The influence of nabicat on the chemical composition of carp meat

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Abstract. Scaly carp was kept in the cages of Troitsk Fishery Factory in Bobrovka, Troitsk District, Chelyabinsk Region. From May to November 2017, Nabicat was added to the diet of carps at a dose of 2 kg per ton. Nabicat is a complex substance containing calcium, phosphorus, magnesium and other 47 macro-microelements, as well as chelated silicon.

1. Introduction
Fish as a food product is not inferior to farm animal meat, and even exceeds it by some properties. The proportion of meat in fish ranges from 50 to 80%, in farm animals – 54% [1]. The biochemical value of fish proteins is not inferior to those of warm-blooded animals. They are easier digested and absorbed by the human body [2, 3].

To achieve the best result, stimulate growth and development of fish, it is necessary to use innovative methods, one of which is the use of various supplements such as the Nabicat complex preparation. Nabicat consists of trace elements, halocatechins of plant origin and a water-soluble form of chelated silicon [4-6].

Nabicat is a weakly flowing powder of dark gray color with a light specific smell. The product is manufactured according to TU 9296-001-60284021-2010 and characterized by the indicators of the chemical composition presented in Table 1 [7, 8].

As can be seen from Table 1, all the results correspond to the regulatory data. Information on the application of Nabicat in the diet of farm birds and animals indicates its complex effect on the body (growth rate, improvement of meat quality and activation of metabolism, improvement of the morphological composition and biochemical properties of blood) [9-13].

The issue of the effect of the nanobiological drug on the chemical composition of fish meat has not been studied. The article aims to study the effect of Nabicat on the chemical and trace element composition of carp meat.

2. Materials and methods
The research experiment was carried out from May to November 2017 in Troitsk Fishery Plant in Bobrovka, Troitsk District, Chelyabinsk Region. 500 young carps were selected and divided into two groups (control and experimental ones). Five water samples from cages and five water samples outside cages were taken. The sediments were located in the water of Troitsk reservoir on the Ui River which flows along the Trans-Ural Plain into the Ural River.
Carps were kept in optimal conditions. Both groups were fed with feed used by the company. The experimental group was fed with Nabicat according to the manufacturer's recommendations at a dose of 2 kg/t of feed.

**Table 1. Requirements to the chemical composition for Nabicat (according to TU 9296-001-60284021-2010)**

| Indicator                                                                 | Content                                    | Test results          | Regulatory documents and test methods |
|---------------------------------------------------------------------------|--------------------------------------------|-----------------------|---------------------------------------|
| Appearance, color, smell                                                 | powder from light brown to brown color     | gray bulk without odor and mold | -                                     |
| Moisture, %                                                               |                                            | 12                    | GOST 13496.3                          |
| Metal-magnetic impurities up to 2 mm, mg/kg                               |                                            | 100                   | GOST 13496.9                          |
| Particles with sharp edges larger than 2 mm                               | not allowed                                | 5                     | GOST 13496.9                          |
| Finess: residue on a sieve with holes with a diameter of 5 mm             |                                            | 5                     | GOST 13496.8                          |
| Sieve residue with a diameter of 3 mm                                     |                                            | 1                     | GOST 13496.8                          |
| Mass fraction of silicon in terms of dioxide, not less than, %            |                                            | 16.0                  | special technique                     |
| Mass fraction of water soluble chelate silicon%                           |                                            | 1.56                  | special technique                     |
| Mass fraction of protein, not less, %                                     |                                            | 5.0                   | GOST R 50817. 51417                   |
| Mass fraction of fiber, not more, %                                       |                                            | 25.0                  | GOST P 52839                          |
| Mass fraction of ash insoluble in HCl, %                                  |                                            | 1.5                   | GOST 51418                            |
| Mass fraction of phosphorus, %                                            |                                            | -                     | GOST R 50852.28902                    |
| Toxicity                                                                  | not allowed                                | when you enter 20% - non-toxic | GOST P 52337                          |
| Mercury mg/kg                                                             | 0.1                                        | less than 0.005       | GOST 26927                            |
| Arsenic, mg/kg                                                            | 2.0                                        | less than 0.02        | GOST 26930                            |
| Lead, mg/kg                                                               | 5.0                                        | 0.51 / 0.18           | GOST 26932                            |
| Cadmium mg / kg                                                           | 0.5                                        | 0.040 / 013           | GOST 2693.3                           |
| Aflatoxin 131, mg/kg                                                      | 0.01                                       | less than 0.001       | MUK 5-1-14 / 1001                     |
| Ochratoxin, mg/kg                                                         | not allowed                                | less than 0.005       | MUK 5-1-14 / 1001                     |
| Pathogenic microflora                                                     | not allowed                                | not selected          | MUGU B (1975)                         |
| Pest infestation in 1 kg                                                  | not allowed                                | not found             | GOST 13496. 13                        |

At the beginning, after one month and at the end of the experiment, studies were conducted on the chemical composition of meat and the content of macro - microelements (magnesium, iron, copper, zinc, cobalt, lead, manganese, cadmium, nickel) in water, meat, gills and fins of carp. The studies were carried out on the basis of the laboratory of the Innovative Scientific Research Center of the South Ural State Agrarian University. Sampling of fish for laboratory tests was carried out according to GOST 31339-2006 “Fish, non-fish objects and products from them. Acceptance rules and sampling methods”. Water sampling was carried out in accordance with the requirements of GOST 31861-2012 “Water. General requirements for sampling”.

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GOST R 50817. 51417

GOST 13496.8

GOST P 52839

GOST 51418

GOST 50852.28902

GOST P 52337

GOST 26927

GOST 26930

GOST 26932

GOST 2693.3

MUK 5-1-14 / 1001

MUK 5-1-14 / 1001

MUGU B (1975)
Determination of the chemical composition of muscle tissue was carried out according to the method adopted in fish farming, according to GOST 7636-85 “Fish, marine mammals, marine invertebrates and their products. Methods of analysis”.

The content of calcium and phosphorus in fish meat was determined according to GOST R 55573-2013 - Meat and meat products. Calcium determination by atomic absorption and titrimetric methods; GOST 32009-2013 - Meat and meat products. Spectrophotometric method for determining the mass fraction of total phosphorus.

The content of macro-microelements in muscle tissue, fins and gills of carp was determined by atomic absorption spectrometry using a Kvant-2A device in accordance with GOST 30178-96 - Food raw materials and products. Atomic absorption method for the determination of toxic elements.

The results were processed using the Microsoft Office software package. Reliability of the difference was determined by Student's criterion.

3. Research results

Accumulation of trace elements in fish is dependent on their content in water; therefore, at the beginning of the research experiment, water samples were taken in cages where the carps were kept and outside the cages to determine the chemical composition.

Data on the chemical elements of Troitsk reservoir are presented in Table 2.

| Chemical elements | Research results | MPC |
|-------------------|-----------------|-----|
|                   | At the beginning of the experiment (05.2017) | At the end of the experiment (11.2017) | |
|                   | Water in the cages | Water outside the cages | Water in the cages | Water outside the cages |
| Iron              | 0.11 ± 0.05 | 0.10 ± 0.06 | 0.11 ± 0.01 | 0.10 ± 0.01 | 0.3 |
| Copper            | 0.024 ± 0.004 | 0.010 ± 0.002 | 0.006 ± 0.001 | 0.004 ± 0.001 | 1.0 |
| Zinc              | 0.027 ± 0.002 | 0.025 ± 0.001 | 0.01 ± 0.002 | 0.01 ± 0.001 | 5.0 |
| Cobalt            | 0.003 ± 0.001 | 0.001 ± 0.0005 | n/o | n/o | 0.1 |
| Lead              | n/o | n/o | n/o | n/o | 0.03 |
| Manganese         | 0.06 ± 0.002 | 0.05 ± 0.06 | 0.07 ± 0.01 | 0.05 ± 0.009 | 0.1 |
| Magnesium         | 60.2 ± 4.55 | 56.3 ± 5.20 | 101.7 ± 0.87 | 98.5 ± 0.69 | 20-85 |
| Cadmium           | n/o | n/o | n/o | n/o | 0.001 |
| Nickel            | 0.006 ± 0.001 | 0.003 ± 0.001 | 0.004 ± 0.001 | 0.003 ± 0.001 | 0.1 |

Note: n / o - not observed

As can be seen from Table 2, before the experiment, water in the cages and outside the fishery factory contained chemical elements within the MPC. Indicators of chemical elements in water in the cages and outside them were unambiguous; the difference was insignificant. By the end of the experiment, the composition of water changed. By the end of the experiment, the concentration of copper, zinc, and nickel decreased, while the content of magnesium and manganese increased. There is no reason to assume that these changes occurred due to the use of Nabicat, since in and outside the cages, changes in the water composition were unidirectional.

The chemical composition of fish meat depends on the species, age, sex, physiological state, habitat, time and place. To study changes in the nutritional value of carp meat before and after feeding Nabicat, the content of moisture, protein, fat and ash was determined.
The chemical composition of carp meat is presented in Table 3. Prior to the use of Nabicat, indicators of the chemical composition of fish from the control and experimental groups had insignificant and unreliable differences, and their values were located in the same digital series.

**Table 3.** The chemical composition of carp meat at the beginning and at the end of the experiment (\(X \pm Sx\)) (\(n = 5\) %)

| Indicator   | At the beginning of the experiment (before the use of Nabicat) | One month after the experiment | At the end of the experiment |
|-------------|---------------------------------------------------------------|--------------------------------|-----------------------------|
|             | Control group \(X \pm Sx\) (\(n = 5\)) | Experimental group \(X \pm Sx\) (\(n = 5\)) | Control group \(X \pm Sx\) (\(n = 5\)) | Experimental group \(X \pm Sx\) (\(n = 5\)) |
| Moisture    | 80.23 ± 1.15 | 79.44 ± 1.28 | 79.19 ± 1.11 | 79.21 ± 0.98 | 78.05 ± 1.14 |
| Crude protein | 16.55 ± 0.22 | 17.0 ± 0.05 | 17.2 ± 0.06 * | 17.45 ± 0.04 | 17.81 ± 0.05 ** |
| Fat         | 1.92 ± 0.08 | 2.29 ± 0.2 | 2.31 ± 0.03 | 2.08 ± 0.1 | 2.40 ± 0.08 |
| Ash         | 1.30 ± 0.07 | 1.27 ± 0.04 | 1.3 ± 0.1 | 1.26 ± 0.02 | 1.74 ± 0.03 ** |

At: *<p<0.05, **<p<0.001

The results of the experiment show that the use of Nabicat has a positive effect on the chemical composition of carp meat. The results obtained one month after the beginning of the experiment differ from the data obtained at the beginning of the experiment. In the first case, protein and fat content increased by 2.72% and 19.27%. This is due to the fact that after wintering, the carps began to feed heavily. Moisture and ash content decreased by 0.98% and 2.31%, respectively.

In the experimental group, one month after the beginning of the experiment, the mass fraction of protein, fat and ash increased by 1.18%, 0.87% and 2.36%, respectively, compared with the control data. Moisture content decreased by 0.31%. At the end of the experiment, in meat of the experimental fish, indicators of crude protein and fat were higher by 2.06% and 15.38%. An increase in ash (minerals) in the meat of the experimental groups fed with silicon-containing supplements increased by 38.09%. Moisture content in the carp meat of the experimental group decreased slightly. This trend is favorable, because with a decrease in the mass fraction of moisture in meat, fat and protein content increased.

Mineral substances entering the human body ensure normal metabolism. Magnesium, calcium and phosphorus compounds are the most important in fish meat. Data on the content of phosphorus in meat are presented in Table 4.

**Table 4.** Calcium and phosphorus content in carp muscles mg/kg \((X \pm Sx)\) (\(n = 5\))

| Indicator   | At the beginning of the experiment | At the end of the experiment |
|-------------|-----------------------------------|-----------------------------|
|             | Control group \(X \pm Sx\) (\(n = 5\)) | Experimental group \(X \pm Sx\) (\(n = 5\)) |
| Calcium     | 320 , 0 ± 6.52 | 320 , 0 ± 2.24 * |
| Phosphorus  | 2800 , 0 ± 10.95 | 2820 , 0 ± 9.65 |

At: *<p<0.05, **<p<0.02

According to the data presented in Table 4, it can be concluded that there were no significant differences between the groups by calcium content. Phosphorus content in meat of the control group was the same at the beginning and at the end of the experiment.

In fish fed with Nabicat, phosphorus content increased by 0.71% compared with the control group. This is probably due to the fact that Nabicat contains phosphorus.
Calcium content in the control group decreased by 3.23%. In the experimental group, this indicator did no change.

Data on magnesium content in the muscles, gills and fins are presented in Table 5.

**Table 5. The content of magnesium in the muscles, gills and carp fins mg/kg (X + Sx) (n = 5)**

| Samples | Period                     | Group            | Research results   |
|---------|----------------------------|------------------|-------------------|
| Muscle  | At the end of the experiment | Control group    | 551.40 + 7.28     |
|         | At the end of the experiment | Experimental group | 604.40 + 3.26 *** |
| Gills   | At the end of the experiment | Control group    | 843.20 + 5.15     |
|         | At the end of the experiment | Experimental group | 720.00 + 6.02 *** |
| Fins    | At the end of the experiment | Control group    | 629.00 + 3.56     |
|         | At the end of the experiment | Experimental group | 748.20 + 4.26 *** |

At * p <0.05; ** p <0.01; *** p <0.0 01

At the end of the experiment, the content of macroelements increased in the experimental groups. In the muscles, magnesium increased by 9.61%, and in fins - by 18.95%. In the gills, magnesium content increased by 14.61%.

Data on the content of toxic elements in the muscles, gills and fins are presented in Table 6.

Based on the data in Table 6, it can be seen that lead and cadmium content in the muscles, gills and fins is within the normal range. The content of cadmium in the muscles of fish of the control group is 77.78% higher than in the muscles of the fish of the experimental group. In the gills and fins of fish from the control group, there is no cadmium. In the experimental group, cadmium is absent in the gills, and its content in fins is insignificant. Lead content in fish of the experimental group is higher than that of the control fish. So in the muscles and fins of fish from the control group, lead is absent; in the experimental group, there is a small amount which corresponds to the norm. In the gills of fish in the experimental group, lead is 13.33% more than the control values. The excess content of cadmium and lead in the fish of the experimental group is due to Nabicat.
Table 6. Lead and cadmium content in muscles, gills and fins of carp mg/kg \((X \pm Sx) (n = 5)\)

| Samples | Period                      | Group      | Research results |
|---------|-----------------------------|------------|------------------|
|         |                             |            | Lead            | Cadmium         |
|         |                             |            | \(0.09 \pm 0.01\) | 0.002 \(\pm 0.0001\) |
| Muscle  | At the beginning of the experiment | Control   | n/o             | 0.0009 \(\pm 0.00\) |
|         | At the end of the experiment | Experimental | 0.078 \(\pm 0.001\) | 0.0002 \(\pm 0.00\) |
|         | At the beginning of the experiment | Control   | n/o             | n/o             |
|         | At the end of the experiment | Experimental | 0.01 \(\pm 0.001\) | 0.003 \(\pm 0.001\) |
| Gills   | At the beginning of the experiment | Control   | n/o             | n/o             |
|         | At the end of the experiment | Experimental | 0.015 \(\pm 0.001\) | n/o             |
|         | At the beginning of the experiment | Control   | n/o             | n/o             |
|         | At the end of the experiment | Experimental | 0.017 \(\pm 0.004\) | n/o             |
| Fins    | At the beginning of the experiment | Control   | n/o             | n/o             |
|         | At the end of the experiment | Experimental | 0.07 \(\pm 0.005\) | 0.007 \(\pm 0.001\) |
|         | At the end of the experiment | Experimental | 0.004 \(\pm 0.0003\) | 0.004 \(\pm 0.0001\) |

At *\(p <0.05\); **\(p < 0.01\); ***\(p <0.001\)

n / a - not observed

Trace elements have a very important physiological value, as they are involved in the metabolism. Researchers pay attention to the selective accumulation of trace elements by various fish organs with the most intense accumulation of elements occurring in the organs interacting with water – gills [14].

Data on the content of trace elements in the muscles, gills and fins are presented in Table 7. Table 7 allows us to conclude that at the beginning of the experiment, the content of iron, copper, manganese and nickel in the muscles and fins was higher than the values at the end of the experiment. This can be due to active participation of these elements in metabolic processes and their excessive entry into the body from environmental components.

When using Nabicat, the content of iron and copper decreased by 6.35% and 9.52%, respectively. A decrease in the specific content of trace elements may be due to an increase in the total body weight of carps (at the end of the experiment, the weight of experimental increased by 18.14%).

Zinc content increased within the MRL. Fish can regulate the level of zinc by changing the intensity of its absorption through the intestines and gills, depositing trace elements of bone, muscle tissue and skin, as well as removing it with excretory organs, among which the most significant is the digestive system [15]. High zinc content is due to the intensive growth of fish and greater palatability of the diet [14, 15]. In the experimental group, zinc content in the muscles was higher by 51.58%.

The content of nickel and manganese in the muscles of experimental carps was 3.5 times and 4.3 times higher than in control fish.

In the gills of the experimental group, the content of iron and zinc was lower by 14.83% and 5.93%. Manganese content in the gills of the experimental fish was higher by 9.87%. Copper and nickel content in the gills of experimental fish did not change.

In the fins of fish fed with Nabicat, content of trace elements increased. Iron, copper, zinc, and manganese content was higher by 25%, 2.86%, 5.09% and 35.13%, respectively.
Table 7. The content of trace elements in the muscles, gills and fins of carp mg/kg \((X \pm Sx)\) \((n = 5)\)

| Samples | Study period | Research results |
|---------|--------------|------------------|
|         |              | Iron  | Copper | Zinc     | Manganese | Nickel |
| Muscle  | At the beginning of the experiment | 4.37 + 0.32 | 0.25 + 0.02 | 3.53 + 0.34 | 0.28 + 0.02 | 0.03 + 0.002 |
|         | At the end of the experiment **Control group** | 3.78 + 0.12 | 0.21 + 0.03 | 8.20 + 0.16 | 0.11 + 0.01 | 0.006 + 0.0003 |
|         | At the end of the experiment **Experimental group** | 3.54 + 0.18 | 0.19 + 0.01 | 12.43 + 0.48 *** | 0.47 + 0.06 *** | 0.021 + 0.001 |
| Gills   | At the beginning of the experiment | 18.80 + 0.06 | 0.31 + 0.02 | 32.5 + 0.1 | 1.90 + 0.06 | 0.02 + 0.003 |
|         | At the end of the experiment **Control group** | 20.03 + 1.14 | 0.12 + 0.01 | 55.60 + 1.03 | 2.43 + 0.08 | 0.007 + 0.0003 |
|         | At the end of the experiment **Experimental group** | 17.06 + 0.37 * | 0.13 + 0.001 | 52.30 + 0.61 * | 2.67 + 0.08 * | 0.008 + 0.0001 |
| Fins    | At the beginning of the experiment | 3.49 + 0.05 | 0.28 + 0.06 | 20.65 + 0.3 | 2.39 + 0.08 | 0.025 + 0.002 |
|         | At the end of the experiment **Control group** | 1.68 + 0.05 | 0.07 + 0.002 | 38.54 + 0.68 | 2.22 + 0.10 | 0.008 + 0.0002 |
|         | At the end of the experiment **Experimental group** | 2.10 + 0.03 *** | 0.072 + 0.002 | 40.50 + 0.64 * | 3.00 + 0.08 ** | n/o |

At * p <0.05; ** p <0.01; *** p <0.001
n / a - not observed

4. Conclusion
The use of Nabicat increases the accumulation of fat reserves in the muscle tissue which is necessary to intensify adaptation to a new climatic period with a low temperature and a poor feed base.

Nabicat contains protein; the mass fraction of protein increases in the meat of experimental fish. Nabicat increases the content of lead and cadmium in the muscles, gills and fins, but their content is within the normal range.

Phosphorus, zinc, cadmium and lead in Nabicat increase the content of these elements in meat of the experimental fish.

The content of copper, manganese and nickel increased in the gills of experimental fish.

In the fins, the silicon-containing supplement increased the accumulation of magnesium, iron, copper, zinc, and manganese.

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