

Water quality indicators in high-density cage farming of trout

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Abstract. Trout fishing means raising fish in water whose temperature does not exceed +18°C under completely or partially artificial conditions. Today, several fish belonging to the salmon family are bred in cold water fisheries in the world. These are river trout (Rainbow trout - *Oncorhynchus mykiss*), brook trout (Brown trout - *Salmo trutta*), and brown trout (Brook trout - *Salvelinus fontinalis*). Currently, river trout breeding dominates global production. Its cultivation has been mastered in almost all regions [8]. In the article, the water quality indicators were studied during high-density breeding of trout in the cage method at the "Golden Fish" fishery LLC, located in the Khojakent reservoir in the Tashkent region of Uzbekistan. This includes water temperature, dissolved oxygen content, and water hydrogen potential, as well as information on fish growth, development, nutrition, and reproduction.

1 Introduction

Today, the rapid growth of the world's population leads to an increasing demand for fish and fish products. The fishing network has become one of the important aspects of the economic development of the society, as well as providing employment to many people around the world [1-5].

In Uzbekistan, fish farming in cage aquaculture, which is convenient for the development of fisheries, efficient use of water resources, and intensive technologies of fish breeding in artificial and natural reservoirs, is considered relevant [6]. River trout, a new object of fisheries in Uzbekistan, is a cold-water fish that can be bred in lowland and mountainous areas. In addition, the conditions in the mountainous and mountainous areas of Uzbekistan are favorable for the cultivation of river trout, which serves the successful development of river trout in Uzbekistan and the creation of a new promising product for the table of the people of Uzbekistan and for export [7, 8].

Fish farming in cage facilities has the following advantages: (1) the ability to grow fish in water bodies 5-6 meters deep; (2) easy maintenance, including hunting, control, feeding; (3) the availability of the opportunity to grow different types of fish, including the installation of cages for different species of fish in the same water body; and, (4) conducting scientific research on fish acclimatization. The use of high-yielding, balanced soft feeds in cage facilities and continuous monitoring of water quality are important [9].

The most favorable temperature for the growth of trout fish is + 12-18 °C. At a temperature of +22 °C and above, its nutrition and growth slow down. At temperatures below

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+7 °C, nutrition is sharply reduced. It is desirable that the stocking should be 550 pieces per 1 m³. Fishing with a 15-20 cm chub allows each fish to reach a weight of 500 g at the end of the season [10-12].

When fish are grown in cage facilities, it is more convenient to use preventive measures against their diseases than in a lake or river [13, 14]. A number of scientists have conducted scientific research on fish breeding and productivity improvement in the natural climatic conditions of Uzbekistan.

2 Materials and methods

The research was conducted in 2020-2021 at "Golden Fish" LLC, which grows trout fish in cages, located in Khojakent reservoir, Bustonliq district, Tashkent region, Uzbekistan (Figure 1). Water quality indicators in the Khojakent reservoir were checked in the following 3 different ways;

1. The uppermost part of the water area where the cages were located;
2. The middle part of the water area where the cages were located;
3. Samples were taken from the bottom of the water area where the cages were located.



Figure 1. "Golden Fish" fish farm pond.

The water temperature was measured with an accuracy of 0.1°C. The amount of dissolved oxygen in water was measured with a portable thermo-oximeter with an accuracy of 0.1 g/l. The hydrogen potential (pH) of water was measured with an accuracy of 0.01 using a special apparatus (pH) meter [11].

The total body length of the selected female remont groups was measured with an accuracy of 0.1 cm, while the total weight was measured with an accuracy of 1 g. 25 fish selected from the parent maintenance flock were isolated and studied at the processing plant. The weight of the gonads was measured to the nearest 0.1 g. Sorted gonads were studied by the (Privezentsev) method based on the data developed for salmon fish [11, 12].

A 25 ml sample was taken from the center of the selected gonads and placed in a 4% formalin solution prepared in a special container. After the scientific research work was completed, the obtained animals were brought to the laboratory of the Department of General Zootechnics and Veterinary Medicine of the Tashkent State Agrarian University. Each sample was treated as follows; half of the sample was placed in a Petri dish. The remaining

formalin liquid in the beaker was carefully poured back into the beaker. Then half of the petri dish was filled with water. The water completely covered the caviar. After 10 minutes, the water in the sample was drained and examined under the Mikrofot-5 PO-1 apparatus with 10 times magnification. A white paper was placed under the screen. After that, one by one, a magnified picture of the caviar was carefully drawn on the white paper. 100 caviar of the sampled fish was drawn on a white paper.

The bilateral perpendicular diameters of each caviar were measured using a caliper (with two pointed ends). In this way, the exact diameter dimensions of the caviar were obtained.

3 Results and discussion

At the "Golden Fish" fish farm, fish are grown only in cages. Cages are stationary, that is, they are fixed to the shore. The total depth of the cages is 4-4.5 meters. Currently, the number of cages available here is more than 50, and they vary in size and size. Trout fish of different ages are bred in such cages. For example, segolet fish are kept in small cages, slightly larger ones are kept in larger cages, and fish that have reached marketable mass are kept in the largest sea cages [9].

Water temperature is very important for trout. The temperature of the water is also important in the development stages of this type of fish. For example, for the development of trout caviar, the water temperature should be 6-12 °C, for bream and fry, it should be 14-16 °C, and for adult fish, it should be 14-18 °C [15].

The temperature of the water in the Golden Fish fish farm was studied by taking samples from the highest point, the middle part and the lowest part of the cage devices (Table 1).

Table 1. Data on the water temperature in different areas of “Golden Fish” fish farm cage facilities.

Indicators	Water temperature (°C), by day of analysis			
	Feb 1	Mar 1	Apr 1	May 16
The top part of the cage	4.9	5.1	7.1	11.1
The middle part of the cage	5.0	5.2	8.2	11.4
The lowest part of the cage	5.0	5.2	6.9	11.7

In February-March, the water of the Khojakent reservoir is very cold and is 4.9-5.2 °C. It is also relatively cold in April (about 7 °C). Only at the end of May, the water temperature of the reservoir rose to a level above 11 °C, where trout growth is noticeable. Cage devices are drawn in a line and they are affected by water temperature. On each day of analysis, the lowest water temperature was observed at the highest point and relatively high middle part of the cage fish farm. Water temperatures at the bottom of the farm were the coldest in April and the warmest in cages in mid-May. At the same time, the temperature difference in February and March was small - 0.1°C, and in April and May, the difference increased.

Khojakent reservoir is deep. Cage devices are also large, their depth is 2-3 meters in pasture cages. We determined whether there was a difference in water temperature in different water layers from the beginning of April, and the information about them is presented in Table 2.

Table 2. Water temperature at different depths of the “Golden Fish” fish farm's cage, °C.

Indicators	Sampling depth, m	Apr 1, °C	May 16, °C
The top part of the cage	3	6.1	9.6
	2	6.8	10.2
	1	7.8	11.6

The middle part of the cage	3	6.9	10.4
	2	7.0	11.8
	1	8.8	12.2
The lowest part of the cage	3	7.2	11.7
	2	7.8	12.1
	1	8.4	14.2

The data show that there is a significant difference in temperature between 1 and 2 meters on the surface of the water. Also, according to the information received on April 1, 2021, the temperature of the water at the beginning of the cage devices, i.e. the highest part, and the lowest part of the cage devices is 1.1 °C at the 3-meter depth, 1 °C at the 2-meter depth, and 2.3 °C at the 1-meter depth was observed to be different. According to the information received on May 16, the temperature of the water at the beginning of the cage devices, i.e. the highest part, and the lowest part of the cage devices is 2.1 °C at the 3-meter depth, 1.9 °C at the 2-meter depth, and 2.6 °C at the 1-meter depth. it was observed that he did. The difference is especially high in the middle and lower points of the economy. The water freezes in May, and the cages are exposed to water currents of perhaps 3 meters. The optimum water temperature for trout is 18 °C. It can be seen that a very convenient place was chosen for breeding trout.

Trout require a high level of dissolved oxygen in the water. "Golden Fish" fish farm cages use intensive aquaculture methods, that is, trout are grown at a high breeding density. In this context, monitoring in this fishery is very important. It should be noted that the lowest amount according to this indicator for trout is 6 mg/L. Table 3 shows the dissolved oxygen content of fish farm cages and observations at different depths.

Table 3. Amount of dissolved oxygen in water at different depths in "Golden Fish" fish farm cage devices, mg/L.

Indicators	Sampling depth, m	Apr 1	May 16
The top part of the cage	3	11.2	9.8
	2	11.3	10.1
	1	11.6	10.3
The middle part of the cage	3	10.2	9.4
	2	11.0	9.6
	1	11.2	9.9
The lowest part of the cage	3	11.2	9.5
	2	11.1	9.8
	1	11.0	9.9

In May, as the water temperature rose, the amount of dissolved oxygen began to decrease. However, at all observed stations and at all depths, the dissolved oxygen content is slightly higher than its minimum permissible value. It is interesting that the amount of oxygen dissolved in water at depths of 1 and 2 meters is higher than at the surface of the water, although it is precisely at the surface of the water that the water is saturated with atmospheric oxygen.

Thus, we can conclude that the amount of dissolved oxygen in the water of the Khojakent reservoir is favorable for trout. Hydrogen index (pH) is another important indicator of water in intensive aquaculture. The quantity (pH) in the studied fishery is presented in Table 4.

It is considered favorable if the amount (pH) is 7-8 in fish farming. According to this indicator, the water of the Khojakent reservoir is close to very favorable conditions for trout. The fixed amount was 7.5-7.64, which means that the water of the reservoir is suitable for trout.

Table 4. Data on pH in different locations of “Golden Fish” fish farm cage facilities.

Indicators	pH, on the day of analysis			
	Feb 1	Mar 1	Apr 1	May 16
The top part of the cage	7.51	7.51	7.5	7.49
The middle part of the cage	7.55	7.53	7.55	7.56
The lowest part of the cage	7.56	7.54	7.61	7.64

The concentration of dissolved ammonium ions (NH_4^+) in water is considered another important indicator of water quality in intensive aquaculture. Ammonia and ammonium ions circulate in these two forms, and the circulation depends on the amount of (pH) in the water and the temperature of the water. Ammonia is a very toxic substance. The lowest permissible value of ammonium ions in trout farming is 1.0 mg/L. Table 5 presents information on water quality indicators for ammonium ions in the studied water body.

Table 5. Data on the amount of ammonium ions in different parts of Khojakent reservoir cage fish farm.

Indicators	Ammonium content by day of analysis, mg/L			
	Feb 1	Mar 1	Apr 1	May 16
The top part of the cage	0.0	0.0	0.0	0.0
The middle part of the cage	0.0	0.0	0.0	0.04
The lowest part of the cage	0.0	0.0	0.0	0.08

As can be seen from the table, the water of the Khojakent reservoir is very clean in the winter-spring season and does not contain ammonium ions at all. This is a very favorable factor for trout farming.

4 Conclusions

According to the results of the conducted research, the temperature of the water in the cages at the "Golden Fish" fish farm located in the Khojakent reservoir is suitable for growing trout. Fish growth started in the second half of May when the water temperature reached 11-12°C.

The amount of dissolved oxygen in water varied between 9.4 and 10.3 mg/l when trout were reared at high densities. The hydrogen index (pH) was 7.5 - 7.64, and the amount of ammonium ions was 0.04 - 0.08 mg/L. The main water quality indicators are favorable for trout breeding.

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