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Technology of cultivation of feeder fish for culturing tilapia (*Tilapia*) and clarid catfish (*Clarias gariepinus*) in the VI fish-breeding zone of Kazakhstan

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Abstract
The article presents the results of cultivation of nekton-benthic crustaceans of the species of mysid (Paramysis) and shrimp (Palaemon modestus) for culturing tilapia (Tilapia) and clarid catfish (Clarias gariepinus) in the VI fish-breeding zone of Kazakhstan. Cultivation of feeder fish was carried out in basins on artesian water with heating. Both cultures developed rapidly during cultivation. When evaluating and comparing these cultures, the shrimp (Palaemon modestus) showed the best properties when feeding fish with them in terms of such indicators as palatability, gain and feeding ratio. The calculation of economic efficiency was performed on juveniles of clarid catfish, as it is more demanding to feeder fish. The lowest primary cost values for the “price - quality ratio” indicator were noted when using shrimp (Palaemon modestus) as a feeder fish.

Keywords: cultivation, mysid, shrimp, aquaculture, tilapia, clarid catfish, gain, feeding ratio

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INTRODUCTION

The development of domestic aquaculture is one of the priority areas of fisheries management in Kazakhstan. According to the program of development of the agro-industrial complex of Kazakhstan for 2017-2021, the production of commercial fish in the country should increase to 5000 tons by 2021. Kazakhstan reached these indicators in 2018, so 5,7 thousand tons of fish were grown in aquaculture (State program for the development of the agro-industrial complex of the Republic of Kazakhstan for 2017-2021). At the moment, a state program for the development of fisheries until 2030 is being developed, where it is planned to increase the production of aquaculture to 50,000 tons. With this intensive development of aquaculture, the need for fish feed will increase several times in the future. In this regard, research on improving existing technologies for the cultivation of feeder fish is very relevant and in demand at fish-breeding enterprises in Kazakhstan. First of all, this is due to the availability of feeder fish for domestic agricultural producers, the possibility of their cultivation in the production conditions of farms. To do this, it is necessary to develop and implement technologies for cultivating various types of feeder fish directly on fish farms.

When growing fish in artificial conditions, the feed used must fully meet the needs of the fish body in nutrients (proteins, fats and carbohydrates), mineral salts, trace elements and vitamins. At different stages of development of hydrobionts, food should be of the appropriate size and shape and not have toxic properties. An important stage in the life of many fish is the transition to independent nutrition. Fish are particularly demanding to feed at the early stages of ontogenesis and feeder fish is preferred for normal development and optimal growth of larvae and juveniles of cultured fish (Ostroumova 2012, Ponomarev et al. 2013, Yarzhombek et al. 1986).

In the practice of world aquaculture with the culturing of juveniles of valuable fish species are widely used a starter feeder fish. Improvement of technological schemes for the cultivation of crustaceans as a starter feed for culturing fish juveniles, despite the existing development of artificial mixed feed of domestic production (Shalgimbayeva et al. 2016), does not lose its relevance in connection with the further development

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of fish breeding and the transition to industrial methods of culturing fish.

With the development and intensification of fish breeding, there is an urgent need to develop effective technologies for culturing various species of fish. Tilapia and clarid catfish are one of the most promising non-traditional objects of industrial cultivation in Kazakhstan.

The most important aspect of the development of tilapia and clarid catfish breeding technology is the study of their nutritional needs and the selection of highly effective feeds on this basis. The most critical period in the breeding process, as with all fish, is the transition of tilapia and clarid catfish larvae to exogenous nutrition and further growth to a viable stage. In this regard, starter feeds in the diet of these fish are of particular interest (Fattolakhi 2006, Tetdoyev 2007, Zharkenov et al. 2017).

MATERIAL AND METHODOLOGY

The objects of cultivation were nekton-benthic crustaceans of the species mysid (*Paramysis)* and shrimp (*Palaemon modestus*). Literary data from foreign authors were used for cultivation (Materials of the all-union meeting on the cultivation of feeder fish 1970, Vorobyova 1988, Kiyashko 2016).

Taking into account that local species were selected as objects of cultivation, harvesting of stock culture was carried out on local reservoirs. Collected hydrobionts were transported to the place of cultivation and sorting and further distribution was carried out on the site.

Cultivation of mysids and shrimps was carried out in basins with parameters 221*150*43 cm, located in the incubation shop of “Kapshagay spawning and culturing farm-1973” LLP, VI fish breeding zone of Kazakhstan. Water from an artesian well was used for cultivation. In the basins, the conditions did not differ, since a single water source was used and the flow rate was maintained at the same level. The thermal regime in the basins was taken into account daily. To study the biology of cultures and determine their biomass in the basins, samples were taken monthly (using a net from a gas sieve # 14GG-1600 μm, with an area of 1 m^2 at 6 sampling points) in the zone of their accumulation. The volume of removed products of cultures grown under different conditions was determined by direct weighing after removing excess moisture through a nylon sieve.

Cultivation of feeder fish was carried out on manure pump, detritus, milled conferva, hydrolysis yeast, pumpkin and carrot-cucumber puree. Feeding of crustaceans was carried out 1 time a day. Determination of the daily supply mysid and shrimp was carried out by observations (feed priorities were determined by the palatability).

Evaluation of the effectiveness of the use of products of cultivated crustacean species as feeder fish was carried out using fish-breeding and biological parameters of juveniles of clarid catfish (*Clarias gariepinus*) and tilapia (*Tilapia*) (Privezentsev 2008, Privezentsev et al. 2006, Peteri et al. 2015, Zaki and Abdul 1983). Culturing fish juveniles when feeding with feeder fish was carried out in basins, also located in the incubation shop of “Kapshagay spawning and culturing farm-1973” LLP. Determination of fish-breeding and biological parameters of juveniles of clarid catfish and tilapia was carried out using generally accepted methods (Pravdin 1966, Kozlov et al. 2006, Collection of regulatory and technological documentation for commercial fish farming 1986). During the work period, the thermal and oxygen conditions of basins with feeder fish and fish juveniles were monitored using the MARK-302E thermooximeter.

The economic efficiency of feeding juveniles of clarid catfish and tilapia was evaluated using a special method (Al-Seeni et al. 2017, Fedorov et al. 2013).

Fig. 1. Collection and transportation of the mysid culture (*Paramysis*) from the Kapshagay reservoir shoreline

RESEARCH RESULTS

For the cultivation of mysid (*Paramysis*), 2 trips were made to the Kapshagay reservoir in the Almaty region to collect the stock culture.

Mysid was caught using a nekton-benthic trawl in different areas and depths of the Kapshagay reservoir. The culture was transported in plastic barrels of 85 liters and live-fish bags with oxygen supply (**Fig. 1**).

The collected stock culture of mysid was transported to the base located in the incubation shop of “Kapshagay spawning and culturing farm-1973” LLP, where sorting and distribution was carried out in the basins. The appearance of the mysid (*Paramysis*) is shown in **Fig. 2**.

Collection of shrimp (*Palaemon modestus*) was carried out in the shallow part of the heating pond of “Kapshagay spawning and culturing farm-1973” LLP, using two methods:

- collecting shrimp culture in the daytime by netting at the bottom of the pond. The captured individuals were concentrated in a bucket, then transferred to the

Fig. 2. Mysid *Paramysis* species

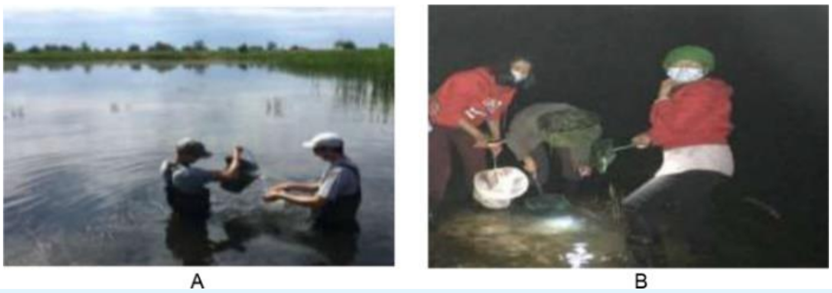

Fig. 3. Mysid *Paramysis* species

Fig. 4. Shrimps (*Palaemon modestus*)

Fig. 5. Basins for the cultivation of nekton-benthic crustaceans

workshop, where they were sorted and distributed among the basins (**Fig. 3A**);

- collecting shrimps in the dark using light, as individuals of shrimps have a positive phototaxis (**Fig. 3B**).

Shrimp collection during the day was carried out for 4 days, from 09:00 to 10:30. At night, the collection was also held for 4 days, from 21:00 to 22:30. The most effective was the collection of shrimp culture at night, mainly caught large females with eggs, harvesting of young individuals was carried out in the daytime.

The appearance of the shrimp (*Palaemon modestus*) is shown in **Fig. 4**.

Cultivation of feeder fish was carried out in stretch plastic basins (**Fig. 5**). Planting density of mysids (*Paramysis*) in pools of 15 000 pcs/m^2. The planting density of shrimps (*Palaemon modestus*) in basins is 1 500 pcs/m^2.

To simulate natural conditions for cultures, sections of plastic pipes and hoses were installed in the basins for shelter during and after molting. Additional aeration was also installed to maintain optimal oxygen performance. Thermoregulators were installed to heat the water, given that the water source was an artesian well with a constant water temperature of 18°C.

Cultivation of mysids and shrimps was carried out on manure pump, detritus, milled conferva, hydrolysis yeast, pumpkin and carrot-cucumber puree (**Fig. 6**). Feeding was carried out 1 time a day. The best growth and fecundity in cultivated objects were observed with mixed nutrition on different nutrient media.

Fig. 6. Appearance of vegetable puree for feeding benthic crustaceans

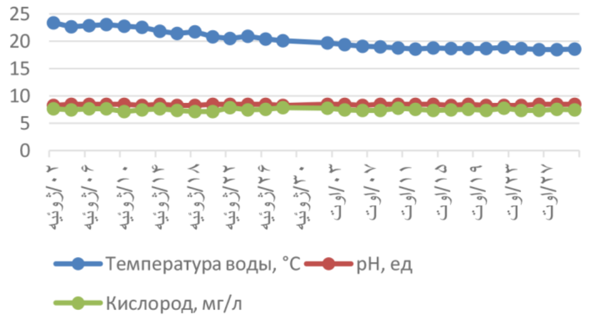

Fig. 7. Results of monitoring the main hydrochemical parameters in the cultivation of mysids (*Paramysis*) and shrimps (*Palaemon modestus*) in the basin

In natural conditions, the basis of food for both small and large shrimps was half-decomposed plant remains and bottom detritus. In the composition of the shrimp feed were mostly filamentous algae, well consumed pumpkin puree. The main part of the mysid feed was occupied by the milled conferva and hydrolyzed yeast, which they were fed. The study of the daily food rhythm of cultivated objects showed that the juvenile feed during the day with the same intensity. Adults consume food during daylight hours (from 7 am to 8 pm) more intensively than at night. From the fish-breeding point of view, the ability of shrimps to eat conferva and vegetable puree, and mysid - feed yeast, is essential. The difference in the feeding spectra of mysids and shrimps cultivated in basins, which we have noted, provides a basis for recommending the joint introduction of these forage crustaceans to ponds.

In the cultivation of shrimps and mysids in the basins, the conditions are not distinguished as it was used one source of water and the flow was maintained at the same level. During the cultivation period, the thermal regime was taken into account daily in the basins where forage crustaceans were cultivated. The results of hydrochemical analysis of water are shown in **Fig. 7**. According to the data obtained, the temperature regime of water in the basins ranged from 18.0-24.2°C, on average 21.5°C, the active reaction index of the medium ranged from 8.5-8.7 units, the content of oxygen dissolved in water was maintained at the level of 7.7 mg/l on average, while fluctuating in the range of 6.9-7.8 mg/l.

Table 1. Results of the cultivation of mysids (*Paramysis*) in basins

Indicators	basins	
	№ 1	**№ 2**
The duration of cultivation, days	75	
Daily production, g/m^2		
average	7.1	6.5
minimum	1.3	1.3
maximum	28.0	25.0
Intensive development, days from the beginning of cultivation	25	25
The attenuation of culture, days from the implementation	not observed	

Table 2. Results of the cultivation of shrimps (*Palaemonmodestus*) in basins

Indicators	basins	
	№ 3	**№ 4**
The duration of cultivation, days	75	
Daily production, g/m^2		
average	10.1	11.0
minimum	1.7	3.3
maximum	45.7	51.7
Intensive development, days from the implementation	30	30
The attenuation of culture, days from the implementation	not observed	

Data were also collected on the daily production of mysid and shrimp cultures, and the state of the artificial population of both cultures was analyzed, the results are presented in **Tables 1** and **2**.

The daily production of mysids in basins averaged 6.8 g/m^2, which is the lowest indicator in comparison with other methods. However, it should be noted that when the water temperature decreased in the autumn period, the cultivation of mysids continued, and therefore this aspect requires additional research in the winter period, since cultivation within this topic was carried out only during the warm growing season.

Shrimp cultivation in the basins produced an average daily production of 10.01 g/m^2, which is also the lowest rate among all methods of shrimp cultivation. In shrimps, as well as with mysid cultures, there was no decrease in the number in the autumn period, which gives reason to continue research on the cultivation of this species in the winter period (**Table 3**).

During the initial period of mysid cultivation, there was a slight increase in the minimum size of mature individuals, which seems to be determined by the absence of new generation of adult crustaceans at the time of sampling. Remains relatively stable average fertility of mysids throughout the cultivation period in the basins. The sex ratio also has a non-uniform structure,

Table 3. Indicators of the state of culture of mysids (*Paramysis*) and shrimps (*Palaemon modestus*) in basins

Indicators	Mysids			Shrimps		
	Females	Males	Juveniles	Females	Males	Juveniles
Fertility, u						
average	17	-	-	79	-	-
oscillation	11-45	-	-	69-98	-	-
Weight, mg						
average	8.6	6.3	1.5	391.0	393.3	26.5
minimum	7.8	1.9	-	266.7	382.5	5.5
maximum	9.0	6.8	-	588.8	403.2	59.0
Length, mm						
average	7.5	5.6	2.20	32.1	31.0	15.4
minimum	3.8	5.7	2	29.2	30.9	15.4
maximum	12.5	6.4	2.5	37.8	39.0	19.5

Table 4. Comparative fish-breeding and biological data on the results of the use of products from different cultures of forage crustaceans when feeding tilapia juveniles up to a weight of 0.9 mg

Parameters	Mysid	Shrimp
Feeding period, days	20	
Planting density, thousand pcs/m^3	1.2	
Initial mass, mg (x±m)	510±3.5	509±2.54
Final mass, mg (x±m)	910.8±5.5	920.5±3.25
Survival rate,%	93.2	91.5
Absolute gain, mg	400.8	411.5
Average daily gain, mg	20.4	20.6
Feeding ratio, units	5.3	5.0
Palatability, %	90	95
Rating place	2	1

and depends on the timing of cultivation. Thus, during the period of culture dispersal, there was a slight predominance of males over females (♂♂:♀♀ - 1:0,9). Maximum number of females (♂♂:♀♀ - 1:4,2) was noted during the breeding outbreak, the basis of their number was females with eggs (81%). At the time of sampling and conducting research on the structure of the artificial shrimp population in the basins, the maximum concentration was characterized by the period from July 15 to August 30 - 29 pcs/m^2, the decrease in concentration by the end of cultivation was insignificant and amounted to 24 pcs/m^2. The sex ratio in the shrimp population was stable throughout cultivation (♂♂:♀♀ - 1:3,1) with a predominance of females. In the period from July 10 to August 10 (cultivation outbreak), egg-bearing females averaged 82% of the total number of females in the basin, varying in timing from 25 to 88%. This structure of the shrimp population indicates an extension of the breeding period in artificial conditions due to the stable water temperature in the basins (18.0-24.2°C).

Experiments on testing of the product as the starter feeder fish were conducted on juveniles of tilapia and clarid catfish. The average weight of clarid catfish juveniles when feeding with mysid and shrimp cultures was 0.6 mg, the average weight of tilapia juveniles was 0.5 mg. Mysid and shrimp were set in a form ground to a homogeneous substance (paste). Culture production was set every 2 hours, and artificial feed was applied when the juvenile reached 1 g. The obtained fish-breeding and biological data of tilapia and clarid catfish

Table 5. Comparative fish-breeding and biological data on the results of the use of products from different cultures of forage crustaceans when clarid catfish juveniles up to a weight of 0.9 mg

Parameters	Mysid	Shrimp
Feeding period, days	20	
Planting density, thousand pcs/m^3	1,2	
Initial mass, mg (x±m)	617±2.1	617±2.3
Final mass, mg (x±m)	910.8±3.5	920.5±2.2
Survival rate,%	94.4	91.5
Absolute gain, mg	293.8	303.5
Average daily gain, mg	14.7	15.17
Feeding ratio, units	5.2	4.9
Palatability, %	98	100
Rating place	2	1

juveniles when feeding with shrimp and mysid culture products are presented in **Tables 4-5**.

When feeding tilapia larvae with feeder fish, the shrimp culture was ranked first in terms of such indicators as palatability, gain and feeding ratio. When using starter live feeder fish, tilapia juvenile showed a normative gain and high survival rate at this stage. However, it is worth noting that the tilapia juvenile, by virtue of the structure of their oral apparatus, were more willing and better at eating planktonic crustaceans at this stage.

However, it is worth noting that as the clarid catfish larvae grow, they switch to bottom feeding and at this stage, the shrimp culture, ground to a homogeneous mass on a coffee grinder (shrimp paste), has proven itself well. The palatability of shrimp paste was 100% and the gain at this stage was 15-17 mg/day. Also, when comparing the shrimp and mysid paste used at the same time, it should be noted that the indicators of gain and feeding ratio also indicate the feasibility of using shrimp at this stage of development.

As a result of culturing clarid catfish and tilapia juveniles using feeder fish, generally positive results were obtained. This experiment confirmed the possibility of using crustacean culture products as an effective starter feed for culturing juveniles of valuable fish species, such as tilapia and clarid catfish.

The calculation of the economic efficiency of the use of cultivated crustacean species was carried out on the example of feeding juveniles of clarid catfish, since the clarid catfish is more demanding to feeder fish at the early stages of development. The results of calculations for feeding juveniles of clarid catfish with mysids and shrimps in a comparative aspect are presented in **Table 6**.

The lowest values of the primary cost in terms of the “price-quality ratio” were noted when using shrimp as a feeder fish. In terms of the “price-quality” ratio, the cost of clarid catfish juveniles, as well as tilapia juveniles grown using shrimp as food, was more cost-effective. The share of feed costs in the total primary cost when using shrimp is 91.85%. This is due to the high primary cost of the feed crustaceans used. For shrimp, the share

Table 6. Economic efficiency of culturing juveniles of clarid catfish (*Clarias gariepinus*) with various feeding options for nekton-benthic forage crustaceans (mysid (*Paramysis*) and shrimp (*Palaemon modestus*))

Indicators	Experiment options	
	mysid (*Paramysis*)	shrimp (*Palaemon modestus*)
The content of production means (technological equipment), tenge/m^3 of basins Feed cost, tenge/m^3 of basins	69049.00	69049.00
Cost of electricity and water consumption, tenge/m^3 of basins	174.47	174.47
The cost of planted juveniles of clarid catfish, tenge/m^3 of basins	60000.00	60000.00
Feed cost, tenge/m^3 of basins	1521424.44	136996.20
Salary fund for operators of a basin workshop, tenge/m^3 of basins	5791.47	5791.47
Total costs, tenge/m^3 of basins	1656439.38	272011.14
Number of juveniles, pcs/m^3 of basins	2940	3000
The cost of cultured juveniles, tenge/pcs	563.41	90.67
Final weight, g	0.910	0.920
The ratio of “price – quality”, tenge/g	48.57	6.87
Rating place	2	1

of feed costs in the total cost of production is 50.36%, which is due to its lower price.

The optimal cost of clarid catfish juveniles as of 2019 is 0.60 tenge/g. At this cost of clarid catfish juveniles, feeding juveniles with crustaceans is unprofitable.

In the practice of fish breeding in Kazakhstan, feeding juveniles with crustaceans is used when culturing early juveniles at fish-breeding enterprises, and then not at all. These aquaculture facilities have a high consumer cost, the duration of feeding juveniles with crustaceans is a maximum of 7-10 days, while in our experiments - 30 days, with a relatively low consumer cost of clarid catfish. Experiments should be continued to address the issues of the duration of feeding fish juveniles with crustaceans. The task of fish farmers in this situation is to gradually increase the biomass of crustaceans on farms, in parallel with the creation of breeding herds of tilapia and clarid catfish. At the first stages of establishing a fishing business, it is necessary to use your own funds. Only in this case, this business will be profitable and payback.

CONCLUSION

In the cultivation of nekton-benthic crustaceans it was revealed that the cultivation of mysids in basins less effectively than the cultivation of shrimps. The content in the basin conditions, the water supply of which was made from an artesian well (18°C), worsened the condition of the mysids. The lack of natural feed, water heating, and oxygen regulation could not have a proper effect on its growth and development when cultivated in basin conditions.

When cultivating shrimps, all conditions of keeping them in the fish farm were acceptable for them. In the basin conditions, the shrimp developed well. When the basin content to the created conditions (water heating and artificial feeding) adapted easily, the waste was isolated.

When comparing both cultures, the following conclusion is made:

- in the conditions of basins, the shrimp proved to be more productive in comparison with the mysid culture.

Experiments were conducted on the effectiveness of using starter feeder fish for culturing tilapia and clarid catfish juveniles in basin conditions.

When feeding juveniles of tilapia and clarid catfish with nekton-benthic crustaceans ranked first place was the culture of shrimp, as when feeding juveniles of tilapia indicators such as palatability, gain and feeding ratio were best, while at juveniles of clarid catfish, indicators of feeding ratio and gain were the best. It should also be noted that the clarid catfish in connection with the transition to bottom feeding well ate nekton-benthic crustaceans. The results obtained on the conditions of cultivation and maintenance of feeder fish can be recommended for implementation in the scheme of activities of fish farms for culturing fish-planting material of valuable fish species.

The use of starter feeder fish is a profitable activity at a fish-breeding enterprise. Fish farmers in this situation will gradually increase the volume of cultivated crustaceans, use them on the farm, eliminating or reducing the cost of purchasing artificial starter mixed feed.

Despite the fact that at present the experience of producing feeder fish on fish farms in the Republic of Kazakhstan is reduced to isolated cases, the development and improvement of technologies for cultivating feeder fish as starter feed must continue. The development of technological standards for culturing juveniles of valuable fish species using feeder fish will strengthen the production capabilities of fish farms and will have a direct impact on increasing the volume and reducing the cost of fish products produced in the country.

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