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CREATION OF ORGANOMINERAL CERAMIC FILLER FOR BIOFILTER AND USE OF THEM IN CULTURE OF SMALL STURGEON FISH IN CONDITIONS OF CLOSED WATER SUPPLY

Abstract

The article presents the results of scientific and experimental research on the creation of organic-mineral ceramic biomaterial for biofilters used in the conditions of growing sturgeon fry using a closed water supply. The information on the analysis of the main stress factors leading to the most frequent diseases of sturgeon fish in closed water supply conditions is presented. To prevent the impact of unfavorable conditions or reduce them to a minimum, the results of studies on the creation of a new organic-mineral ceramic biomaterial based on environmentally friendly natural raw materials for biofiltration and water purification in conditions of closed water supply are presented. It has been established that the proposed organomineral ceramic biomaterial serves as biofilters both as water purification and as an element of prophylaxis against fish diseases.

Keywords*: biofilter, sturgeon fish, fry breeding, ceramic filling, closed water supply,aquaculture.*

Introduction. The global food market has seen a steady increase in the consumption of fish and other aquatic organisms. At the same time, the share of cultivated objects in relation to natural conditions is increasing. [1-2].The high demand for these products contributes to the development of fish farming with a closed water supply.This situation is also dictated by the fact that there are no large reservoirs in Kazakhstan that would allow raising the sturgeon family in natural conditions.In view of the need to provide the world population with high-quality and healthy fish products, aquaculture, which is already one of the most rapidly developing agricultural and food sectors, has great potential for future development.

In this regard, an increase in the survival rate of sturgeon fish during artificial reproduction is of particular relevance. An important role in this is played by the reduction in the death of fish from diseases, which sometimes reach 40% or more [3-4].

The most common fish diseases under these conditions are influenced by stress factors. The most common stressors in the aquatic environment include nitrates, nitrites, chronic exposure to low concentrations of pesticides or heavy metals, low oxygen content, high concentrations of carbon dioxide, sudden changes in pH or temperature, inadequate salinity and nutrition, and increased stocking density.

For the onset of the disease, the cumulative effect of several of the above stress factors is often necessary. However, disease can occur when only one of these factors is involved. Therefore, understanding the extent to which a particular stress factor contributes to the development of fish diseases makes it possible to develop preventive measures to prevent exposure to adverse conditions or reduce them to a minimum.As practical experience shows, it is the low quality of treated water that is the main factor in the disease and death of fish in conditions of closed supply. Because it is in it that the decomposition of harmful ammonia compounds occurs, which are destructive for fish in a closed reservoir.

In recent decades, biofilters have become increasingly common for removing pollutants from wastewater and waste gases. Biofilters use microorganisms that are capable of degrading many

compounds fixed in an inorganic / organic medium (carrier) to break down contaminants present in the fluid stream. Removal of pollutants from wastewater and waste gases is often achieved with biological agents in one-off operations such as biofilters [5]. Therefore, the development of research in the direction of creating new types of fillers and the design of biofilters that provide effective biofiltration and water purification is an urgent task.

Aquaculture technology is based on the use of mechanical and biological filters.A mechanical filter does not remove all organic matter; the smallest particles pass through it in the same way as solutes such as phosphate or nitrogen. Phosphate is an inert substance with no toxic effects, but nitrogen in the form of free ammonia (NH_3) is toxic and must be converted into harmless nitrate in a biofilter.Decomposition of organic matter and ammonia is a biological process, with the help of bacteria in the biofilter. Heterotrophic bacteria oxidize organic matter by consuming oxygen and producing carbon dioxide, ammonia and sludge. Nitrifying bacteria convert ammonia to nitrite and then to nitrate.An analysis of the fillers used in modern conditions shows that mainly expensive imported types of fillers made of polymeric materials are used as a loading material. The polymeric fillers used do not meet the requirements of ensuring an ecologically clean aquatic environment in a confined space, which can affect the health of fish. As you know, long-term presence of polymer fillers in an aqueous medium can affect a change in the chemical composition of water. In addition, the process of colonizing beneficial bacteria in polymer fillers is carried out only through its surface, since polymer fillers have a dense structure. These factors significantly reduce the efficiency of biofilters in terms of complete nitrification and water purification in conditions of fish breeding with closed water supply. A deep analysis of theoretical and scientific-experimental studies in this area allows us to conclude that the type of fillers for biofilters plays a key role in the process of nitrification and water purification in fish breeding in closed water supply conditions.

Scientists around the world are working on solving this problem. For example, to increase the efficiency of denitrification of drip filters, a biofilter with a drip top layer and a flooded bottom layer was developed, which was used to purify highly polluted river water. Porous ceramic granules made on the basis of coal ash were used as a filler. Its starting characteristics, the influence of hydraulic load rate, carbon to nitrogen ratio (C / N) and filtration depth on the removal of pollutants were investigated. The results of the study have shown their high efficiency in biofiltration and water purification [6].

The area of application of biofilters is constantly expanding. In the work of scientists the results of a study on the use of new types of biofilter design for the removal of volatile organic compounds (VOCs) emitted at treatment plants during dyeing of textiles are presented. At the same time, a positive effect of reducing the risks to respiratory health was achieved using the developed pilot-scale bio filter [7].

In our opinion, for the cultivation of sturgeon fish in a closed supply, it is necessary to develop new types of fillers made on the basis of natural raw materials, providing not only high-quality biological, but also at the same time fine water purification with the neutralization of all harmful impurities. The use of natural materials as fillers in biofilters contributes to the creation of a natural natural aquatic environment for fish reared in a closed water supply. Since water, seeping through the porous structure of a natural material, attracts microparticles of useful minerals in the form of silicon, calcium, magnesium, sodium, potassium, etc. and serve as a prophylactic agent against fish diseases.

Purpose of the study. Creation of a new loading composite organomineral biomaterial for biofilters based on environmentally friendly natural materials and scientific and experimental research on their practical application in biofiltration of water under conditions of closed water supply for breeding sturgeon fry.

Based on the analysis of the literature, it has been established that the most promising sources of natural raw materials for the creation of organomineral fillers for biofiltration of water are siliceous rocks - flasks, bentonite clays and coal [8]. In addition, the presence of their significant reserves in the Republic of Kazakhstan was taken into account. Therefore, the following raw materials were selected as the object of research: siliceous rock of the flask of the Taskalinsky deposit of the West Kazakhstan deposit, bentonite clay of the Pogodaevsky deposit (West Kazakhstan region) and coal from the Karaganda deposit.

Research objectives.

Scientific and experimental work was carried out in the following sequence:

- preparation of raw materials for experiments by dosing with electronic scales;
- carrying out joint grinding in a laboratory ball mill to obtain an organomineral powder with a high specific surface area;
- mixing the raw mixture with water until a homogeneous organic-mineral biological mass is obtained;
- preparation of organomineral biological material in the form of granules and cylinders with a through hole of various diameters and heights,
- roasting of organic-mineral biological material in the form of granules and cylinders in a high-speed rotary kiln and in a chamber kiln;
- scientific and experimental studies to study their complex of properties and their effectiveness in bifiltration and water purification;
- conducting a comparative analysis of the organomineral biological material obtained by us in comparison with similar materials;
- conducting experiments on the practical application of organomineral biological material.

Materials and research methods:

To conduct scientific experimental work, standard methods were used to determine the biological characteristics, biochemical, physical and mechanical properties of raw materials and finished products.To achieve the set goals and objectives of the project, at the initial stage, experimental work was carried out to determine the optimal component composition of organomineral biological material, providing the best indicators of the studied properties.The studies were carried out in the following limiting concentrations of the selected raw materials, wt%: siliceous rock - flask - 70-80, bentonite clay - 10-27, coal - 3-10.Based on the raw materials under study, three batches of the composition were prepared with the following composition:

composition No. 1 siliceous rock - sludge - 70%, bentonite clay - 27, coal - 3.

composition No. 2 siliceous rock - sludge - 75%, bentonite clay - 19, coal - 6.

composition No. 3 siliceous rock-flask - 80%, bentonite clay -10, coal -10.

First, the raw materials were dosed according to the indicated compositions using an electronic balance and dried in a drying oven at a temperature of 80 °C to a residual moisture content of 5-6%. Then the dried mixture was loaded into a laboratory ball mill and subjected to joint grinding to a specific surface area of 3000 g / cm^2.The specific surface of the powders was controlled by sieving through a 008 sieve.The resulting powders were discharged from a ball mill into a spherical bowl for further mixing with water. To obtain the molding mass, the mixture was thoroughly mixed with the addition of water in an amount of 25-27% of the dry component mass until a homogeneous plastic organomineral mass (biomass) was obtained. Fillers for biofilters in the form of granules and cylinders with a through hole were manually molded from the organomineral mass (biomass). Thus prepared fillers for biofilters in the form of cylinders with a through hole and in the form of granules were again dried in an oven at a temperature of 65-70 °C to a residual moisture content of 5-7%. The dried samples were fired in rotary kilns at a temperature of 950 °C. The heat-treated finished samples of fillers for water biofiltration were subjected to a study of their properties. Figure 1 shows samples of finished products of organomineral ceramic biomaterial.

Results and discussion. The next stage of the study was a comparative analysis of the properties of the proposed organomineral biomaterial in comparison with existing analogues. Below are the results of a comparative analysis (Table 1).

Figure -1 Samples of finished products of organomineral ceramic biomaterial

Table 1- The results of a comparative analysis of the properties of the proposed organomineral ceramic biomaterial in comparison with existing analogues

Fillers name	Compressive strength, MPa	Average density, kg / m^3	Open porosity, %	Water-persistence, %	Frost-durability, - cycles,	Sorption-capacity, m^2 / g
Organomineral Ceramic biomaterial	8,9	724,2	90,7	0,84	more 47	1645
Polymer fillers	4,6	375	missing	0, 94	more 35	missing
Expanded clay	3,2	350	missing	0,78	12	missing

As the results of the comparative analysis of properties show, the compared objects do not possess such important properties as open porosity and sorption capacity. The absence of open porosity in them does not ensure the colonization of bacteria colonies that are the main participants in water biofiltration. And the lack of sorption capacity in them is the main factor that they are not at all involved in the additional process of purifying water from harmful impurities. To achieve these goals, an experimental-industrial batch of organic-mineral biomaterial was made in the conditions of the scientific and educational-production center of the Research Institute «Engineering and Resource Saving» Zhangir Khan.WKATU. The produced organomineral ceramic biomaterial of our own production was tested for the biofiltration of water in the conditions of the aquarium system and on the basis of the experimental production site «Aquaculture» for growing sturgeon fry in conditions of closed water supply at the WKATU named after Zhangir Khan (Figure 2).

Figure 2- General view of a pilot-industrial batch of organic-mineral ceramic biomaterial of our own production made on the basis of the scientific and educational-production center of the Research Institute «Engineering and Resource Saving» Zhangir Khan WKATU.

The second stage of scientific and experimental work was the replacement of imported fillers with organomineral biomaterial of our own production on the basis of the existing experimental production site «Aquaculture» for growing sturgeon fish in closed water supply conditions (Figure 3).

Figure 3 - The process of replacing imported fillers with organic-mineral ceramic biomaterial of our own production for biofiltration and water purification of the pool of the operating experimental-production site of Aquaculture on growing sturgeon fry in a closed water supply

Complete replacement of imported fillers with organomineral biomaterial of our own production for biofiltration and water purification in the conditions of the aquarium system and the pool of the operating experimental production site of Aquaculture "for growing sturgeon fry in closed water supply conditions allowed us to obtain the following effective results:

- Allowed to reduce the duration of the lag phase to 12 days (versus 25-30 days when using imported fillers) i.e. the period of adaptation of a bacterium to a new habitat is almost 2 times faster. Therefore, the process of biofiltration of water occurs in a short time, which is an important factor for creating a favorable environment for the life and growth of fish.

To achieve this goal, the growth of sturgeon fry was observed during biofiltration of water using imported polymer fillers and organomineral biomaterial of our own production (pilot industrial samples). Below are the results of the research (Table 2).

Table 2 - Research results and comparative analysis of sturgeon fry growth

Indicators	Biofiltration using imported fillers	Biofiltration using organomineral biomaterial
Initial weight, g	10,0±0,29	10,0±0,29
Weight after the trial period, g	27,65±1,47	31,06±1,04
Total weight gain, g	17,95	21,02
Average daily weight, g	0,69	0,88
Survival,%	91	98
Test period, days	30	30

As the results of the study show, when using the organomineral ceramic biomaterial developed by us for biofiltration of water under conditions of closed water supply, an increase in the weight and survival rate of sturgeon fry is observed. At the same time, the survival rate of fish reaches 98% (Figure 3).

Conclusion.

1. It has been established that the main factor of disease and death of fish in conditions of closed supply is the low quality of treated water. Because it is in it that the decomposition of harmful ammonia compounds occurs, which are destructive for fish in a closed reservoir.

2. For better water purification, a new organic-mineral ceramic biomaterial has been developed on the basis of environmentally friendly natural raw materials for biofiltration and water purification in conditions of closed water supply.

3. In experimental-industrial conditions, the effectiveness of the proposed new material has been proven in relation to deeper high-quality biofiltration and water purification and survival of sturgeon fry.

4. It has been established that the proposed organomineral ceramic biomaterial is used in biofilters both as a water purification and as an element of prophylaxis against fish diseases.

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ТҮЙІН

Мақалада бекіре шабақтарын жабық сумен жабдықтауды пайдалану жағдайында қолданылатын биофильтрлерге арналған органикалық-минералды керамикалық биоматериалды құру бойынша ғылыми-тәжірибелік зерттеулердің нәтижелері келтірілген. Жабық сумен жабдықтау жағдайында бекіре балықтарының жиі кездесетін ауруларына әкелетін негізгі стресс факторларын талдау туралы ақпарат келтірілген. Жағымсыз жағдайлардың әсерін болдырмау немесе оларды минимумға дейін төмендету үшін биофильтрация және суды жабық сумен тазарту үшін экологиялық таза табиғи шикізат негізінде жаңа органикалық-минералды керамикалық биоматериалды құру бойынша зерттеулердің нәтижелері келтірілген. Ұсынылып отырған органоминералды керамикалық биоматериал биофильтр ретінде суды тазарту ретінде де, балық ауруларының алдын алу элементі ретінде де қызмет ететіндігі анықталды.

РЕЗЮМЕ

В статье представлены результаты научно-экспериментальных исследований по созданию органоминерального керамического биоматериала для биофильтров используемых в условиях выращивания мальков осетровых рыб по замкнутому водоснабжению. Приведены

сведения по анализу основных стресс – факторов приводящие к наиболее частым заболеваниям осетровых рыб в условиях замкнутого водообеспечения. Для предотвращения воздействия неблагоприятных условий или снижение их до минимума представлены результаты исследований по созданию нового органоминеральный керамического биоматериал на основе экологический чистой природных сырьевых материалов для биофильтрации и очистки воды в условиях замкнутого водообеспечения. Установлено, что предлагаемый органоминеральный керамический биоматериал служат биофильтрах как в качестве очистки воды, а так же как элемент профилактики против заболеваний рыб.

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КӨЛДЕ ТАУАРЛЫ БАЛЫҚ ӨСІРУ БАҒЫТЫНДА ТҰҚЫ ЖӘНЕ ӨСІМДІК ҚОРЕКТІ БАЛЫҚТАРДЫҢ ДЕРНӘСІЛДЕРІН ЖӘНЕ ШАБАҚТАРЫН ӨСІРУ
GROWING LARVAE AND JUVENILES OF CARP AND HERBIVOROUS FISH IN THE DIRECTION OF COMMERCIAL LAKE FISH FARMING

Аннотация

Мақалада тұқы және өсімдікқоректі балықтардың көл-тауарлы балық өсіру шаруашылығы жағдайында, дернәсіл сатысынан тауарлы балықтарға дейінгі өсімі қарастырылған. Инкубациялық аппараттардан кейінгі дернәсілдердің шабақтық тоғандарға бейімделуі және алғашқы қорекпен қоректенуі, күзге дейінгі өсу темпі анықталды. Сонымен қатар, 50-110 гр. аралығындағы тұқы және өсімдікқоректі балықтардың шабақтарының суқоймаға жіберілуінен кейінгі өсу қарқындылығы баяндалған.

Шабақтық тоғандарға 50 см-ден бастап сумен толтырылғаннан кейін өсірілетін шабақтар жіберілді. Шабақтарды жібермей тұрып, балық тасымалдаушы бассейндегі судың температурасы тоғандардағы судың температурасымен теңестірілді. Шабақтық тоғандарда шабақтарды өсіру технологиясы бойынша келесідей жұмыстар атқарылды: тоғандарды сумен толтыру және дайындау, жас шабақтарды жіберу және осы жылдық шабаққа дейін өсіру, шабақтық тоғанның су деңгейін түсіру және осы жылдық балықтарды аулау. Шабақтық тоғандардың балықтарын аулау күзде, яғни қыркүйек айының соңы мен қазан айының басында жүргізілді.