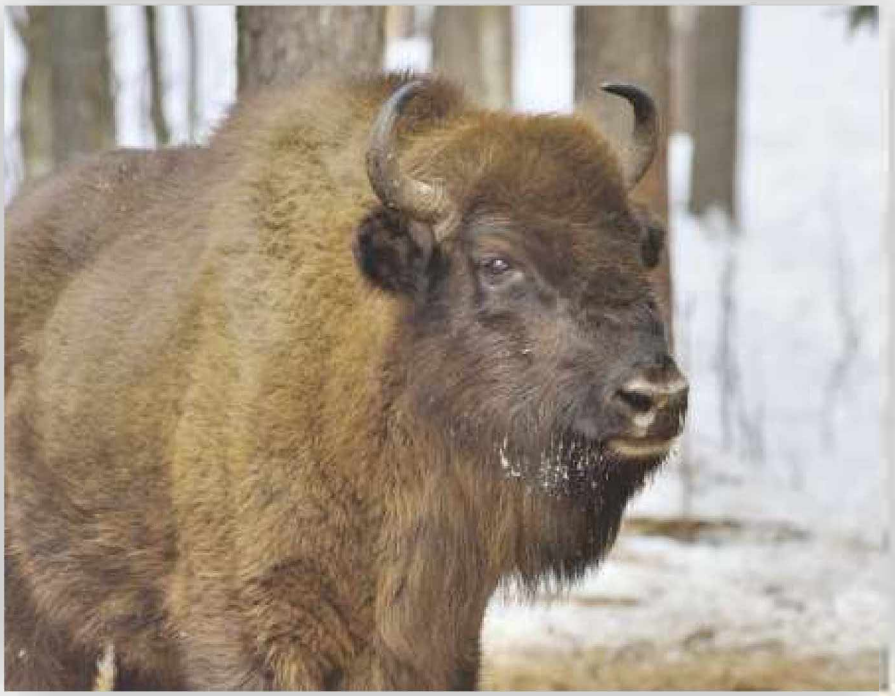

ПРИРОДНЫЕ РЕСУРСЫ

ПР

ISSN 1810-9810

№ 2
2016

«ПРИРОДНЫЕ РЕСУРСЫ»

Научный журнал
Издается с 1996 года
Выходит 2 раза в год
Ноябрь 2016 г.

УЧРЕДИТЕЛИ:
Национальная академия наук Беларуси
Министерство природных ресурсов
и охраны окружающей среды Республики Беларусь

ИЗДАТЕЛЬ:
Республиканское унитарное предприятие
«Издательский дом «Беларуская навука»
Национальной академии наук Беларуси

РЕДАКЦИЯ:
Беларусь, 220072, г. Минск, ул. Академическая 27,
Тел.: +375 /017/ 284-05-23, 284-15-85, Факс: +375 /017/ 284-15-93
E-mail: 430vinok@gmail.com, tsinkevichva@mail.ru

ISSN 1810-9810

ПРИРОДНЫЕ РЕСУРСЫ

NATURAL RESOURCES

№ 2
2016

Научное издание
SCIENTIFIC EDITION

Национальная академия наук Беларуси
Министерство природных ресурсов и охраны окружающей среды Республики Беларусь
National Academy of Sciences of Belarus
Ministry of Natural Resources and Environmental Protection of the Republic of Belarus

Навуковы часопіс
«ПРЫРОДНЫЯ РЭСУРСЫ»
Выдаецца з 1996 года
Выходзіць 2 разы ў год
Лістапад 2016 г.

Scientific Journal
«NATURAL RESOURCES»
Published since 1996
Issued twice a year
November 2016

ЗАСНАВАЛЬНІКІ:

Нацыянальная акадэмія навук Беларусі
Міністэрства прыродных рэсурсаў і аховы навакольнага асяроддзя
Рэспублікі Беларусь

FOUNDERS:

National Academy of Sciences of Belarus
Ministry of Natural Resources and Environmental Protection
of the Republic of Belarus

ВЫДАВЕЦ:

Рэспубліканскае унітарнае прадпрыемства
«Вылавецкі дом «Беларуская навука»
Нацыянальнай акадэміі навук Беларусі

PUBLISHER:

The Republican Unitary Enterprise
«Publishing House «Belaruskaya Navuka»
National Academy of Sciences of Belarus

АДРАС РЭДАКЦЫІ:

Беларусь, 220072, г. Мінск,
вул. Акадэмічная 27,
Тэл.: +375 /017/ 2840523, 2841585
Факс: +375 /017/ 2841036
E-mail: 430vinok@gmail.com, tsinkevichva@mail.ru

ADDRESS OF EDITORIAL OFFICE:

Academic street 27,
Minsk, 220072, Belarus,
Phone: +375 /017/ 2840523, 2841585
Fax: +375 /017/ 2841036
E-mail: 430vinok@gmail.com, tsinkevichva@mail.ru

ISSN 1810-9810

УДК 639.311:639.3.043.13:639.3.043.2

A.I. Kozlov, T.V. Kozlova, N.G. Kruchynsky,
G.A. Raylyan, N.P. Dzmitrovich, N.M. Raylyan

COST EFFECTIVE TECHNOLOGY OF MARKETABLE FISH IN POND AQUACULTURE

Studies on reclamation ponds of Pripyat Polesie showed their suitability to conduct feeding, cage and integrated fish farming. Results of the studies indicate the appropriateness to use as seeding pike yearlings, two-year carp, grass carp and bighead carp for aquaculture feeding. Growing of sturgeon in cages, using as feed supplements Chlorella suspension, showed that the addition to the feed mixture of 10 % suspension of chlorella on the mass of the food provided to increase the average weight of Sterlet and Lena sturgeon by 19,9 and 25,1 % respectively. This technology saves up 4.3 € (7,5 %) of the 57 € spent on feeding the fish per day. The positive results showed during production of marketable fish in conjunction with the Muscovy ducks. The live weight of ducks that received during the initial period of growing the suspension of chlorella was 9,2 % higher than in the control group.

Introduction

The composition of fish products includes vitamins, enzymes and other organic compounds valuable for the human body. Also in the fish meat it has all the essential amino acids, which determines its special value as one of the best sources of high quality protein food. Meat of pond fish contains in its composition a complete set of proteinogenic amino acids, of which a high proportion of aspartic (1,28–1,56 %) and glutamine (1,75–2,16 %) acids, the chemical precursors of flavor and aroma. Aspartic acid is involved in the immune system and the synthesis of DNA and RNA (the main carrier of genetic information), and promotes the conversion of carbohydrates into glucose and subsequent storage of glycogen, as a major energy source during exercise.

Proteins of fish muscle more fulfilling and perspective in creating culinary readiness of products, since to a large extent, they can cover the daily human need for protein diet. It should be noted that the fish proteins after correct processing have high absorbency (up to 93–95 %) is significantly superior to similar proteins of animal meat. The best balance of the composition of the amino acids are proteins of grass carp, carp and silver carp, roughly equivalent proteins had pike and perch. Studies confirm that there is no ideal ratio of amino acids in muscle tissue of pond fish, but they are not inferior to the usefulness of the proteins of meat of warm-blooded animals. It should be noted that the aquaculture objects are a source of food and biologically active substances. Purposeful and metered consumption of fish products are largely provides the physiological norm in the diet and is useful for the development of products, corrective and support human health [5].

It was found that the chemical composition of fish meat depends on the quality of habitat. Therefore, careful attention must be paid to the conditions of cultivation of fish in fish farms, and to ensure greater use of new technologies to obtain high-quality product [14].

In world practice there are several areas of aquaculture, which are based on different methods of growing marketable fish: pasture, pond and industrial, differing in the various levels of intensification of fish-breeding process: extensive, semi-intensive and intensive [1, 15]. The relevance of research is the need to develop cost effective technologies of growing fish in reclamation ponds of Pripyat Polesie. The purpose of these investigations is to study the possibility of pasture, cage aquaculture and integrated fish farming, taking into account the characteristics of hydrological, hydrochemical and hydrobiological regimes of ponds. The pasture and integrated aquaculture using polyculture of fish (carp + phytophagous fish + pike) and Muscovy ducks. When growing sturgeon in cages and raceways used pasty feed and the suspension of Chlorella.

Materials and methods

The pasture and cage aquaculture

Research was carried out on multi-purpose ponds Krivichi-1 and Krivichi-2, located in the Pinsk district, Brest region. Both pond fenced dam, water surface area has 47 and 49 hectares, respectively, and were created for the purpose of irrigation, water supply for agricultural and fish farming. The greatest depth of Krivichi-1 – 11,9 m, Krivichi-2 – 4,5 m. Filling ponds are using pumping stations. Ponds have a similar sedi-

ments, they are represented by silty sands and peaty soils. The littoral zone is partially overgrown. Lakes freeze over in late November – early December, opening in early April. Ice thickness reaches an average of 0,4–0,5 m. Both the pond was used for pasture aquaculture. Cage line was put at the site with greater depths on the pond Krivichi-1, and on the pond Krivichi-2 using an integrated fish farming technology.

In pasture aquaculture ponds were seeding in mid-April with two-year carp (Cyprinus carpio L) with an average weight of 420±15,54 g, grass carp (Ctenopharyngodon idella Valencinnes) – 310±6,5 g, bighead carp (Hypophthalmichthys molitrix Valencinnes) – 125±3,50 g and pike yearlings (Esox lucius L.) – 315±10,01 g. At the same time we studied the thermal, hydrochemical and hydrological regimes of ponds. The water temperature was measured daily: at 9.00, 14.00 and 19.00 hours. Water samples from ponds were collected every 15 days. At the same time carry out test fishing to study the growth rate of fish, using conventional techniques [2, 3, 4, 6, 7, 13].

Using the suspension of Chlorella like additive for different age groups of fish

When cage growing of fish studied the effect of the suspension of Chlorella in different doses in feeds on the survival and growth rate of different age groups of Sterlet.

Fry Sterlets were grown in raceways adding the suspension of chlorella (Chlorella vulgaris strain IFR № C-111) to feed («Coppens») in an amount of 4 ml/g feed (option №1) and 8 ml/g feed (option № 2). The suspension was added to a dry feed 15 minutes before feeding. The fish were fed manually four times per day during daylight hours. Experiments were performed in duplicate. The duration of the feeding of fish was 14 days.

When grown in cages three years old Sterlet (average weight was 558±9,91 g) and Lena sturgeon (*Acipenser baerii* Brandt, with average weight was 631±13,92 g) studied the effect of the suspension of chlorella (Chlorella vulgaris strain IFR № C-111) of their growth rate. Wet paste feed was produced by mixing the combined feed company «PANTO» and stuffing made from fine-mesh low-value fish caught from the same pond. Thus fish was passed twice through a meat grinder and mixed with the combined feed and chlorella suspension in the following ratios of components:

- 50 % of stuffing and 50 % of combined feed (variant I);
- 25 % of stuffing + 75 % of combined feed + 5 % of Chlorella suspension by weight of feed mixture (variant II);
- 50 % of stuffing + 50 % of combined feed + 10 % of Chlorella suspension by weight of feed mixture (variant III).

Feed ready an hour before the distribution of fish. The fish were fed by hand 3 times per day during daylight hours. Experiments were performed in duplicate. The duration of the experimental fish feeding was 42 days. The period of growing Sturgeon and Sterlet in cages was 150 days.

Using the suspension of Chlorella like additive in integrated technology of aquaculture

Fish and ducks grown using integrated technology of aquaculture. To determine the effect of chlorella suspension on the growth and development of Muskovy ducks all ducklings were divided into three groups of 100 animals each: Option I (control) – ducklings did not receive the suspension of chlorella; Option II – ducklings receive Chlorella suspension at a dose of 60 mg/head and Option III – ducklings receive Chlorella suspension at a dose of 100 mg/head. Ducklings received the suspension of Chlorella when grown in a greenhouse until the age of six weeks inclusive. Then the birds were transferred to grow on the pond. When grown in the greenhouse ducks fed a mixture of grain (50 % of barley and 50 % of wheat) and in pond' – a fodder flour.

Results

Water quality parameters and the growth rate of fish in pasture technology

Water quality parameters

As a whole the temperature regime of ponds meet the requirements of fish farming, but it was characterized by high temperatures during the period from the second decade of July to the third decade of August, when the water temperature was up to 29 °C.

Table 1 – Seasonal dynamics of hydrochemical parameters of ponds

Parameters	«Krivichi-1»	«Krivichi-2»
Water temperature (°C)	14,0–25,0	14,0–25,0
Oxygen (O_2, mg/L)	4,20–7,80	3,30–7,50
Active water reaction (pH)	8,00–8,62	7,50–8,64
Nitrate (NO_3, mg/L)	0,13–1,00	0,00–0,00
Nitrite (NO_2, mg/L)	0,00–0,25	0,00–0,26
Phosphate (mg P/L)	0,10–0,28	0,10–0,25
Total iron (mg/L)	0,05–1,25	0,10–2,50

In general, in the hydrochemical regime of the investigated ponds were no significant differences, except for slightly elevated nitrates indicators in pond Krivichi-1 (Table 1), but that does not impact on piscicultural parameters.

Analysis of seasonal hydrochemical parameters have shown that significant changes in the hydrochemical regime is not mentioned when growing on the pond «Krivichi-2» Muskovy ducks with stocking density 26 ind./Ha compared to pasture growing of fish in the pond «Krivichi-1». This allows us to characterize both ponds as eutrophic with hydrochemical regime suitable for fish farming.

The growth rate of fish

High values of the summer water temperatures have been favorable for the development of a natural feed reserve.

As part of the zooplankton of both ponds during the study period were constantly present Cladocera: *Daphnia magna*, *D. longispina*, *D. cucullata*, *D. pulex*, *Ceriodaphnia pulchella*, *Moina rectirostris*, *Sida cristallina*, *Bosmina longirostris*, *Chydorus sphaericus*, etc. In general, in the zooplankton composition of ponds identified representatives of the following groups of organisms: Rotatoria, Cladocera, Copepoda, Ostracoda and Chironomidae.

In the pond «Krivichi-2» the maximum value of zooplankton biomass in the region of places of musk ducks observed in the third week of June, when it was equal to 33,5±2,56 g/m^3. At this time in the water prevailed *D. magna*, *D. longispina*, *D. pulex*, *S. cristallina*. A small peak in the dynamics of zooplankton biomass observed in the third week of July, due to the development of these same Cladocera. In general, seasonal mean values of the zooplankton biomass in the region place of growing of musk ducks and 50 m away from it were 1,3 times higher, and equal to 10,9±0,98 and 8,4±1,52 g/m^3 respectively.

Benthos in the ponds was presented Gastropoda, Oligochaeta, Crustacea and Insecta. In the benthic fauna was dominated by Chironomidae, mainly larvae of *Chironomus plumosus*. The small number of larvae was also attended by Ephemeroptera and Odonata. Rarely of Oligochaeta in the composition of benthos marked *Aulophorus furcatus*. From Gastropoda were met *Limnaea stagnalis* and *Planorbis* sp. and crustaceans – *Asellus aquaticus*. The maximum biomass of benthos at the place and location of musk ducks at a distance of 50 meters from them are marked in mid-June and late July, when their value was respectively 20,5±0,86 and 10,7±1,75 g/m^2.

In an average season values of biomass of benthos near the location of the place of cultivation of ducks were higher by 1,5 times than at a distance of 50 meters from it equal to 8,5±0,80 and 5,1±0,60 g/m^2, respectively.

In the qualitative composition of native fish fauna marked the following species of fish: carp, perch, roach and ruff.

These conditions reflected in the growth rate of carp (Figure 1), grass carp (Figure 2), bighead carp (Figure 3) and pike (Figure 4).

Growing commercial fish using pasture technology has showed that the growth rate of fish was high. In October, the three-year carp has an average weight of 1050±66,4 g, which was caused by a wide range of food and its high level of natural forage fish throughout the growing period, and the high weight of the planting material. Because of herbivorous fish the greatest average weight in October had grass carp (1071,0±112,8 g). Bighead carp at this time reached 718,5±128,5 g, the average weight of pike caught during fishing on the control at the end of the study period, reaching 792,0±107,9 g (Figures 1, 2, 3, 4).

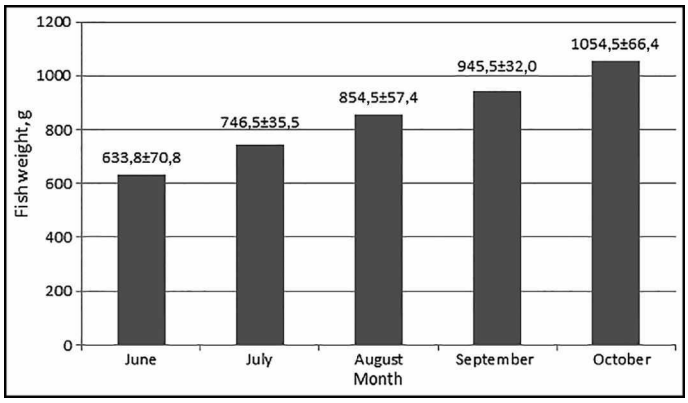

Figure 1 – The growth rate of carp (hereinafter Mean±Standart error).

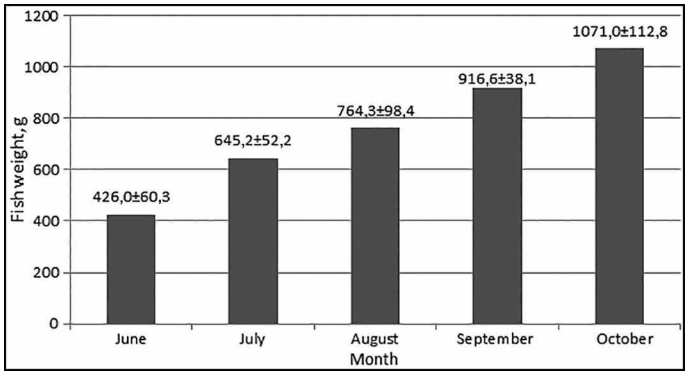

Figure 2 – The growth rate of grass carp.

The typical diseases of carp fish (like aeromonas, saprolegnioz, ligulosis and etc.) have been no identified upon visual examination and autopsy of caught fish. This was due to the impact of pike on the ecosystem of the pond, which in turn, also have a positive impact on its growth. Pike, eating the small carp, perch, roach and ruff, thereby reduced competition in the diet of studied fish.

Impact of the suspension of Chlorella like additive for different age groups of fish

Cage aquaculture is used both in natural and in artificial ponds, such as reservoirs and reclamation ponds [11], and has many important social, economic and environmental benefits.

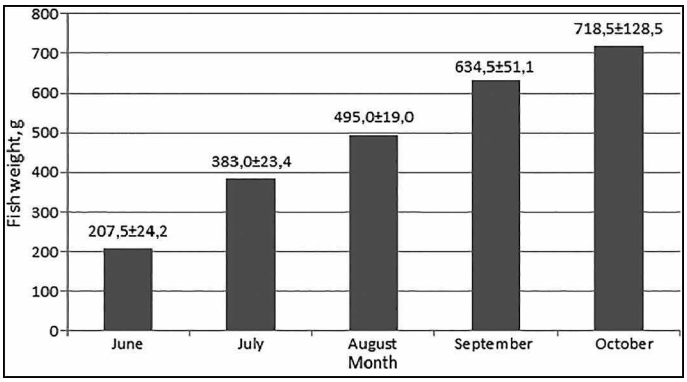

Figure 3 – The growth rate of bighead carp.

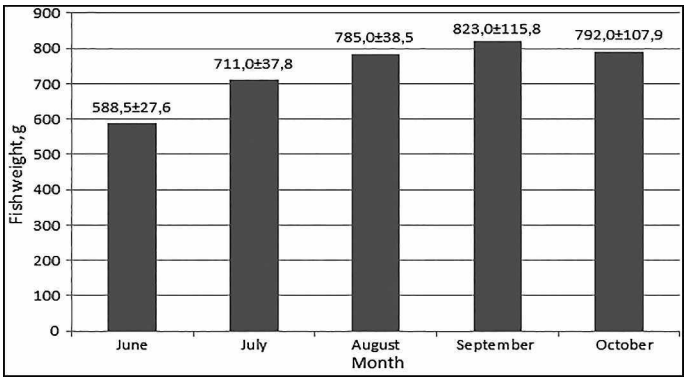

Figure 4 – The growth rate of pike.

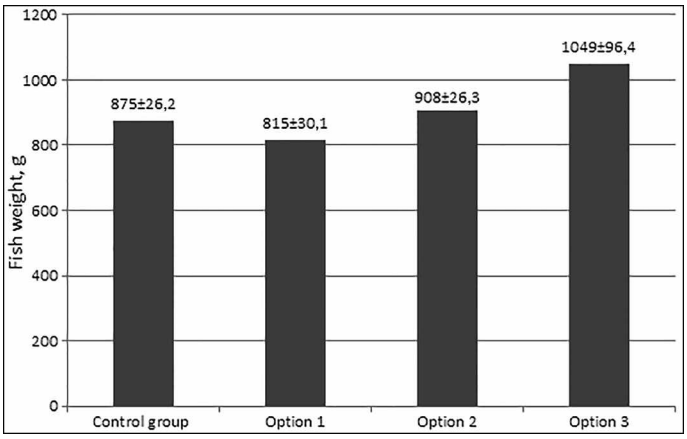

Figure 5 – Weight of Sterlet in the experimental and control groups.

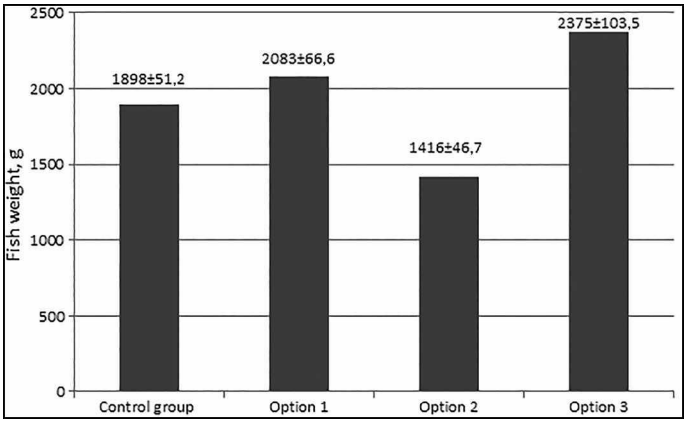

Figure 6 – Weight of Lena sturgeon in the experimental and control groups.

Using Chlorella suspension as feed additive for breeding fry Sterlet possible to increase survival by an average of 21,47 % (2,18 times) as compared to the standard feeding technology with feed of Coppens company without adding chlorella suspension. After 14 days, the average weight of fry Sterlet (4,562 g) exceeds was bigger on 1,77 times the mass of the fish grown by standard techniques using Coppens fish feed, which averaged 2,576 g.

The use of cage technology in the production of the sturgeon showed that when feeding fish with standard combined feed periods of increased body mass indices coincide with the most comfortable water temperature for fish. When grown Sterlet use of feed mixtures in the ratio of 50/50 % of combined feed and stuffing from invaluable fish though it gives economic effect, but the growth rate of the fish was still 7,0 % lower compared to their feeding with combined feed only. The best results were obtained in the third option, when feeding fish with a mixture consisting of 50 % of combined feed + 50 % of stuffing + 10 % of the Chlorella suspension. Using such mixtures allow having excess Sterlet average weight of 19,9 %, and sturgeon – by 25,1 % as compared with the control. In this final average weight of Sterlet was 1049±96,42 g (Figure 5), and the mass of the three-year Lena sturgeon was equal to 2375±103,54 g (Figure 6).

Impact the suspension of Chlorella like additive in integrated technology of aquaculture

Integrated cultivation of commercial fish and Muskovy ducks contributed the most complete utilization of the natural resources of the pond [7, 11, 12]. Co-growing of fish and birds reduced the cost of production of fish and gave meliorative effect. It is known that in an integrated aquaculture when roaming ducks or geese on fish ponds save up to 50–70 % of the feed, and thus the feces of birds serve as an excellent organic fertilizer and promote the development of the natural forage base of the pond [10].

Thus, the final mass of males receiving Chlorella in doses 60 and 100 mg/head was bigger at 6,0–10,8 % as compared with the control, while in females, this figures were 2,5–12,4 %, respectively (Table 2).

Studies have shown that the use of a suspension of Chlorella as a feed additive for growing juvenile Muskovy ducks

Table 2 – Growth rate of ducks using a suspension of Chlorella

Experience (option II, 60 mg/head, n = 100 animals)		Experience (option III, 100 mg/head, n = 100 animals)		Control (n = 100 animals)	
♂	♀	♂	♀	♂	♀
Age 1 week, weight (g)					
101,06±0,35	91,68±0,35	111,56±0,60	93,62±0,24	98,88±0,43	90,00±0,70
Age 2 week, weight (g)					
241,44±0,81	195,81±0,60	241,44±0,81	195,81±0,60	231,31±1,03	190,56±1,03
Age 3 week, weight (g)					
514,62±0,77	451,56±0,68	550,62±0,64	501,31±0,36	500,43±0,52	400,19±0,52
Age 4 week, weight (g)					
807,56±2,02	658,81±2,34	912,50±2,04	731,69±0,76	803,00±1,68	610,06±2,87
Age 5 week, weight (g)					
1135,00±0,59	904,39±1,10	1206,72±1,32	1082,72±0,83	1033,22±0,83	784,67±1,19
Age 6 week, weight (g)					
1586,91±3,06	1146,75±1,13	1611,75±1,02	1198,00±2,21	1478,31±3,85	1034,75±1,22
Gain for the period of growing in the greenhouse					
1485,85	1055,07	1500,20	1104,40	1379,43	944,80
Age 7 week, weight (g)					
1797,19±1,38	1301,38±1,18	1858,44±1,15	1344,38±1,52	1792,69±1,31	1291,56±0,86
Age 8 week, weight (g)					
1945,56±1,35	1443,62±0,84	2013,69±1,08	1476,56±2,83	1951,44±2,08	1432,25±2,49
Age 9 week, weight (g)					
2247,81±1,06	1588,94±1,14	2302,06±1,31	1601,44±1,28	2237,06±1,10	1559,50±5,71
Age 10 week, weight (g)					
2595,62±1,51	1693,81±0,54	2641,31±2,82	1729,25±0,95	2592,12±1,43	1691,62±1,02
Age 11 week, weight (g)					
2771,38±5,81	1733,62±1,79	2828,06±1,10	1752,88±4,54	2751,00±3,57	1742,69±1,62
Age 12 week, weight (g)					
3085,94±5,55	1808,38±4,51	3227,62±11,0	1982,00±2,80	2913,38±5,07	1763,94±2,23
Gain for the period of growing in the pond					
1288,75	507,00	1369,18	537,62	1120,69	472,38
The overall increace over the period of growing					
2984,88	1796,70	3116,06	1988,38	2814,50	1673,94

until the age of six weeks had a positive effect on their growth rate and when growing on the pond. Thus higher rates of mass had birds receiving Chlorella suspension at a dose of 100 mg/head. And the male Muskovy ducks had higher gains than females, due to their biological characteristics [12] (Table 2).

When grown in pond duck consume aquatic plants, shellfish, insects and larvae of other aquatic organisms, and therefore consumption of feed on growing them reduced by 35 % compared with conventional technology. At the same time as feed the ducks asked fodder flour, which is 3 times cheaper combined feed. This gives a significant economic effect on the growing of Muskovy ducks using such technology. Besides ducks, consuming higher aquatic plants, significantly reduce of number of aquatic plants on pond riverside and reduce the number of gastropods, which are the intermediate hosts for agents of fish diseases.

Discussion

Pasture technology allow to produce clean and cheap fish products without the use of artificial feeds. Considering that the fish uses a fully natural food base of the pond. This reduces the organic load on the pond and stored it trophic status.

Using of the suspension of Chlorella like food additive for fish shown better growth rate in raceways and cages. The use of such technology will reduce the cost of feeding fish with 0,152 $ to 0,07 $ per day. As a result, taking into account the resulting higher survival rate, saving 14 days of an experimental batch feeding

of 680 fish it amounted to 5,16 $. Taking into account the cost of rearing each batch of Sterlet economic effect of using of the results amounted to 7,59 $ per 1,000 farmed fish of the growing period of 14 days.

The use of the cage technology will reduce the cost of feeding fish from 1,35 € to 0,83 € per day. As a result, saving 50 days of feeding an experimental batch of fish was 26 €. In terms of all the quantities of fish for the period of its growing (150 days), the economic effect amounted to 300 €.

Thus, studies have shown that when grown Muskovy ducks on the pond together with the fish they consumed a considerable amount of natural food (plants and invertebrates), which contributed to their faster growth. This indicated a significant saving of feed for birds and economic suitability of doing integrated fish farming. The growth rate of the fish grown in polyculture in pond with ducks, were higher on average by 20 % compared to the same fish species composition grown on pasture technology, which can be explained as follows:

- in addition to the natural food base of the pond fish (carp) consume feces of Muskovy ducks, in which the percentage of combined feed reached 60 %;
- feces of ducks were organic fertilizers and stimulated the development of the natural food base for fish in the pond.

As a result of the proposed technology of integrated production of fish and ducks provided:

- saving combined feed, for production of ducks;
- decrease in production costs;
- increase the security of fish natural food;
- environmental cleanliness and safety of products;
- the possibility of selective removal of fish from the pond and ducks as they reach marketable weight.

The economic feasibility of the proposed technology in production is achieved through the rational use of bioresources of ponds to produce marketable products of fish and ducks and cost of combined feed used in the traditional production of fish and birds. The proposed technology will save up to 35 % of ducks feed compared with the standard technology of growing Muscovy ducks. Save money on the production of 1 ton of commercial products of Muscovy ducks could reach near 100 €.

Conclusion

Analysis of the research showed that reclamation ponds of Pripyat Polesie depending on the characteristics of hydrological, hydrochemical and hydrobiological regimes can be used for fishery purposes. In the ponds of this type it is advisable to use the pasture, cage and integrated aquaculture technology. This ensures that the environmental safety of production and economic benefits of technologies used.

- **References**

1. **AQUACULTURE** and Integrated Technologies: Challenges and Opportunities: Materials of international scientific-practical conference. 3 m. – M.: VNIIR, 2005. – 399/359/311 (RUS).
2. **ALEKIN O.A.** Guidelines for chemical analysis of surface waters / O.A. Alekin, A.D. Semenov, B.A. Skopintsev. – M.: Gidrometeoizdat, 1973. – 268 p. (RUS).
3. **BERNIKOV T.A.** Hydrology and hydrochemistry / T.A. Bernikov, A.G. Demidova. – M.: Food Industry, 1977. – 311 p. (RUS).
4. **GALASUN P.T.** Fish breeding and biological control in fish farms / P.T. Galasun. – M.: Food Industry, 1976. – 126 p. (RUS).
5. **DVORYANINOVA O.P.** The development of high-value food products based on aquaculture projects for the balanced nutrition of the population / O.P. Dvoryaninova, A.V. Sokolov // Modern problems of science and education. 2015. № 1-1. – P. 254–264 (RUS).
6. **ZHADIN V.I.** Methods of hydro-biological research / V.I. Zhadin. – M.: Higher School, 1960. – 189 p. (RUS).
7. **KISELEV I.A.** Plankton seas and inland waters / I.A. Kiselev. – L.: Leningrad Science. Div., 1969. – Vol. 1. – P. 24–51 (RUS).
8. **KOZLOV A.I.** The first experience of cage rearing sturgeon (Acipenseridae) in the waters of the Pripyat floodplain reclamation / A.I. Kozlov, T.V. Kozlova, A.V. Shashko, O.A. Glushakov, V.G. Agavelov, V.P. Sholomitskij, I.N. Deyneko // Sustainable economic development: state, problems and prospects: mat. IV Intern. nauch.-pract. conf. – Pinsk: Polessky State University, 2010. – P. 192–194 (RUS).
9. **KONCHITS V.V.** Integrated fish farming and farm animals as an example of selection – breeding farm «Izobelino» / V.V. Konchits // Aquaculture. Resource conservation in commercial fish farming. Integrated fish farming. – Minsk, 1999. – P. 54–57 (RUS).
10. **KOZLOVA T.V.** The first experience of using musk ducks in integrated aquaculture pond in the reclamation of the Pripyat Polesye / T.V. Kozlova, A.I. Kozlov, M.V. Shalak, O.A. Glushakov // Agricultural fish breeding: development opportunities, and scientific support for innovative technologies. International scientific-practical conference on 5–7 Sept. 2012. Reports / GNU VNIIIR, RAAS. – M.: Publisher RGAU-ICCA, 2012. – P. 155–162 (RUS).

11. **KOZLOVA T.V.** Integrated fish farming technology using musk ducks and suspension of chlorella on reclamation pond / T.V. Kozlova, A.I. Kozlov, T.A. Lupoli // Realizari si perspective in zootehniesi biotehnologii: Lucrari stiiintifice. – Vol. 34 «Zootehnie si Biotehnologii. – Chisinau, 2013. – P. 421–425 (RUS).
12. **KOSYANENKO S.V.** Muscovy duck on a farmstead / S.V. Kosyanenko. – Minsk: Ed. LLC «Krasiko-Print», 2002. – 108 p. (RUS).
13. **MITROPOLSKY V.I.** Macrobenthos / V.I. Mitropolsky, F.D. Mordukhai-Boltovskoi // Methods of study of inland waters ecosystems. – M., 1975. – P. 158–170 (RUS).
14. **NIKITIN B.P.** Fish products / B.P. Nikitin. – M.: Food Industry, 1968. – 342 p. (RUS).
15. **KOZLOV A.I.** Resource saving technology of hculture for Reclamative Water reservoirs / A.I. Kozlov, T.V. Kozlova, I.V. Bubyr, N.M. Raylyan // European Science and Technology: materials of the VIII international research and practice conference. – Munich: Vela Verlag Waldkraiburg, 2014. – P. 21–29.

Educational Establishment Polessky State University
(E-mail: natali-rigo@rambler.ru)

Рецензент В.К. Ризевский **Поступила 23.08.2016**

А.І. Казлоў, Т.В. Казлова, Н.Г. Кручынскі, Г.А. Райлян, Н.П. Дзмітровіч, Н.М. Райлян
НІЗКАЗАТРАТНЫЯ ТЭХНАЛОГІІ АКВАКУЛЬТУРЫ ДЛЯ МЕЛІЯРАЦЫЙНЫХ ВАДАЁМАЎ

Пры вядзенні нагульнай аквакультуры ў якасці пасадкавага матэрыялу выкарыстоўвалі гадавікоў шчупака, двухгадавікоў карпа, белага амура і пярэстага таўсталобіка. Па заканчэнні эксперыменту (кастрычнік) трохгодкі карпа мелі сярэднюю масу 1054,5±66,4 г, белы амур – 1071,0± 112,8 г, пярэсты таўсталобік дасягнуў сярэдняй масы 718,5±128,5 г, а шчупак – 792,0±107,9 г, што сведчыць аб мэтазгоднасці прымянення такога роду пасадкавага матэрыялу пры вядзенні нагульнай аквакультуры. Вырошчванне асятровых рыб у латках з выкарыстаннем суспензіі хларэлы як кармавой дабаўкі дазволіла павысіць выжывальнасць малькоў сцерлядзі у сярэднім на 21,47 % (у 2,18 разоў) і забяспечыць павелічэнне сярэдняй масы ў 1,77 разоў у параўнанні са стандартнай тэхналогіяй кармлення кармамі фірмы «Копенц» без дадання суспензіі хларэлы. Вырошчванне асятровых рыб у садках з выкарыстаннем у якасці дадатку да кармоў суспензіі хларэлы забяспечвае павелічэнне сярэдняй масы сцерлядзі і ленскага асятра. Найлепшыя вынікі былі атрыманы пры кармленні рыб сумессю, якая складаецца з 50 % камбікорму + 50 % фаршу + 10 % хларэлы. Выкарыстанне такой сумесі дазволіла атрымаць перавышэнне сярэдняй масы сцерлядзі на 19,9 %, а асятроў – на 25,1 % у параўнанні з кантролем. Атрыманы станоўчыя вынікі пры вытворчасці таварнай рыбы сумесна з мускуснай качкай. Даследаванні паказалі, што таварная маса самцоў мускуснай качкі, якія атрымлівалі хларэлу ў дозах 60 і 100 мг/гол, перавышала кантрольныя паказчыкі на 6,0–10,8 %, а таварная маса самак – на 2,5–12,4 %. Пры гэтым больш высокія паказчыкі масы мелі птушкі, якія атрымлівалі суспензію хларэлы ў дозе 100 мг/гол. Акрамя таго качкі, спажываючы вышэйшую водную расліннасць, значна зніжалі колькасць вышэйшай воднай расліннасці прыбярэжнай паласы вадаёма і памяншалі колькасць бруханогіх малюскаў, якія з'яўляюцца прамежнымі гаспадарамі захворванняў рыб.

А.И. Козлов, Т.В. Козлова, Н.Г. Кручинский, Г.А. Райлян, Н.П. Дмитрович, Н.М. Райлян
НИЗКОЗАТРАТНЫЕ ТЕХНОЛОГИИ АКВАКУЛЬТУРЫ ДЛЯ МЕЛИОРАТИВНЫХ ВОДОЕМОВ

При ведении нагульной аквакультуры в качестве посадочного материала использовали годовиков щуки, двухгодовиков карпа, белого амура и пестрого толстолобика. По окончании эксперимента (октябрь) трехлетки карпа имели среднюю массу 1054,5±66,4 г, белый амур – 1071,0± 112,8 г, пестрый толстолобик достиг средней массы 718,5±128,5 г, а щука – 792,0±107,9 г, что свидетельствует о целесообразности применения такого рода посадочного материала при ведении пастбищной аквакультуры. Выращивание осетровых рыб в лотках с использованием суспензии хлореллы как кормовой добавки позволило повысить выживаемость мальков стерляди

в среднем на 21,47 % (в 2,18 раза) и обеспечить увеличение средней массы в 1,77 раза по сравнению со стандартной технологией кормления кормами фирмы «Копенц» без добавления суспензии хлореллы. Выращивание осетровых рыб в садках с использованием в качестве добавки к кормам суспензии хлореллы обеспечивает увеличение средней массы стерляди и ленского осетра. Наилучшие результаты были получены при кормлении рыб смесью, состоящей из 50 % комбикорма + 50 % фарша + 10 % хлореллы. Использование такой смеси позволило получить превышение средней массы стерляди на 19,9 %, а осетров – на 25,1 % по сравнению с контролем. Получены положительные результаты при производстве товарной рыбы совместно с мускусной уткой. Исследования показали, что товарная масса самцов мускусной утки, получавших хлореллу в дозах 60 и 100 мг/гол, превышала контрольные показатели на 6,0–10,8 %, а товарная масса самок – на 2,5–12,4 %. При этом более высокие показатели массы имели птицы, получающие суспензию хлореллы в дозе 100 мг/гол. Кроме того утки, потребляя высшую водную растительность, значительно снижают зарастаемость прибрежной полосы водоема высшей водной растительностью и уменьшают численность брюхоногих моллюсков, являющихся промежуточными хозяевами заболеваний рыб.

СОДЕРЖАНИЕ

ЗМЕСТ

CONTENTS