The Impact of Various Additives in Water during the Transportation of Juvenile Fish

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Abstract. This paper presents the results of the studies that have been conducted to research the impact of the addition of table salt, clove oil and “Prolam” probiotic to water on improving the survival and adaptive properties of transported fish. By adding table salt and clove oil to water during the transportation of sturgeon fish, the survival rate of juvenile fish was increased by 0.4%, and by 1.0% more in the group in which “Prolam” probiotic was added to the water in the amount of 2 ml/10 l (the fourth experimental group), compared with the control group. The adaptation time amounted to 25 minutes for the group transported in water without additives, 25 minutes for the group in which table salt was added to the water, 32 minutes for the group transported in water with clove oil added, and 20 minutes for the group transported with the addition of “Prolam” probiotic. Being further grown for 90 days, the final weight of sterbel fingerlings increased by 8.1% when they were transported in water with the addition of “Prolam” probiotic in the amount of 2 ml/10 l. The average daily weight gain was higher in the second, third, and fourth groups by 8.4% compared to the control group. The yield of fish products when transported with the addition of table salt was higher by 6.1%; when adding clove oil – by 3.4%; with the addition of “Prolam” probiotic – by 15.8% in comparison with the fish transported without additives in water.

1. Introduction

Sturgeons are widely known as high-quality delicatessen fish products with valuable caviar. In industrial fish farming, it is important to minimize the death of fish as a result of exposure to severe stress factors, including transportation, which, especially at a long distance, can have a significant effect on the adaptation of fish at the place of arrival and its further growth and development [1].

To decrease the level of stress, it is necessary to develop new techniques and scientifically substantiate the existing methods of fish transportation.

Stress is a complex homeostatic regulatory mechanism that can directly or indirectly affect major body systems. Stress can be caused by exposure to environmental conditions. Various systems and organs respond to hormones, such as cortisol and catecholamines, which are released during the stress response.

Transportation of juvenile sturgeon fish weighing up to 15 grams is recommended to be carried out in spring and autumn. Plastic fish-breeding bags can be used for transportation. In separate packages, there should be fish with relatively the same weight and size to prevent damage to smaller fish from larger ones. Packages must be sealed with hard rubber rings or other clamps [2, 3].
It is necessary to stop feeding the fish 2–3 days before transportation. Before placing the fish into the bag, 20 liters of water are poured into it. After that, the package is pumped with oxygen and hermetically sealed. When transporting larvae and juveniles of sturgeon fish, the water temperature can be in the range from 10 to 20 °C. The bags can be installed in isothermal foam boxes [4, 5].

For the normal life of sturgeon fish, it is necessary to maintain the oxygen concentration in the water in the range from 7 mg/l to 11 mg/l.

If water from a water pipe is used to transport fish, it must be cleaned of dissolved chlorine. To purify water from chlorine, sedimentation, filtration, heating, and the addition of hyposulfite can be used [6–8].

Changing the pH value is dangerous for the transported fish. To reduce the fluctuations in acidity, table salt is added to the water.

It is advisable to use anesthetic substances in order to extend the time spent by the fish in closed bags. When being used, they make the content of fish waste products increase more slowly.

To increase the safety of larvae and juveniles, while breeding and transporting, biologically active substances can be used. Vitamins, various plant extracts, anesthetics, some hormonal preparations, prebiotic and probiotic, amino acids and antioxidants have a beneficial effect on the safety and further growth of fish [9–11].

Russian and foreign researchers in the fish farming industry pay considerable attention to the development of new elements in the transportation of sturgeon fish, based on advanced scientific achievements [12–15].

2. Material and methods
The purpose of the study is to research the impact of adding table salt, clove oil and “Prolam” probiotic to water on improving the survival and adaptive properties of transported fish.

To achieve this purpose, the following tasks were fulfilled:
1) To determine the fish waste during transportation, the adaptation time and the survival rate of juveniles during habituation;
2) To study the most important fish-breeding biological indicators of sterbel juveniles when using various additives in water during transportation;
3) To calculate the economic effect (additional profit) with various additives in the water when transporting fish.

Table salt is used as a mineral component during transportation to optimize osmoregulation and mucus production in freshwater fish. In small doses, it can be a permanent component for the life support of fish. Table salt can be effective against parasites, for the prevention and treatment of methemoglobinemia.

Clove oil being a natural anesthetic reduces the impact of stress on fish during transportation, immobilizes them, which results in decrease of the injury rate and the occurrence of mechanical injuries (the development of VNIRO - Russian Federal Research Institute of Fisheries and Oceanography).

“Prolam” probiotic (produced by “Biotechagro” LLC) is made from live cultures of Lactobacillus delbrueckii subsp strains. bulgaricus, Bacillus sporothermodurans, it also includes Lactococcus lactis subsp. lactis, Lactococcus lactis subsp. When using probiotics, bacterial diseases of fish are prevented, their survival rate increases, and stress after transportation is relieved.

The research was carried out in “Albashi” LLC, located in the Leningradsky district of the Krasnodar Territory on sterbel juveniles (a hybrid of sterlet and beluga). The fish was transported to “Albashi” LLC from Private Entrepreneur Akhtyrtsev (Starominsky district) and “Dinskoy Fish Hatchery” LLC (Dinskoy district) of Krasnodar Territory. There were 8 packages in each group.

The number of fish in each transported package was 250 species. The weight of one species of fish was 2 grams. Transportation was carried out by road freight transport at a distance of 50 km.

The main indicator of transportation efficiency was the survival of fish and the optimal period of adaptation.
The survival rate of fish during transportation was estimated by direct calculation with a normal waste level of no more than 5.0%.

During the adaptation period, the live weight of the fish (caught weight) was studied by individual weighing on torsion scales. The studies also continued after 90-days adaptation. During this period, the following was also determined:

- live weight by individual weighing;
- the length of the fish's body using a ruler;
- the average daily increase was calculated based on the results of control weighing at the beginning and end of the experiment;
- fish survival rate during the experiment period;
- Fulton fatness coefficient;
- fish yield from the moment of transportation to the end of the experiment;
- the yield of fish products, taking into account its mass.

Based on the yield of fish products, its cost and production expenses, the economic effect (additional profit) were calculated.

The research results were processed biometrically according to G. F. Lakin (1990).

3. Results and discussion

Table 1 shows the results of studying the impact of adding table salt, clove oil and “Prolam” probiotic to water on increasing the survival rate of transported fish.

When studying the impact of adding table salt, clove oil, “Prolam” probiotic to water during transportation on increasing the survival rate of transported fish, it was found that without additives (in the first control group), the survival rate of young sterbel fish was 98.8%; and in the group in which table salt was added to the water in the amount of 100 g/m³ (the second experimental group), the survival rate was 0.4% higher; in the group in which clove oil was added to the water (the third experimental group) – by 0.4% more, in the group in which “Prolam” probiotic was added to the water in the amount of 2 ml/10 l (the fourth experimental group) – by 1.0% more, compared with the control group.

Table 1. The impact of the addition of table salt, clove oil and “Prolam” probiotic to the water on increasing the survival rate of transported fish (50 km distance).

| Group       | Additive                  | Waste during transportation, species | Survival rate during transportation, % | Adaptation time, min. | Survival during habituation, % |
|-------------|---------------------------|-------------------------------------|----------------------------------------|------------------------|--------------------------------|
| 1 control   | Water without additives   | 3.0±0.27                            | 98.8                                   | 25.0±0.53              | 99.2                           |
| 2 experimental | Water + table salt 100 g/m³ | 2.0±0.27a                           | 99.2                                   | 25.0±0.80              | 99.2                           |
| 3 experimental | Water + clove oil         | 2.1±0.30a                           | 99.2                                   | 32.2±0.82b             | 100.0                          |
| 4 experimental | Water + “Prolam” probiotic 2 ml/10 l | 1.1±0.30b                           | 99.6                                   | 20.0±0.27b             | 100.0                          |

a p<0.01; b p<0.001
The adaptation time equals 25 minutes for the group transported in water without additives, 25 minutes for the group in which table salt was added to the water, 32 minutes for the group transported with water with the addition of clove oil, and 20 minutes for the group transported with the addition of “Prolam” probiotic.

It was also found that when transporting fish without additives (the first control group), with their further growing for 90 days, the final weight of sterbel fingerlings was estimated at 55.3 grams, with the addition of 100 g/m³ salt to water (the second group) – 55.8 grams; water + clove oil (the third group) – 55.9 grams; water + “Prolam” probiotic in the amount of 2 ml/10 l (the fourth group) – 59.8 grams, or 8.1% more (p<0.001) (table 2).

| Table 2. Growth indicators of sterbel juveniles with the use of various additives during transportation (90 days), n=100. |
|---------------------------------------------------------------|
| **Indicator** | **Group** |
| | 1 | 2 | 3 | 4 |
| Initial mass of juvenile fish, g | 2.02±0.03 | 2.02±0.03 | 2.03±0.03 | 2.01±0.03 |
| Final mass of juvenile fish, g | 55.30±0.51 | 55.80±0.49 | 55.90±0.49 | 59.75±0.48* |
| Body length of juvenile fish at the end of the experiment, cm | 13.00±0.30 | 12.83±0.22 | 12.77±0.17 | 13.20±0.25 |
| Weight gain per fish during the period, g | 53.28 | 53.78 | 53.87 | 57.74 |
| Average daily weight gain, g | 0.592 | 0.598 | 0.599 | 0.642 |
| The survival rate of fish during the experiment period - 90 days, % | 89.8 | 90.2 | 90.7 | 94.4 |
| Fatness coefficient | 2.82±0.18 | 2.87±0.15 | 2.85±0.13 | 2.91±0.18 |
| Fish yield from the moment of transportation to the end of the experiment, species | 1760 | 1776 | 1800 | 1880 |
| Total fish yield, % | 88.0 | 88.8 | 90.0 | 94.0 |
| Yield of fish products, kg | 93.77 | 99.51 | 96.97 | 108.55 |
| Cost of gross output, RUB. | 43041.72 | 43840.60 | 44507.39 | 49825.00 |
| Economic effect (additional profit), RUB. | - | +798.88 | +1465.68 | +6783.29 |
| per 1 fish, RUB. | - | +0.45 | +0.81 | +3.61 |

*p<0.001

The average daily increase in the fish of the experimental groups was greater than in the control group by 1.0, 1.2 and 8.4%, respectively. Compared with the control group (when transported without additives), there was a certain tendency to increase the fatness coefficient of sterbel juveniles in the group with table salt added to the water – by 1.8%, in the group transported with water when clove oil was added – by 1.1%, in the group transported with the addition of “Prolam” probiotic to the water – by 3.2%.

The yield of fish products in comparison with fish transported without additives in water, when transported with the addition of table salt was higher by 6.1%, when adding clove oil – by 3.4%, with the addition of “Prolam” probiotic – by 15.8 %.

Additional profit was obtained, compared to transportation without additives in water: 798.88 rubles when adding table salt; 1465.68 rubles when adding clove oil; 6783.29 rubles when adding “Prolam” probiotic.
4. Conclusion

With the addition of table salt and clove oil to water during the transportation of sturgeon fish, the survival rate of juveniles increased by 0.4%, and in the group in which “Prolam” probiotic was added to the water in the amount of 2 ml/10 l (the fourth experimental group) – by 1.0% more, compared with the control group. The adaptation time was estimated for the group transported in water without additives – 25 min., in the group in which table salt was added to the water – 25 min., in the group transported with clove oil added to the water – 32 min., in the group transported with the addition of “Prolam” probiotic – 20 min.

When grown for 90 days, the final weight of sterbel fingerlings increased by 8.1% when they were transported in water with the addition of “Prolam” probiotic in the amount of 2 ml/10 l.

The average daily weight gain was higher in the second, third, and fourth groups by 8.4% in comparison with the control group. Compared with the control group (when transported without additives), there was a tendency to increase the fatness coefficient of fish in the experimental groups by 1.1–3.2%.

The yield of sturgeon fish products in comparison with fish transported without additives in water, when transported with the addition of table salt was higher by 6.1%, when adding clove oil – by 3.4%, with the addition of “Prolam” probiotic – by 15.8%.

Additional profit was obtained, compared to transportation without additives in water: 798.88 rubles when adding table salt; 1465.68 rubles when adding clove oil; 6783.29 rubles when adding “Prolam” probiotic.

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