

The effectiveness of using humic acids for feeding sturgeons in the conditions of a ras (Recirculation aquaculture system)

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ABSTRACT

The use of humic acids in combined feeds in the dosages of 1.0, 1.5, and 2.0 g per 1 kg of the feed has a positive effect on the productivity indicators of sturgeon rearing in a RAS (recirculation aquaculture system). The source of humic acids was the Reasil® Humic Health dry feed additive.

Key words: Humic acids, Combined feed, Feeding, Sturgeons, Ichthyomass, Growth, Feed conversion rate.

Introduction

The effectiveness of livestock development determines the economy and food security of the country. Insufficient provision of complete feeds, feed additives, and sources of biologically active substances for animals, poultry, and fish is a limiting factor for the future development of the industry as a whole. The use of imported therapeutic and prophylactic products increases the cost of livestock production and reduces its profitability. As a result, searching for domestic resources that can satisfy the needs of animal breeding in biologically active additives is of particular importance (Vasilyev *et al.*, 2018).

Until recently, the beneficial properties of humic acids and their salts (humates) have not been fully studied and scientifically proven, although their practical use has been evidence of the implicitly positive effect of humic substances on living organisms. They are used in ecology, for soil remediation

and restoration, in drilling operations, in construction, medicine, and in agriculture.

Preparations based on humic acids and their salts (humates) contain polysaccharides, peptides, amino acids, fulvic and hematomelanic acids, micro and macro elements (potassium, phosphorus), proteins, vitamins, and enzymes. Due to the form that is easily accessible for living organisms, humic substances can influence the metabolic processes in the cells, enhance immune and other vital properties, i.e., they are natural growth promoters and productivity stimulants.

As practice has shown, the nutritional value of the normal diet in combination with humic food supplements contributes to a significant increase in animal productivity (by 10 – 20 %) (The use of humates in livestock, 2018).

Humic acids can retain minerals (Bensassi, 2009) and microorganisms (*Bacillus subtilis*) (Elfarissi and Pefferkorn, 2000). Scientific works show that humic acids can bind heavy metals (Jansen van Rensburg

2006), deoxynivalenol (DON) and zearalenone (Madronová 2001).

Studies on the content of mycotoxins in the compound feed confirmed the high sorption capacity of humic acids for toxin T-2, ochratoxin A, aflatoxin B1, zearalenone, and fumonisin B1. With the maximum permissible concentration (MPC) of mycotoxins in the combined feeds, when the adsorbent was in excess, the sorption capacity for toxin T-2 was 84.0%, for aflatoxin B1–100.0%, for zearalenone–100.0%, for ochratoxin–97.7% and for fumonisin–100.0%. With that, rather low desorption of mycotoxins (from 0 to 8 %) was noted for certain types of toxins produced by microscopic fungi. With the initial concentration of the studied mycotoxins that exceeded the MPC, and upon the introduction of humates in the amount of the minimum feeding norm (2.0 g per kg of the feed), it was found that they were capable of adsorbing 19.0 – 72.4 % of artificially incubated mycotoxins (Vasiliev *et al.*, 2018).

The effect of humic acid in the dosages of 50 – 90 mg/L reduces fish morbidity and mortality. The use of food additives with various content of humic ac-

ids in rearing common carp (*Cyprinu scarpio*) stimulates the fish weight gain, reduces mortality, increases the level of nonspecific resistance, and induces protection against infestation (Udintsev and Zhilyakova, 2004).

Materials and Methods

At the Technology of Fish Rearing and Feeding Scientific Research Laboratory of the Department of Feeding, Zoohygiene, and Aquaculture at the FSBEI HESaratov State Agricultural University, research was made aiming at studying the effect of humic acids in the feed mixture on the effectiveness of sturgeon rearing in a RAS. The source of humic acids was Reasil® Humic Health, the dry feed additive made by Life Force LLC based on unmodified microporous humic acids made of Leonardite with the content of humic acid exceeding 80.0 % of the dry matter.

In 2018 – 2019, the authors studied the effect of the Reasil®Humic Health drug on the growth, development, and marketable quality of sturgeons

Table 1. Scheme of the experiment

Group of fish, pcs	The composition of the diet
I reference	Complete feed (MD)
II experimental	MD + Reasil®Humic Health at the rate of 1.0 g per kg of the feed
III experimental	MD + Reasil®Humic Health at the rate of 1.5 g per kg of the feed
IV experimental	MD + Reasil®Humic Health at the rate of 2.0 g per kg of the feed

Table 2. The sturgeons weight dynamics, g

The period of the experiment, week	Group			
	Reference I	Experimental II	Experimental III	Experimental IV
Start of the experiment	50.80 ± 0.48	51.10 ± 0.88	50.30 ± 0.43	51.40 ± 0.59
1	76.00 ± 2.40	86.50 ± 7.84	85.10 ± 2.33	85.20 ± 1.21*
2	89.30 ± 2.66	97.20 ± 0.51*	93.60 ± 2.77	96.70 ± 1.18
3	105.50 ± 1.36	115.30 ± 2.06*	112.20 ± 1.17*	114.70 ± 1.22**
4	122.70 ± 3.69	133.10 ± 1.78	130.60 ± 1.02	132.00 ± 1.88
5	142.20 ± 2.16	159.00 ± 3.60*	156.40 ± 2.45*	157.80 ± 2.20**
6	163.40 ± 2.06	177.00 ± 2.08**	173.90 ± 2.05*	175.60 ± 2.21*
7	185.10 ± 3.15	198.40 ± 3.58*	193.50 ± 2.82	196.80 ± 1.90*
8	207.00 ± 1.73	232.20 ± 1.04***	229.00 ± 2.86**	231.90 ± 22.80
9	237.10 ± 1.73	254.40 ± 1.51**	251.60 ± 3.49*	253.90 ± 3.35*
10	255.50 ± 1.00	282.20 ± 2.83***	277.30 ± 3.28**	279.60 ± 2.40***
11	279.50 ± 4.02	307.00 ± 1.73**	298.70 ± 3.23*	304.50 ± 2.44**
12	302.60 ± 1.70	334.40 ± 3.21***	323.20 ± 1.96**	324.10 ± 2.31**
Weight gain over the entire period	251.80	283.30	272.90	272.70

Note: * $P \geq 0.95$; ** $P \geq 0.99$; *** $P \geq 0.99$

grown in a recirculation aquaculture system, following the general scheme of the studies shown in Table 1.

To increase the content of humic acids in the feed for the fish in the experimental groups, Reasil® Humic Health was added at the rate of 1.0 g per kg of the feed for experimental group II, 1.5 g – for experimental group III, and 2.0 g – for experimental group IV.

The groups had been formed by the method of analogs: group I was the reference group with 151 specimens, experimental group II included 152 specimens, experimental group III included 152 specimens, and experimental group IV included 151 specimens.

Results and Discussion

Some of the main indicators of the effect of complete feed on fish growth and development are the dynamics of fish weight and its accompanying indicators: the ichthyomass, the absolute and relative weight gain, and feed requirements for 1 kg of weight gain. They show the objective results of using additives in the diet of the fish during the experiment.

During the scientific and production experiment, it was found that in the reference group that did not receive Reasil® Humic Health, growth lag was noted, and the use of the drug for feeding the fish at the concentration of 1.0 g per kg of the feed yielded the best results, compared to other dosages used.

The data about the dynamics of weight gain in

Table 2 show that throughout the experiment, the best results were obtained in experimental group II, where the dosage was 1.0 g.

During the scientific and production experiment, the following data were obtained about the ichthyomass: in experimental group II, at the beginning of the experiment, it was 7.77 kg, and at the end – 50.84 kg; in group III, at the beginning of the experiment, it was 7.65 kg, and at the end – 49.13 kg; in experimental group IV, at the beginning of the experiment, it was 7.76 kg, and at the end of the experiment – 48.94 kg. In these groups, the fish gained weight faster than in the reference group, in which these indicators were 7.67 kg at the beginning of the experiment, and at the end of the experiment – 45.69 kg. In the reference group, retarded growth was noted.

During the experiment, the preservation rate in all groups was 100 %. This can be explained by the fact that fish keeping and growing conditions were at the optimal level, and the fish themselves were well developed and had strong immunity. Besides, feeding the Reasil® Humic Health drug at the rate of 1.0 – 2.0 g per kg of the feed increased fish productivity, compared to the reference group. For instance, the best absolute weight gain was noted in experimental group I; over the entire experiment, it was 283.3 g, while in the reference group it was the lowest, and amounted to 251.8 g. In experimental groups III and IV, this value was 272.9 g and 272.7 g, respectively.

In experimental group II, the relative weight gain by the sturgeons during the period of the studies

Table 3. Feed consumption per kg of the weight gain, kg

The period of the experiment, week	Group			
	Reference I	Experimental II	Experimental III	Experimental IV
1	0.40	0.32	0.33	0.34
2	0.89	1.21	1.46	1.12
3	0.87	0.85	0.80	0.85
4	0.95	0.99	0.94	1.01
5	0.97	0.82	0.81	0.81
6	1.03	1.31	1.32	0.90
7	1.13	1.23	1.31	1.23
8	1.26	0.91	0.86	0.88
9	1.05	1.52	1.48	1.53
10	1.75	1.28	1.36	1.37
11	1.47	1.56	1.76	1.54
12	1.65	1.53	1.66	2.08
Average for the experiment	1.12	1.09	1.11	1.10

Table 4. Cost-effectiveness

Indicator	Group			
	Reference I	Experimental II	Experimental III	Experimental IV
The cost of all stocking material, rubles	10,117.00	10,184.00	10,184.00	10,117.00
The cost of 1 kg of the combined feed, rubles	150.00	150.00	150.00	150.00
The combined feed used for the group, kg	42.61	47.07	46.05	45.18
The cost of combined feed, rubles	6,391.86	7,059.92	6,907.20	6,776.65
The cost of 1 g of the additive, rubles	-	0.35	0.35	0.35
Additive used for feeding, g	-	47.07	69.07	90.36
The cost of the additive used for feeding, rubles	-	16.47	24.18	31.62
The cost of the combined feed with the additive, rubles	6,391.86	7,076.39	6,931.37	6,808.27
Feed requirements for 1 kg of weight gain, kg	1.12	1.09	1.11	1.10
The sales price of 1 kg of fish, rubles	700.00	700.00	700.00	700.00
Revenue from fish sales, rubles	31,984.82	35,588.22	34,391.25	34,257.31
Fish cost, rubles	20,821.86	21,556.92	21,404.20	21,206.65
Cost of 1 kg of fish, rubles	455.69	424.01	435.66	433.33
Profit from the fish sales, rubles	11,162.96	14,031.30	12,987.05	13,050.66
Additional profit from sales, rubles	-	2,868.34	1,824.10	1,887.70
Profitability, %	53.61	65.09	60.68	61.54

was also higher, compared to other groups, and amounted to 84.72%. The relative weight gain in the reference group amounted to 83.21%, in experimental group III–84.44%, and in experimental group IV, it was 84.14%.

The feed cost per 1 kg of the fish weight gain in experimental groups II and IV was lower and amounted to 1.09 kg and 1.10 kg, respectively, compared to the reference group and experimental group III, where these values were 1.12 kg and 1.11 kg of the combined feed, respectively (Table 3).

The calculation of the cost-effectiveness in Table 4 shows the positive effect of the Reasil® Humic Health feed additive on profitability. For instance, it was higher in experimental group II, compared to the other three groups, and amounted to 65.09%. In experimental group III, it amounted to 60.68%, and in group IV—to 61.54%.

Based on the obtained results, the authors have concluded that the presence of additional humic acids in the diet at the above dosages of the Reasil® Humic Health drug yields better ichthyomass weight gain rate, compared to the reference, and the drug itself can be successfully used for feeding fish in the industrial conditions.

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