ISSN 0975-2366
https://doi.org/10.31838/ijpr/2018.10.04.029

Research Article

Changesof Weight Indicatorsin Sturgeon Fish When Using Combined Feedswith Various Proteinand Fat Contentsin Closed Water Supply Installations

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Received: 18.08.18, Revised: 05.09.18, Accepted: 25.10.18

ABSTRACT
The purpose of the research is to summarize the results of observations, conducted at in production and laboratory conditions on the basis of operating closed water supply installation, on changes in size-weight characteristics, viability indicators when using combined feeds with different content of crude protein and raw fat, as well as hydrochemical and water temperature rate. The research was carried out under the conditions of the operating production unit of closed water supply installation (Saudi Arabia, Dammam) and the experimental small-size module of the closed water supply installation based on the business incubator (Krasnodar). Two age groups of the backcross of Russian sturgeon with Siberian sturgeon and sterlet were used in the experiments. The use of combined feeds with a lower fat content in conditions of closed water supply installations helps significantly reduce the risk of excessive accumulation of fat in the fish body while maintaining, at an acceptable level, the physiological adequacy and fish-breeding qualities of the object. The reduction of the energy value of the used combined feed can be provided due to a certain reduction in the total content of the most energy-intensive components.

Keywords: sturgeon (Acipenseridae), closed water supply installation, weight gain, rate of available feed utilization.

INTRODUCTION
According to V.G. Krymov[1], it is necessary to analyze the current state and prospects for the further development of industrial aquaculture of commercial-valuable species of hydrobionts (in particular, sturgeon and their hybrid forms) on the basis of closed water supply installations. The above is particularly relevant for domestic aquaculture. In the light of possible solutions of the problem of the integrated optimization of industrial aquaculture for commercial-valuable species of hydrobionts on the basis of closed water supply installations, among other things, a special place still occupies a whole range of issues, related to the development and organization of adapted and optimal for appropriate conditions of keeping, compositions and affordable recipes, and feeding schedules of the object[2].According to V.A. Amineva[3], in order to maintain a positive balance of nutrients and energy during the feeding of hydrobionts, along with energy costs for digesting and availability of essential nutrients, as well as for the synthesis of nutrients in the body, it is also necessary to take into account the level of the motion activity of the object in specific conditions of keeping, which is in accordance with the available information on this issue. The level of motion activity is associated with a whole complex of behavioral responses of the object under specific conditions of keeping and, in many respects, is determined by the stability of the latter. First of all, we are talking about the motion activity associated with the search behavior of the object: feeding behavior[4].Negative direct or indirect, short-term or long-term impact on the object of one or several deviating from the standard factors of keeping conditions, with other optimal conditions, including physiological adequacy of the object, assumes in the latter an adaptive activation of search behavior, related to the search for more comfortable zones or search for food, and, as a consequence, a temporary increase in motion activity, the duration of which depends on the size of the reservoir or the pool, food availability and the degree of its correspondence with the food requirement of the object in the circumstances, character, degree and duration of extreme exposure to factors.The foregoing gives grounds for assuming the possibility of energy cost increase for muscle work, with a parallel shift in the balance of a nutrient and energy and changing food requirements of the object. Thus, a stable and prolonged extreme (negative) impact on the object of the external environmental factor, even with a slight deviation from the optimal values and without correction of feeding in accordance with changes in the nutritional requirements of the object, may lead to a decrease in the growth rate of the latter, up to some lose in body weight[5-9].In certain accordance with the last position, there are some results obtained from the data of A.N. Pashkov[10] in the study of water, treated with a low-frequency electromagnetic

field (EMF), on juveniles of Sumatran barbs *(Barbustetrazona)*. In the series of the conducted experiments, the most pronounced positive effect on the growth of the object was observed in the water treated with EMF at a frequency of 16 Hz. According to Amineva[3], in the pond or basin raising of hydrobionts using an open water supply scheme, it is possible to assume an increase of food energy requirement for an object, in comparison with the requirements of the same object kept in the conditions of closed water supply installation. According to V.I. Kozlov[11], in comparison with traditional technologies, the use of closed water supply installation provides the creation and maintenance of the most stable and optimal conditions for keeping hydrobionts. This implies a reduction and stabilization of the motion activity of hydrobionts at a relatively constant level and a reduction in energy costs, which implies the possibility of developing adapted production combined feed by reducing the energy value (without significant risk of deterioration in physiological adequacy, fish-breeding and productive qualities of the object). First of all, we are talking about the acceptable reduction of fat content and proportional protein reduction, while maintaining the optimal ratio between these components[12].

Materials And Methods

The purpose of the research is to summarize the results of observations conducted at different periods of time for several years in production and laboratory conditions on the basis of operating closed water supply installation on changes in size-weight (linear-weight) characteristics, viability indicators when using combined feeds with different content of crude protein and raw fat, as well as hydrochemical and water temperature rate. The present study can be conditionally divided into two stages, the characteristics of which are presented in Table 1.Throughout each of the stages, we controlled the change in size and weight characteristics, viability indicators, and hydrochemical and water temperature regimes.

Table 1: Conditions Of Keeping The Object Of Industrial Commercial Raising In Monoculture On The Basis Of Closed Water Supply Installation (By Stages Of The Study)

Values		Stage of research	
		1	2
Basis		production module of CWSI* (AlFarisGroupof Companies, AlFarisFishFarm unit, CaviarCourt; Dammam,Saudi Arabia)	experimental small-size CWSI* module based on a business incubator of Kuban State Agrarian University (Krasnodar)
Water conditioning unit (clearing of circulating water)	Mechanical	mesh drum filter with washer and electric motor	sand-gravel high-pressure filter
	Biological	aerated biofilter; non-aerated (denitrification) biofilter	filter of biological purification, separated by partial partitions into compartments that make up the aerated and non-aerated (denitrification) sections
	antibacterial treatment and aeration	air channel with a submersible UV-sterilizer; aeration in tanks for keeping hydrobionts	aerated distribution compartment of a biological filter with surface UV lamps; aeration in tanks
The scheme of recirculation (water circulation)		autonomous water supply and spillway of all elements of the water treatment unit and tanks for the keeping of hydrobionts via the air channel	all elements are assembled in a single ring of water circulation, with autonomous water supply and spillway of tanks
Rate of water circulation (per hour)		1.3	1.0
Duration of the stage, days		712	407
Object		two age groups of Russian sturgeon backcross with Siberian sturgeon	(*Acipenserruthenus*)
Production combined feed (raw protein / crude fat)		Aller Crystal SGP 493 53/14, Aller Aqua 45/15 (Denmark); Marine Fish 48/12 и Marine Fish 45/12 (Saudi Arabia)	BIOMAR EFICO Sigma 840 44/16 (France); Aquarex "Osotr" 45/12 (Russia)

Dailyfeedrates,%	at the beginning of the stage	2.0–2.5	0.9–1.0
	at the end of the stage	0.4–0.5	0.45–0.5
Number of feeds, per day		10–12	10–12

Note: CWSI* - closed water supply installation

Comparing the results of the analysis of the water temperature and hydrochemical regimes, it can be stated that during the first stage of the study, the temperature of the circulating water and the hydrochemical parameters were more unstable and more deviating from the optimal values for sturgeon. The temperature range according to the stages of the study was as follow: for the first stage - an average of 23.65°C, with a minimum value of 15.83°C, and a maximum value of 30.83°C; for the second stage - an average of 22.80°C, with a minimum of 18.00° C and a maximum of 27.00°C.In addition, comparing the results of the analysis of the water temperature regime at the first stage of the study with the data on the hydrochemical regime, given for the same stage, it can be asserted that it was the unstable temperature regime that was the main reason for the destabilization of hydrochemical indicators and their deviation from the norm, causing suppression of the microflora of biofilters and, as a consequence, leading to malfunctions in the water treatment unit (Table 2).

Table 2: Some Hydrochemical Values Of Recycled Water Quality In Different Sampling Sites (By Stages Of The Study)

WaterQualityIndicators	Samplingsites					
	Stage 1				Stage 2	
	Aerated biofilter	Non-aerated (denitrification) biofilter	Outlet ditch	External source of fresh water	Before feeding into the biological filter	At the outlet of the biological filter
NH_4^+/NH_3, mg/l (min–max)	1.64 (0.40–15.00)	6.57 (0.50–22.00)	2.30 (–)	0.80 (0.70–120)	0.30 (0.00–1.00)	0.10 (0.00–1.00)
NO_2^-, mg/l (min–max)	0.91 (0.02–3.50)	1.46 (0.11–2.60)	–	0.26 (0.15–0.70)	0.00 (0.00–0.80)	0.10 (0.00–0.80)
NO_3^-, mg/l (min–max)	79.27 (39.60–16.,80)	95.35 (13.20–202.40)	126.29 (44.00–202.40)	13.30 (8.80-17.60)	12.60 (0.00-100.00)	12.50 (0.00–100.00)
pH, units. (min–max)	7.57 (6.00–9.00)	7.54 (7.50–8.00)	–	7.76 (7.38–8.00)	8.00 (7.50–8.50)	8.00 (7.50–8.50)

The oxygen regime in the tanks for keeping hydrobionts, during the first stage of the study was favorable. The oxygen content of the circulating water averaged 7.83 mg/l. The second stage of the study is characterized by milder hydrochemical and temperature conditions of the object throughout the stage. It should be noted that visual examination of the loss and assessment of the internal organs during autopsy showed the presence in the loss of a certain number of affected individuals which had an adjacent clinical picture, including both symptoms of intoxication with nitrogen-containing substances, presumably, acidemia (ammonium / ammonia poisoning) and methemoglobinemia (nitrites poisoning), and symptoms, that did not exclude the possibility of a secondary infection. Results of the research. Since the duration of individual experiments in the series varied significantly, in order to simplify the comparison of the results, the values of most of the indicators characterizing the survival rate and the weight gain rate of the research object, as well as the efficiency of feed costs (the rate of available utilization) of the tested combined feed for the growth of the object, were recalculated by calculating the "specific" values. Some results of raising the object on the basis of closed water supply installation using combined feeds with different content of protein and fat are presented in Tables 3,

4 and 5.A comparison of the indicators characterizing the survival rate of the object in the older age group (Table 3) revealed the superiority of the object in the test groups (variants), where combined feeds with a 12% fat content were used (minimum daily loss was found in the test group, which used combined feed with a crude protein content of 48%). The maximum value of daily loss was recorded in the test group, where combined feed contained 45% of crude protein and 15% of raw fat.

Table 3: Results Of Rearing Russian Sturgeon Backcross With Siberian Sturgeon (Older Age Group) On The Basis Of Closed Water Supply Installation Using Combined Feeds With Different Level Of Crude Protein And Raw Fat (First Stage Of The Study)

Object		Backcross of Russian sturgeon with Siberian sturgeon			
Combined feed		AllerAqua 45/15		Marinefish 48/12	Marinefish 45/12
Duration of the experiment, days.		200	27	27	435
Agecategory (Age, days)	at the beginning of the experiment	yearlings 1 (326)	two-year-old 1+ (526)	two-year-old 1+ (526)	two-year-old 2 (599)
	at the end of the experiment	two-year-old 1+ (525)	two-year-old (552)	two-year-old 2 (552)	three-year-old 3 (1033)
Loss per day (averaged data),%		0.172	0.021	0.010	0.033
Average individual weight (min–max), kg	initial	0.253 (0.150–0.500)	0.841 (0.756–0.935)	1.602 (0.997–2.071)	1.574 (0.988–2.425)
	final	1.232 (0.750–2.054)	0.998 (0.872–1.094)	1.858 (1.325–2.321)	5.473 (4.102–6.917)
Average stocking density rate (min–max), kg/m^2		6.060–35.342	43.856–51.869	25.400–29.432	26.877–58.489
Feed cost coefficient		2.581	2.195	1.594	1.514
Weight gain rate		0.007	0.006	0.007	0.004

The main indicators characterizing the weight gain rate of the object in the same age group were relatively small (in comparison with the results obtained during the second stage of the study) and differed slightly in favor of the object in the test groups, grown with the use of combined feeds containing 15% of raw fat. A comparative analysis of the indicators characterizing the efficiency of feed costs for the growth of the object in the older age group showed a higher degree of available utilization of feed for the increase of the individual weight of the object in the test groups, where the combined feed contained 12% of raw fat. The maximum value of the feed cost coefficient was recorded in the test group with 45% of crude protein and 15% of raw fat in the combined feed. Comparison of the survival rate results and indicators, characterizing the rate of weight gain of the object of the younger age group (both within the group and in comparison, with the corresponding indices obtained for the older age group, and also during the second stage of the study), revealed the same ratio and dimensionality of the values (Table 4), as in the case of an older object.

Table 4: Results Of Rearing Backcross Of Russian Sturgeon With Siberian Sturgeon (Younger Age Group) On The Basis Of Closed Water Supply Installation Using Combined Feeds With Different Levels Of Crude Protein And Raw Fat (First Stage Of The Study)

Object		Backcross of Russian sturgeon with Siberian sturgeon			
Combined feed		AllerCrystal SGP-493 53/14	AllerAqua 45/15	Marinefish 48/12	Marinefish 45/12
Duration of the experiment, days		47	157	27	435
Agecategory (Age, days)	at the beginning of the experiment	underyearlings 0+ (148)	yearlings 1 (195)	yearlings 1 (352)	two-year-old 1+ (425)
	at the end of the experiment	yearlings 1 (194)	yearlings 1 (351)	two-year-old 1+ (378)	three-year-old 2+ (859)
Loss per day (on average),%		0.172	0.203	0.043	0.022
Average individual	initial	0.171	0.287	1.123	1.235

weight (min–max), kg		(0.138–0.200)	(0.250–0.367)	(0.854–1.418)	(0.850–1.575)
	final	0.287 (0.245–0.365)	1.122 (0.846–1.432)	1.316 (0.921–1.611)	4.561 (3.108–5.833)
Average stocking density rate (min–max), kg/m^2		5.759–9.460	6.243–19.408	17.769–20.560	19.035–35.633
Feedcostcoefficient		2.703	2.056	2.205	2.270
Weightgainrate		0.007	0.007	0.006	0.004

The minimum value of daily waste in the younger age group was recorded in the test group, where combined feeds containing 45% of crude protein and 12% of raw fat were used; the maximum was when a combined feed contained 45% of crude protein and 15% of raw fat. The parameters characterizing the weight gain rate were slightly higher in the test group, where combined feeds containing 14% and 15% of raw fat were used. In the younger age group, the cost of combined feeds for the growth of the object in the test groups with the use of combined feeds with both a smaller (12%) and a larger (14% and 15%) content of raw fat, were comparable. In this case, the object in the test groups grown with the use of combined feeds containing 12% of crude fat, the values of feed cost coefficient were slightly higher than those for the object in the corresponding test groups of the older age. The maximum value of feed cost coefficient in the younger age group was recorded in the test group, where combined feed containing 53% of crude protein 14% of raw fat was used. Having regard to the higher mortality rate of the object in the test groups, where combined feeds containing 14% and 15% of raw fat were used, it can be assumed that a large feed cost coefficient value here was associated with a more significant cost of feed "for loss", which is consistent with the data obtained in during the second stage of the study (Table 5).

Table 5: Results Of Cultivation Of Sterlet (Acipenserruthenus) On The Basis Of Closed Water Supply Installation Using Combined Feeds With Different Content Of Crude Protein And Crude Fat (Second Stage Of The Study)

Combined feed		BIOMAR EFICO Sigma 840 44/16	Aquarex «Osotr» 45/12
Duration of the experiment, days		302	106
Age category	at the beginning of the experiment	two-year-old (2)	three-year-old (3)
	at the end of the experiment	three-year-old (3)	three-year-old (3)
Loss per day (on average),%		0.018	0.000
Average individual weight (min–max), kg	initial	750.000 (500.000–1000.000)	1289.710 (760.000–1900.000)
	final	1289.710 (760.000–1900.000)	1593.530 (940.000–2300.000)
Average stocking density rate (min–max), kg/m^2		9.060–15.604	14.715–18.181
Feedcostcoefficient		3.379	1.810
Weightgainrate		0.018	0.023

Comparative analysis of indicators, characterizing the survival rate of the object, revealed both superiority, in general, over the corresponding results obtained during the first stage of the study and the superiority of the object in the test group, where a combined feed with 12% of raw fat was used. Survival rate of the object in the corresponding test group was 100%. The maximum, for the stage, the value of daily loss was recorded in the test group, where combined feed containing 44% of crude protein and 16% of raw fat was used. Moreover, the obtained value was quite comparable with the values of the corresponding indicators, noted during the first stage for test groups grown with feeds with a smaller (12%) content of raw fat. The weight gain rate of the object during the stage was significantly higher, in comparison with the corresponding results obtained for the first stage of the study, and differed in favor of

the object in the test group, where combined feeds contained 12% of raw fat. A higher degree of available feed utilization for the increase in the individual weight of the object in the test group was revealed, where a combined feed containing 12% of raw fat was used. The maximum value of feed cost coefficient (both during the stage and throughout the study as a whole) was recorded in the group where mixed fodder containing 44% of crude protein and 16% of raw fat was used. Specified for the stage the minimum feed cost coefficient value (12% of raw fat), in absolute value, was between the corresponding values obtained during the first stage of the study for the test groups of both ages, grown using combined feeds with the same raw fat content.

Results And Discussion

Thus, the generalized results of this study can be presented in the form of the following provisions.

1. Throughout the study, the object was in acceptable conditions of keeping, although it was subjected to a relatively unfavorable effect of certain environmental factors, deviating from the optimal level (not exceeding, however, the limits of possible long-term resistance of the object to the corresponding influence). At the first stage - a stable, long-term, relatively constant and complex impact of the water temperature regime in combination with the hydrochemical regime; at the second - the temporary effect of the hydrochemical regime before and at the end of the stage.2. According to the results of the second stage, the object in the test group, where the combined feed with a higher content of raw fat (16%, with 44% crude protein) was used, with similar conditions, was slightly inferior to the object in the test group fed a combined feed with a lower content of raw fat (12%, with 45% crude protein).3. The survival rate of fish was superior in the variants where combined feed with less raw fat content (12%, with 45% and 48% crude protein) was used, to the object in the test groups fed the combined feed with a higher content (14% and 15%, with 53% and 45% of crude protein, respectively) of raw fat (with the exception of one older test group, where the survival rate of the object was significantly higher).4. The weight gain rate of the object in all test groups during the first stage, when the conditions of the object rearing (stocking density, water temperature and hydrochemical regimes) were less favorable (compared to the second stage), was significantly lower than in the second stage of the study. At the same time, according to the results of the first stage, the invert correlation of the weight gain rate was revealed – the object in the test groups, where combined feeds with a higher content of raw fat (14% and 15%, with 53% and 45% crude protein) were used, with other similar terms of the corresponding parameters, slightly exceeded the object in variants where combined feed with a lower content of raw fat (12%, with 45% and 48% crude protein) was used.5. For each stage of the study, in general, the ratio of available feed utilization for the individual weight gain of the object in the test groups, where combined feeds were used with a lower (12%, with 45% crude protein) content of raw fat, the feed cost coefficients were significantly higher, in comparison with test groups, where combined feeds with higher (14%, 15% and 16%, with 53%, 45% and 44% of crude protein, respectively) raw fat content, by 35.0-49.0%, wereused. Moreover, during the second stage of the study, there was a slight increase of this indicator in both test groups, compared to the values, obtained during the first stage, which may be due to adverse effects on the object of the hydrochemical regime before and at the end of the stage.

Conclusion

As a result of the study, it was found that stable and optimal keeping conditions (or maximally approximate to those) provide the conditions for more effective utilization of combined feeds with lower energy value.

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