

A Comprehensive Assessment of the Impact of the Additive “Abiopeptide with Iodine” on the Growth, Development and Marketable Quality of the Lena sturgeon Grown in Cages

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This paper examines the use of a feed additive “Abiopeptide” in a chemical bonds with the organic iodine in the feeding of the Lena` sturgeon. Was carried out a technology of adding of iodinated feed additive “Abiopeptide” into the feed fed with the purpose of studying the effects of iodine on the productivity and functional status of the fry of the Lena` sturgeon. Calculation of economic efficiency of a fish farming of the Lena` sturgeon showed that during the implementation of fish was obtained the highest profit in the group, which was additionally fed with the iodine at a dose of 200 μcg in 1 ml per 1 kg of ichthyomass. This indicates the profitability of fish production using a fish feeding “Abiopeptide with iodine”.

Key words: Lena` (Siberian) sturgeon, feed additive, iodine, feeding, cages.

In recent years, the fishery of a valuable food fish has declined significantly. This was primarily concerned sturgeons. The water engineering, poaching and other negative anthropogenic factors have led to the catastrophic decline in population of these valuable species of fish^{2, 8, 9, 10}.

In modern terms, a reliable source of increasing the volume of food fish production is aquaculture. In a connection with the increase in the rate of production of valuable fishery products, accelerating growth of fish has assumed great significance. With this purpose in the practice of domestic and foreign fish industry are already used various growth factors, containing complexes of amino acids, vitamins and microelements³.

Iodine is a very important trace element in fish nutrition, its low concentration in fresh water shows about the need to monitor its presence in feed. Iodine value is determined by the fact that it is a mandatory structural component of thyroid hormones and in case of inadequate intake from the environment decreases the intensity of the biosynthesis of hormones, appear different marked disorders of the numerous functions of the various organs and systems of the organism^{1, 4, 5}.

The use of iodine-containing supplements in the feeding of the Lena` sturgeon in the industrial fish farming with the aim of increasing fish productivity, resistance to diseases, adverse environmental conditions and ultimately the accumulation of iodine in fishery products is an innovative approach to creating a highly nutritious protein product enriched with iodine^{6, 7, 11}.

In this regard, was conducted a research on the productivity of the Lena` sturgeon due to

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the adding in the diet of biologically active additives “Abiopeptide with iodine” when grown in cages.

The methodology of a research

In the period from 2012 to 2015 we have conducted researches on the study of the influence of biologically active additives “Abiopeptide with iodine” on the productivity of the Lena sturgeon grown in cages in a natural water of a fourth fish farming zone of the Russian Federation. Studies were conducted at the department of “Feeding, zoohygiene and aquaculture” and at the research laboratory “Technologies of feeding and growing fish”, according to the scheme presented in table 1.

To study the effect of iodine on the productivity of fish was selected fodder additive “Abiopeptide with iodine”. In the additive “Abiopeptide”, which represents a 25.0 percent concentrate enzymatic hydrolysate of soy protein, was dissolved organic iodine in different concentrations to identify the optimal value of its efficiency during the experiment.

Additive “Abiopeptide with iodine” was produced and provided by a research and production company “A-BIO”, Pushchino, Moscow region.

The iodine is presented in the additive in the most available for absorption and harmless

organic form, in the form of iodine-gorgonic acid in which iodine is bound in a stable complex with amino acid.

The projected experiment was carried out in a laboratory aquarium installation in the research laboratory “Technologies of feeding and growing fish”⁸. To develop an optimum rate of feeding additives “Abiopeptide with iodine” was selected fry of the Lena sturgeon, and it was divided into 6 groups with 11 specimens in each of them. The average mass of the specimens were approximately 280 g. Each group was placed in an aquarium with a capacity of 250 liters each. The control group received a complete feed (OR) with the additive “Abiopeptide”, and five experimental groups received the OR with biologically active additive “Abiopeptide with iodine” containing 1 ml of iodine, respectively: 100 µcg, 150 µcg, 200 µcg, 250 µcg and 500 µcg. The duration of the experiment was 56 days (table. 1).

Scientific-production experiment was carried out on the territory of Krasnoyarsk municipal district of Engels district of Saratov region in the natural pond in the period from May to October 2014 in cages of a latex knotless netting with a size of 2,0×2,2×2,0 m. The cages system is developed by us and is protected by patent of the Russian Federation⁹. The duration of the experiment was 112 days.

Table 1. Scheme of the experiments

Group	The number of individuals	Type of feeding
Predictable experience		
Control	11	Granulated feed (OR) with the addition of “Abiopeptide”, at the rate of 1 ml per 1 kg of a fish weight
1 experimental	11	The OR with the addition of “Abiopeptide with iodine” at the rate of 1 ml per 1 kg of fish containing 100 µcg of iodine per 1 ml
2 experimental	11	The OR with the addition of “Abiopeptide with iodine” at the rate of 1 ml per 1 kg of fish containing 150 µcg iodine in 1 ml
3 experimental	11	The OR with the addition of “Abiopeptide with iodine” at the rate of 1 ml per 1 kg of fish containing 200 µcg of iodine per 1 ml
4 experimental	11	The OR with the addition of “Abiopeptide with iodine” at the rate of 1 ml per 1 kg of weight of fish, containing 250 µcg of iodine per 1 ml
5 experimental	11	The OR with the addition of “Abiopeptide with iodine” at the rate of 1 ml per 1 kg of fish containing 500 µcg of iodine per 1 ml
Scientific and production experience		
Control	16	Granulated feed (OR)
Experimental	16	The OR with the addition of iodine at the rate of 200 µcg of iodine per 1 kg of a fish weight

Table 2. Results of the predictable experience

Indicator	Group					
	control	1 – experimental	2 – experimental	3 – experimental	4 – experimental	5 – experimental
Weight in the beginning of the experiment, g	280,8 ± 1,9	277,8±2,4	289,4± 7,4	285,5±2,7	288,8±1,9	279,8±3,0
Weight at the end of the experiment, g	418,0 ± 5,7	422,5±3,1	429,5 ± 1,5*	440,0±0,4*	441,7±1,5*	429,3 ±2,4*
The absolute gain, g	137,7	144,7	140,1	154,5	152,9	149,5
The cost of 1 kg gain in feed, kg	1,18	1,23	1,27	1,14	1,15	1,14
Crude protein, g	552,79	579,79	598,18	536,62	540,64	536,36
Metabolizable energy, MJ	20,46	21,46	22,15	19,87	20,02	19,86
The iodine content in 1 kg of muscle tissue in fish, micrograms	56,8±0,92	65,7±0,79***	76,6±0,61***	77,6±0,49***	75,6±0,46***	45,6±0,66
Safekeeping, %	100,00	100,00	100,00	100,00	100,00	100,00

* P>0,95; ** P>0,99; *** P>0,999

For the experiment were selected 210 specimens of the Lena' sturgeons at one year of age with an average weight of 370 – 374 g and they were divided them into two groups - control and experimental.

The control group received a complete feed (OR) and the experimental group received the OR with the biologically active additive "Abiopeptide with iodine", at the rate of 200 µcg of iodine (1 ml) for 1 kg of fish.

During the experiment, sturgeons were fed 2 times a day, at 7:00 h and 19:00 h. Daily amount of food was calculated according to the standard technique, taking into account water temperature, fish weight and the concentration of dissolved oxygen. Control weighing was performed every 10 days on the electronic scales. Based on the live weight of fish were calculated the absolute, average daily and relative gains of the masses of sturgeons.

Hydrochemical composition of water was determined at the beginning and at the end of the experiments according to standard techniques.

Biochemical blood parameters were determined at the beginning and at the end of scientific and economic experiment. When assessing the hormonal status of the thyroid gland were determined the levels of TSH, T4 free, T4 total and T3. The level of thyroid hormones in the blood of fish was determined on the biochemical and immunoassay automatic analyzer Chem Well type 2009 (T).

Tissue of internal organs for histological studies was taken at the end of the experiment. The overall picture of the changes was studied histologically, coloured by hematoxylin - eosin according to the method of Ehrlich. Histological sections with a thickness of 4-7 µm were produced on a microtome "Mikrom HM450" from the paraffin blocks of pieces of organs, fixed in the fluid by Carnoy.

The slaughter of the Lena' sturgeons and the definition of a ratio of edible and inedible body parts were carried out according to the accepted farming methods.

A definition of iodine in the muscle tissue of the Lena' sturgeons was carried out on the voltamperometric analyzer "ECOTEST – VA" on the methodology of measurement of mass concentration of iodine in food products, food raw materials, food and biologically active supplements

by a direct current inversion voltamperometry with a carbon electrode.

The obtained experimental data were subjected to biometric processing by regression analysis using the software package MS Excel 2007.

The results of the research

Based on the results of the predicted experiences, it was revealed that Siberian sturgeons in the third experimental group who received biologically active additive "Abiopeptide with iodine", at the rate of 200 µcg of iodine per 1 kg of weight of fish, had a greater growth rate at the lowest cost of feed per 1 kg gain compared with fish from the control and the other experimental groups (table. 2).

Chemical analysis of muscle tissue of the Lena' sturgeon showed that the highest iodine content was in the third experimental group (77,6 µcg/kg) compared to the iodine content in muscle of sturgeons in the control and the other experimental groups.

Scientific-production experiment was conducted in natural water. Water quality in the reservoir was consistent with the fish-biological standards (OST 15-372-87), and it was suitable for growing sturgeon. Water temperature during a period of an experiment was within the

physiological norm of Lena' sturgeons: 19 – 22 °C.

On the basis of experiment it was established that the adding in the diet of biologically active additives "Abiopeptide with iodine" for the sturgeons of the experimental group was increased the safety of fish by 0.96 %, was marked the absolute increase in fish weight by 14.12 %, and the cost of feed per 1 kg gain decreased by 9.62 % compared with the control group (table. 3).

The biochemical values of blood were studied during the experiment in order to find a mechanism of the influence of a high dose of iodine on the functional activity of a thyroid gland, at the same time without damaging a fish.

Blood was taken from the Lena' sturgeons at the beginning of the experiment, when the water temperature was 20 °C and in the end of the experiment, when the water temperature in the reservoir was 14 °C.

It was established that in fish of the control group at the beginning of the experiment, the level of thyroid-stimulating hormone amounted to 2.76, Mked/ml. At the end of the experiment it was a rising of the TSH level to 3.12, Mked/ml. In the experimental group TSH level at the end of the experiment was higher than in fish of the control

Table 3. Results of a scientific-production experiment

Indicator	Group	
	Control	Experimental
Weight in the beginning of the experiment, g	374,3±7,49	370,1±7,18
Weight at the end of experiment, g	938,6±18,72	1014,1±18,82
The absolute gain, g	564,30	644,00
The cost of 1 kg gain: of feed, kg	1,56	1,41
Crude protein, g	733,50	663,90
Metabolizable energy, MJ	27,20	24,60
Safekeeping, %	95,23	96,19

Table 4. Values of pituitary hormones (TSH) and thyroid (T3 and T4) in blood serum of the Lena' sturgeons

The name of the group	Concentration of hormones			
	Total T4 nmol/l	T3 nmol/l	Free T4 nmol/l	TSH, Mked/ml
The beginning of the experiment Pilot fish	26,26±3,25	0,12±0,02	10,63±1,99	2,76±0,12
The end of the experiment Control	18,20±2,87	0,07±0,01	9,37±1,64	3,12±0,27
Experimental	30,10±3,00*	0,23±0,03	15,22±0,82*	5,02±0,39**

*P >0,95; **P >0,99; ***P>0,999

group to 61.1 per cent and amounted to 5.02, Mked/ml (table. 4).

The level of free thyroxine at the end of the experiment in fish of the control group decreased by 13.4 % in comparison with the value at the beginning of the experience. The value in the experimental group was higher on 61.6% in comparison with the control. The level of a total thyroxine in fish of the control group at the end of the experience also reduced by 69.3 per cent compared to the beginning of the experiment. And in the experimental group the value increased by

65% compared to a control.

Biochemical parameters of blood serum: the content of direct and total bilirubin, total protein, urea, glucose, macronutrients: calcium, phosphorus, magnesium, sodium, potassium, iron, show that the feeding of the Lena' sturgeons by forage with the additive "Abiopeptide with iodine" has no negative effects and supports blood biochemical parameters in the optimal physiological limits.

To determine the impact of biologically active additive "Abiopeptide with iodine" on the

Table 5. Results of the slaughter of the Lena' sturgeons

Indicator	Group			
	Control		Experimental	
	g	% of mass	g	% of mass
Weight of fish, g	938,6±14,0	100	1014,0±15,0	100,0
The mass of the head and fins, g	201,8±11,0	21,5	204,8±12,0	20,2
Weight of a skin g	187,1±10,0	19,9	195,6±11,0	19,3
The mass of cartilage, g	46,9±6,0	5,0	57,8±7,0	5,7
Mass of muscle tissue, g	319,1±15,2	34,0	405,6± 14,3*	40,0
The mass of the heart, g	1,9±0,6	0,2	1,0±0,5	0,1
Liver weight, g	56,3±0,4	6,0	49,7±0,5	4,9
The mass of a stomach, g	9,4±0,8	1,0	8,1±0,7	0,8
The mass of a spiral valve, g	10,3±0,3	1,1	9,1±0,4	0,9
The mass of intestine, g	12,2±0,5	1,3	11,3±0,6	1,1
The mass of the gills, mucus, blood, etc., g	93,5±7,5	9,9	71,1±8,8	7,0
The weight of edible parts, g	375,4±13,1	40,0	455,3±14,1 *	44,9
The mass of the non-edible parts, g	314,4±6,5	33,5	296,2±7,6	29,3
The sum of edible and conditionally edible parts, g	624,1±17,5	66,5	717,9±18,3***	70,8

* >0,95; ** >0,99; *** >0,999

Table 6. Chemical composition and caloric value of muscle tissue of the Lena' sturgeons

Substances	Group	
	Control	Experimental
Water, %	70,60±0,17	70,40±0,12
Dry substance, %	29,40±0,12	29,60±0,53
Protein, %	17,10±0,15	17,30±0,19
Fat, %	10,46±0,08	10,59±0,09
Ash, %	1,20±0,15	1,40±0,09
Nitrogen-free extractive substances, %	0,64±0,05	0,31±0,06*
Calcium, %	0,38±0,07	0,80±0,04**
Phosphorus, %	0,29±0,02	0,47±0,05*
Iodine, µcg/kg	88,4±1,62	108,0±1,15***
Calorific value, kcal	170,88±0,86	171,46±0,66

*≥0,95; **≥0,99, ***≥0,999

organism of the fish was conducted a histological examination of the internal organs of the Lena` sturgeons. The results show that the use of biologically active additives "Abiopeptide with iodine" in the feeding of the Lena` sturgeons has no negative influence on the development of its internal organs. The significant differences in histological structure of the gills, heart, kidney, liver, spleen, esophagus, gall bladder, sections of the small intestine and colon samples of the control

and the experimental groups were not revealed.

Quality assessment of grown fish products was carried out at the end of scientific-production experiment (table. 5).

These results indicate the increased slaughter yield of a fish treated with the additive "Abiopeptide with iodine" in an amount of 200 µcg/kg of a fish weight. Output of edible parts was higher on 21.3 % in individuals in the experimental group, compared with the yield of edible parts of fish of

Table 7. The economic efficiency

Indicator	Group	
	Control	Experimental
Ichthyomass at the beginning, kg	39,30	38,86
Ichthyomass in the end, kg	93,86	102,42
Growth ichthyomass, kg	54,56	63,56
The cost of 1 kg of a fish seed material, the RUB.	850,00	850,00
The total cost of a fish seed material, thousands of RUB	33,41	33,03
Of feed fed per group, kg	85,15	89,78
The cost of feed with the additive, thousands of RUB	5,62	7,90
Sales price of 1 kg of fish in RUB.	680,00	680,00
Revenue from sales of fish, thousands of RUB	63,82	69,65
The cost of the fish, thousands of RUB	49,98	51,87
The cost of 1 kg of fish, RUB.	532,45	506,46
Profit from sales of fish, thousand RUB.	13,85	17,77
Profit from selling 1 kg of fish, RUB.	147,55	173,54
Additionally the profit, thousand RUB		3,93
Margin, %	27,71	34,27

the control group. The output of the non-edible parts in the experimental group was lower on 29.3% comparing with the similar values for the individuals of the control group.

A nutritional value of fish also depends on the chemical composition of muscle tissue of a fish. The chemical composition of muscle tissue of the Lena` sturgeons in the control and experimental groups was approximately the same (table. 6). Only the number of nitrogen-free extractive substances, calcium, phosphorus and iodine was significantly higher in muscles of sturgeons in the experimental group compared to those values in fish in the control group. Iodine in the muscle tissue of experimental individuals was on 22.1 % higher, compared with the control.

The effectiveness of the cultivation of the Lena` sturgeons was determined at the end of the experiments by the fish-biological and physiological-biochemical parameters. On the basis

of the obtained data was calculated the economic efficiency of the use of additives "Abiopeptide with iodine" in the feeding of the Lena` sturgeons (table. 7).

The total cost of cultivation of Lena` sturgeons in the experimental group was on 1.89 thousand rubles higher than in the control due to the adding of biologically active additives in the diet of the experimental groups, and due to the increasing of a feed fed cost and, therefore, a fish cost.

In the experimental group the fish grew more rapidly and their need in a feed was on 2.28 thousand RUB higher compared with the control individuals.

The largest increase in ichthyomass in the experimental group allowed making big profits from sales of fish compared to the control group. It allowed increasing the profitability of production in the experimental group by 6.56% to 34.27 %.

CONCLUSIONS

The results of these studies established a positive influence of biologically active additive “Abiopeptide with iodine” at the rate of 200 µcg per 1 kg of a fish weight used in the feeding of the Lena` sturgeons grown in cages to increase the overall growth of ichthyomass, improving the quality of fishery products due to substantial yield of edible parts and accumulation of iodine in the muscle tissue. The use of the additive in the feeding of the Lena` sturgeons reduces the cost of a feed per unit weight gain of fish, cost of fish products and achieves profitability 34.27 %.

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