Influence of food additives from fish milt roe and glycerin on productivity parameters of sturgeon fish

Denis A. Yurin[*1], *Ekaterina* A. Maksim[1,2], *Aleksandra* A. Danilova[1], *Anna* N. Gneush[2], and *Flora* G. Nikoghosyan[2,3]

[1]Krasnodar Research Centre for Animal Husbandry and Veterinary Medicine, 350055 Krasnodar, Russian Federation
[2]Kuban State Agrarian University named after I. T. Trubilin, 350044 Krasnodar, Russian Federation
[3]MODUS GRANUM Ltd, 0624 Republic of Armenia

Abstract. The effect of a new feed additive "GLINMOL" in the form of emulsion on productivity of sturgeons was studied. The aim of the research was to study the effect of newly developed feed additives based on fish milt roe and glycerin on sturgeon fish productivity. The experiment consisted of two parts; groups of fish of 3-4 and 4 maturity stages were formed. The first group (control) received complete mixed feed without additives, the second - 2.0% of glycerin of total feed weight; the third - feed additive "GLINMOL" at a dose of 2.0% of total feed weight. The largest gross increase of live weight for the entire rearing period was noted when "GLINMOL" feed additive was used - 11.9% ($P<0.01$) higher than the control parameter. Glycerin application in the second group also exceeded the control value of live weight increase by 8.1% ($P<0.05$). The final body length of sturgeons in the second experimental group was almost equal to the control. In the third group, this parameter significantly exceeded the control by 0.5% ($P<0.05$). The values of the fatness coefficient did not differ significantly among the groups and were in the range of 1.11-1.13.

1 Introduction

In recent decades, the importance of the global aquaculture industry has increased. Fish consumption has increased worldwide due to the high health benefits of fish products, mainly due to the high content of polyunsaturated fatty acids [1].

The fish industry, in addition to food for the population, produces by-products that are considered a good source of protein and fat. These by-products make up about 60% of the total weight of fish after industrial processing [2]. A significant amount of residue is not used for human consumption, resulting in waste, and the processing and use of this material can contribute to food supply security by providing low-cost protein with high biological value. Non-use of waste represents a loss for the fishing industry, and inadequate management of waste increases the impact on the environment [3-5].

* Corresponding author: 4806144@mail.ru

A wide range of high-quality compounds can be extracted from the by-products obtained from fish processing. Among these compounds, proteins, amino acids, fats, enzymes have a large added value, since their study is of great interest to increase the value of fish waste. Fish by-products are mainly obtained from cutting and waste of industrially processed fish [6].

Fish by-products are mainly used for oil production and animal feed production [7]. As it is known, fish is a rich source of long-chain ω-3, they can also be found in other by-products such as skin, head, male gonads and others [8].

An important factor in feeding fish is a balanced diet, enriched with all the necessary nutrients for normal life and active weight gain. A sufficient amount of fats in the diet is especially important, as they perform an energy function [9].

One of the most common applications of fish waste is the production of feed for animals or other fish. Fish waste is a source of minerals and fat (19% dry matter), as well as monounsaturated palmitic and oleic acids. Gonads (milt) of male fish, as a rule, are not used for food purposes and are often utilized during fish processing [10, 11].

Male gonad lipids (milt) are highly bioavailable. All fish gonads, regardless of species, are capable of emulsifying fat; therefore, it is technologically possible to obtain emulsions from them.

Emulsion is a finely dispersed system consisting of fat and water fractions, as well as other components (proteins, fats, carbohydrates, biologically active substances). Fish gonads can act as a natural emulsifier, and together with glycerol, which also acts as an emulsifier, it is possible to obtain a more stable emulsion [10].

Glycerol is also used in animal husbandry as an additional source of energy. Especially its use is widespread in feeding highly productive cows in the first phase of lactation to compensate for the lack of energy, normalize metabolic processes, increase productivity, and extend the terms of economic use [12].

Glycerol in fish farming has been used as part of a coniferous energy supplement (CES). According to the results of the study, there was a trend towards an increase in the live weight of fish by 5.0% [13, 14].

Thus, there are very few studies on the use of male gonads together with glycerol in feeding sturgeons, and therefore it is necessary to continue research on this topic.

The purpose of the work is to study the effect of a newly developed feed additive based on milt and glycerol on the productivity of sturgeon fish.

In order to achieve this goal, it was necessary to solve the following tasks:

1) determine the gain in live weight of fish when using the developed feed additive;
2) determine the coefficient of fatness according to Fulton;
3) set the length of the fish body.

2 Material and methods

The object of this research is a replacement stock of sturgeons (Bester). The experiment was carried out on the replacement herd of Bester in the conditions of the fish farm of BISKO LLC, Bryukhovetsky District, Krasnodar Territory. The conditions of keeping corresponded to fish-breeding standards.

The duration of the experiment was 8 months. The fish were kept in temperature-controlled pools according to the scheme of the experiment presented in Table 1.

Table 1. Experiment design on the use of reproduction food on sturgeons (n=100).

Groups	Feeding conditions
1 group (control)	CF (complete feed)
2 group	98 % CF + glycerol 2.0% by weight of the feed
3 group	98 % CF + «GLINMOL» 2.0% by weight of the feed 2

From table 1 it follows that the first group was the control and received CF (complete feed) without additives. The second group of the experiment received 98% PC and glycerol 2.0% by weight of the feed. The third group of the experiment received 98% PC and a new developed feed additive of GLINMOL 2.0% by weight of the feed.

Feed additive of GLINMOL is a joint development of employees of the Krasnodar Research Centre for Animal Husbandry and Veterinary Medicine and Kuban State Agrarian University and is an emulsion of pond fish milt in a ratio of 50 to 50% glycerol. The colour of the emulsion is creamy with a characteristic fishy smell.

First, studies were carried out on the groups of fish of 3rd-4th, and then 4th stage of maturity (Table 2).

Table 2. Stages of the experiments.

Type of fish	Stage of maturity	Number of fish	Age, years
Sturgeons (hybrids)	3-4	30	4-5
	4	25	5-7
	4	25	3

In all groups, food for sturgeons produced by BISKO (Bryukhovetskaya village) was used. The nutritional value of feed is presented in table 3.

Live weight gain control was carried out by individual weighing on electronic scales. During the statistical processing of experimental data, standard biometric methods according to N.A. Plokhinsky (1969).

The fatness coefficient according to Fulton was determined as the ratio of fish weight to body length (cm).

Table 3. Nutrient indicators of complete compound feed (CCF) for sturgeons.

Nutrient indicators	Value
Protein	48.0 %
Crude fat	10.0 %
Crude fiber	2.5 %
Lysine	3.0 %
Phosphorus	1.6 %
Methionine + Cystine	1.5 %
Pellet diameter, mm	1.0-3.0 mm
Feed conversion:	1.0-1.2

3 Research results

As a result of the study, the main fish-breeding and biological indicators of the replacement stock of sturgeons of 3-4 stages of maturity were determined (Table 4).

Table 4. Live weight of sturgeons (3-4 stages of maturity) and fatness coefficients according to Fulton.

Indicator	Initial weight, g	Final weight, g	Gross weight gain, g	Average daily gain, g	Final body length, cm	Coefficient of fatness according to Fulton
Group 1	4927±73	5368±42	441±18	1.84±0.09	78.0±2.1	1.13±0.02
Group 2	4931±64	5411±35*	480±21*	2,00±0,11*	78.1±3.2	1.14±0.01
Group 3	4952±46	5455±54*	499±19*	2,08±0,1*	78.8±3.8	1.11±0.01

Note: * - differences with group 1 at P<0.05

The inclusion of milt and glycerol in the CF of the experimental groups had a positive effect on the final live weight of sturgeons. The addition of 2.0% glycerol to the CF of the second group contributed to an increase in fish gross weight gain by 8.8% (P<0.05). When feeding "GLINMOL", an increase in this indicator by 13.2% (P<0.001) relative to the control was also noted.

The average daily weight gain of sturgeons in the second group of the experiment was higher than the control by 8.6% (P<0.05), in the third - by 13.0% (P<0.01).

The body length of the fish in the control group was 78 cm; there were no significant differences in the experimental groups.

Based on the data obtained, the fatness coefficient according to Fulton was calculated. The highest coefficient of fatness was noted in the second group and amounted to 1.14. In the first group, the coefficient was equal to 1.13. The lowest coefficient was in group 3 - 1.11.

The main fish-breeding and biological indicators of the replacement stock (4^{th} stage of maturity) are presented in Table 5.

Table 5. The main fish-breeding and biological indicators of the replacement stock (4 stage of maturity).

Indicator	Initial weight, g	Final weight, g	Gross weight gain, g	Average daily gain, g	Final body length, cm	Coefficient of fatness according to Fulton
Group 1	6952±91	7087±78	135±9	0.56±0.2	84.8±2.6	1.16±0.03
Group 2	6910±107	7055±86	146±7*	0.61±0.02*	84.6±2.8	1.17±0.04
Group 3	6923±94	7074±99	151±8*	0.63±0.03*	85.2±3.0*	1.14±0.04

Note: * - differences with group 1 at P<0.05

The highest gross weight gain for the entire period of growing was with the use of the GLINMOL supplement and significantly exceeded the control by 11.9% (P<0.01). In the second group, when using glycerol, this indicator also exceeded the control value by 8.1% (P<0.05).

With the inclusion of 2.0% glycerol in the CF in the second group, the average daily gain was 0.61 g, which exceeded the control value by 8.9% (P<0.05). The addition of the GLINMOL feed agent 2.0% by weight of the feed contributed to an increase in this indicator by 12.5% (P<0.01) relative to the control.

The final body length of sturgeons in the second experimental group was almost identical to the control. In the third group, this indicator significantly exceeded the control by 0.5% (P<0.05).

The values of the fatness coefficient were approximately at the same level in the groups, but the highest indicator was in the second group (1.17).

4 Discussion

Glycerol in the composition of feed energy supplements in the diet of sturgeons was previously used as a carrier and additional source of energy and had a positive effect on the live weight gain of fish [1, 2]. The gain in live weight of bester when using glycerol can be explained by its energy function. Based on the fact that long-chain polyunsaturated fatty acids are recognized as physiologically valuable for the normal course of fish life processes [4], the best gains in live weight of bester when using GLINMOL feed emulsion in the experiment can be explained by the fact that the combination of glycerol and pond fish milt provide additional energy and the intake of essential fatty acids for the development of the body.

5 Conclusion

Based on the results of the experiment, it can be concluded that the newly developed feed agent of GLINMOL and glycerol have a positive effect on the productivity of the bester replacement stock of 3-4 and 4 stages of maturity.

The increase in live weight for the entire period of growing was with the use of the GLINMOL supplement and significantly exceeded the control by 11.9-13.2% ($P<0.01$). In the second group, when using glycerol, this indicator also exceeded the control value by 8.1-8.8% ($P<0.05$).

With the inclusion of 2.0% glycerol in the CF in the second group, the average daily gain was 0.61 g, which exceeded the control value by 8.6-8.9% ($P<0.05$). The addition of the GLINMOL feed agent 2.0% by weight of the feed contributed to an increase in this indicator by 12.5-13.0% ($P<0.01$) relative to the control.

The values of the fatness coefficient were approximately at the same level in the groups (1.11-1.17).

The final body length of sturgeons in the experimental groups was almost identical to the control at 3-4 stages of maturity. At stage 4 of maturity in the second group of the experiment, this indicator was approximately equal to the control one, and in the third group it significantly exceeded the control by 0.5% ($P<0.05$).

References

1. F. Shahidi, P. Ambigaipalan, *Omega-3 polyunsaturated fatty acids and their health benefits,* Annual Review of Food Science and Technology, v. **9**, pp. 345-381 (2018)
2. P. Ideia, J. Pinto, R. Ferreira, L. Figueiredo, V. Spínola, P. C. Castilho *Fish processing industry residues: a review of valuable products extraction and characterization methods*, Waste Biomass Valoriz, pp. 1-24 (2019)
3. V.K.R. Surasani, A. Singh, A. Gupta, S. Sharma Functionality and cooking characteristics of pasta supplemented with protein isolates from Pangas processing waste, LWT – Food Science and Technology, v. **111**, pp. 443-448 (2019)
4. V.K.R. Surasani, C.V. Raju, U. Shafiq, M.V. Chandra, I. P. Lakshmisha, Influence of protein isolates from Pangas processing waste on physico-chemical, textural, rheological and sensory quality characteristics of fish sausages, LWT – Food Science and Technology. v. **117**, P. 108662 (2020)
5. J. Zamora-Sillero, A. Gharsallaoui, C. Mar, Peptides from fish by-product protein hydrolysates and its functional properties: an overview, Biotechnol, v. **20**, pp. 118-130 (2018)

6. J. Vázquez, A. Meduíña, A. Durán, M. Nogueira, A. Fernández-Compás, R. Pérez-Martín, I. Rodríguez-Amado, J. A. Vázquez, A. Meduíña, A. I. Durán [et al.], *Production of valuable compounds and bioactive metabolites from by-products of fish discards using chemical processing, enzymatic hydrolysis, and bacterial fermentation*, Mar Drugs, v. **17**, P. 139 (2019)
7. V. Kumar, A. U. Muzaddadi, S. Mann, R. Balakrishnan, K. Bembem, Y. Kalnar, *Utilization of fish processing waste: a waste to wealth approach,* Emerging Post-Harvest Engineering and Technological Interventions for Enhancing Farmer's Income: compend ICAR Summer School, v. **04**, pp. 127-131 (2018)
8. O.N. Mahutova, M.I. Gladyshev *Essential polyunsaturated fatty acids in the physiology and metabolism of fish and humans: significance, needs, sources*, Russian Journal of Physiology named after V.I. Sechenov, v. **106 (5)**, pp. 601-621 (2020)
9. V.V. Mungin, E. A. Aryukova, N. I. Gibalkina, *Influence of raw fat in production compound feeds on the productivity and slaughter qualities of marketable carp*, Agrarnyj nauchnyj zhurnal, v. **3**, pp. 25-27 (2018)
10. N.V. Dement'eva *Emulsified food products based on fish milt*, Innovations in the technology of healthy food products: IV All-Russian Scientific Conference: a collection of scientific papers, Kaliningrad: Kaliningrad State Technical University, pp. 110-116 (2017)
11. T.I. Oborina *The use of a coniferous energy supplement in feeding dairy cows*, Youth Science 2021: technologies, innovations: materials of the All-Russian scientific and practical conference of young scientists, graduate students and students dedicated to the Year of Science and Technology in the Russian Federation, Perm, pp. 116-119 (2021)
12. W.Y. Mo, Y.B. Man, M.H. Wong *Use of food waste, fish waste and food processing waste for China's aquaculture industry: needs and challenge*, Sci Total Environ, v. **613**, pp. 635-643 (2018)
13. A.A. Danilova, N.A. YUrina *The use of safe feed in aquaculture*, Aquatic bioresources and aquaculture of the South of Russia: materials of the All-Russian scientific-practical conference of students, graduate students and young scientists, Krasnodar: Kuban State University, pp. 31-33 (2020)
14. A.A. Danilova, V.A. Ovsep'yan, N.A. YUrina, D.V. Osepchuk, V.P. Korotkij, V.A. Ryzhov *Feed additive with phytogenic properties in poultry farming*, Collection of scientific papers of the Krasnodar Scientific Centre for Animal Science and Veterinary Medicine, v. **10 (2)**, pp. 10-13 (2021)