but in the control group they are increased, which indicates the microbiological stability of gaprin in the diets of the experimental groups.

Blood indicators were within the normal range for this age group of fish.

Histological studies showed that when using 100% fish meal, the condition of the fish liver is normal, in other cases, deviations from signs of fibrosis to the initial stages of liver necrosis were noted.

Gross weight gain in the 2nd experimental group exceeded the control indicator by 0.9 kg; in the 3rd – by 3.1 kg.

The cost price of 1 kg of fish weight gain compared to the control in the second experimental group decreased by 10.4%, in the third – by 26.9%.

Based on the obtained results, in order to increase weight, reduce feed costs, maintain survival rate and improve the profitability of sturgeon farming, it is recommended to use gaprin when replacing no more than 50% of the fish meal weight in sterlet diets.

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