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Fisheries and Biological Indicators of Hungarian Carp Fish

Temirova Nilufar T.[1], Kuzmetov Abdulakhmet R.[2], Khaydarov Saidkamol M.[3], Kim Svetlana I.[4], Durkhojaev Khasan F.[4], Toxirjonov Nosirjon T.[4], Madumarov Maqsadjon J.[5*], Abdinazarov Xasanboy Kh.[5], Imanova Dairash[6], Tanirbergenova Samal l.[6], Saparov Abdirahman D.[7], Mammadiyev Absaxat X.[8]

[1]Tashkent Branch of Samarkand State University of Veterinary Medicine, Animal Husbandry and Biotechnologies Department of “Zooengineering and Sericulture” Lecturer, PhD in Agricultural Sciences (Candidate of Agricultural Sciences)
[2]Department of Medicine, Faculty of Medicine, Alfraganus University, Uzbekistan, Tashkent
[3]Fergana State University, Fergana
[4]Tashkent State Agrarian University,
[5]Kokand State Unuversitet, Kokand
[6]Khoja Akhmet Yassawi International Kazakh-Turkish University, Kazakhstan
[7]Nukus State Pedagogical Institute named after Ajiniyaz
[8]Denov Institute of Entrepreneurship and Pedagogy

***Corresponding Author:** maqsadjon_mj84@umail.uz

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ABSTRACT

In this study, 60 Ukrainian and 53 Hungarian carp, aged +1 to +5 years, with body lengths ranging from 8 to 76cm and total weights between 11 and 8800 grams, were used at the experimental base of the Fisheries Research Institute. In addition, in April 2020, 500 samples of Hungarian carp fry and +1 to +3-year-old fish were obtained from the "Al-Said" farm in the Ishtikhon District, Samarkand Region. The determination of morpho-biochemical blood indicators was considered one of the main criteria in evaluating the fish grown in the research. Regarding the reproductive characteristics of Hungarian carp, the average absolute fertility of females was 886,700 - 254,700 eggs more than that of the Ukrainian carp. An increase in caviar spawning ensured a 12.8% rise in larval output (productivity). One of the most effective methods for developing high-yield breeds is fish hybridization. Typically, first-generation hybrids demonstrated high fishery value. It was found that the fertility level of carp females of different origins (Ukrainian and Hungarian) varied greatly. This variability made it possible to select and form broodstock characterized by high productivity and to obtain hybrid offspring from highly fertile females.

INTRODUCTION

The history of fishing goes back several hundred thousand years. According to the ancient encyclopedist Gaius Pliny (27-29 BC), the first fish ponds and cages were invented in Rome. By the 14th-16th centuries, fish farming in ponds began to develop dramatically and covered all European water bodies. Even over time, pond fishing has developed to a great extent in Europe that the German King Rudolph II banned the creation of ponds and the cultivation of fish in them without a license **(https://www.gbif.org/)**.

The value and benefits of carp have been known since ancient times. The first information on artificial breeding of carp fish was practiced in China 2500 years ago. Based on the possibilities of those times, the organization of carp breeding goes back thousands of years. At the same time, practicing fish breeders of the best fisheries have selected the best, fast-growing samples and improved carp fish by the folk selection method **(Welcomme, 1992)**.

Carp is the most common species in the world. Over the past centuries, carp fish has been introduced to more than 50 countries. In some countries, it is an invasive species that damages aquatic ecosystems. Currently, about 100 breeds of carp have been created through selection in the world, which have high growth characteristics and viability, easily adapt to cold conditions, and are distinguished by their resistance to diseases (Hungarian, Tatay, Ukrainian, Russian, Sarboyan, Krasnodar, Central Russian, Belarusian, Kazakh, German, Vietnamese and others). The most common among them are Hungarian, Ukrainian, Czech and Vietnamese carp breeds **(Welcomme, 1992)**.

According to **Wydoski and Wiley (1830)**, in the 19th century, carp was brought from Europe to North America and released into the Hudson River in New York. Carp is widely distributed from the rivers of the temperate zones of the USA to California **(Wydoski & Wiley, 1999)**.

Carp can multiply very quickly in lake-type water bodies in America, and in stagnant water bodies with a high natural nutrient base, fish productivity can reach 200-300kg per hectare, and in the southern regions of the USA, it can reach 1125kg. US experts believe that carp eats zooplankton organisms in many water bodies, increases water turbidity and has a negative effect on water purity **(Eddy & Underhill, 1974)**.

According to **Berstein and Olson (2001)**, the purpose of carp fish transplanted to America was to breed them and increase fish productivity. Introduced carp have become widespread in natural water bodies and even have a negative effect on local fish species, displacing numerous species from the composition of the ichthyofauna **(Berstein & Olson, 2001)**.

In recent years, new fish species have been brought to Uzbekistan from foreign countries such as Hungary, Malaysia, China and Russia - Hungarian carp (*Cyprinus carpio*), Siberian carp (*Acipenser baerii*), African carp (*Silurus glanis*), European silverfish (*Clarias gariepinus*), and tilapia (*Oreochromis mossambicus*). Carp fish were imported from Hungary, Ukraine, and Vietnam in order to increase the productivity of commercial fish in fisheries. To date, some of these types of fish have been grown adapted to the climate of Uzbekistan, and are giving very good results **(Kurbanov, 2021)**.

Carp is considered one of the fish that perfectly adapts to the conditions of natural and artificial water bodies. It is a valuable catch fish in natural reservoirs and the main breeding object in pond fisheries. Carp feels great in lakes and reservoirs and is among the species that are developing sustainably. This is made possible by the longevity of the fish, its rapid growth and reaching large sizes. In order to maintain the number of carp in natural water bodies at the same level, they are fished with carp fry grown in nurseries. Carp grows quickly, the rate of growth depends on feeding conditions and water temperature. It tolerates a lack of dissolved oxygen in water. Body length can reach 100cm and weight reaches 16- 32kg. Additonally, average length reaches 35- 55cm and weight reaches 1- 3kg **(Kozlov, 1998; Kozlov *et al*., 2006)**.

The survival of carp is influenced by the presence of natural food base and predatory fish in natural water bodies. Carp fish in natural reservoirs suffer huge losses in the early stages of their life, especially at the beginning of the larval and juvenile period, the mortality rate can reach 90%, and in the ponds grown in the conditions of fish farms, it can reach 50% **(Ricker 1975; Feldlite & Milstein 1999; Kumar *et al*., 2012)**.

The spawning season of carp in temperate water bodies of the world is April-May. Caviar develops into larvae in less than 10 days **(Bieniazz, 1976)**.

On the first day after hatching from carp caviar, free embryos (prelarvae) attach to plants and feed on the yolk of the egg sac. Larvae, 6,5- 7,0mm long, first attach to plants, then begin to actively move and feed on small forms of zooplankton (horned and paddle-footed crustaceans). Mixed nutrition continues until the complete resorption of the egg sac, then the transition to the larval stage of development occurs and begins to actively consume zooplankton (horned and paddle-footed crustaceans). Zooplankton is the basis of the diet of fish for one summer, gradually small organisms of benthofauna are added. Adult fish feed on molluscs, plants, insects and other aquatic organisms.

Breeding of carp is one of the promising directions of breeding fish of hunting importance. Carp has a special place among fish, because it grows quickly, gives high-quality meat products and brings a lot of income.

MATERIALS AND METHODS

The inside of the pools was cleaned of mud and dirt. The bottom of the pond was softened. During the vegetation period, the development of phytoplankton and zooplankton organisms was fully developed. The experimental ponds were completely cleared of aquatic plants. The water intake and drainage system has been restored. The pools were ready for testing in late April - early May. Then, breeding (male and female) Hungarian carp fish were released for spawning in the pond.

The experiments were carried out in full compliance with all the requirements for fish breeding in the basins. During the winter months, the water was removed and the basins were completely dried up. After that, the bottom of the basin was disinfected and fertilized. Then the water was slowly filled.

The total length (L) and standard length (l) of the studied fish (measured to the end of the caudal fin) were recorded to the nearest 0.1cm. The total body weight (W, g) and the gutted body weight (without internal organs) were measured to the nearest gram. The standard body length (l) was used as the main indicator of length.

To obtain indicators describing the body structure of 3–5-year-old fish, the following measurements were taken: body length (l), head length (c), maximum body height (H), maximum body width (thickness) (Br), and maximum body circumference (O).

Based on a comprehensive study of breed, origin, sex, age, health condition, body weight, external morphology, and other parameters, sorting and inspection were carried out to qualitatively assess the suitability of fish for breeding.

The relationship between body weight and body length was determined using the generally accepted correlation equation. To study the morphological features, sexually mature specimens (n = 500) were randomly selected from fish caught using a *sudrama* (nevod) net during industrial pond fishing. Meristic characters were determined by counting them under field conditions. Considering that meristic characters play a key role in evaluating the morphological traits of carp species, standard meristic features were used. A carp measurement chart was applied to assess plastic (morphometric) traits. The distances between reference points were measured on the left side of the fish using a caliper with an accuracy of 0.05mm **(Pravdin, 1966)**.

The age of the fish was determined using coins. 4-5 consecutive coins were taken from under the first fins of the shoulder fin and placed in the "coin book" over the left side lines. The annual rings on the coins were identified with a 10-fold magnification on the Mikrofot 5 PO-1 device designed for reading microfilms **(Kozlov & Abramovich, 1982)**.

Fish fertility was determined based on generally accepted methods. In the spring (from the last ten days of February to the end of April), a piece of the middle part of the gonad of sexually mature female fish is cut and fixed in a formalin solution (4% formaldehyde solution). Under laboratory conditions, 1 gram of this piece was measured with an accuracy of 0.01g; the yolk oocytes in the sample were counted in the Bogorov chamber, and individual absolute fertility (*IAF*, thousand pieces) was determined by multiplying it by the total weight of the gonad. Individual relative fatness was determined in relation to body weight without viscera (*IRF*, caviar/g) **(Rabazanov *et al.*, 2009; Sergeeva *et al*., 2022)**.

The methods and schemes of artificial insemination of fish were followed to obtain caviar from sexually mature females. An acetone suspension of carp pituitary glands was used to stimulate the maturation of caviar. Incubation was performed in a

Weiss apparatus. The most productive 4-6-year-old females were used for breeding **(Hill *et al*., 2004; Tarazevich *et al*., 2005)**.

The quality of male fish spermatozoa was determined according to **Persov (1953)** scale. A small drop of sperm was placed on the object glass, and a larger drop of water was placed next to it. A drop of sperm was connected to water using a needle when viewed under a microscope under low magnification. In water, spermatozoa are mobile and spread quickly (Table 1) **(Eddy &Underhill, 1974)**.

Table 1. Persov scale for determining sperm quality

Points	Sperm characteristics
5 points	All spermatozoa are equally mobile and it is difficult to single out one in the total mass
4 points	In a mass of motile spermatozoa, spermatozoa can be separated by zigzag or oscillating movements
3 points	Dominant sperm with zigzag or oscillating motion. There is a non-motile sperm
2 points	Spermatozoa up to 75% immobile (unfit for fertilization)
1 point	All spermatozoa are immobile (unfit for fertilization)

Sperm concentration of male fish was determined using the Goryaev camera. A stopwatch was used to determine the duration of sperm movement. To determine the fertilization ability of spermatozoa, fertilized eggs were taken at the 2nd division stage (300-400 eggs) and examined under binoculars **(Tikhomirov & Firsova, 2013)**.

RESULTS AND DISCUSSION

In the experiments, 60 Ukrainian and 53 Hungarian carp, aged +1 to +5 years, with body lengths ranging from 8 to 76cm and total weights from 11 to 8800 grams, grown in the ponds of the Fisheries Research Institute, were used. Additionally, in April 2021, 387 Hungarian carp fry and +1 to +3-year-old fish were obtained from the "Al-Said" farm, located in the Ishtikhon District of the Samarkand Region.

Experimental work was conducted to evaluate the use of the biopreparation "Bactovit uz", developed by the Institute of Microbiology, in closed recirculating aquaculture systems.

During the experiments on the intensive cultivation of Hungarian carp in a small innovative pond, fry were transferred to open ponds for intensive rearing to produce high-quality fry (weighing more than 200 grams) and marketable fish. Innovative improvements were introduced into the pond, including the installation of geomembrane linings along the sides and bottom to prevent water seepage into the ground.

To ensure the rational use of water resources, a recirculating water supply system capable of purifying and biologically balancing pond water was implemented. Within this system, aeration devices were installed to enrich the water with oxygen. The pond measured 22 × 35 meters, with a total breeding area of 600m². The depth ranged from 1.3

to 1.8 meters, with an average of 1.5 meters. Water in the pond was continuously circulated and purified, while aerators operated during the evening to increase the dissolved oxygen content (Fig. 1).

Additionally, a live insect trap, serving as an extra natural food source for the fish, was installed and tested in the pond.

Fish were stocked on May 30, 2021, with a total of 3,500 individuals and a combined weight of 135kg. It should be noted that, according to traditional fish farming technology in the republic, this stocking density (3,500 fish) corresponds to one hectare of pond area. In this study, however, the area used was only 0.06 hectares, meaning that production equivalent to one hectare was achieved using just 6% of that area.

This innovative technology enables significant savings in both land and water resources used in aquaculture. It represents not only a major advancement for the national fisheries sector but also a potential model for adoption by neighboring republics.

Fig. 1. Intensive cultivation of Hungarian carp in a small innovative pond

In the process of intensive breeding of fish, the dynamics of changes in the amount of oxygen in the water and the temperature of the water were checked (Figs. 2,3).

High-quality and balanced feed is necessary for intensive fish farming. The fish in this experiment were fed 4 times a day with local soft feed and black coldier fly larvae developed by "Vitae group" limited liability company. The daily feed ration was given in the amount of 5% of the total biomass of the fish. The hydrochemical parameters of the basin water were checked three times daily (12 times on control days) (Table 2).

Table 2. Average hydrochemical parameters of geomembrane basin water during intensive fish farming

Indicator	Technological standard	Hour		
		9.00	**12.00**	**16.00**
t°C	-	25	26	26.1
pH	7-8	7.43	7.43	7.41
O_2	7.0	7.8	9.9	9.4
NO_2	0.2	0.002	0.002	0.001
NH_4	1.0	0.2	0.2	0.2
NH_3	0.01-0.07	0.05	0.05	0.05

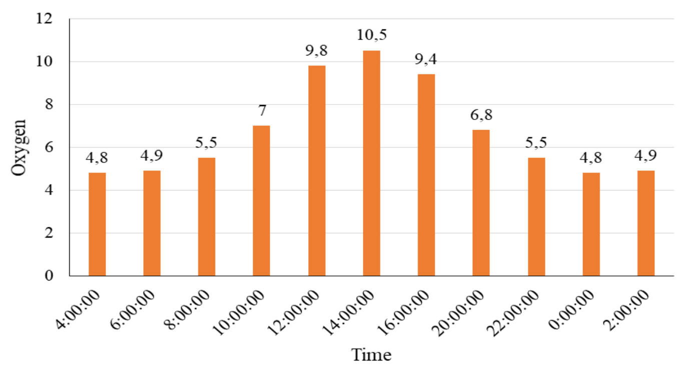

Fig. 2. Dynamics of changes in the amount of oxygen in water during the intensive breeding of fish, mg/l

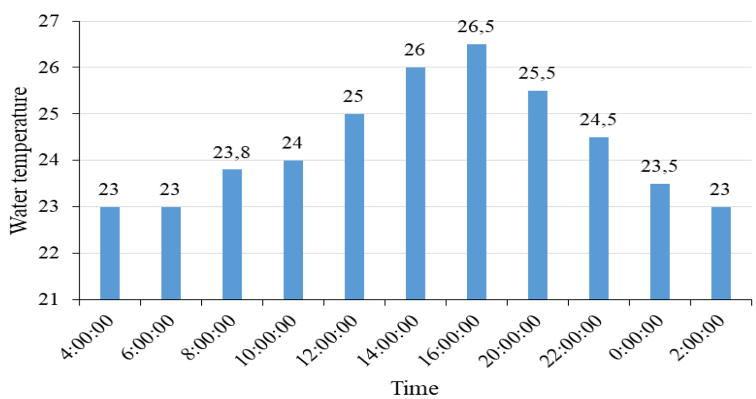

Fig. 3. Dynamics of water temperature changes during intensive fish farming

Control fishing (fish hunting) was conducted every 15-20 days, the average weight of the fish was determined, and the daily feed ration was given accordingly.

The initial total biomass of fish thrown into intensive breeding ponds was 135kg, and at the end of the experiment it was 1138kg. Feed consumption: 2.5kg of dry feed and 0.9kg of live feed (*Hermetia illuncens*) were used for 1kg of fish. During the experiment, fish mortality was 5% of the total number. Individual live weight of fish was 350- 500g. Fig. (4) shows the growth rates of fish in innovative ponds.

Thus, feeding Hungarian carp in an intensive rearing pond with local carp feed and additional black lionfish (*Hermetia illuncens*) live food organism made it possible to increase their individual live weight by 350-500 grams, and the fish became more productive due to the increase in fish fatness in products obtained.

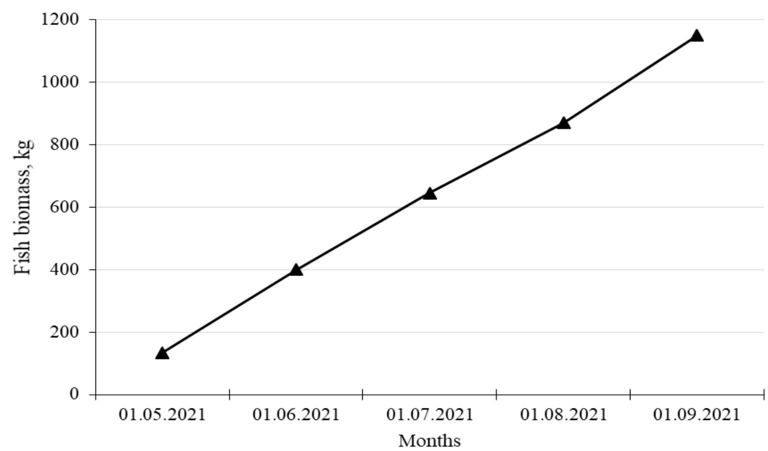

Fig. 4. Growth rates of fish in innovative ponds

In conclusion, it can be said that the intensive cultivation of Hungarian carp fish in the introduced innovative pond has a positive effect.

For the hematological analysis of Hungarian carp, the determination of morpho-biochemical indicators of blood is considered one of the main indicators in the assessment of farmed fish in research. Morpho-biochemical analysis of fish blood is widely used in the research of fishery practices. The study of the morpho-biochemical composition of blood allows to describe the natural and artificial conditions for keeping fish, monitor the condition of parent fish and fry, feed them, and diagnose their diseases. **Popov (1976)** claims that hematological analysis provides unique quick information that determines the results of traditional methods of control in fish farming.

Fish meat (45-65%) is represented by two pairs of muscles (two dorsal and two abdominal), containing complete proteins, fats, extractable nitrogenous substances, macro- and microelements and other substances.

Fish muscle tissues and organs are a source of many vitamins. Water-soluble vitamins B1, B2, B6, PP, C are found in many organs of meat and fish, fat-soluble vitamins A, D - in internal organs and parts of the body where fats are located, especially in the liver.

The amount of vitamin A in the liver increases with the age and size of the fish and changes depending on the seasons (more in spring-summer than in autumn-winter). Vitamin A increases the body's resistance and maintains the health of the skin, mucous membranes, bones, teeth, hair, vision, and reproductive system. Vitamin D (calciferol) is represented by vitamins D1, D2, D3, D4, D5, D6, D7. It stimulates the absorption of calcium and phosphorus, which are necessary for the growth and maintenance of bone tissues in good condition.

B vitamins support oxidation processes in the body. Vitamin B1 is necessary for the normal functioning of the nervous system; B2 helps the body release energy from food; B12 helps the formation of red blood cells, proper metabolism, etc.

The amount of mineral substances in the tissues of different fish is almost the same and is 1.5-2.5%. The main part of minerals is accumulated in bone tissue (about 80% of their total amount) and consists of macroelements: calcium salts, potassium salts, sodium, phosphorus, magnesium and iron. Therefore, it is important to include fish with bones in the diet. Microelements are accumulated in muscle tissue and individual organs of fish (I, Cu, Zn, Mn, Co, etc.). Minerals are present in the body of fish in different proportions; they enter with food and accumulate in the body of fish through osmosis from the place of residence (water).

The chemical composition of fish meat was addressed. Meat is called the muscles of the body. The connective tissue, blood and lymphatic vessels and small intermuscular bones in them are not permanent and depend on the type of fish, its breed, age, physiological condition, cultivation technology, time and place of hunting, storage conditions and duration.

The amount of protein in fish meat ranges from 14 to 20%. Of all muscle proteins, myosin (a salt-soluble globulin-type protein) is the most important due to its quantitative superiority. Proteins in muscles are mainly in the colloidal state - in the form of gels and sols, which determines the instability and variability of fish meat protein substances when storage conditions change.

Fish oils, unlike the oils of warm-blooded animals, have a liquid consistency at room temperature due to the presence of glycerides of unsaturated fatty acids in large quantities. They quickly deteriorate even at a temperature of -10ºC. In addition to muscles, fat in fish accumulates in other organs: in fatty fish, it is located in the thickness of muscles, and in lean fish, it is located in the liver.

Carbohydrates are mainly represented by glycogen, which is located in the muscles of the trunk and liver. Considering their very small amount, carbohydrates are not taken into account when determining the nutritional value of fish meat.

General blood analysis of Hungarian carp is presented in Table (3). Table (3) shows that the average amount of hemoglobin in erythrocytes is slightly high, and on the contrary, the average concentration of hemoglobin in erythrocytes and hematocrit is low.

Table 3. General analysis of Hungarian carp fish blood

Test Names	**Results**	**Normal**	**Units of Measure**
Leukocyte (WBC)	3.65	3.50-9.50 10 ^9/l	10^9 l
Erythrocytes (RBC)	2.54	-4.30-5.80♂ -3.80-5.10♀	10^{12}/l
Hematocrit (HCT)	0.327	0.350-0.500	%
Mean erythrocyte volume (MCV)	128.9	V2.0-100.0	fL
Average amount of hemoglobin in erythrocytes (MSNS)	38.3	27-34	Pg
Average concentration of hemoglobin in erythrocytes (MSHS)	297	316-354	g/l
Variation coefficient of erythrocyte width distribution (RDW-CV)	0.098	0.110-0.160	%
Standard deviation of the width distribution of erythrocytes (RDW-SD)	51.8	35.0-56.0	g/l
ICHLA (immunochemiluminescent assay)			
Immunoglobulin M (IgM) CLIA	1.18	-	-
Biochemical analyses			
Total protein	29.5	-	g/l
Albumin	12.3	-	g/l
Glucose	19.0	-	Mmol/l

Table (3) shows that the mean amount of hemoglobin in erythrocytes (MCH) is slightly imbalanced, while the mean concentration of hemoglobin in erythrocytes (MCHC) and the hematocrit are reduced. During this period (July 2022), the water temperature in the pool was high, which led to a decline in the fish’s feeding. As a result, the erythrocyte count in the blood decreased, confirming a simultaneous decrease in the mean hemoglobin content per erythrocyte and hematocrit. Studying biochemical blood parameters that describe the metabolic state of fish can be used for the early detection of various diseases related to digestive insufficiency.

The results of the research show that the use of resources of foreign carp breeds (Hungarian and Ukrainian) through cross-breeding made it possible to create a new hybrid breed that includes the best qualities of the parent forms (high growth rate, suitability for intensive breeding). As a result, the technological stages of intensive fish breeding - spawning and growing processes were created.

CONCLUSION

The average absolute fertility of female Hungarian carp was 886,700 eggs, which is 254,700 eggs more than that of the Ukrainian carp. An increase in the caviar spawning rate resulted in a 12.8% rise in larval output (productivity).

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