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Efficiency of pond rearing of juvenile carp with an initial weight of 10 grams when fed with granulated feed in the Republic of Iraq

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Abstract. The effectiveness of pond cultivation of juvenile common carp with an initial weight of 10 grams was studied in the Central Fish Hatchery of Essaouira (Wasit province, Republic of Iraq). The research material is presented by juvenile common carp with an initial weight of 10 grams (2 100 specimens), divided into 3 replicas of 700 specimens. The cultivation of juvenile carp was carried out for 90 days in three earthen ponds with an area of 0.2 hectares with direct running water supply with fresh water from the Tigris River. The young carp were fed with granular compound feed containing 18 MJ of exchangeable energy and 32% of crude protein. Control catches with the study of juveniles were carried out on the 21st, 42nd, 63rd and 90th days from the beginning of cultivation. Fish-breeding, biological, economic and statistical indicators of cultivation were determined by generally accepted methods. The survival rate of juveniles during the first stage of cultivation (from the 1st to the 21st days) was the lowest – 88.67 ± 0.55%, however, in the following stages it stabilized in the range of 98.77-99.45%. The preservation rate of fish for 90 days of cultivation was 86.24 ± 0.13%. Morphological parameters of juvenile carp were characterized on the 90th day of cultivation by a body weight of 267.29 ± 5.23 g, a total body length of 24.83 ± 0.01 cm, a fatness coefficient of 1.75 ± 0.03. Fish productivity of ponds for 90 days of juvenile cultivation was 771.85 ± 16.82 kg/ha. The efficiency of converting feed into an increase in fish biomass was maximum at the first stage of cultivation, gradually decreasing at the next stages. The feed conversion coefficient for the entire growing period was 1.95 ± 0.07. The cost of reared juveniles amounted to 25,953.03 Russian rubles or 426,148.75 Iraqi dinars per 1 hundredweight. The costs of working capital and amortization of fixed assets turned out to be the largest in the cost structure – 55.75 and 20.21%, respectively. The results of the performed research can be used in the cultivation of fish-planting material of common carp at fish-breeding enterprises in Iraq.

Keywords: common carp, juveniles, cultivation, fish productivity, cost value

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Научная статья

Эффективность прудового выращивания молоди карпа начальной массой 10 г при кормлении гранулированным кормом в Республике Ирак

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Аннотация. Эффективность прудового выращивания молоди карпа обыкновенного начальной массой 10 г исследовали в Центральном рыбоводном питомнике Эс-Сувейре (провинция Васит, Республика Ирак). Материал исследования представлен молодью карпа обыкновенного начальной массой 10 г (2 100 экз.), разделенной на 3 повторности по 700 экз. Выращивание молоди карпа выполняли в течение 90 дней в трех земляных прудах площадью 0,2 га при прямоточном водоснабжении пресной водой из р. Тигр. Молодь карпа кормили гра-

нулированным комбикормом, содержащим 18 МДж обменной энергии и 32 % сырого протеина. Контрольные обловы с исследованием молоди проводили на 21, 42, 63 и 90 день от начала выращивания. Рыбоводно-биологические, экономические и статистические показатели выращивания определяли общепринятыми методами. Выживаемость молоди на первом этапе выращивания (с 1 по 21 дни) была наименьшей – 88,67 ± 0,55 %, однако на следующих этапах стабилизировалась в диапазоне 98,77–99,45 %. Сохранность рыбы за 90 дней выращивания составила 86,24 ± 0,13 %. Морфологические показатели молоди карпа характеризовались на 90 день выращивания массой тела 267,29 ± 5,23 г, общей длиной тела 24,83 ± 0,01 см, коэффициентом упитанности 1,75 ± 0,03. Рыбопродуктивность прудов за 90 дней выращивания молоди составила 771,85 ± 16,82 кг/га. Эффективность конвертации корма в прирост биомассы рыбы была максимальной на первом этапе выращивания, постепенно снижаясь на следующих этапах. Коэфициент конвертации корма за все время выращивания составил 1,95 ± 0,07. Себестоимость выращенной молоди составила 25 953,03 руб., или 426 148,75 иракских динаров за 1 ц. Затраты на оборотные фонды и амортизацию основных фондов оказались в структуре себестоимости наибольшими – 55,75 и 20,21 % соответственно. Результаты выполненного исследования могут быть использованы при выращивании рыбопосадочного материала карпа обыкновенного на рыбоводных предприятиях Ирака.

Ключевые слова: карп обыкновенный, молодь, выращивание, рыбопродуктивность, себестоимость

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Introduction

Pond fish farming is a primary sector of aquaculture established in Iraq, in conjunction with fish farming in floating cages and recirculating systems. Aquaculture development in Iraq commenced in 1956 with the introduction of cultured species, including carp, tilapia, and rainbow trout, at the Al-Zafarania fish farm. Consequently, both public and private aquaculture facilities appeared across several provinces of Iraq, with the number of farms fluctuating between 1 600 and 2 700 at different intervals. The yearly output quantities of pond fish in Iraq have consistently risen: from 1980 to 2000, production remained below 2-4 thousand tons, however from 2005 to 2019, it escalated to 17-21 thousand tons. The aquaculture system in earthen ponds use semi-intensive polyculture technology. The predominant species farmed in pond aquaculture are common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), and grass carp (*Ctenopharyngodon idella*) [1].

Investigations into the aquaculture system in earthen ponds in Iraq concentrate on examining the present condition and future potential of pond fish farming in designated provinces [2], the efficacy of common carp cultivation within and outside cages situated in earthen ponds [3], the aquaculture practices and biological metrics of diverse carp groups [4], and the impact of various feed types on the growth rate and survival of carp larvae [5].

The progress of technology for cultivating common carp fingerlings is crucial for the future expansion of pond aquaculture in Iraq; nevertheless, the efficacy of rearing carp juveniles of different sizes has not been extensively investigated.

This study aims to evaluate the efficacy of raising common carp juveniles from an initial weight of 10 grams to the fingerling stage in earthen ponds, utilizing pellet feed, in central Iraq.

Materials and methods of research

The research was carried out in the Central Fish Hatchery in Al-Suwayrah, Wasit Province, Republic of Iraq, from July to October 2023. The hatchery, constructed by a Hungarian firm in the 1980s, has fish breeding ponds, a production laboratory, and administrative facilities.

The research focused on one-month-old common carp (*Cyprinus carpio*) fingerlings, averaging 10 g in body weight. A total of 2 100 fingerlings were allocated across three ponds, with 700 individuals in each pond.

The fingerlings were cultivated in earthen ponds covering an area of 2 000 m². To improve the natural food substrate, organic fertilizers (cattle dung at 400 kg/ha) were utilized before to the commencement of raising. The ponds were initially filled with freshwater from the Tigris River to a level of 0.2 m, which was subsequently elevated to 1 m after a duration of 10 days. The physicochemical properties of the water were assessed everyday.

The health of the fish was monitored via visual evaluation of their look and activity. All operations were conducted in compliance with international regulations for the management of experimental animals, ensuring the reduction of stress and suffering in the fish [6].

Temperature, dissolved oxygen, transparency, pH, electrical conductivity, total alkalinity, and total hardness of pond water determined daily were measured daily in the field using the Multiparameter Water Quality Meter (Pro Plus, YSI Inc., USA), equipped with high-precision sensors for rapid and accurate readings. Water samples for laboratory analysis were collected in acid-washed polyethylene bottles, filtered through glass fiber filters (0.45 microns) and stored at a temperature of <10 °C before shipment. Concentration of ions (phosphates, nitrates, nitrites, ammonium) were analyzed using standard spectrophotometric methods according to APHA (American Public Health Association) guidelines. The average monthly values of physicochemical indicators corresponded to the regulatory requirements for carp (Table 1).

Table 1

Physico-chemical indicators of pond water quality

Indicator	July	August	September	October
Temperature, °C	31.2 ± 1.13	30.9 ± 1.43	29.4 ± 1.32	28.3 ± 1.5
Dissolved oxygen, mg/l	6.5 ± 0.26	6.7 ± 0,3	6.3 ± 0.43	6.1 ± 0.41
Water transparency, cm	13.4 ± 1.12	11.0 ± 1.42	13.0 ± 1.20	11.5 ± 1.35
pH	7.37 ± 0.49	7.24 ± 0.42	7.8 ± 0.41	7.53 ± 0.89
Electric conductivity, mS/cm	0.952 ± 0.20	1.203 ± 0.21	1.543 ± 0.38	1.754 ± 0.38
Total alkalinity, mg/l	190.0 ± 61.0	267.0 ± 64.0	260.0 ± 70.0	376.0 ± 77.0
Total hardness, mg/l	188.0 ± 92.20	230.0 ± 85.59	384.0 ± 80.12	409.0 ± 94.3
Phosphate concentration, mg/l	0.09 ± 0.04	0.07 ± 0.06	0.08 ± 0.03	0.19 ± 0.08
Nitrate concentration, mg/l	0.73 ± 0.49	1.04 ± 0.32	1.16 ± 0.02	1.46 ± 0.06
Nitrite concentration, mg/l	0.27 ± 0.10	0.31 ± 0.11	0.3 ± 0.16	0.09 ± 0.12
Ammonium concentration, mg/l	0.04 ± 0.01	0.06 ± 0.01	0.02 ± 0.05	0.03 ± 0.03

Phytoplankton abundance was determined in water samples with a volume of 1 liter, which were treated with a 1% Lugol solution and examined under a microscope to identify and count species. The monthly average values of phytoplankton abundance in July and October were small, but increased in August and especially in September, with the pronounced dominance of Chlorophyta and Cyanobacteria groups (Table 2).

Table 2

The average monthly abundance of phytoplankton of various groups in ponds, ×10^4 individuals/l

Phytoplankton groups	July	August	September	October
Cyanobacterium	34.9 ± 4.3	207.7 ± 2.5	900.0 ± 10.0	27.6 ± 0.2
Chlorophyta	18.8 ± 0.5	320.7 ± 9.0	1 630.0 ± 30.0	12.5 ± 12.5
Bacillariophyta	10.3 ± 1.1	25.5 ± 0.3	314.7 ± 4.2	15.3 ± 0.1
Euglenophyta	12.0 ± 0.6	141.3 ± 1.5	147.3 ± 1.6	15.5 ± 15.5
Pyrrhophyta	10.0 ± 0.2	123.7 ± 3.5	353.3 ± 15.3	6.4 ± 6.4
Chrysophyta	12.5 ± 0.6	27.2 ± 1.1	334.4 ± 14.5	12.1 ± 12.1
Pennales	10.5 ± 0.6	19.2 ± 0.4	283.0 ± 4.4	11.5 ± 11.5

Zooplankton abundance was determined by filtering 30 liters of water through a plankton network with a mesh size of 50 microns, fixing the sample in a 4% formalin solution and examining it under a microscope. The average monthly zooplankton abundance was minimal in July and maximal in August, with the Rotifers group dominating (Table 3).

Table 3

The average monthly abundance of zooplankton of various groups in ponds, ×10^4 individuals/l

Zooplankton groups	July	August	September	October
Rotifers	58.7 ± 8.1	206.7 ± 10.7	115.0 ± 5.0	113.3 ± 15.3
Copepoda	8.6 ± 1.2	37.0 ± 2.0	54.2 ± 2.7	54.1 ± 2.9
Cladocera	10.8 ± 3.3	31.7 ± 4.7	22.0 ± 4.6	12.7 ± 3.5
Daphniidae	12.3 ± 5.9	15.0 ± 3.6	11.5 ± 3.9	16.0 ± 3.6
Others	25.0 ± 2.0	110.0 ± 10.0	31.7 ± 5.0	19.0 ± 9.5

Feeding was performed twice a day using granular feed. The daily feeding ration was 5% of the fish biomass. The food contained fishmeal, soy meal, corn flour, rice bran, vegetable oil “Vizavit” and mineral and vitamin premix. The feed contained 32% crude protein and 18 megajoules of metabolic energy (Table 4).

Table 4

The content of nutrients and energy in the feed

Indicator	Parameter
Dry matter, %	90.4
Crude protein, %	32.0
Crude fat, %	4.5
Crude fiber, %	6.5
Ash, %	10.6
Exchangeable energy, MJ/kg feed	18.0

Morphological studies of juvenile common carp were carried out in accordance with the methodological recommendations developed by I. F. Pravdin [7]. Fish for measurements were caught after a partial decrease in the water level in the pond in the early morning to reduce its stress. The caught fish were placed in plastic containers with water from the same pond. After taking measurements, the fish were carefully returned to the pond. The mass and total body length of the juveniles were recorded at the beginning of the experiment, then every 21 days and at the end of the growing period. Measurements were carried out on a sample of at least 100 fish. Body weight was measured with an accuracy of 0.01 g using electronic scales, and body length with a caliper with an accuracy of 0.1 cm. Body weight gain and feed conversion rate (FCR) were determined by a generally accepted method. The costs associated with the cultivation of juvenile carp were estimated in accordance with the following articles:

– costs of fixed assets (depreciation and maintenance of ponds, equipment and transport);

– costs of working capital (fish planting material for stocking, feed, water resources, electricity, fuel, fertilizers);

– the cost of the wage fund (remuneration of personnel engaged in the cultivation, feeding and maintenance of ponds.; deductions for social needs);

– overhead costs (administrative, utility).

Research results

The number of juvenile carp decreased significantly during the first three weeks of cultivation: from 700 at the beginning to 615-628 specimens per pond at the end of the stage (Table 5).

Table 5

Dynamics of the number of juvenile carp in ponds, specimens

Replicate	When stocking	Duration of cultivation, days			
		21	42	63	90
Pond R1	700	628	616	606	605
Pond R2		615	614	610	602
Pond R3		619	609	605	604

The number of juveniles at the next stages of cultivation changed little, amounting to 602-605 specimens per pond by the 90th day of cultivation. As a result, the safety of juveniles during the first stage of cultivation turned out to be the lowest – 88.67 ± 0.55%. The preservation rate at the next stages of juvenile cultivation was stable in the range from 98.77 to 99.45%. The safety of fish for the entire time of cultivation was 86.24 ± 0.13%. The obtained parameters are consistent with the data of earlier studies, which confirm the high survival rate of carp with proper management of the reservoir [8, 9].

The body weight of the cultured carp juveniles exhibited a consistent growth during all cultivation periods (Table 6).

Table 6

Dynamics of body weight of juvenile carp, grams

Replicate	When stocking	Duration of cultivation, days			
		21	42	63	90
Pond R1	9.96 ± 0.89	46.25 ± 4.00	90.12 ± 6.36	184.75 ± 9.40	270.45 ± 11.3
Pond R2	10.01 ± 0.49	50.27 ± 3.84	89.37 ± 7.30	173.04 ± 9.38	257.07 ± 11.8
Pond R3	10.00 ± 0.70	50.25 ± 5.32	94.44 ± 7.83	187.61 ± 9.89	274.36 ± 12.4

On the 90th day of cultivation, the average body weight of juveniles in ponds ranged from 257.07 to 274.36 grams, showing no significant differences between replicas. The individual body weight gain of juveniles over the entire growing period was in the range from 247.06 to 264.36 grams. The average body weight of the grown juveniles on the 90th day of cultivation was 267.29 ± 5.23 grams. Thus, the value of this indicator increased by 26.76 times during cultivation. There is no doubt that the intensive growth of juveniles in ponds largely depends on additional feeding, as indicated by other authors [10].

The total body length of juveniles gradually increased during the growing period from 7.03-7.14 cm initially to 24.82-24.85 cm (Table 7).

Table 7

Dynamics of total body length of juvenile carp, cm

Replicate	When stocking	Duration of cultivation, days			
		21	42	63	90
Pond R1	7.13 ± 0.89	14.04 ± 1.00	15.89 ± 1.45	21.08 ± 1.67	24.85 ± 1.89
Pond R2	7.14 ± 0.49	14.03 ± 1.24	15.84 ± 1.46	21.09 ± 1.68	24.82 ± 1.90
Pond R3	7.14 ± 0.70	13.97 ± 1.25	15.82 ± 1.47	21.06 ± 1.69	24.83 ± 1.91

The absolute increase in total body length over 90 days was 17.68-17.72 cm. The average value of the total body length of juvenile carp at the end of cultivation was 24.83 ± 0.01 cm.

The fatness coefficient of juveniles at the stages of cultivation fluctuated in waves, which can be explained by the uneven linear growth of fish in different directions (Table 8).

Table 8

Dynamics of the fatness coefficient of juvenile carp, units

Replicate	When stocking	Duration of cultivation, days			
		21	42	63	90
Pond R1	2.75 ± 0.10	1.67 ± 0.08	2.25 ± 0.12	1.97 ± 0.10	1.76 ± 0.09
Pond R2		1.82 ± 0.09	2.25 ± 0.13	1.85 ± 0.09	1.68 ± 0.08
Pond R3		1.84 ± 0.09	2.39 ± 0.13	2.01 ± 0.10	1.79 ± 0.09

The value of the fatness coefficient at the end of cultivation turned out to be in the range from 1.68 to 1.79, which indicates a good fatness of the fish planting material. The average value of the fatness coefficient of carp juveniles by the 90th day of cultivation turned out to be 1.75 ± 0.03.

The total biomass of juvenile carp steadily increased from the initial 6.97-7.01 kg per pond to 154.76-165.71 kg per pond at the end. The total increase in biomass over 90 days ranged from 147.75 to 158.71 kg per pond (Table 9).

Table 9

Dynamics of the biomass of juvenile carp, kg per pond

Replicate	When stocking	Duration of cultivation, days			
		21	42	63	90
Pond R1	6.97	29.05	55.51	111.96	163.63
Pond R2	7.01	30.91	54.87	105.55	154.76
Pond R3	7.00	31.11	57.51	113.51	165.71

The average biomass value of the grown juveniles on the 90th day of cultivation was 161.36 ± 3.36 kg per pond. As a result, the value of the analyzed indicator increased by 23.08 times during cultivation.

The fish productivity of ponds gradually increased during the growing of juvenile carp, reaching the level of 738.75-793.57 kg/ha after 90 days (Table 10).

Table 10

Dynamics of fish productivity of ponds during the cultivation of juvenile carp, kg/ha

Replicate	Duration of cultivation, days			
	21	42	63	90
Pond R1	110.37	242.71	524.93	783.25
Pond R2	119.55	239.33	492.74	738.75
Pond R3	120.52	252.57	532.52	793.57

The average value of fish productivity of ponds for 90 days of growing juvenile carp was 771.85 ± 16.82 kg/ha. The results of the study indicate a steady increase in fish productivity of ponds during the cultivation of juvenile carp.

Feed consumption at the first stage of cultivation turned out to be in the range of 25.24-27.65 kg per pond, but later it increased significantly. Feed consumption for 90 days of cultivation was 300.09 ± 3.56 kg per pond with fluctuations from 295.81 to 307.16 (Table 11).

Table 11

Dynamics of feed consumption during rearing of carp juveniles in ponds, kg per pond

Replicate	Growing stage, days				
	first (from the 1st to the 21st	second (from the 22nd to the 42nd)	third (from the 43rd to the 63rd)	fourth (from the 64th to the 90th)	for all the time (from the 1st to the 90th)
Pond R1	27.65	46.31	92.05	131.29	297.30
Pond R2	25.29	47.77	96.54	137.56	307.16
Pond R3	25.24	44.55	92.67	133.35	295.81

The maximum conversion of feed into biomass growth of juvenile carp was observed at the first stage of cultivation, when the average FCR value was 1.12 ± 0.07 with variability ranging from 1.05 to 1.25 (Table 12).

Table 12

Dynamics of the feed conversion ratio during the cultivation of juvenile carp, units

Replicate	Growing stage, days				
	first (from the 1st to the 21st	second (from the 22nd to the 42nd)	third (from the 43rd to the 63rd)	fourth (from the 64th to the 90th)	for all the time (from the 1st to the 90th)
Pond R1	1.25	1.75	1.63	2.54	1.90
Pond R2	1.06	1.99	1.90	2.80	2.08
Pond R3	1.05	1.69	1.66	2.55	1.86

At the next stages of cultivation, an increase in this indicator was noted to 1.81 ± 0.09 (second), 1.73 ± 0.09 (third) and 2.63 ± 0.08 (fourth). The feed conversion rate for 90 days of growing juvenile carp was 1.95 ± 0.07 with fluctuations in the range from 1.86 to 2.08. The value of the feed conversion rate is an important parameter in the cultivation of juvenile carp, having a strong impact on its cost.

The total biomass of juvenile carp after 90 days of cultivation was 484.1 kg. Total costs of fish farming was 125,638.61 Russian rubles (RUB) or 2,062,985.98 Iraqi dinars (IQD). Costs of growing 1 hundredweight of juvenile carp was 25,953.03 RUB or 426,148.75 IQD. The share of expenses on working capital and depreciation of fixed assets turned out to be the most significant in the structure of production costs: 55.75 and 20.21%, respectively (Table 13).

Table 13

Cost structure of growing young carp

Cost item	Total costs, RUB	Costs for 1 hundredweight of grown juveniles, RUB	Share of costs in the cost price of reared calves, %
Fixed assets	25,403.03	5,247.48	20.22
Working assets	70,053.76	14,470.93	55.76
Wages fund	15,719.70	3,247.20	12.51
Overhead costs	14,462.12	2,987.42	11.51
Total	125,638.61	25,953.03	100.00

Conclusion

An assessment of the effectiveness of growing juvenile common carp with an initial weight of 10 grams in the environmental conditions of groundwater ponds in the Central part of Iraq showed a high level of preservation for 90 days – 86.24 ± 0.13%. At the end of adulthood, juveniles reach a body weight of 257.07-274.36 grams and a total length of 24.8-24.9 cm. Intensive growth of juveniles makes it possible to obtain a high level of fish productivity in ponds in 90 days – 771.85 ± 16.82 kg/ha. Most of costs of growing juvenile carp in ground ponds are accounted for by the use of working capital (55.75%) and depreciation of fixed assets (20.21%).

The cost of the grown carp planting material is 25,953.03 Russian rubles or 426,148.75 Iraqi dinars per one hundredweight of products, which indicates its competitiveness.

The results of the study of fish farming, biological and economic indicators of the cultivation of juvenile carp with an initial weight of 10 grams in ground ponds are of great importance for the production of carp planting material in Iraq.

References

1. Salman N. A., Saleh K. I. Aquaculture Industry in Iraq: Past, Present, and Future Perspectives. Tigris and Euphrates Rivers: Their Environment from Headwaters to Mouth. *Aquatic Ecology Series*, 2020, vol. 11, pp. 1053-1076. https: doi.org/10.1007/978-3-030-57570-0 48.

2. Ahmed A. R., Al-Zewar J. M., Fawzi N. A. M., Abulhasan A. A. Culture of common carp (*Cyprinus carpio* L.) culture in Basrah Governorate, southern Iraq; current status and suggestion for development. *Ecology, Environment and Nature Conservation*, 2020, vol. 26 (2), pp. 824-831. https:// www.envirobiotechjournals.com/EEC/v26i220/EEC-55.pdf.

3. Sayed-Lafi R. M., Al-Budairy H. K. The impact of common carp (*Cyprinus carpio*) cages on the water quality characteristics of Shamiya River in Al-Qadisiyah Governorate (Central Iraq). *AIP Conference Proceedings*, 2023, vol. 2845 (1), p. 070005. https://doi.org/10.1063/5.0172069.

4. Al-Humairi K. O., Al-Tamimi R. A., Al-Nour S. S. Growth performance and feed efficiency evaluation of two groups of common carp (*Cyprinus carpio* L.) farmed in Iraq. *Basrah Journal of Agricultural Sciences*, 2020, vol. 33 (1), pp. 189-199. https:.doi.org/10.37077/25200860.2020.33.1.14.

5. Mojer A. M., Al-Dubakel A. Y. Effect of different feeds on growth rate and survival of common carp (*Cyprinus carpio* L.) larvae. *Basrah Journal of Agricultural Sciences*, 2024, vol. 37 (1), pp. 47-54. https:.doi.org/10.37077/ 25200860.2024.37.1.04.

6. Jenkins J. A., Bart Jr H. L., Bowker J. D., Bowser P. R., MacMillan J. R., Nickum J. G., Warkentine B. E. *Guide to the Use of Fishes in Research*. Bethesda, MD, USA, American Fisheries Society, 2014. 90 p.

7. Pravdin I. F. *Rukovodstvo po izucheniiu ryb (preimushchestvenno presnovodnykh)* [Guidelines for the study of fish (mainly freshwater)]. Moscow, Pishchevaia promyshlennost' Publ., 1966. 376 p.

8. Hayat M. A., Nugroho R. A., Aryani R. Influence of different stocking density on the growth, feed efficiency, and survival of Majalaya common carp (*Cyprinus carpio* Linnaeus 1758). *F1000Research*, 2018, vol. 7, pp. 1-9. https://f1000research.com/articles/7-1917/v1.

9. Oprea L., Mocanu M. C., Vanghelie T., Sandu P. G., Dediu L. The influence of stocking density on growth performance, feed intake and production of common carp, *Cyprinus carpio* L., at one summer of age, in ponds aquaculture systems. *Aquaculture, Aquarium, Conservation & Legislation*, 2015, vol. 8 (5), pp. 632-639. https://www.bioflux.com.ro/docs/2015.632-639.

10. Hlaváč D., Adámek Z., Hartman P., Másílko J. Effects of supplementary feeding in carp ponds on discharge water quality: A review. *Aquaculture international*, 2014, vol. 22, pp. 299-320. https://doi.org/10.1007/s10499-013-9718-6.

Список источников

1. Salman N. A., Saleh K. I. Aquaculture Industry in Iraq: Past, Present, and Future Perspectives // Tigris and Euphrates Rivers: Their Environment from Headwaters to Mouth. Aquatic Ecology Series. 2020. V. 11. P. 1053–1076. https://doi.org/10.1007/978-3-030-57570-0_48.

2. Ahmed A. R., Al-Zewar J. M., Fawzi N. A. M., Abulhasan A. A. Culture of common carp (*Cyprinus carpio* L.) culture in Basrah Governorate, southern Iraq; current status and suggestion for development // Ecology, Environment and Nature Conservation. 2020. V. 26 (2). P. 824–831. https://www.envirobiotechjournals.com/EEC/v26i220/EEC-55.pdf.

3. Sayed-Lafi R. M., Al-Budairy H. K. The impact of common carp (*Cyprinus carpio*) cages on the water quality characteristics of Shamiya River in Al-Qadisiyah Governorate (Central Iraq) // AIP Conference Proceedings. 2023. V. 2845 (1). P. 070005. https://doi.org/10.1063/5.0172069.

4. Al-Humairi K. O., Al-Tamimi R. A., Al-Nour S. S. Growth performance and feed efficiency evaluation of two groups of common carp (*Cyprinus carpio* L.) farmed in Iraq // Basrah Journal of Agricultural Sciences. 2020. V. 33 (1). P. 189–199. https://doi.org/10.37077/25200860.2020.33.1.14.

5. Mojer A. M., Al-Dubakel A. Y. Effect of different feeds on growth rate and survival of common carp (*Cyprinus carpio* L.) larvae // Basrah Journal of Agricultural Sciences. 2024. V. 37 (1). P. 47–54. https://doi.org/10.37077/25200860.2024.37.1.04.

6. Jenkins J. A., Bart Jr H. L., Bowker J. D., Bowser P. R., MacMillan J. R., Nickum J. G., Warkentine B. E. Guide to the Use of Fishes in Research. Bethesda, MD, USA: American Fisheries Society, 2014. 90 p.

7. Правдин И. Ф. Руководство по изучению рыб (преимущественно пресноводных). М.: Пищ. пром-сть, 1966. 376 с.

8. Hayat M. A., Nugroho R. A., Aryani R. Influence of different stocking density on the growth, feed efficiency, and survival of Majalaya common carp (*Cyprinus carpio* Linnaeus 1758) // F1000Research. 2018. V. 7. P. 1–9. https://f1000research.com/articles/7-1917/v1.

9. Oprea L., Mocanu M. C., Vanghelie T., Sandu P. G., Dediu L. The influence of stocking density on growth performance, feed intake and production of common carp, *Cyprinus carpio* L., at one summer of age, in ponds aquaculture systems // Aquaculture, Aquarium, Conservation & Legislation. 2015. V. 8 (5). P. 632–639. https://www.bioflux.com.ro/docs/2015.632-639.

10. Hlaváč D., Adámek Z., Hartman P., Másílko J. Effects of supplementary feeding in carp ponds on discharge water quality: A review // Aquaculture international. 2014. V. 22. P. 299–320. https://doi.org/10.1007/s10499-013-9718-6.

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