Study of the use of biologically active additives in the cultivation of amber trout

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Abstract. The object of the research was amber trout. The growth, development of fish, and the morphological composition of fish were studied. Gross weight gain of trout when fed with additives containing glycerin and milt increased by 12.7 - 18.2%. The condition factor of trout in the control was 1.74. In the groups receiving feed additives, the coefficient of fatness exceeded that of the control group; in group 2, the difference was significant and amounted to 5.2%. There was a decrease in the feed ratio when using feed additives by 0.7 - 4.0%, compared to the control. The weight of the gutted carcass in all groups ranges from 77.6 to 79.7%. No pathologies were found in the internal organs of fish in all groups. In the experimental groups, bone tissue mass was greater than in the control group, in groups 2 and 3 at $P<0.05$, in groups 4 at $P<0.01$. The weight of muscle tissue in all experimental groups exceeded the control, in groups 2, 3 and 4 with significant differences at $P<0.05$.

1 Introduction

Fish farming, like all livestock farming, depends on feed that is formulated to meet the nutritional requirements of the animals. Ingredients for large-scale feed production are available on the market, but the availability and price of various feed ingredients and feed additives vary depending on each other.

Consumer expectations and climate change can influence ingredient selection over time, while sanctions and annual changes in weather patterns can lead to rapid changes in the availability and price of feed ingredients [1-3].

The development of rainbow trout depends on high-quality feeds that are high in digestible protein, fat, and energy, and therefore dependent on high-quality feed ingredients that are high in nutrient and energy density. Assessing and further improving the use of feed resources depends on detailed knowledge of the feed ingredients used and the fish produced.

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Trout production volumes are currently relatively small, but the search for feed ingredients is still a necessary condition for increasing the sustainability of production [4-6].

Trout is a cold-water aquaculture fish species that accounts for about 2% of global aquaculture production. Trout farming is usually practiced in flow-through systems and is gradually increasing in various regions of Russia. The development of trout farming methods depends on technological advances and good quality feed.

Trout farming is a complex enterprise that provides nutritious food, economics, exports, employment and tourism. Optimization of feeding is essential, in addition to obtaining nutritious and inexpensive feeds, to maximize growth and productivity with minimal feed wastage to make trout farming profitable and environmentally friendly [7-9].

Of the total amount of phosphorus and nitrogen supplied to the trout diet, about 30% will be absorbed in the cultivated biomass, and the rest enters the receiving reservoir with wastewater. The main source of protein in trout feeding is usually fishmeal, which accounts for the largest expense in trout farming, accounting for about 80% of the total costs associated with rearing cycles. Thus, optimizing feeding practices using feed amounts at different stocking densities will be key for sustainable trout farming, avoiding environmental problems by preventing eutrophication and allowing trout producers to maximize profits [3, 10, 11].

The limited availability of traditional feed resources means that future aquaculture feed formulations require ingredients from a variety of sources. Consequently, new raw materials such as by-products from the agro-industrial and livestock industries are being tested for inclusion in aquaculture feeds. Historically, raw materials have been included in feeds based on their nutritional properties, availability and price.

Caviar is a valuable food product obtained from different types of fish.

Although the eggs of different fish have different sizes, their composition and morphology differ little. Unprocessed fish roe on average contains 72–74% water, 18–20% protein, 3–6% fat and 1–2% minerals.

Unsaturated fatty acids in feed are relatively unstable. Double bonds are easily oxidized in the presence of oxygen and light. As a result, fatty acids are decomposed into fragments, which are precursors of aromatic compounds.

The quality requirements for food caviar and fish eggs for producing offspring are much higher than for commercial fish, and therefore it is especially important to obtain environmentally safe, high-quality products. Currently, caviar production in our country is carried out mainly through fish breeding, and it is not the main product, but a by-product. The percentage of imports of commercial black caviar is still high.

The energy value of fish milt is on average 143 kcal.

The central problem in the nutrition of production herds is the elimination of the degeneration of gonads into fat and the focus on reproduction [2, 4].

The purpose of the research is to study the effect of newly developed feed additives containing fish milt and glycerol on the productivity of salmon fish.

To achieve the goal, the following tasks were solved: feed salmon fish with different proportions of milt and glycerol; study the growth, development and morphological composition of the body of fish.

2 Material and methods

The object of the research was amber trout. All fish were under the same conditions.

In all groups, complete feed for trout produced by BISKO LLC (Bryukhovetskaya village) was used to feed the fish.

Fish in 2-5 experimental groups received an emulsion of milk with glycerol.

The experiment on breeding salmon was carried out in the conditions of the farm of Azhogin Alexander Anatolyevich, Rostov region, Shakhty, in closed water supply installations.

Groups were formed according to the scheme for determining gonad maturity according to Kiselevich. The experiment lasted 6 months.

The growth and development of fish, the morphological composition of fish, absolute and relative fertility, and the timing of ripening of eggs were studied in a comparative aspect.

Groups of trout were formed at the 4th stage of maturity at the age of 3 years. The number of fish in the group is 25.

Amber trout were placed in temperature-controlled tanks and reared according to the experimental design (Table 1).

Table 1. Design of the experiment on salmon (amber trout).

Groups	Feeding conditions
1 control	CF (complete feed)
2 experiment	98 % CF + glycerol 2.0% by weight of feed
3 experiment	98 % CF + milt with glycerol 50 by 50% in an amount of 2.0% by weight of feed
4 experiment	98 % CF + milt with glycerol 70 by 30% in an amount of 2.0% by weight of feed
5 experiment	98 %CF + milt with glycerol 80 by 20 % in an amount of 2.0% by weight of feed

An analysis of the data obtained on breeding fish was carried out and, on its basis, new elements of the technology for the production of food caviar were created when additives based on glycerol and milt were included in the diet.

3 Results and discussion

Live weight, weight gain and Fulton body condition factor of trout at the 4th stage of maturity are presented in Table 2.

Table 2. Live weight and body condition factor of trout according to Fulton.

Parameter	Group				
	Group 1	Group 2	Group 3	Group 4	Group 5
Initial weight, g	842±19	846±11	839±13	840±17	844±20
Final weight, g	1023±23	1060±19**	1051±18**	1047±21*	1048±19*
Gross weight gain, g	181±8	214±11**	212±8**	207±7*	204±9*
Average daily weight gain, g	1.01±0.05	1.19±0.07**	1.18±0.06**	1.15±0.04*	1.13±0.05*
Final body length, cm	38.9±0.12	38.7±0.8	39±0.07	39.1±0.09	38.8±0.10
Fulton Body Condition factor	1.74±0.03	1.83±0.04*	1.77±0.06	1.75±0.05	1.79±0.06

Note: * - differences with group 1 at $P<0.05$, ** - differences with group 1 at $P<0.01$

The gross weight gain in the control group was 181 g. In the 2nd experimental group, the gross weight gain exceeded the control by 18.2% at $P<0.01$. In group 3, the excess over control was 17.1% at $P<0.01$. In group 4, the gross weight gain was greater than the control by 14.4% at P<0.05. In group 5, the gross weight gain was 12.7% greater than the control at P<0.05.

The body condition factor of trout in the control was 1.74. In the groups receiving feed additives, the body condition factor exceeded that of the control group; in group 2 the difference was significant and amounted to 5.2%.

Trout feed costs per head are presented in Table 3.

Table 3. Trout feed costs per 1 head.

Group	Feed consumed, g	Feeding ratio	% to control
Group 1	273±6	1.51±0.03	-
Group 2	310±8*	1.45±0.02	96.03
Group 3	310±7*	1.46±0.02	96.69
Group 4	306±7*	1.48±0.03	98.01
Group 5	304±8*	1.49±0.02	98.68

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

At stage 4 of maturity, trout experienced a significant increase in feed consumption in the groups receiving the feed additive. In the control group, feed consumption was 0.273 kg. In the experimental groups, feed costs were higher than in the control by 11.3 - 13.5% at P <0.05. But, at the same time, there was a decrease in the feed ratio when using feed additives by 0.7 - 4.0%, compared to the control due to greater weight gain.

According to the results of morphometric analysis of trout, it was found that the weight of the gutted carcass in all groups ranges from 77.6 to 79.7%.

The weight of the gutted carcass in the control group was 437.6 g. In the second, third and fourth experimental groups, this indicator significantly exceeded the control (P<0.05). In the fifth group, the weight of gutted fish tended to be higher than in the control.

The weight of the head and fins in groups 2 and 3 exceeded the control indicators with a high degree of significance (P<0.01), in group 4 - at P<0.05. In group 5 there was a tendency to reduce the weight of the head and fins compared to the control.

No pathologies were found in the internal organs of fish in all groups.

There were no significant differences between the groups in skin weight. In the experimental groups, bone tissue mass was greater than in the control group, in groups 2 and 3 - at (P<0.05), in 4 - at P<0.01.

The weight of muscle tissue in all experimental groups exceeded the control, in groups 2, 3 and 4 with significant differences at P <0.05.

As a result of the research, new knowledge was obtained for the first time about the effect of feed containing glycerol and fish milt on the productivity of salmon fish.

Data on the development and rate of maturation of female reproductive products were obtained and presented.

The absolute and working fertility of trout at the 4th stage of maturity is presented in Table 4.

Table 4. Absolute and relative fertility of trout

Group	Absolute fertility, thousand pcs.	Relative fertility, thousand pcs. / kg body weight
Group 1	3.12±0.03	3.05±0.06
Group 2	3.10±0.06	2.92±0.07

Group 3	3.17±0.07	3.02±0.05
Group 4	3.21±0.04*	3.07±0.03
Group 5	3.26±0.05*	3.11±0.04

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

Based on the data obtained on absolute fertility, it can be noted that in the second group this indicator was lower by 0.02 thousand pieces, or 0.6%, than in the first group. In the third group, there was a positive trend towards an increase in fertility by 1.6%, compared to the control. In the fourth and fifth groups, there was a significant increase in this indicator by 2.8% ($P<0.05$) and 4.5% ($P<0.05$) relative to the first group.

4 Conclusion

The inclusion of milt and glycerol in the diet of amber trout had a positive effect on the weight gain rates of trout. Gross weight gain of trout when fed with additives containing glycerol and milt increased by 12.7 - 18.2%.

In the groups receiving feed additives, the body condition factor exceeded that of the control group.

The absolute fertility of amber trout when receiving 70 and 80% additives was significantly higher by 2.8% ($P<0.05$) and 4.5% ($P<0.05$) compared to the control.

The research results can be applied in various fish farming areas.

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